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Physician's Effective use of Mobile Health Applications: Using an Affordance Theory Lens

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A Thesis

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School of Economic and Business Sciences

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by

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Abstract

Mobile health (mhealth) applications (apps) have to be used effectively by physicians in order to achieve maximum benefits from them. Limited research papers have investigated what entails effective use or how effective use is achieved. In order to understand whether mhealth apps are effectively used by physicians, this research draws on the affordance theory that states that affordances are what the technology offers the users.

From this theory it is investigated why physicians chose to actualize certain affordances. The study aims to divert the research from investigating the features of the systems and rather focus at understanding whether systems are used effectively therefore unearthing possibilities that were never possible without the use of technologies. To achieve the set objective this study was conducted by means of qualitative research that utilized semi-structured interviews as a data collections method.

It is critical for physicians to understand whether they are benefiting from the use of health applications. It is also important for mhealth apps developers to understand what the basic needs and preferences of the physicians are when utilising health apps.

This research contributed to theory by extending the definition of effective use. Added contributions were that of highlighting some important issues that developers may need to consider when developing mHealth applications for physicians and for physicians to understand whether they gain any benefits from using these apps.

Dedication

I would like to thank my daughter Sentebale Ngaka for the support and the patience while writing my dissertation. Although you were struggling with your health you always found a way of encouraging and supporting me and I am grateful for that.

I would like to thank my family, my mother Makatiso Ngaka and my sisters Gladys Ngaka, Mathapelo Ngaka and Ntaoleng Ngaka for always being there when I needed their support and always supporting my dreams.

I want to thank Prof Kalemba Mwambazambi and his wife Mymy Kalemba for encouraging me to continue with my studies when I thought it was not possible.

I want to thank my dissertation supervisor Dr. Emma Coleman for her guidance and advices. I also want to thank my Masters classmates for always supporting each other and being there when times were tough.

I dedicate this dissertation to my family and all the Bakoena family. I want them to know that it is possible against all odds.

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CHAPTER 1: INTRODUCTION

Whilst mobile applications are claimed to bear numerous benefits for the patients, physicians can also utilize Mobile health (mHealth) to further improve health care services in their respective medical practice settings (Phillips and Thornbory, 2014). For this to happen physicians have to integrate mhealth in their work-practices (Ventola, 2014). However it would only be through effective use of mHealth that the physicians would be able to realize the full benefits of this technology investment (Phichitchaisopa and Naenna, 2013).

Use of mHealth applications can be understood as a medical and a public health practice that is reinforced by mobile devices with a variety of features namely: service data gathering, care provision, patient communication and a measure for medical monitoring and adherence support (Heerden van, Tomlinson, Swartzb 2012; Tomlinson et al 2013).

Burton-Jones and Volkoff (2016) said that when users achieve their desired goals through the use of a specific technology this is referred to as effective use. The quality of mHealth application will determine whether the application can be used effectively or not (Burton-Jones and Volkof, 2016). Burton-Jones and Grange (2012) argue that understanding the nature and purpose of the system helps in moving from use to *effective* use. This research applies the affordance theory to determine whether physicians are using their mHealth applications effectively. This is achieved by examining the reasons for physician's actualization of some affordances provided by the mhealth applications and not actualising other perceived affordances.

Background of the Problem

mHealth apps allow physicians to access patient information and other medical information using a tablet device or a smartphone (Boulos et al, 2014). Health application usage by physicians have been reported by Garritty and Emam (2016) to have risen from an estimated 45% to 85% between 1999 and 2005.

With these devices physicians have quick access to the support software for clinical decisions and patient information even when they are not at their workstation. This is critical when physicians are at the patient bedside, when they are attending to emergencies and when they are away from their offices. It is also critical in an emergency where physicians may not have any information of the patient.

Sclafani et al. (2013) have shown that increased use of mHealth by healthcare providers has improved communication among them and their patients, reduced the number of devices physicians need to carry, and provided physicians with a quick, convenient way of accessing their patient records at the place of care (Akter et al, 2013; Motamarri et al, 2012; Trmčić et al, 2016). The integration of mobile devices and electronic health records (EHR) software is providing new solutions to solving the information and communication needs of providers. However Labrique et al. (2013) argue that most of the mHealth applications have not been implemented successfully in the existing health system, due to software provider's lack of health system knowledge and competency, and the information system's lack of privacy and security (Akter et al, 2013).

Yang and Silverman (2014) have found that there are usually discrepancies between the provider perception of mHealth use and the actual use by the physician. Fiordelli et al. (2013) mentioned that some of these discrepancies are caused by the attitudes, perceptions and behaviours of mHealth users who may not perceive that some of the innovative services provide added benefits and advantages.

In order for Information Technology (IT) to improve healthcare outcomes, technology should be aligned to the work-processes of the Health Care Practitioners (HCP) (Bredican et al, 2013). Mobile application users should incorporate these technologies into their work-practices in order to get the best out of them (Pollák and Dorčák, 2016). mHealth apps are but one of these technologies that are designed to help HCP's improve efficiency in their work-practices.

Problem Description

Although the use of mHealth is expected to improve how physicians do their work, there is no guarantee that this will happen as it depends on how mHealth is used by the physicians (Scott, 1999). Seddon (1997) argues that if system use is not efficient then system use cannot produce benefits.

A literature review by Fiordelli et al (2013) found that research on mHealth has focused more on its impact on the health outcomes and less on understanding whether the users use the software effectively. This lack of research on the effective use of the technology in the healthcare setting poses several problems (Agarwal et al, 2015). Firstly the physicians may have no knowledge of whether they are getting value on their investment (Hatton, 2012).

Also the providers of mHealth will not know what needs to be improved or whether the application is compatible with the work-practices it was intended for (Fiordelli et al, 2013). Some researchers have suggested that the designers of technology in the healthcare environment develop technologies that fit into the healthcare environment, arguing that the current technologies expect healthcare to adjust to their design (Akter and Ray, 2010).
This research investigates the issue of affordances offered by mHealth applications to physicians and the reasons for their choices in actualizing them. The results of this research will help physicians understand whether they are using the mHealth applications effectively or not and therefore knowing if they are getting any value for their investment. The research will also inform the designers of the mHealth applications on what needs to be improved on the existing applications and what are the physicians' expectations for future applications.

Problem Statement

Effective use of mHealth technology have proven to be a challenge in the healthcare sector (Burton-Jones and Volkoff, 2016; Agarwal et al, 2015)
The features of mHealth are generally not fully utilized resulting to ineffective use of the apps (Savoli and Barki, 2017; Agarwal et al, 2015). Savoli and Barki (2017), found that these ineffective use of apps are experienced even when the users are being positive about using the mHealth apps. Effective use of mHealth apps help physicians in increasing the achievement of their set goals (Larkin, 2011; HIMMS Analytics, 2011). When the mHealth apps are not used in a thorough and effective way they may have a significant impact in the outcome of the intended goal (LeRouge et al, 2007). Previous research has noted the benefits of using mHealth apps effectively. Agarwal et al, 2015 argues that using mHealth apps effectively may improve the delivery of the healthcare. While Savoli and Barki (2017 found that effective use leads to goal achievement. Although the use of mHealth applications have been investigated, effective use outcome was found to be inconclusive and insufficient (Agarwal et al, 2015; Fiordelli et al., 2013). Therefore this research aims to contribute to the research by investigating whether physicians are using the mHealth apps effectively or not.

Purpose of the Study

It has been shown that mHealth is a key resource for healthcare practices (Heerden van, Tomlinson, Swartzb 2012; Tomlinson et al 2013). Understanding effective use of mHealth in

physicians' work practices is therefore important in healthcare practices (Boudreau and Seligman, (2005), Burton-Jones and Grange, 2011; Burton-Jones and Volkoff, 2016). It has also been noted that mHealth provides healthcare professionals with affordances. Affordances are defined by Markus and Silver (2008) as "*possibilities for goal-oriented action afforded to specified user groups by technical objects*" (pg14). Gibson, (1979) makes an example of a fire that can afford warming or burning. One person could choose to warm themselves, while another could choose to burn meat. In other words what the fire affords to each is related to their goals therefore allowing goal-orientated action. It is through investigation that the reason for their choices can be known. mHealth can afford physicians with many affordances but the reasons why they decide to actualise only some of these affordances have not been investigated as far as the reviewing of literature on mHealth. Therefore the purpose of this study is to investigate why physicians actualise some affordances and not others.

Research Question

The main question of the research is to determine whether physicians are using their mHealth applications effectively.

This will be answered by asking the following questions:

- Why do physicians choose to actualise some affordances?
- Do actualized affordances increase the achievement of the physician's goal?
- What are the reasons for physicians to not actualise some affordances?
- Are there barriers or limitations offered by mHealth applications, or are they just not useful to physicians' work/needs?

Delimitations of the study

Because of limited number of physicians using mHealth in South Africa and a short time frame to conduct the research, physicians at WITS medical school who are academics and also known to be using mHealth applications were interviewed for this study.

Thesis Organisation

The Thesis is organised into six chapters. Firstly it is the introduction which gives a summation of the mHealth applications, their use by physicians and in the healthcare space. Also discussed is the effective use and the challenge of actualisation of mHealth affordances by physicians. Chapter 2 gives a thorough review of the previous literature. The third chapter deliberates on the framework used by the study and formulation of the research questions. Chapter 4 discusses the methodology of the study. Chapter 5 narrates and discuss the findings. Lastly Chapter 6 gives the conclusions and future work.

CHAPER 2: LITERATURE REVIEW

The literature review is focused on providing a summary and evaluating the current body of knowledge relating to the context of the study. This is a qualitative research study that aims at investigating whether physicians are using mHealth applications effectively.

This review looked at the overview of mHealth apps in the health sector, their use by physicians. It also looked at different definitions of effective use from the past literature, the overview of the general effective use of the mHealth and effective use by the physicians and the affordances and barriers of mHealth applications.

The literature review approach for this research was primarily executed via the boolean search within the University of the Witwatersrand Libraries databases. The main Databases that were used are Business Source Complete, ABI/INFORM Complete , ProQuest Dissertations and Theses Global and Web of Science**.**

The boolean strategy included the following keywords: physicians, mHealth, mobile health applications, smartphones applications, mobile devices, ehealth, effective use, effective use definitions, effective use of technology, affordances, actualisation and technology barriers.

Mobile Health applications (mHealth)

Many researchers have associated the rise in mHealth with the increase in the accessibility of the mobile phone and mobile phone applications (Free et al, 2010; Tomlinson1 et al 2013; Moore; 2012). Mobile health (known as mHealth) is described by Motamarri et al (2012) as the practice of mobile communications using mobile phones, iPads and tablets for medical

and health purposes. mHealth is identified as a subset of electronic health (eHealth), as it entails a number of features available on eHealth (Deng et al, 2014; Guo et al 2015).

The unique feature of mHealth according to Sultan & Mohan (2013) is the adaptation and customisation of its user interface. These researchers explain that mHealth applications are developed in such a way that users should be able to adapt them to their usage preference. Different users can use different types of healthcare services offered by the mHealth application according to their needs (Okazaki et al, 2015; Akter et al, 2012).

There are mHealth applications for diagnosing, treating and managing disease (Phillips et al, 2010). Other applications are for disease monitoring, intervention and prevention. The example is that of Okazaki et al (2015) who conducted a study that focused on physicians' mobile phone monitoring of diabetes patients. They discovered that a continual monitoring of patients was enabled, and avoided unnecessary travelling while cutting waiting times in terms of service delivery. There are also applications that aim at improving health processes like sending advice notifications, sending test results and booking appointments (Phillips et al, 2010).

mHealth facilitates the evolution of healthcare past the setting of traditional hospitals (Yang and Silverman, 2014) by enabling healthcare professionals and patients to access healthcare related information at a convenient time (Michael, 2009; Okazaki et al, 2015). They provide automated systems and real time communication (Akter and Ray, 2010; Braa et al, 2007) which allows flexibility in physicians' daily work practices. mHealth devices are portable, convenient to use and can bring about the reduction of health costs (Norris et al, 2009; Ivantury et al 2009, Michael 2009).

Although mHealth is considered to positively change clinical practice, there are also some concerns about them not being regulated. Moore et al (2012) argue that most medical applications are developed by commercial companies who have an interest in making money rather than making sure that these applications are reliable and safe to use. Another concern is that medical practitioners may become over reliant on apps and end up not knowing how to do simple things like calculating medicine doses for patients, or calculating body mass index without the help of an application (Moore et al., 2012).

Physicians' use of mHealth

Physicians have been increasingly using the mHealth applications, with a market research firm finding that 77% of physicians use mHealth in the United States (Franko and Tirrell,

2012; Norris et al, 2009). Physicians turned to these mHealth platforms for their convenience and so that they could increase productivity in their practices (Martin, 2014). The authors mention being able to access patients' information remotely and monitoring of patients information without patients' physical presence as major benefits of the applications (Larkin, 2011, HIMMS Analytics, 2011).

Although the use of medical apps among physicians is said to be generally positive (Ozdalga et al, 2012) physicians that are using mHealth applications are faced with a challenge of having to choose authentic and reliable applications (Sclafani et al, 2013; Buijink et al, 2013). They argue that many developers create and release these applications without undergoing any review process and hence compromise their reliability and authenticity. This lack of authenticity and reliability could affect physicians' choices of which affordances offered by these applications to actualise and which ones not to actualise; therefore preventing the effective use of the applications. Some authors are calling for the involvement of medical professionals, medical institutions and government authority in the peer reviewing of mHealth applications used by physicians (Sclafani et al, 2013; Buijink et al, 2013). This is so that it could be easier for physicians to know which apps are valid to be used based on peer review.

Effective use definitions

Authors in the field of Information Technology (IT) have made a concerted effort to consider IT beyond just use (Boudreau and Seligman, 2005; LeRouge et al, 2007; Burton-Jones and Grange, 2012; Burton-Jones and Volkof, 2016).

Burton-Jones and Grange, (2012) define *effective use* as "*using a system in a way that increases achievement of the goals for using the system" (pg4).*

LeRouge et al, (2007) define *use quality* as an intelligent effort by direct users of the system, with the effect that the use facilitates desired outcomes. Both the definition of *effective use by* Burton-Jones and Grange (2012) and the definition of *use quality* by LeRouge et al (2007) are not only focusing on the use of the system that leads to the intended outcome. The definitions are specifically considering how the system was used in order to produce increased achievement on the intended use. In this light, *effective use* and *use quality* describe system use beyond just use. This means that it is not only about using the system but about how the system is used to achieve the intended results.

Boudreau and Seligman (2005) argue that it is of great importance to study quality of use rather than contrasting use vs non-use in order to understand how a complex technology is being used. Their research findings suggest that quality of use is gained through evolving beliefs and continued learning of the system. The more the user learns how to use the system, their perception of the system changes and they use it effectively.

LeRouge et al (2007) argue that the use of IS does not necessarily equal success. Drawing on the attributes of *use quality* they demonstrate their argument using a telemedicine system to argue that both system use and how users interact with the system are important in measuring the success of the technology.

Burton-Jones and Grange (2011) argue that the use of a system alone cannot produce benefits, unless the use is effective. Using the two dimensions of effective use, adaptation and learning they draw on the representative theory to demonstrate how any system may produce benefits if used effectively.

Burton-Jones and Volkof (2016) extend the above studies by studying the network of affordances in relation to actions, interactions and outcomes to show what effective use of the organisational IS involves. They draw on the concept of affordance network and affordance actualization to study effective use of EHR by clinicians. What makes their study different from the above studies is their approach in studying effective use. Rather than focussing on the antecedents of effective use they study what constitutes effective use. They describe the antecedents of effective use as dynamics that either support or constrain effective use. For example training of users will lead to them effectively using the system. What constitutes effective use refers to what forms or makes effective use rather than what lead to effective use. This approach seeks to understand whether IS system effective use produces system designer intended benefits versus just producing benefits. They have illustrated their research at an organisational level. In their study they concluded that consistency in system use and data accuracy were the main elements that constitute effective use. This research will demonstrate what constitutes effective use following the concepts used in Burton-Jones and Volkof (2016) at an individual level as was the original intention of affordance theory.

Effective use of mHealth

Effective use of mHealth is measured by the goals set for using the technology and the accuracy and completeness with which these goals can be achieved (Bevan, 1995). In trying to understand how mHealth is used the assessments of mHealth interventions need objective

outcomes, not simply indications of acceptability (Chaiyachat et al, 2013) before they can be reported to be used effectively.

Several studies have reported the use of mHealth in administering patient care by healthcare providers. They suggest that mHealth apps are an effective way for collecting and reporting patients' data (Bogan et al, 2009; Alam et al, 2010; Rotheram-Borus et al, 2011). The collected data is then transferred to a centralised database, by doing that it reduces the need for a face-to-face communication among healthcare professionals and other members of the health team such as clinic Staff, drivers of the ambulances, staff in the health facility and staff at district and at the hospitals (Ngabo et al,2012; Manda & Herstad, 2009). The usefulness of the mHealth technology in day-to-day data collection by clinicians from patients depends on being capable to quickly extract critical information and display it in a format that is readable (De-Buenaga et al, 2008). The use of text messages have been seen to ensure accurate real-time data collection in reducing stock outs of antimalarial commodities and proved to be a strong potential for collection of health related data from rural communities (Andreatta et al, 2011; Githinji et al 2013). In their research Kaewkungwal et al (2010) have revealed that mHealth application for short message distribution and data collection was effective in the outreach of healthcare services. They reported an increase in adherences in asthma care, diabetes and vaccination services by patients when they received message reminders from healthcare workers. The use of the depression screening app had a positive effect in motivating users to seek depression diagnoses (Nasser et al 2016), while m-screening of the pap test have provided acceptability, feasibility and satisfaction (Lee et al,2014). mHealth applications are reported to bring knowledge and encourage those who use them to seek treatment solutions and by so doing becoming useful health interventions in the society.

Another study reported effectively using mHealth application called Click Module to collect information from pregnant women and sending it in real time to specialists (Alam et al, 2010). They reported the reduction from 30 minutes to 3 to 4 minutes in handling each case due to the effectiveness of the mobile technology application. The effective use of mHealth apps in patients' data collection and submission have enabled health workers to be more efficient and the collection process to be cost effective and friendly (Ganesan et al, 2011).

mHealth applications have also been reported to be effective in illness management and offering of coping strategies. For example Aschbrenner et al (2016) found that client-centred text messaging was important in managing illnesses for people with multiple diagnoses and offered them coping mechanisms that were custom-made to their individual needs. The

findings on the above literature review seem to agree with the definition of effective use in that users reported improved achievements due to mHealth use.

Physicians Effective Use of mHealth

A physician moving away from the traditional design of operating their practice may find that using technology will add considerable effectiveness and efficiency in their daily practice (Meisel, 1998). However, like any other technology, mhealth applications have to be chosen and used with care. If the applications are used poorly they may have the same slow response effects as the existing methods and waste a potentially good opportunity to be effective. Even the best app may add little or no benefit in the practice unless considerable effort is made to create readiness for the proper use.

A study that recently focused on 78 medical practices that were using mobile communication with their patients came to a conclusion that the use of electronic media in the relationship of physicians and their patients improves access to healthcare, it saved time for their patients, and the overall satisfaction of patients increased (Bishop et al, 2013). The report by physicians was that mobile communication systems improved their overall productivity, as they had spent less time when they sent patients secured digital messages than when they were trying to reach them telephonically. In another study the consequence of instigating training programs for physicians and other healthcare providers taking care of cardiothoracic surgery patients were examined. In this study the findings were that those patients cared for by physicians and other healthcare workers who were trained in mHealth communications experienced fewer post-operative complications (Trummer et al, 2006).

Dash et al (2016) argue that the use of mHealth is simple, has minimal costs and can have far reaching effects in improving medical and surgical outcomes, streamlining patient care and improving patient satisfaction with that care.

The utmost advantages of mHealth (emails, text messages, cell phone calls) that were identified were patient relationship that had improved, time saved and improving the follow-up.

Using mobile technology allows the physicians to connect and view all the information required, reducing the time that is generally required for preplanning in real time telemedicine consultations. Some studies have researched the use of mHealth by physicians, but there has been no research found to focus on the effective use of the mHealth by physicians.

Affordances

Affordance is a noun coined by James Gibson (1989) in his research of visual perception. He narrates the affordances as what is offered to the animal by the environment, what it provides for them either pleasant or unpleasant. In his example, the environment affords animals' terrain, fire, water, shelter, tools, objects, human displays and other animals.

In terms of technology affordances Leonardi (2011) suggests that based on what technology is used for, its material properties offer different possibilities. Markus and Silver (2008) define these affordances as "possibilities for goal-oriented action afforded to specified user groups by technical objects" (pg14). Technologies are perceived by people in terms of the possibilities for action that they offer them (Wyche and Steinfield, 2016).

When supple routines meet supple technology, people and material properties are intertwined (Leonardi, 2011). Meaning that when physicians meet these applications it is how materialistic they are towards them and what they perceive will be offered by them that makes physicians want to have them. Richins and Dawson (1992) define materialistic values as the importance the individual attributes to the acquisition and ownership of material goods. Leonardi (2011) argues that technology features gives a technology material properties and points out that these material properties are the same for each person, but the affordances of the actual artefact are not, as they are exclusive to the habits in which each individual perceives materiality. In other words people can use the same technology with the same features and perceive their affordances differently. This research argues that physicians perceive the mHealth affordances differently and therefore seeks to investigate this phenomenon.

Barriers of mHealth

Although mHealth seems to generally bring about positive benefits to those who use it, there have also been reports on how the use of technology can slow the process compared to traditional methods. An example is the use of text messaging to notify the villagers in Mali of the fumigation for malaria prevention. The villagers who received text messages had a slow response as compared to those who received the information through door to door interventions (Mangam et al, 2016).

Some health workers found that using the application took longer due to freezing of the technology and preferred to make phone calls instead (Chaiyachat et al, 2013).

The main drawbacks included exploitation by the patient, interfering with private life and lack of reimbursement (Dash et al, 2016).

Privacy and protection is considered to be another barrier that prevent the use of mHealth, especially where sensitive information and treatment is involved (Parker et al 2013; Arora et al 2014). Parker et al 2013's research investigates barriers of using mHealth by older adults and discovered that technology unfamiliarity, lack of human contact and connection problems are among the barriers that prevent them to use mHealth.

Summary

The use of mHealth is associated with the increase in mobile phone usage. In the health sector mHealth is seen as a subset of eHealth. The main difference between eHealth and mHealth is that mHealth can be accessible at a convenient time. Another characteristic of mHealth is that they may be designed for specific group of users like those designed for physicians, pharmacists or nurses or they may be designed for a specific type of issue example being those designed to monitor diabetes patients, weight loss and for HIV patients. Some advantages of these mHealth applications are said to be cost saving, availability to a wide population of users and time saving. Shareef et al. (2014) argues that mHealth is consistent with the dynamic lifestyle of the 21st century which is an ICT driven era. In the health practice time is of importance especially for physicians as they always have to deal with many patients at a given time. Convenience and improved productivity are cited to be the major things that influence physicians to use mHealth applications. For these benefits to be realised physicians need to use the applications effectively.

How the technology is used and the measurement of the intended goals against the achievements, determines whether the system was used effectively or not. Effective use of technology has been reported on applications that are for collection and reporting of patients' data that provide communication amongst healthcare workers and patients via text messaging. By using mHealth apps patients' data was collected accurately and in real time. Patients were administered from the comfort of their own homes which resulted to their adherence to treatment and saving of their travelling costs.

Physicians like other medical staff are using mHealth in order to reduce waiting times of their patients and increased patients' satisfaction. mHealth has also enabled communication between physicians' and their patients which has resulted to streamlined medical care and general improvement in medical and surgical outcomes.

For mHealth applications to be used effectively they must have affordances that are streamlined to the needs and goals of the users. Some affordances may however, pose some barriers or limitations that restrict physicians from using them. Affordance theory was used in this study to determine whether physicians are using mHealth applications effectively or not. The theoretical framework of affordance theory is discussed in the next chapter.

CHAPTER 3: THEORETICAL FREAMEWORK

Affordance theory provides a framework for investigating physician's mhealth apps usage forms. In this theory, the mhealth apps and an individual's perceptions are conveyed in a composed manner to explain why physicians perceive some affordances as being more valuable to actualize than others.

Perceived Affordances

Gibson (1989) presumed that affordances are not merely prodigious abilities of subjective knowledge; instead, they are environmental, meaning that they are properties of the environment that relates to an animal. In argument, affordances shows the support of an acting entity and specified features of an environment, and can lead behaviours (Zhao et al, 2013). Physicians' behaviour towards mHealth applications could be guided by the affordances they perceive to be offered by the respective application, while affordances are not related to features, they rather relate to the possibility for action that the feature affords (offers) the physicians.

Affordances are dynamic relational elements between entities and the environment and it depends on the human abilities to either see them or not see them (Zhao et al, 2013). If the physician does not see a specific feature of the application they will not use it and hence miss an opportunity to effectively use the application (i.e. the possibility for action).

For example a smart mobile phone may have features for calling, texting, searching the internet, emailing and keeping memos. But some individuals may not be aware of the memo option hence the smart mobile phone may not afford them that option. The theory of affordance helps to identify what individuals can do with the technology, rather than focusing on the features of the technology (Wagner et al, 2014).

In another case an individual may know about the feature but opt not to use it. In this case the individual does perceive the memo option of the smart mobile phone but they choose not to actualize this affordance. Affordances have to be perceived by the actor before they can be actualized (Chemero, 2003), but this perception does not necessarily lead to the realization of the offered action possibility (Stoffregen, 2003). Leading us to the research questions:

Question1: why do physicians choose to actualise some affordances?
Question 2: do actualized affordances increase the achievement of the physician's goal?

Affordance Actualization

Strong et al. (2014, pg18) define actualization as "the actions taken by actors as they take advantage of one or more affordances through their use of the technology to achieve immediate concrete outcomes in support of organizational goals". They argue that actualization takes the form of a learning process to the actors and that there may be obstacles on their way of trying to actualize an affordance leading to an affordance that may not be fully actualized. They contend that affordance actualization is the way the actors interact with the artefact while the affordances are a reflection of the outcome. Physicians may perceive affordances offered by mHealth application, but may not get the outcome they expected; this could result from how they tried to actualize this affordance and they may subsequently decide not to actualize the affordance in the future.
Affordances are seen simply as capabilities for action that need to be actualized for the system to be used effectively (Burton-Jones and Volkoff, 2016). If affordances are not actualized this may result in the ineffective use of the system. It is therefore important to understand why users may perceive some affordances but not actualize them. Hence this research is asking the question:

Question 3: what are the reasons for physicians to not actualise some affordances?

Affordances as Barriers

The environment does not offer animal affordances that only provide good; it may also offer affordances that are for ill, terrains that are not safe for animals to walk on. Animals would then use these perceived unsafe affordances to guide their direction towards a much safer

environment (Gibson, 1979). These ill affordances are seen as barriers or obstacles for the animal's movement.

In terms of technology Leonardi (2011) argues that individuals may perceive that technology constraints their capacity to convey out their goals, or perceive no affordances for action offered by a technology. This could be likened to the affordances that are seen as barriers or obstacles in Gibson's view. Seidel et al (2013) from another perspective argue that an individuals' attitude towards technology may become a barrier towards their performance. It is because of the above reasons that this research sees it fit to investigate whether physicians see some of the affordances that they do not actualize as either barriers, limitations (i.e. constraints) or just not useful to their work or needs. Hence asking the question:

Q4: Are there barriers or limitations offered by mHealth applications, or are they just not useful to physicians' work/needs?

Summary

Affordance theory was a concept used by Gibson (1989) as a way of explaining what the environment offers to different species. In terms of technology the features of the technology offers the user certain functionalities. In the context of this study physicians are using mHealth applications as the technology. mHealth applications are used through mobile phones, tablets, iPads, iPods and iPhones. The type of mobile phone that physicians are using may enable or restrict physicians into using certain applications. This is because some applications are only available on certain devices, like those that are only developed to only work on apple platform or those that are developed to work only on android platforms.

According to the theory physicians may or may not see all the features offered by the applications they are using, which may inform their choices of affordances that they actualise. This choice may also be driven by whether they find the feature to be useful, reliable and user friendly. Un-actualised features may also be as a result that the physicians did not know about them or as a result that they found them to be unusable, barriers or limitation to their working space. This research uses qualitative method as a research design. The following section discusses the research methodology.

CHAPTER 4: RESEARCH METHODOLOGY

To achieve the primary objective of this study chapter 4 explains the research paradigm. Then a thorough clarification of the research design and method is presented. In addition, the data collection and analysis method is presented in detail. This chapter concludes with ethical considerations, assumptions and limitations.

Research Paradigm and Approach

A paradigm is a mental frame that a researcher uses in organizing and observing the conduct that shapes the research (Bhattacherjee, 2012). According to Bhattachherjee, (2012) and Hussy and Hussy (1997) there are two commonly used paradigms in scientific research which are positivism and interpretivism. In positivist research, a researcher separates themselves from the population on which the research is done. They do not get involved or interfere with the responding party while answering the research questions. In the interpretivist paradigm; practice, interaction and communication are used to construct knowledge and reality from the research subject (Tracy, 2013). Klein and Myers (1999) argue that in IS interpretive research has to assume that information of reality should be only gained through implementing social methods such as documents, shared connotations, tools, consciousness and language to be classified as an interpretive study. Therefore, interpretive study appeared to be more relevant for this research paper as it seeks to gain knowledge of reality from the physicians' use of mHealth applications. In Interpretive research theories inform concepts and direct researcher attention towards meaningful data (Tracy, 2013). This research used affordance theory as a guide to collecting meaningful data.

Research Method and Design

A research method refers to the plan for collecting and analysing data that will make it possible for the researcher to be able to answer questions that were posed (Bhattacherjee, 2012). This study used a qualitative method of research. In qualitative research a researcher searches for answers by engaging with the studied subject (Tracy, 2013). The method may be used in theory creating or hypothesis formulation and is valuable in answering the "why" and "how" questions in regard to human behaviour (Mistry, 2012). The "why" and "how" in this study refers to the actualization behaviour of physicians of mHealth affordances.

Qualitative method generates data that would have otherwise been lost by using the structured methods like surveys or experiments (Tracy, 2013). Data is captured from the participants' point of view. The method of collecting data and analysing it are focused more on gaining a more complete overview of the subject matter (Mistry, 2012). This allows the researcher to understand society and the world, to provide real knowledge for targeting issues, questions, and problems (Tracy, 203).

Ethical Assurances

Ethical questions are dynamic, can arise throughout the process of research and are of more concern than ethical committee approval (Wiles, 2012). This study obtained approval from The Wits University Ethics Committee, Wits Central Human Resources and Head of Clinical Medicine at Charlotte Maxhenghe Hospital before commencing with data collection.
Qualitative researchers have to be interesting aesthetic, rigorous, practical and ethical to be classified as good (Tracy, 2013). Manipulation and use of research for scientist and organisational gain has led to strict ethical measures to be a requirement when conducting research (Bhattacherjee, 2012). Some of the five ethical measures that were followed in this research are discussed below.

Informed Consent

Grinnell and Unrau (2008), emphasize the need for researchers to respect research participants by giving them an opportunity to choose whether to participate or not to participate prior to commencement of the research. Sufficient information should be given to participants regarding their involvement in a particular research, the benefits, consequences and dangers that they may be exposed to and trustworthiness of the researcher (Royse, 2007). Wiles, (2012) describes informed consent as involving providing participants clear information about what the research entails and providing them with the opportunity to decide whether to participate or not. At the start of each interview the purpose of the study was thoroughly explained and participants were given an opportunity to either continue or not. Should the participant wish to continue the physicians were given consent forms to complete and sign. The consent form approved by The Wits University Ethics Committee explained the purpose of the research project to the participants (See appendix C). The

consent form will be kept for a minimum period of five years after the interview was conducted (Bhattacherjee, 2012).

Confidentiality and Anonymity

Subject identity, well-being and interest should be protected by the research (Bhattacherjee, 2012). According to Babbie and Motoun (2009), confidentiality suggests that only the researcher should know the identity of participants. Data represent something of an individual therefore should be treated with care (Lategan, 2012).
In this research participants were given codes and were referred by codes throughout the study in order to make sure that their information is kept anonymous and confidential.

Integrity and Use of Data

The researcher will not voluntarily hold valuable information from the participants or misinterpret the facts deliberately (Struwig and Stead, 2010). Data will be reported truthfully and will not contain fabricated or falsified results in any report, assignment or publication (Lategan, 2012). It is the researchers' responsibility to make sure that data remains confidential to safeguard the privacy of the participants (Lategan, 2012). To ensure that this research was conducted with the best interest of the participants and integrity, the purpose of the study was explained to the participants and they were given an opportunity to clarify any matters of concern.

Analysis and Reporting

How the data is collected, analysed and reported were thoroughly explained as a researcher's obligation to the science community (Bhattacherjee, 2012). These include but are not limited to reporting of unexpected or negative findings, not twisting findings to look like a product of deliberate design and misrepresenting questionable claims as valid (Bhattacherjee, 2012). Data analysis was open to concepts that emerged from the data during data analysis and this was reported.

Assumptions

The research design contained some assumptions. Firstly, it was assumed that the data that were collected from the participants is genuine. Another assumption was that the researcher might have had some influence in the way participants answered the questions.

Data Collection Methods

This part discuss how data was sampled, collected and analysed.

Sampling

Data collection was carried out through unstructured interviews. Through interviews, participants can provide justifications, explanations and rationales for their actions and opinions (Tracy, 2013). The purpose of this research was to comprehend why physicians actualize some affordances and do not actualize others and therefore interviews seemed to be a suitable method of probing reasons more deeply.

The sample target for this study was physicians who are employed at the University of Witwatersrand. This population of physicians were selected because they are known to be using mHealth.

A small sample of 10 physicians was selected for this study. In qualitative studies, data sampling tends to be small and focused on a particular group in order to gain thorough information from the target group (Mistry, 2012). Typically if the researcher could almost predict what the respondent's answers are going to be then it is usually time to stop interviewing and this stage is called the theoretical saturation (Tracy, 2013). Once the saturation stage has been reached there would be little or no new information that will surface, this is estimated at after between 10 to 12 interviews (Guest et al, 2006). The main focus of the qualitative method is to gather sufficient cases of rich information in order to explain the investigated matter (Mistry, 2012).

Purposive sampling was utilised in this study. Purposive sampling was suitable as the research focused on a specific group of physicians which were those that are using mHealth apps. In interpretive research it is acceptable to use a small purposive sample (Bhattacherjee, 2012).

Interview

Interviews are one of the data collection methods for a qualitative research (Mistry, 2012). Interviews are said to provide opportunities for reflection, explanation, discovery and understanding (Tracy, 2013). This research conducted open ended semi-structured interviews, refer to interview protocol in appendix A. Mistry, (2012) describes semi-structured interviews as a conversation with a purpose and has become the major method for collecting data in qualitative research.

Semi-structured interviews were conducted face-to-face by the researcher for all the physicians who agreed to be interviewed and were using at least one mHealth app. The interviews were recorded using a Samsung smartphone recording application. An interview guide was developed specifically for this study [Appendix A]. Interviews lasted for a maximum of 15 minutes and varied by participant. Prior to each interview a consent form was read by the participant and signed [Appendix C]. The Wits University Ethics Committee, Wits Central Human Resources and Head of Clinical Medicine at Charlotte Maxeke Hospital approved all procedures used in this research and granted access to the hospital's Wits University Physicians.

Data Collection

Data was collected between August and October 2017 using semi-structured, in-depth qualitative interviews. Ten interviews were conducted. A code was assigned to each participant in the Roman numerals form: IVX, X being a number 1 to 10 according to the sequence of the interviews. Each session lasted approximately fifteen minutes. The interviewer also took notes during all the interviews. A full transcription of all the interviews was done for analysis. When a researcher wants to understand a situation from another's point of view an in-depth interview is recommended (Mistry, 2012). In order not to only understand what the participants say or does in a situation, but to also explore their feelings and attitudes and the broader context in which behaviour takes place, interviews are recommended (see Mellon,1990;Lincoln and Guba,1985; Seidman, 1998). Interview guide was used and the same questions were asked in the same sequence for each interview (see Appendix A), however conversation with each participant was allowed to flow in a natural manner in order to explore each participant's experience with their use of the mobile health application.

Data Analysis

The recordings were transcribed into a written text. A comparison between the transcribed text and the researcher's notes was done in order to validate the accuracy of the data. In qualitative research data analysis often happens in conjunction with data collection to allow development of new avenues of enquiry and the refining of questions where applicable (Pope et al, 2000).

Some of the qualitative research approaches for data analysis are grounded theory, narrative analysis and content analysis. Because of the exploratory nature of this study content analysis was chosen. In content analysis contextual meaning of data is facilitated through the development of emergent themes (Priest et al, 2002). The researcher derived concepts from the participants' actual words and formulated categories relating to questions asked in the study. The number of times the concepts or derived text appeared was then grouped and counted. This was done while the derived concepts were continually checked and questioned for emerging themes.

Following The Miles and Huberman (1994) Framework data was coded manually. Major themes that emerged from the literature review of the physicians' effective use of the mHealth were 'improved access, 'increased achievement', authenticity and efficiency.

The framework consists of three components which are induction, data presentation and depiction and verifying conclusions (Miles and Huberman, 1994). This section will explain the induction component of the data analysis based on The Miles and Huberman (1994) framework which consists of memoing, coding, abstraction and comparison. Following this method of thinking the above mentioned themes came from the literature review.

Memoing

The process of writing ideas as they arise and theorising them according to specific concepts is referred to as memoing (Miles and Huberman, 1994). As the researcher thinks of ideas related to research concepts during interviews or during data coding, these ideas are written electronically as memos. These memos are dated and titled according to different concepts. The memos are then used in the refinement of the pattern coding at a later stage in data analysis.

Coding

This process was achieved through applying Miles and Huberman (1994) coding framework. Miles and Huberman (1994) proposed that the qualitative data be coded in two cycles that are applicable to the The Miles and Huberman (1994) Framework. Coding can be done manually or using electronic coding methods. This study used manual coding. In the first cycle of coding the study used a combination of 'themeing the data' and 'open coding' approaches. Themeing the data is explained by Saldaña, (2009) as capturing the essence and essentials of the participants meaning. Themeing data was done while data was being collected. When data collection was completed these codes were grouped and labelled. The frequency of times that each code appears in the data was then assigned to each code. For a complete set of these codes see Appendix D tables 12 and 13.

After data collection was completed, codes that came from themeing were then categorized to capture a single meaning in a form of open coding. Corbin and Strauss (2008) explain open coding as the process of decomposing the data into discrete parts, carefully probing and relating it for similarities, conceptualizing and then categorizing it.

After the open coding was performed the data was read multiple times, compared against each other and reorganised. From this coding process six categories emerged. These categories are provided in tables 1 and 2 below:

Table 1: Open Code Categories

Open Code Categories	Number of Codes	Properties Description of Codes	Examples of Participant's Words
App Usage	31	**Action** Information lookup, Information reminder, Information Clarification, study purposes, decision making **App performance** Easily accessible, quick reference, easy to use, user friendly, easy reference	"Lookup information in regards to various conditions (IV5)","looking for correct information that I would not remember. Sometimes it is hard to remember all those details that you need and it's just a way of being confident in the actual numbers that you get (IV2)" , "I use the app to make treatment decisions (IV4)" "Because is in my phone is easy to lookup. I always carry my phone with me so it's basically information on my fingertips (IV1)", "I feel quicker in using them and also I don't have to carry along text books (IV3)", "they are easy to use, because they are on the phone it's easy to reference something quickly"
Benefits	11	Become efficient, gain/update knowledge, gain confidence	"I think the intended use of the feature is to expand people's knowledge and for information to be quickly available at your fingertips (IV1)", "To improve my knowledge and get some of the skills that is required in my field (IV5)", "I get a little bit confidence in dealing with my patients (IV6)"
Outcome	8	Patient's trust, best patient's management	"Using these features helps me to gain my patient's trust (IV6) ","They help me with better management of my patient's (IV9)", "They help me to update my knowledge and assist my patients better (IV9)"
Authenticity and Reliability	10	Evidence based, relevant, well designed	"You get answers quickly to some of the questions you have and of significance is that it's all evidence based (IV4)", "well designed, probably designed but someone who knows what is needed in practice (IV2)"

Table 2: Open Code Categories…continued

Open Code Categories	Number of Codes	Properties Description of Codes	Examples of Participant's Words
Drawbacks	8	Lack of information, slow network, high data price, not useful, no updates, time consuming	"Sometimes not all the information is there that I need. And Medscape is international and not based on South African guidelines so sometimes it's not relevant to our patients. (IV1)", "The problems in South Africa in app purchases are not available. Some of the latest updates are not always available. South Africa has a slow Wi-Fi and we don't have a good fibre network. Data is extremely expensive which makes for the inefficiency compared to the US. (IV3)"
Requirement	2	Basic needs	"I don't use the advanced features because I have basic needs for the clinic. (IV3)"

Source: Author's compilation

The app usage category is subdivided into what it is used for 'The action of the user' and how the app performs when used. The data shows that the physicians' gained self-improvement which is the benefit that leads to the positive outcomes.

After the first cycle another cycle of coding was performed using descriptive coding, descriptive coding was done in order to identify connections among the codes as well as categories that had shaped during the open coding. Descriptive coding is said to allow the researcher to get a sense of the data and get the analysis started (Miles and Huberman, 1994). Determining dominant codes was the primary purpose of descriptive coding. Data was reorganized, redundant codes removed, codes that were not significant removed and only codes that best represented the data (Saldana, 2013) were chosen. Five descriptive categories emerged. Table 3 and 4 below summarises these five categories

Table 3: Descriptive Categories

Descriptive Code and Category	Number of Codes	Category Properties	Examples of Participants' Words
Functional features	25	Lookup, Calculator	"I mainly use the app for referencing, just to check that what I am doing is up to date with the recent and latest guidelines. IV10" "The app helps me with the calculations of severity scores and antibiotics dosing. IV2 "
usage preference	2	What is applicable to the user	"I only use the general section with basic information. Because it is time consuming and often times I don't have time to sit and read journals and articles. IV1"
service delivery	9	Easily accessible, quick and easy reference, easy to use/user friendly	"The apps are easy to use; because they are on the phone it's easy to reference something quickly. You get quick access to the answer. IV 10", "The apps are easy to use and use friendly. You get answers quickly to some of the questions you have and of significance it's that is all evidence based. IV 4"
Increased productivity/achievement	7	Become more efficient, gain patient's trust, better patients' management	"The app helps me to gain my patients trust, as the use results with patients having no complication or minimal complications and I also get a little bit confident in dealing with my patients. IV6", "I think it allows me to manage my patients better and to be confident on the drugs I give them. IV2 "

Table 4: Descriptive Categories…..Continued

Descriptive Code and Category	Number of Codes	Category Properties	Examples of Participants' Words
Authenticity and reliability	4	safe to use, comfortable to use, unable to always rely on the app.	"The app is very comprehensive and evidence based", "The app is well designed, probably designed by someone who knows what is needed in the practice. IV2", "The information that you get from the apps, when you go read up the textbook you find that it is correct" ,"I think the fact that is not South African based and is not always relevant to our patients'. IV1 "

Source: Author's compilation

Three dominant categories emerged from the following five categories: Functional features, usage preference, service delivery, increased productivity/achievement and Authenticity and reliability. Usage preference and service delivery were initially two separate categories, which were later merged to one. Further analysis revealed that data from user preference category referred to how the service was delivered by the mHealth apps, which led to the combination of the two. Based on the number of observations authenticity and reliability did not provide substantial data. Three themes emerged from the remaining four categories. The categories and themes are represented on Table 5 below. In chapter five the themes will be discussed in detail.

Table 5: Theme Development

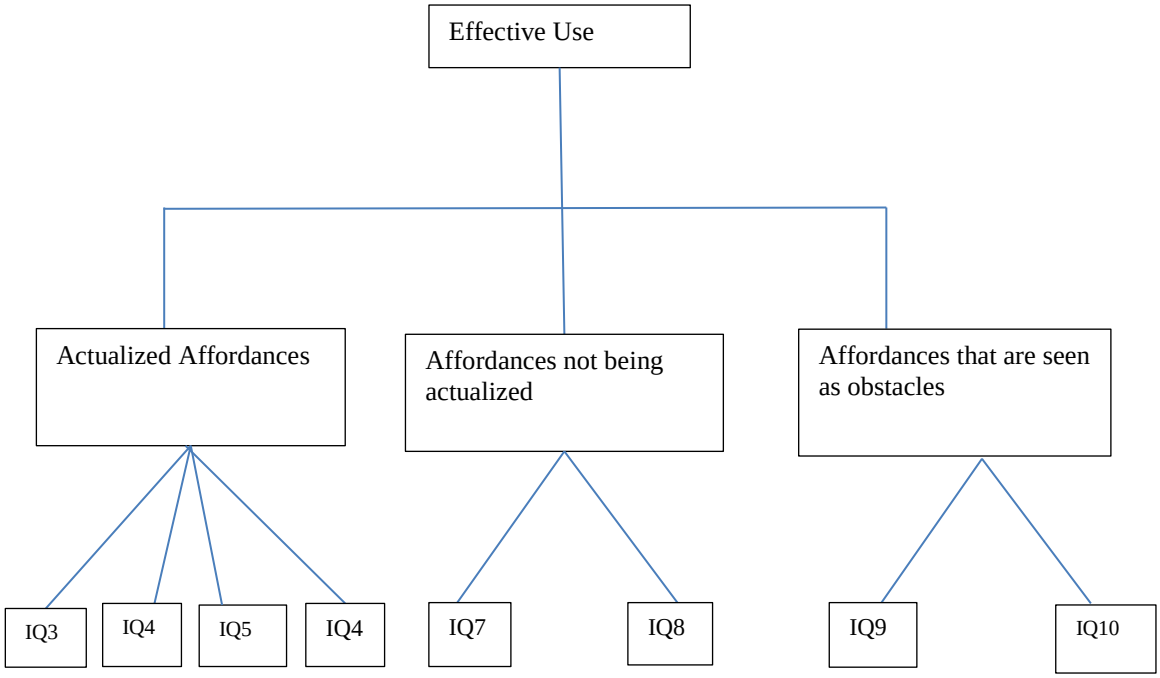
Theme	Description
Functional affordances	Physicians utilize the apps for looking up the information and making medical calculations.
Service delivery and usefulness	The app performance and the information it offers influence the app feature selection by physicians.
Increased productivity/achievement	Physicians feel that their productivity improves when using the apps and therefore their overall achievement increases.

Source: Author's compilation

Levels of abstraction

Figure 1 below shows the level of abstraction that was followed during the coding process

Figure 1: Abstraction Level. * IQ: Interview Question



Source: Author's compilation

This process shows how data coding was refined and recoded from the interview questions to the first order concepts and to second order which is the main concept of the research. During this process data was analysed and reanalysed while being coded until a stage where it reached clear concepts that were aligned to the research question.

Comparison

In order to identify abstract concepts at all levels the systematic and constant comparison of different concepts was conducted (Miles and Huberman, 1994).

Data Verification Methods

All research methods should have more focus on reliability and validity of the research (Brink, 1993); Morse et al, 2002). In order to ensure reliability and validity in qualitative

research a verification process is implemented (Morse et al, 2002). Verification defines a process that checks, confirms, makes sure, and certain (Morse et al, 2002). In order to guarantee reliability and validity in qualitative research different approaches have been used (Ali and Yusof, 2011; Stenbacka, 2001; Tracy, 2012). For the purpose of this study the following strategy was followed:

Methodological Coherence

Methodological coherence is to make sure there are similarities across all the components of the research. This means that there should be a match between the research question and the data and between the data and the analytical method used. The question of the research may be changed depending on the data analysis and sampling plans may be required to expand. In this research there was no need to change the question of the research. The researcher always made sure that all the components of the research remained congruent as suggested by Morse et al (2002).

Sampling Sufficiency

To ensure effective and efficient saturation the participants selected had to have understanding of the research topic. In order to make sure that the population selected have knowledge of the research topic, this research selected the physicians at the University of the Witwatersrand who are known to use mHealth. Aspects of the developing analysis that were not obvious were validated by seeking negative cases (Morse et al, 2002).

Data Collection and Analysis

In order to form shared interaction between what is known and what is not known data should be collected and analysed simultaneously (Morse et al, 2002). In this research the user analysed the data after each interview.

Thinking theoretically

Emerging ideas were verified with new data which gave rise to new ideas which were then verified with already existing data (Morse et al, 2002).

Summary

In this chapter the methodology of the study was discussed, the ethical considerations and the processes of data analysis were also discussed. The following chapter discusses the findings of the research.

CHAPTER 5: FINDINGS AND DISCUSSION

This chapter will discuss the context of the data, how themes were developed and how they relate to the research questions.

Data Context

Of the 10 physicians whom participated in this study 7 of them practiced at different wards within the hospital while three were based at different clinics. Seven of the physicians were females and only three males participated.

Data revealed that there are two types of mHealth app technologies that were mostly used by these physicians. Those that have features that offer information lookup and those that offer calculation function. These were the core features of the apps used by these physicians. Markus and Silver (2008) describe core features of a technology as follows:
"Core features are basic or those that makes a technology identifiable as a certain type" pg615.

Of the eight frequently used applications, Medscape, Bugwise, SAMF, MIMS, Royalcol and UpToDate are described as essential for prescribing and drug reference guide, quick look up of medications and dosages, and providing tools for checking medical interactions. Quality control Calculators (QC Calc) and medical calculators (MDCalc) are for medical quality control grid calculations and clinical calculations.
Below is table 6 showing use of applications and the ones that are frequently used per participant.

Table 6: App Usage by Physicians

	Apps Used	**Most used apps**
IV1	Medscape, Lancet Mobile app	Medscape
IV2	QC Caltulate, Bugwise, Palmacalc, BNF	QC Calculate, Bugwise
IV3	PAC (Picture Archiving Communication System), SAMF(South African Medical Formulary), MIMS for drugs	SAMF, MIMS
IV4	Medscape, Up to date Qx Caltulate	Medscape
IV5	RCog (Royal College app), Acog (American College app)	Royalcol
IV6	Medscape	Medscape
IV7	Medscape, uptodate, Medicalculate	Medscape
IV8	Medscape, Uptodate, Sand for autho microbial, QCalculate	UpToDate
IV9	Medscape, Medcalc	Medscape, MDCalc
IV10	Medscape, Uptodate	Medscape

Source: Author's compilation

When thorough investigation was done in order to understand the mHealth apps provided by the physicians and their features, it was discovered that they mostly provided features that were for medical information search, drug search, drug use, medical guidelines, medical calculation and education. This was supported by Kaufman, (2011) who stated that mHeath apps were used more widely for educating physicians and doctors, for the purpose of diagnosing patients, finding health and medical information and medical health information research. Beulos et al, (2011) also emphasizes that the use of mHealth technology allows for access of enormous amount of medical information on the go. The applications used by these physicians attest to the idea that mHealth applications are used for the purpose of information access and medical calculations. Below in table 7 is detailed information on the features of the applications.

Table 7: mHealth Applications Features

App	Key Features	Reference
Medscape	• Drug, supplements and over the counter medicstion identification. Medication and usage quick look up.	https://www.medscape.com/public/medscapeapp, accessed:10 Feb 2018
QC Calc	• Calculation features	http://tools.westgard.com/qccalculator.html, accessed:10 Feb 2018
SAMF(South African Medical Formulary)	• Drug information l.ookup	https://mdinc.co.za/store/products/books/samf-south-african-medicines-formulary-12th-edition/, accessed:10 Feb 2018
MIMS for drugs	• Medication browser	http://www.mims.co.za/Products.aspx , accessed:10 Feb 2018
RCog (Royal College app)	• Access to Green-top Guidelines, • Search facility and Bookmark	https://www.rcog.org.uk/en/guidelines-research-services/guidelines/rcog-guidelines-app/, accessed:10 Feb 2018
UpToDate	• Updates, search features and education • Medical Calculators • Feedback • Drugs & Drug Interactions	https://www.uptodate.com/home/features, accessed:10 Feb 2018
MDCalc	• pre-populated input values, results previews, • Advanced Search and Customizable Menus • Full Use Offline	http://apps.mdcalc.com/, accessed:10 Feb 2018

Source: Author's compilation

The number of years the physicians has used the mHealth apps varied from 5months to 6 years. The average number of years that physicians have been using the apps was about 4.3 years. Below is the table 8 showing the number of years per participant.

Table 8: Number of Years Physicians Using mHealth Apps

Participant	Number of years using the app
IV1	5 months
IV2	2 -3 years
IV3	3- 4 years
IV4	4-5 years
IV5	5 years
IV6	6 years
IV7	4 years
IV8	1 year
IV9	5 years
IV10	5 years

Source: Author's compilation

Physicians' Goals for using the apps

In their study, Hwang et al. (2016) concluded that if a user of the technology is aware of their intended goals, they are likely to achieve job satisfaction if the technology is used for decision making. In this study in order to understand whether by actualizing certain affordances the physicians' had achieved their goals, physicians were asked if they had goals for using the applications. Of the ten physicians only one indicated that they did not really have goals for using the applications.

The physicians mentioned the following goals:

1. to gain knowledge of their field, examples

"I think the intended use of the feature is to expand people's knowledge (IV1)",
"So to broaden my medical knowledge (IV4)"
"To improve my knowledge and get some of the skills that is required in my field (IV5)"
"To update my knowledge (IV9)".

2. To have quick access to correct evidence based information, examples

"For information to be available at your fingertips. You do not have to open a text book and the information is evidence based (IV1)"

"Looking for correct dosages. Correct information I would not remember by myself (IV2)"

3. To stay up to date with the latest information and guidelines, examples

"To stay current. To stay up to date (IV3)"
"Mainly for referencing, just to check that what I am doing is up to date with the recent and latest guidelines (IV10)"

4. Manage patients and give them the best service.

"So I can give my patients the best service (IV6)"
"To manage my patients better"

5. Study purposes, examples

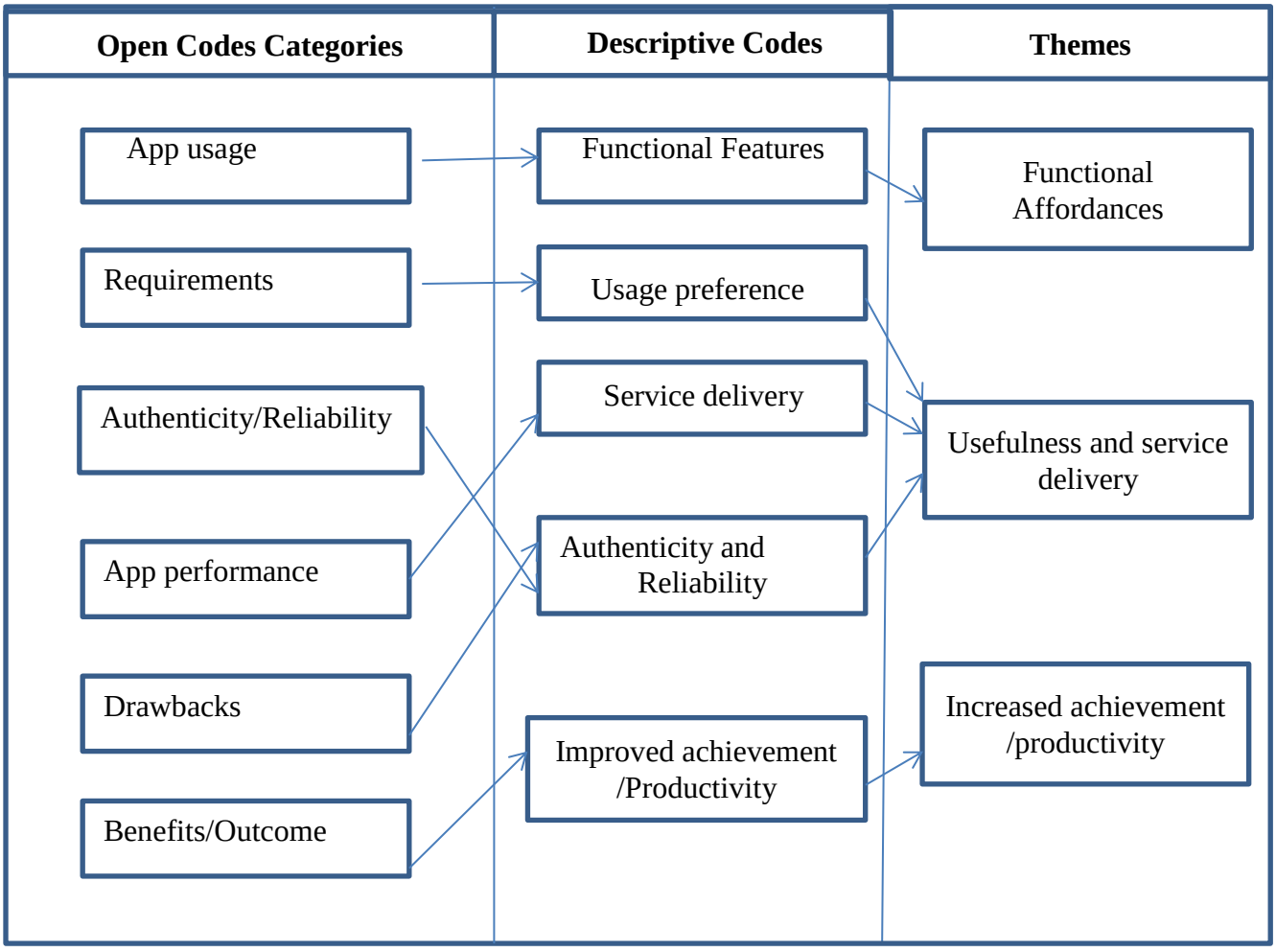
"I use them to study to supplement my text books (IV8)"

The finding in this research was that, whether physicians had goals or not they still understood their achievement. For example the physician who said "I do not have any goals exactly (IV7)" has also stated that they had high achievement when asked the level of achievement after using the features.
It was found that eight physicians had goals for using the applications and had reported having high achievement levels for their goals, with two reporting medium achievement due to lack of updates, slow network and irrelevance to South Africa. Because majority had goals for using the applications, this supported the definition of affordances by Markus and Silver (2008) that defined affordances as "possibilities for goal-oriented action afforded to specified user groups by technical objects" (pg14).
Bernhard and Recker, (2013) argue that expertise plays a role in improved achievement of the goals intended when actualising perceived affordances. This was seen in the physician's data, as the high numbers of years they have been using the apps agree with the overall high achievement and high satisfaction of use with those who have used the app for a year or less showing medium satisfaction.
From this information this study may argue that physician's use the mHealth applications in order to equip themselves and be able to better manage their patients and give their patients

the best service as argued by (Kohli and Kettinger, 2004). It may also be arguable that although the physicians may use the same mHealth apps, their intended goals may differ resulting to the actualizing of the features differently.

Theme Development

Figure 2: Illustrates of how coding evolved from open codes into themes



The arrows in figure 2 indicates how the categories evolved from open categories to descriptive categories and from descriptive categories to forming themes.

First Theme: Functional Affordance

The theme functional affordance emerged from the category of functional features. Markus and Silver (2008) define functional affordances as those features that have capabilities to process information. In this study physicians were able to lookup information and to do

medical calculations using mHealth apps. As one of the participants' comments about what they use the app for they said,

"Dosing, lookup contradictions and dosing interactions (IV6)".

Descriptive coding was coded according to the features perceived and used by the physicians within the code: "features actualized by the physicians". The development of this code came from the interview guide that asked of the features of the applications used by the physicians. The responses revealed apps categories based on two types of perceived features: information based features and results bases features.

Information based features are also identified as services to improve ability to diagnose, treat, monitor and manage patients (Free et al, 2010). Results based services are features that let the user input information in order to get the intended results. Examples of these features are those that give calculation results, severity scores and alveolar/arterial gradient.

These two categories seemed to be the core features of this set of physicians that were used as interventions to deliver treatment to patients.

Seven participants mentioned that they use the features for information lookup while two mentioned using the apps for calculation purposes and only one mentioned the use of both services as per quote below,

"To get information on diseases, to calculate scores or calculate results of scores for correcting calcium or scores for chemical diseases (IV9)".

Different users can use different types of healthcare services offered by the mHealth application according to their needs (Okazaki et al, 2015; Akter et al, 2012).

The physicians of this study used the information service features more than double those that used the result based features. The physicians mentioned eight different apps and of those six had information based features used. This also meant that many of the apps were chosen because of their information based feature capabilities.

Quick and easy access to reliable information is critical to physicians as they work under time constraints.

"You get answers quickly to some of the questions you have. And of significance is that it's all evidence based (IV4)".

"It has all the information and it's easy to use (IV7)".

Ilie et al. (2009) argue that physicians have to go to different floors of large hospitals to see their patients. This would indicate that by using the applications physicians may not have to go around carrying books or notes for referencing while attending to their patients. It is also of importance that the source of information is correct and reliable at all times as the physicians' job involves peoples' lives.

Data revealed that the most used feature was for information look up where physicians had stressed that they only looked up information that was easily accessible, accurate and reliable. An example of this need to access quick, easily accessible and reliable information is indicated by the comment

"I lookup dosages of drugs, and information with regards to various conditions (IV4)".

This was in agreement with the findings of Ilie et al. (2009) that accessibility to reliable information was an important influence in physicians' choice of technology.

The second characteristic was to assist with decision making. Physicians appeared to want features that would help them with making quick decisions while treating their patients.

Decision making is an important element of the physicians' job. Being able to make decisions that are quick, informed and those that include the patients it's a necessity to physicians.

"*To help with treatment decisions (IV4)".*

"The features help me to risk stratify patients in terms of their risk factors and prognosis (IV7)".

Charles et al. (1997) argue that physicians' prerequisite to shared decision making is having different treatment options available to patients at the right time. Using mHealth apps, physicians would be able to quickly come to a decision as they may have information at their disposal that they may also share with their patients and therefore allowing them to come to an agreement to a preferred decision much quicker.

The third characteristic that was revealed by the data was improving efficiency and effectiveness, being efficient and effective is an important aspect in satisfying patients (Larkin, 2011; HIMMS Analytics, 2011).

When physicians are quicker, it means they may see more patients at a time and therefore reduce the waiting time of their patients.

"Applications help me to be more efficient (IV3)".
"I feel quicker in using them and I don't have to carry along books (IV3)".
"Using the application helps me to give my patients the best service (IV6)".

Akter and Ray, (2010) found out that the use of mHealth saves time for health professionals' and their patients. The issue of time also came strong with physicians stating that only features that do not waste their time are useful by them. When they were asked why they did not actualize some features one physician said

"Because it takes time to read journals and articles, its time consuming and often times I don't have time to sit and read (IV1)".

Mentzer and Konrad, (1991) define efficiency as the proportion of properties utilized against the results that are achieved, measuring how well the expanded resources are utilized.
Physicians agree to the idea that using the applications helps them to be more efficient.
The fourth characteristic of these features was boosting physicians' confidence. Because the applications provide physicians with accurate and up to date information on the spot which allows them to make diagnosis, treatment decisions and performing any calculations required without worrying that they will not be correct, this makes them to feel more confident. As one physician puts it

"I also get a little confidence in dealing with my patients (IV6)".

Pluye and Grad (2004) in their study of the use of information retrieval technology by physicians found that physicians showed significant confidence when making clinical decisions.
Table 9 below shows the summary of the applications feature classification and the number of times they were referred to by physicians.

Table 9: App feature classification among Participants

App feature classification	Feature types	Number of times referred to by per participants
Information based features	Information lookup	8
	Information reminder	3
	Decision making	5
	Information clarification	1
	Evidence based information	3
Results based features	Medical calculations	2
	Risk score calculations	1
	Unit conventions	1

Source: Author's compilation

Of the twenty two times mention of feature use, twenty were information based usage. Just as having a need for relevant and up to date information was a reason for physician's to actualize certain features of the app, irrelevant information and lack of updates was the reason for not actualizing some features. Some participants cited that the origin of the app and their relevance to their patients were highly influential to their choice of whether to use or not to use an app.

"I think, the fact that it is not South African based and is not relevant to our patients (IV1)."

This theme is supported by the types of features used and stated reasons for actualizing or not actualizing features. As it is concisely stated by one participant

"For the purpose of time I never look at them, they are not useful to me. (IV5)".

Second Theme: Service delivery and Usefulness

The theme service delivery and usefulness emerged from the codes usage preference, service delivery, and authenticity and reliability respectively. Physicians seemed to base the choice of whether to actualise a feature or not to actualise on their assessment of how long it would take them to use the feature and how useful the feature seem to be to them.

The participants viewed the quick and easy to use as preferred features, while they made it clear that they were not interested in the use of the features that would take their time. Physicians commented not using features because of the below reasons:

"It's because of the time factor (IV5)"
"For the purpose of time I never looked at them (IV4)"
"Because it takes time to read journals and articles (IV10)"

Service delivery provided by mobile applications in the health sector improves physicians' capabilities and patients' interactions (Sclafani et al, 2013).

The findings suggest that physicians took into consideration the time they will need to spend on the use of the mHealth feature.

Another aspect that was considered by these physicians was the usefulness and applicability to their specific setting. Physicians' mentioned basic needs and usefulness as per below examples.

"I go to the general section and only use the basics IV1"
"I do not use the advanced features because I have basic needs for the clinic (IV3)"
"They are not useful to me (IV5)"

In the research that explored physicians' use of commercial e-prescribing system, physicians were found to avoid using advanced features because they thought the features had no value for them (Grossman et al., 2007).

This finding was in line with the findings of this study, as data shows that physicians were only interested in the basic features of the mHealth apps.

Another aspect that seemed to influence actualisation of features by physicians was the relevance of the content. Asked why they do not use some features, physician stated that features were either not relevant for their patients or their specific discipline.

"I think that they are not South African based and are not relevant to our patients (IV1)".
"Those that are for a different discipline those are not useful to you (IV7)".

Furthermore, a physician was not going to use the app if it was not from a reputable institution. As participant 5 puts it

"Royal College is one of the best colleges in the world and is often the one we look up to IV5".

Chismar and Wiley-Patton, 2003 found out that, physicians were more concerned about how useful and relevant the features of the health technology were. They argued that physicians were more concerned about the usefulness of the technology rather than how easy it was to use considering that with physicians learning a technology would be less of a problem compared to non-professionals. Keil et al. 1999 as referenced by Chismar and Wiley-Patton (2003) has also found that physicians would adopt and use beneficial applications even if they are not easy to use.
The findings of this research are agreeing with the above three studies that physicians are more interested in basic but useful and relevant features of the health technology. Over and above these findings this research has found that the time that will be spent using the feature is also important in physicians deciding which features of the technology to use.
It is also important to mention that other than the elements that emanate from direct use of the features, physicians also stated external influences like cost of data and unavailability of the wifi as something that discourages them from using the applications. Participant three concisely
stated,

"*South Africa has a slow wifi and we don't have a good fibre network. Data is extremely expensive which makes for the inefficiency compared to US".*

The physicians' usage preference was also evident in how they not only evaluated the apps information but also how they were to use them. Physicians desired to know the feasibility and the cost of the app before using them.

Hence this theme associates with the category of usage preference and service delivery, because physicians are more likely to want to use the features of an app that have the functions they need and the service delivery will not be slow and costly. What influenced the actualization of features by physicians is supported by the type of features physicians chose to use. That is how the app performs when being used and the information it offers the physicians while with their patients.

None of the physicians have mentioned finding the features of the mHealth to be a barrier or a limitation. Medhanyie et al. (2015) argued that mHealth barriers are due to health professionals' attitudes, health processes and work flows.

Third Theme: Improved productivity/achievement

The theme that Physicians feel that their productivity improves when using the apps and therefore their overall achievement improves emerged from the increased productivity/achievement category. Participants shared their feeling of achievement and improved productivity when asked about their intended goals for using the features. This theme does not refer to achievements in general, but specifically for the intended goals. These are the sentiments of the participants:

"I manage my patients better" (IV9)
"I stay current and up to date" (IV3)
"So I can give my patients the best service" (IV6)

This theme connects directly from the previous themes. Usage preference and service delivery influences are accompanied by improvements in decision making, and ensuring that the correct people get the correct information at the right time (Akter and Ray, 2010).

"The app enables me to get correct information that I would not remember by myself (IV2)".

When physicians where asked what the features were helping them to achieve they mentioned different things like getting quick information, managing patients better and gaining patient trust as on specifically says

"I can get information quickly (IV1)"

"I think it allows me to manage my patients better (IV1)"
"using the apps helps me gain my patient trust (IV6)"

Hence physicians are aware that it is critical for them to assess the features of the application and the services they offer before deciding on actualizing them. Physicians also factored the 'ease of use, 'user friendliness' and the quick response of these features. As one physician states

"They are easy to use. They are user friendly. You get an answer quickly to some of the questions you have and of significance it's that it's all evidence based" (IV4).

Someone will actualize an affordance if in addition to having the capabilities necessary to do so; they also have goals that need to be served (Stoffregen, 2003). The intended goal will be specific to the user and they will feel a sense of achievement if the goal was met by actualizing the perceived affordance (Volkoff and Strong, 2013).
The physicians' strive to better themselves and their service through using the apps. Although physicians seemed to use the mobile apps to benefit their performance while treating patients, they revealed that they also use the app for their studies.

"I use them to study to supplement my text books" (IV8),
"for the purpose of revision in studying" (IV5).

When physicians use the app for studying, it means they become more skilled in their profession which will lead to them being more knowledgeable and efficient when performing their duties. This is in line with the physicians goals for using the mHealth aps.
Earlier effective use was defined as

"*using a system in a way that increases achievement of the goals for using the system" (pg4),* *Burton*-Jones and Grange, 2012).

And affordance actualisation was defined by Strong et al. (2014, pg18) as

"*the actions taken by actors as they take advantage of one or more affordances through their use of the technology to achieve immediate concrete outcomes in support of organizational goals*".

These definitions focus at the achievement of the set goals. The results of this study shows that physicians have actually received increased achievement for the goals they had for using mHealth applications. Synthesizing the outcomes achieved it seems that there were other unintended consequences achieved by physicians, which goes beyond both the definition of effective use and of affordance actualisation.
These outcomes were gaining confidence by physicians and the improved relationship between physicians and their patients.

Application to Research Questions

Four questions were presented by this study to understand why physicians actualise some affordances and not others. The following section discusses how these categories and the related themes apply to the questions.
The first question was: why do physicians choose to actualise some affordances? The category of functional features and the theme that emerged from this category, physicians utilize the apps for looking up the information and making medical calculations addressed this research question. Within the affordance theory, affordances are associated with what the environment offers the animal (Gibson, 1989), what technology offers the user. Different behaviour of layout is afforded to animals by the environment (Gibson, 1989). Different physicians of this study perceived different functionalities offered by the mhealth apps. When actors take advantage of offered affordances by using the technology for the immediate achievement of goals, this is referred to as actualization. As the animal is offered different terrains by the environment, the animal chooses the terrain that is suitable for them (Gibson, 1989). In the case of physicians, the mobile apps offered those features and they then chose which ones to actualize depending on their intended goals. Goals stated by physicians were to gain knowledge of their field, to have quick access to evidence based information, to stay current and is up to date with the latest information and guidelines, better management of their patients and giving them the best service.
For example most physicians chose to actualize app features that have information lookup functionalities, while only three actualized app features that had calculation functionalities.

Physicians gave reasons for their actions, for example information has to be relevant, up to date and reliable. They also mentioned the fact that it has to be quick, easy and user friendly to use the apps. These have led to the reason why physicians chose to actualise selected features.

Of interest is the finding that the uses of mHealth by physicians have improved the relationship between physicians and their patients which is not informed by affordance theory.

The second question inquired whether the actualized affordances increased the achievement of the physician's goals. This question is addressed through the category: Increased productivity/achievement and theme: Physicians feels that their productivity improves when using the apps and therefore their overall achievement increased. The foundation for this question was the notion that affordances are possibilities of goal oriented action that are being offered to a group of specified users by a technology (Strong et al., 2014). Physicians were asked what the use of apps' features helped them to achieve in their job.

Kenagy et al, (1999) found that where high quality of service was highly present in institutions and practices, clinical, patient and physicians' outcomes were improved, and patients and physicians were also satisfied while the cost of service was reduced, which becomes a competitive advantage for practitioners. Physicians as service providers to their patients and strive to enhance the quality of the service that they provide in order to make their patients satisfied and win their trust. mHealth applications are argued to ensure the correct information to the correct user at the right time and dramatically improve production processes and decision making by health professionals (Akter and Ray, 2010). mHealth apps are seen by physicians as vehicles to increase satisfaction of patients and also improve their knowledge in their respective specialities. When asked how satisfied they were with their goal achievement eight of the ten physicians stated that they were highly satisfied with two stating medium satisfaction.

When addressing the question of what led to satisfaction, physicians stated design, relevance and usability as being the main aspects. Those that had a medium satisfaction stated indirect causes like the origin of the app, price and network connection as the reason for not being fully satisfied. Overall physicians were found to have been satisfied, which addressed the question of whether the actualized affordances increased the achievement of the physician's goals.

The third question inquired reasons for physicians to not actualise some affordances. This question was addressed by the category of usage preference and service delivery and the theme Usefulness.

The app performance and the information it offers influence the app feature selection by physicians. Affordances have to be perceived by the actor before they can be actualized (Chemero, 2003), but this perception does not necessarily lead to the realization of the offered action possibility (Stoffregen, 2003). As the physicians' learn about the affordances offered by the certain apps they assess whether the affordance will benefit them and then make a decision on whether to use or not to use them.

Physicians were asked if there were features of the applications they were using that they knew of but chose not to actualize. Six participants' did not have while four answered yes and stated lack of information, information that is not up to date and information that was irrelevant to the physician's patients as reasons that led these physicians choosing not to actualise those affordances offered by the mHealth apps. This difference could have emerged from the fact that physicians differ in their perception of features that are useful, for example, because of their specialties as one physician was being specific by saying

"It gives the basic principles of obstetrics and gynaecology (IV5)".

Treating patients is a critical job and physicians from this study have shown that they cannot take chances when coming to making choices of apps and app features. Only app features that provided good, relevant and verified information were used.

The fourth question inquired whether there are barriers or limitations offered by mHealth applications, or whether they are simply not useful to physicians' work/needs. This question was also addressed by the category of Usage preference and service delivery and the theme Usefulness. The app performance and the information it offers influence the app feature selection by physicians. Markus and Silver (2008) makes an example of species, arguing that different species may perceive certain information of the environment differently, others as useful while another may not, based on their body sizes. For example a shrub that affords a shade for a wild pig may not afford the same for an elephant. Participants were asked the question of whether there are features that were perceived as barriers or not useful to their work. Participants mentioned that features were not being useful to their particular space rather than being barriers or limitations.

Summary

This chapter the explained in detail how the themes relate to the four questions of this study. A summarised view of the questions and how they were answered is given on the conclusion chapter. The below chapter discusses the conclusion, theoretical and practical contribution, limitations and future work.

CHAPTER 6: CONCLUSIONS AND FUTURE WORK

mHealth applications help physicians to achieve their intended goals, but these goals can only be achieved through effective use. This study throw some light on why physicians' decides to actualize or not to actualize some affordances. Affordance theory was used as a theoretical underpinning to discover the reason's that led to actualisation and non-actualisation of mHealth application features by physicians. Through qualitative research approach the study utilised interviews as a data collection method.

Through thematic analysis approach, The Miles and Hubberman Framework (1994), was used to explain and execute the data analysis. From this process three themes developed that did not only address how affordances can be used to explain the effective use, but also delivered a more in-depth interpretation of how it can be explored to address effective use of mHealth. The four questions that were asked by this study were answered by the different themes that remerged. Below table 10 shows the questions and a summary of how they were answered.

Table 10: Summary of questions and respective answers

Question	Answer
Why do physicians choose to actualise some affordances?	Physicians choose to actualize the affordances that help them to achieve their intended goals. In this case the functionalities were information look up and calculation features
Do actualized affordances increase the achievement of the physician's goal?	Physicians felt that their productivity improved when using the apps and therefore increasing the chances of achieving their goals. The main achievements were increased satisfaction by their patients and improved knowledge in their field of work.
What are the reasons for physicians to not actualise some affordances?	Physicians felt that features had to be useful to them for them to actualise them. They mentioned lack of information,

	information that is not up to date and information that was irrelevant as reasons that led to choosing not to actualise some affordances offered by the mHealth apps. Only app features that provided good, relevant and verified information were used.
Are there barriers or limitations offered by mHealth applications, or are they just not useful to physicians' work/needs?	Physicians' mentioned that features were not being useful to their particular space rather than being barriers or limitations.

Source: Author's compilation

In this chapter a discussion of the research results is provided relative to the objective and research questions, and the main implications of the research findings are explained.

Conclusion

Physicians are the important stakeholders in the health industry. Demand for expertise, efficiency and general understanding of the role of physicians in the society remains a critical one. The profession allows zero tolerance of error in the practice. Due to this physicians are experiencing enormous amount of pressure on a daily basis, including that of avoiding to be sued as a result of their decision making. Although medical errors are unfortunately inevitable in the healthcare settings that are complex, there are ways that can be implemented to reduce them. mHealth applications if used effectively are one of the solutions that are innovative to deal with this challenge. This study entails four research questions that set forth to explore whether physicians are using mHealth applications effectively. The study sample included ten sample physicians employed by the University of the Witwatersrand who shared their experience and opinions about mHealth applications and their feature.

The purpose of this study was to investigate why physicians actualise some affordances and not others. What the study found was that reliability, authenticity, and validity were the main aspects that influenced physicians to actualise certain features of mHealth. This was broadly in line with the findings of (Keil et al. 1999; Chismar and Wiley-Patton, 2003). What was also discovered was that physicians did not have to have specific goals in order to have improved achievement in their work after actualising app features. This finding was in odd with the explanation of affordances by (Markus and Silver, 2008), which defines affordances as a possibility of goal oriented action.

Another interesting finding was that the use of mHealth had increased physician to patient relationship which was an unintended consequence. These two later findings were additional outcomes beyond those that were influenced by the affordance theory. On the face of it, this may suggest that achieving unintended consequences maybe an important aspect of effective use.

The study appears to support the argument that the technology should be used effectively in order to produce benefits. The findings of this study are restricted to physicians employed by the University of Witwatersrand based in Johannesburg, South Africa.

Theoretical Contribution

This study made some contribution to the literature of effective use of mHealth. The study contributes to literature regarding the reasons that influence physicians to actualise affordances offered by mHealth applications.

The major contribution however, lies in the achievements that were up and above the definition of effective use. The definition of effective use refers to using as a system in order to improve set goals. The findings of this study were that not only goals were improved but other benefits not planned for were achieved too. Therefore this study extends the definition of effective use to include unintended consequences.

Practical Contribution

The theme of usefulness and service delivery could have significant contribution to future mHealth app development. Developers of the physician's health apps should take into consideration the performance of the features, and the relevance to the target audience of physicians. Lastly through the increased productivity and improved achievements physicians may have an idea what sort of achievements to expect from actualising the applications. This may also encourage physicians to try to actualise more features.

Limitations

One of the limitations of this research was that developers were not part of the study, which would have helped to determine whether physicians were actualising features for their intended use. The possibility of the researcher bias during the interview process was

considered to be another limitation. To address these limitation participants were encouraged to speak freely and the sense of trust was reinforced before each interview. Again all participants were asked the same questions in the same sequence using the interview protocol. Bias also resulting from using a sample from one institution; which happened to be the institution where the researcher was studying. Lastly, the researcher's lack of experience of the interview process is expected to be another limitation of this study.

Reflection on the Research

Affordance theory seemed to be a fit theory for determining aspects of effective use of mHealth by physicians. The extension of this theory to include unintended consequences however may give a better explanation of these aspects.

Although other methods may well have given possible explanations, the qualitative method proved to be satisfactory in approaching the subject area of this research.

The use of semi-structured interviews provided a meaningful exercise for both the researcher and the participants. Some had mentioned that they gained some good insight from taking part in the study and there would be conscious when using the apps than before.

Future Research

Future research of physician effective use of technology may consider extending the affordance theory to include unintended consequences – i.e. not original goals for use. A consideration may be to involve developers of mhealth apps so that they may determine whether features are used for their intended use by physicians. A research in the South African context of mHealth use by physicians may also be enhanced as it did not come out clearly. Also a further research that considers how these mHealth apps assist in emergency cases when patient information can be extracted quickly. Lastly designers of the mHealth apps may consider using design thinking practices and apply design processes using the study findings in enhancing the development of the apps.

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APPENDICES

Appendix A

Interview Protocol

Introduction Questions

1. Which mobile health applications are you using?
2. If using more than one application which one would you say you are using most frequently?

Table 11: Research Questions

Research Question	Interview Question
Q1: why do physicians choose to actualise some affordances?	3. What features of this application do you use? 4. Why do you use these features? 5. What are these features helping you to achieve in your job? 6. Do you think you are using these features for the purpose they were meant for? 7. If not what do you do with the feature/s differently from their intended purpose?
Q2: Does actualized affordances increase the achievement of the physician's goal?	8. How long have you been using this feature/s? 9. What are your goals for using this feature/s of the application? 10. To what level do you feel satisfied to have achieved your goals by using this feature/s? (low, medium, high) 11. What do you think are the reasons that lead to this achievement?
Q3: what are the reasons for physicians to not actualise some affordances?	12. Are there features of the application that you know of but not using? 13. If yes, why did you choose not to use these features?
Q4: Are there barriers or limitations offered by mHealth applications, or are they just not useful to their work/needs?	14. Are there any features that maybe unusable or that negatively affect your work? 15. If yes, why do you think so? 16. Are there any features that you don't find useful? 17. If yes, why do you think they are not useful?

Appendix B

Participant Information Sheet

Thank you for taking the time to be a part of this research study. My name is Nkhahleng Ngaka. I am a Masters student at the University of Witwatersrand.

You are invited to participate in this research because you have been identified as a physician who is using mobile health application. The aim of this research is to understand what informs your choice of features in mobile health application.

I will be using my phone to record our conversation today. Only me as the researcher in this study will have access to your comments and this discussion. The length of this interview will be approximately one hour.

Appendix C

Consent Form for Interview Recording (SCIR)

Title of research project: *Physician's Effective use of Mobile Health Applications: Using an Affordance Theory Lense*

Name/s of principal researcher/s: Nkhahleng Ngaka

Department/research group address: Division of Information Systems, Wits West Campus

Telephone: 011 667 2148

Email: ngaka88@gmail.com

Name of participant:

Nature of the research: Qualitative study of the use of mobile health applications

Participant's involvement: Interview

What's involved?

Risks: there is no risk involved

Benefits: there are no benefits involved

I acknowledge the following:

- I agree to participate in this research project.
- I agree that the interview will be recorded
- I have read this consent form and the information it contains and had the opportunity to ask questions about them.
- I agree to my responses being used for education and research on condition that my privacy is respected, subject to the following:
  - I understand that my personal details will not be used so that I will not be personally identifiable.
  - I understand that I am under no obligation to take part in this project.
  - I understand I have the right to withdraw from this project at any stage.

Signature of Participant:

Name of Participant:

Signature of person who sought consent:

Name of person who sought consent:

Date:

Appendix D

Table 12: Data Themeing

Code	**Frequency**
Information Lookup	8
Easily accessible	3
Efficiency (become efficient)	1
Quick reference	2
Decision making	5
Information Clarification	1
Study purposed	3
Information access	3

Table 13: Data Themeing ….Continued

Code	Frequency
Knowledge gain	9
Patient trust	2
Confidence gain	1
Medical calculations	2
Patient management	4
Knowledge update	2
Easy to use/user friendly	3
Quick information	2
Evidence based information	3
Lack of information	1
Irrelevant/lack of updates	3
Well designed	1
Stay-up-to date/relevant/current	3
Slow network	1
High data price	1
Give best service	1
Good information	1
Referencing	1
Easy reference	1
Basic use /needs	2
Comprehensive	1
Time consuming	3
Not useful	2
Good information	1
Referencing	1
Easy reference	1
Basic use /needs	2
Comprehensive	1
Time consuming	3
Not useful	2