Radio frequency spectrum monitoring: Officers' acceptance of monitoring technologies such as fixed direction finders

by

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DECLARATION

I, Silas M. Phoshoko, hereby declare that the contents of this research project represent my own investigation, and that the project has not previously been submitted for academic examination towards any qualification. Furthermore, it represents my own opinions and not necessarily those of the University of the Western Cape.

Silas M. Phoshoko

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KEYWORDS

Technology Acceptance Model (TAM), Independent Communication Authority of South Africa (ICASA), Fixed Direction Finder (FDF), remote sites antenna mast, mobile monitoring unit, perceived usefulness, perceived ease of use, perceived enjoyment, attitude towards use, intention to use.

ABSTRACT

This research focuses on the acceptance of new technologies within the telecommunications industry. The study will examine three models namely Innovation theory, Theory of Reason Action (TRA) and Technology Acceptance Model (TAM). The acceptance of new technologies in the work place has recently been recognized as of paramount importance in their wide and efficient usage, and as a result organizations are busy investigating means towards this acceptance of technologies they invest in and/or deploy. In the past, acceptance of a new technology by employees was not taken seriously because employees were compelled to use what was at their disposal, irrespective of how they felt about it and this, unfortunately, was at the expense of their acceptance and efficient utilization. In a quest to maximise the benefits of technologies, organisations recognise the need to pay attention to the factors that could influence the views of employees about a particular technology. One such example of a situation where technology acceptance is investigated is in the introduction of Fixed Direction Finders (FDFs) at Independent Communications Authority of South Africa (ICASA).

Because there is no conceptual defination of the term FDF, this study defines an FDF as a stationary technology utilized to monitors radio frequency spectrum and locate unlicensed transmitters. ICASA has recently acquired this technology to help it clamp down on these transgressing transmitters. The logic behind this acquisition is that if FDF technology is used to its full capacity, it will lead to only one mode of monitoring technology being supported and legacy technologies being discontinued. Discontinued legacy technology will mean lower maintenance costs. This study investigates the reasons behind mixed and non-usage of FDFs as one of the technologies used in monitoring. Moreover, the study will investigate the main drivers which could motivate monitoring officers to use FDFs that ICASA needs to address in order to encourage the use of this

technology. In this study, the literature on innovation theory, theory of reasoned action (TRA) and TAM was reviewed and a justification for using these models to investigate the factors contributing to mixed and non-usage of FDFs is also given. Data were collected through personal and telephonic interviews, and with the use of questionnaires. The findings reveal the key drivers of intentions to use, which indicate the eagerness to use in terms of perceived usefulness, perceived enjoyment and attitude towards use, respectively.

This study will explore the technology acceptance models in order to explain why certain monitoring officers at ICASA would prefer specific technologies over the others. Models of interest would be the Innovation theory, TRA and TAM. After reviewing both models, the author will examine the TAM in detail as a model of interest in this study. In turn, this model is expected to assist us to understand why monitoring officers' at ICASA would prefer a particular frequency monitoring technology over the other.

Chapter 1. INTRODUCTION

1.1 Background

Radio frequency spectrum monitoring plays an important role when one wants to locate the sources of unlicensed radio frequency transmissions. It is conducted to provide specific data for the evaluation of the condition of the radio environment and to assess whether licensees have installed and have maintained the installation in accordance with authorized radio station licence parameters. Wellenius and Neto (2006), defined radio frequency spectrum as the range of wavelengths used, for example, for broadcasting radio, terrestrial television and satellite television. The author will operationalize the defination by stating that radio is a range of waves with a wavelength between 0.5 cm to 30,000 m. Independent Communications Authority of South Africa (ICASA), a regulatory body in the telecommunications industry in South Africa has identified the need to monitor the spectrum for detecting unlicensed radio transmitters, which they can do, either by using remote site antenna masts, mobile monitoring units or by using Fixed Direction Finders (FDFs). According to ICASA (2002), radio spectrum monitoring in South Africa will ensure that licensed broadcasting and signal distribution services adhere to their: licence conditions and obligations, the various codes and also to regulations.

The introduction of these technologies will present considerable reactions from those who will be using them. In order to determine the reactions, certain technology acceptance models and theories such as Innovation theory, Theory of Reasoned Action and Technology Acceptance Model could be used.

Acceptance of new technologies in the workplace has recently become of paramount importance to the extent that organisations investigate the acceptance of each technology that they invest in and deploy. In this study, the monitoring officers' acceptance of FDF technology deployed recently by ICASA, to monitoring of radio frequency spectrum, is investigated. All five ICASA regions where this technology is deployed, namely the central monitoring office (CMO), Cape Town, Port Elizabeth, Bloemfontein and Durban, participated in this study.

The purpose of this study is to investigate the acceptance of radio frequency spectrum monitoring technologies such as FDFs. The population of this study will be officers at ICASA's monitoring division, which consists of central and regional offices.

1.2 Background to the problem

ICASA, a body charged with the regulation of the communications industry, has experienced some challenges as far as monitoring and locating of sources of unlicensed radio transmissions are concerned (ICASA annual report, 2001). In the article it is mentioned that these challenges were attributed to the organisation's first set of radio direction finders, called remote site antenna masts systems, which serve the purpose of locating sources of unlicensed radio transmitters. A radio direction finder is a device for finding the direction to a radio source or a radio transmitter. Remote site antenna masts systems are those antennas that are mounted on high sites and are arranged in such a way that they complement each other in locating a radio transmitter (Skinner, S, 2005, Personal Interview). They are controlled from the regional or main office through network links. They are focused in such a way that they form a triangle around an area that most likely contains a transgressing radio transmitter.

In the Cape Town region this infrastructure was installed in 1998 and has been operating ever since. There were challenges that the monitoring team faced when using these antennae, such as low level of accuracy, relatively high time consumption and relatively high level of manpower. The first disadvantage was that the method used through remote sites antenna masts, was not accurate (Rossouw, A, 2005, Personal Interview). The monitoring officers had to assume that the transmitter was within the triangle, only to find in certain instances that they were detecting a reflected signal (i.e., the system did not average the signal to supply the exact location of the source). Secondly, it needed a minimum of two people: a driver and a person to carry the handle antenna system and continuously take readings as the vehicle moved in order to locate the exact position of the transmitter. The role of the vehicle was to get closer or zero in on the targeted transmitter. Thirdly, it took a long time because when, for instance, there were many high sites in a triangle, one had to drive from one site to the other, which was time consuming.

In order to overcome this, ICASA introduced mobile monitoring units (Basson, P, 2005, Personal Interview). These units were deployed in the Cape Town region in 2000. These are vehicles with antennae mounted on their rooftops. Therefore, instead of an officer stopping a car and taking readings or the one person driving and the other carrying a handle antenna system, readings are taken continuously and the signal strength is averaged to locate the transmitter more accurately. This system is based on maps that are detailed up to street level and, therefore, are better suited to approximate the position of an illegal transmitter. These maps are mounted in such a way that the driver can read them while driving – as a result, the manpower requirements are reduced. The disadvantage of the mobile systems is that if the triangle (which is formed by the remote sites' antenna masts) is large, the officers will have to drive several kilometres from one point to another in search of one transmitter, which can be quite time consuming. Another disadvantage is that they work hand in hand with remote sites antenna masts, and if the network for remote sites is down, they cannot perform their task.

In order to overcome these shortcomings, ICASA introduced FDFs in 2003. Unlike the previous technology, an FDF works without the help of remote sites. There are cases where FDF systems are used together with a mobile system; in such cases they are first employed to locate the transmitter within some area of uncertainty. The mobile system is then dispatched to that area where it locates the transmitter precisely by physically homing in on it.

Another reason for the implementation of FDFs is that the infrastructure used prior to the introduction of FDFs could no longer cope with an increased demand in monitoring work. This is highlighted in a quote below extracted from ICASA (2001:4):

> "Due to the complexity of monitoring all the licensees and their compliance with regulations such as South African Music Content, the Authority's monitoring capacity is extremely ill-equipped – both in terms of human and technical resources. The processes and equipment, put in place in 1995, are now outdated and can no longer service the workload, which continues to increase as more stations are licensed".

ICASA was optimistic that this project would solve the challenges that it had encountered with the equipment that was used before FDFs. This was indicated by ICASA (2004:35) as follows:

> "This infrastructure will significantly improve the effectiveness of spectrum monitoring and location of sources of unlicensed radio transmissions".

However, preliminary interviews revealed that there were mixed feelings concerning the acceptance of FDFs. These preliminary interviews were conducted with three monitoring officers and a manager of the Cape Town regional office of ICASA, and a telephone interview with officers from ICASA's Durban regional office. The general view of monitoring officers at the Cape Town regional office is that it is best to combine the capabilities of the new and the old system for better results.

1.3 Research problem and question

Based on preliminary investigations, the following problem was identified:

- The author observed that in some cases, monitoring officers will combine legacy as well as new technologies such as FDFs when monitoring radio frequency spectrum.

The basic research questions therefore became the following:

- What is the level of acceptance of FDFs in all ICASA regions and the CMO?
- What are the factors responsible for this level of acceptance?
- What can be done to improve this acceptance level?

1.4 Aim and objective of research

The broad aim of this study was to examine the acceptance of the technologies available to monitoring officers at ICASA, and why the newer technologies are seemingly not used to their full capacity. In this study the following objectives were addressed:

~~1.4.1~~ To study literature on TAM.

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~~1.4.2~~ To investigate the use and acceptance of FDF technology in all ICASA regions (through quantitative and qualitative methods).

~~1.4.3~~ To investigate how the officers who are currently not using FDFs (non-current FDFs users) perceive these technologies as compared to officers who are currently using FDFs (current FDFs users).

~~1.4.4~~ To determine through the use of TAM the factors responsible for combining monitoring technologies.

~~1.4.5~~ To suggest and recommend ways to address these factors.

1.5 Rationale for the research

Although FDFs offer increased accuracy, it has become apparent that these systems are not used to their full capacity and that the older system is still in place and being used.

It was, therefore, decided that a study focusing on acceptance of technology be undertaken to investigate the matter further. TAM by Davis (1986) has been used extensively, and with success in studies related to this area of interest, and it will therefore be a helpful model to use as a basis for the investigation of the acceptance of these FDFs by officers.

It is important to study these issues because lack of acceptance would imply that two or more modes of monitoring have to be supported. If one can determine the factors that inhibit acceptance, they can be addressed and legacy systems can be discontinued, leading to lower maintenance costs.

1.6 Organisation of the work

The remaining parts of this study are structured as follows:

Chapter 2 presents a literature review on acceptance of technology, which consists of three areas of interest (innovation theory, theory of reasoned action and TAM) on which this study is based, together with hypotheses development.

Chapter 3 presents the methodology used in this study. It also provides an explanation of the procedure on how data analysis was done. The data is analysed using factor, correlation and regression analyses.

Chapter 4 presents the finding and interpretation of results. This process is done in three stages, namely motivational measures, construct validity and intercorrelation analysis. This chapter also shows hypothesis testing done in three steps, namely model summary, analysis of variance and model parameters.

Chapter 5 presents the conclusions and recommendations. This chapter consists of overview, recommendations and limitations of the study.

1.7 Summary

This chapter introduced the frequency spectrum monitoring concept and described how frequency monitoring activities were carried out by ICASA in the past, and how it is being done at present. The information about the monitoring technologies used prior to FDFs is given in this chapter to help the reader understand the evolution of direction finding technology. The aim and objectives of the research, rationale for the research, as well as research problem and questions are also outlined in this chapter. The next chapter provides a review of the relevant literature.

Chapter 2. LITERATURE REVIEW

2.1 Introduction

The previous chapter described the rationale for embarking on the current study from ICASA's and the researcher's perspective. This chapter, therefore, provides that theoretical basis, and does this by referring to similar previous studies together with the relevant models that were used in each case. The chapter starts by arguing why the model that was applied in this study is the most relevant compared to the other models that were used in similar studies.

The model applied in this study is an extension of TAM suggested by Davis (1989). Davis based TAM on TRA, which originates from innovation theory. The study, therefore, starts by describing innovation theory and TRA. It will show how innovation theory evolved into TRA and how Davis (1989) extended TRA to create TAM. This chapter also indicates how innovation theory and TRA individually form a basis for this study on the acceptance of FDFs by individuals at ICASA's frequency monitoring unit. Finally, past studies are used to generate hypotheses for the current study.

This chapter starts with definations of main concepts used in the thesis, followed by a literature on the acceptance of FDFs. It then goes on to draw attention to innovation theory and its relevance to this study. Fourthly, TRA is discussed showing its relevance to the current study. Finally, Davis' TAM is discussed in full and its relevance to the current study shown. The chapter concludes with the model and hypotheses generation.

2.2 Definations

The main concepts used in this thesis are defined as follows:

Radio frequency spectrum: the range of wavelengths used, for example, for broadcasting radio, terrestrial television and satellite television (Wellenius *et al.*, 2006).

Fixed Direction Finder: a static direction finder technology used for the purpose of frequency spectrum monitoring and location of unlicensed transmitters (ICASA, 2002:17).

2.3 Radio frequency spectrum monitoring

Mayher and Kisrawi (2002) described the importance of radio frequency spectrum monitoring (which is often called spectrum monitoring), in their forward to the third edition of the Handbook on Spectrum Monitoring published by the ITU. They stated that spectrum monitoring is one of the essential tools of spectrum management, the development of whose techniques are informed by the need to ensure compliance with design parameters and standards for radiocommunications.

Méndez (2001) described spectrum management, in his paper to International Telecommunications Union-Radio (ITU-R), as the combination of administrative, scientific and technical procedures necessary to ensure efficient operation of the radiocommunication services without causing harmful interference. The main objective of spectrum management is to maximize the efficiency of spectrum utilization, whilst simultaneously minimizing interference.

Spectrum monitoring is very useful for an investigation of the sources of harmful interference to authorized transmitters. In order to resolve certain types of harmful interference, measurements in combination with an engineering analysis are necessary, and monitoring plays an important part in this process. In short, spectrum monitoring is mainly important because:

- an unlicensed or defective transmitter harmfully interferes with other, legally permitted transmissions,
- allowing the operations of unlicensed transmitters constitutes loss in revenue to the spectrum administration, and further compounds by encouraging others to operate illegally, and
- Planning can only be systematic and consequently effective in an arena that is at once coordinated, stable, and predictable.

One of the techniques or technologies used to conduct spectrum monitoring is FDF. There is not much literature written or at least published on this new technology.

2.4 Acceptance of FDFs

According to Morris (2007, Personal Interview) of Grintek ewation, a company that supplied ICASA with FDFs, there has been a high acceptance of FDFs worldwide. Many of the organisations and countries who bought the FDF technology from Grintek ewation reported a high level of FDF acceptance by employees, added Morris - Grintek's regional marketing director for Asian countries. Most of Grintek's clients has been the military. In order to investigate the acceptance of this technology in South Africa and at ICASA in particular, we first explore different theories and models used to study acceptance of technology in general.

2.5 Innovation theory

While doing research on how new ideas spread through a society, Rogers (1968) developed a theory that came to be known as innovation theory. One of his studies focused on how Midwestern farmers adopted hardier corn. In 1962 Rogers published the first of his four editions that dealt with this theory and its application. The latest edition was published in 1995.

An innovation is described as an idea, practice, or object such as a technology (Rogers, 1982). There are two types of innovations, namely radical and incremental. Radical innovations are those objects or technologies that are new or are designed to serve needs yet to be known, while incremental innovations are improvements of what already exists. This study will adopt the incremental description of innovation because FDF is an improvement of what already exists. When people are exposed to innovation frequently, they are able to decide whether or not to accept it. Some innovations take a long time to be accepted by individuals or an organisation, while others do not. The concept of acceptance is dealt with in full below. The different rates of acceptance have been closely associated with the characteristics of innovations. According to Agarwal and Prasad (1998), there are three main characteristics of innovation that are most referred to in empirical studies on an individual's decision as to whether or not to use a particular technology. These characteristics are stated as being relative advantage, compatibility and complexity. A simple description of these characteristics is given by Rogers (1995), who describes relative advantage, compatibility and complexity as follows:

- relative advantage: the level to which an innovation is viewed as being superior to the idea it replaces,
- compatibility: the level of perception to which the innovation is viewed as being consistent with the organisation's existing values, past experiences and needs, and
- complexity: the level at which an innovation is viewed as difficult to understand and use.

As mentioned above, innovations include technology. Stewards and Nihel (1987) describe technology as new and better ways of achieving economic ends that contribute to economic development. These ways include, amongst others, computers, the internet, satellites, broadband and direction finders. According to Stewards and Nihel (1987), the usage of these technologies contributes to economic growth in the sense that they increase efficiency and reduce the time required to accomplish a task.

Rogers (1982), on the other hand, describes technology as a design for instrumental action that reduces the uncertainty in the cause-effect relationships involved in achieving a desired outcome. He describes uncertainty as the hesitation within an individual or an organisation to accept and probably use a particular technology, because they doubt its superiority over the previous one. For the purpose of this study, the first description of technology by Stewards and Nihel (1987) will be adopted. Rogers (1982) nevertheless explained the two aspects of technology that are useful for this study. These two aspects are: hardware, consisting of the tool that embodies the technology as a material or physical object, and software, consisting of the information base for the tool.

Dillon (2001) describes user acceptance as the demonstrable eagerness within a user group to utilise a technology for the tasks it is intended to support. Acceptance of innovations in organisations worldwide is of great concern because if users are not willing to accept and use them, those innovations will not bring full benefits to the organisation (Davis and Venkatesh, 1996; Davis, 1993). Perceived benefit is described clearly by Pérez *et al.* (2004) as the adopter's belief of the probability that the technology can improve the economic benefits to the organisation and/or to the person. The more beneficial an organisation believes a particular technology is, the greater the likelihood that they will adopt it. Rogers (1995) describes adoption as a social change process, in which an innovation is communicated over time among members of a social system. As can be noticed from the definitions of acceptance and adoption, the two terms mean two different things. However, for the purpose of this study it will be assumed that they mean one and the same thing, and therefore, from now onwards these definitions will be used interchangeably.

The notion of acceptance of innovation forms the basis of this study on the acceptance of FDFs. In this study, the reasons behind mixed or non-usage of FDFs are investigated so that those obstacles can be addressed, which could then result in the realisation of the full benefits of innovations. Acceptance theorists are more concerned with understanding the factors influencing the adoption of technologies as planned by users who have some degree of choice. If the users of a new system are more accepting of it, the more willing they will be to make changes in their practices and use their time and effort to start using that new system (Succi and Walter, 1999). This corresponds with the objectives of the present study on acceptance of FDFs. The objectives are to study the problems that individuals encounter so that ways of minimising resistance can be explored and suggested, which will lead to individuals readily accepting the technology.

Resistance is clearly described by Spacey *et al*. (2003) as negative reactions to technology displayed by individuals. Individuals develop negative reactions towards a technology according to the way they perceive that particular technology. According to Utterback (1994), the management of innovation and innovation adoption studies recognise that what appears to be the best technology does not always become the most widely accepted. There are different factors that result in prospective users having negative reactions towards these seemingly best technologies. Among them are factors related to the substitution of a particular technology with a new one in an organisation. Scholars such as Rogers (1995), Tornatzky and Klein (1982), Wolfe (1994) and others conducted extensive research on technological innovation that focused on problems of technology-based change in organisational and social settings. In summary, the literature has shown that there are a substantial number of individuals that are resistant to innovation. Having discussed innovation theory, technology acceptance and resistance, there still remains the challenge to show their relevance to the current study on the acceptance of FDFs.

According to Damanpour (1991), innovation theory has assisted many researchers in establishing whether an organisation will adopt one of a wide range of innovations that are new to the organisation. Pérez *et al*. (2004) shared the same view. They stated that innovation theory could aid in the understanding of technologies that are not being absorbed as expected. Therefore, the adoption of FDF technology could also be studied and understood with the help of innovation theory. Innovation theory has both its strong points and its shortcomings.

Brancheau and Wetherbe (1990) discovered that traditional variables that are normally used to investigate diffusion of technologies in the innovation diffusion theory are inadequate to explain diffusion of complex organisational technologies. Diffusion is described as the process by which an innovation is communicated through certain channels over time among the members of a social system (Rogers, 1983). Brancheau and Wetherbe (1990) suggested that an independent or control variable be added to the theory to accommodate studies on complex technologies. As a result of this shortcoming in the innovation theory, TRA was then introduced to complement it.

2.6 TRA

TRA is based on the assumption that people act logically and that they gather and assess thoroughly all of the available information. According to Ajzen and Fishbein (1980), TRA assumes that people consider the outcomes of their probable actions and, depending on this analysis, make decisions on whether or not to take action. This implies that people would use a technology if they sensed that there could be positive outcomes as a result of its usage.

TRA (Fishbein and Azjen, 1975) states that people's viewpoints influence attitude, which in turn shapes intention that subsequently guides or dictates behaviour. Unlike the innovation theory, which focuses on the characteristics fundamental to a technology, TRA focuses its analysis on how important characteristics of a technology are communicated and perceived by target users (Pérez *et al*., 2004). This theory is relevant to this study on the acceptance of FDFs because in this study, ways in which variables such as perceived ease of use, perceived usefulness and perceived enjoyment influence attitudes towards using a particular technology (which subsequently shapes behaviour) are investigated. The main shortcoming with TRA as far as prediction of technology acceptance is concerned, is that it is technology specific. This implies that the factors affecting the acceptance hold for that particular technology only. Therefore, after the development of the two above-mentioned theories, researchers were yet to develop a model that would be appropriate to predict acceptance of various technologies by individuals. Davis (1989) developed TAM, which was basically an extension of TRA. This model was tested by scholars such as Adams *et al*. (1992), Segars and Grover (1993), and Doll *et al*. (1998). These authors found the model more reliable in predicting individuals' acceptance of various technologies. Of course, there are those who still think that it is very difficult to predict the degree of rejection or acceptance on the basis of externally visible characteristics (Ortega *et al*., 2007).

2.7 TAM

Davis *et al*. (1989) defined TAM as a model in which the impact of external factors on internal beliefs, attitudes and intentions is used to explain the determinants of technology acceptance. They developed this model by modifying Fishbein and Ajzen' TRA. This is referred to as the basic TAM. Models such as TRA, theory of planned behaviour (TPB) or TAM, which are generally regarded as attitude models, measure attitudes towards an object by focusing on consumers' beliefs about the attributes of a product (or a technology in the case of TAM) and their evaluation of these attributes (McKechnie *et al*., 2006). Internal beliefs in this case refer to perceived usefulness and perceived ease of use, which are regarded in the technology acceptance model as the most important determinants of technology acceptance in organisations. Perceived usefulness is the degree to which an individual believes that using a particular system would enhance his/her job performance, and perceived ease of use is the degree to which an individual believes that using a particular system would be uncomplicated, as suggested by Davis (1986).

According to McKechnie *et al*. (2006), these two determinants are seen by many researchers as essential to the individual's formation of attitude towards using a particular technology, which in turn dictates intention to use, that then generates the actual usage. Attitude towards using is defined as the mediating affective response between usefulness and ease of use beliefs, and intentions to use a target system (Davis, 1989). The author added that effects of external variables such as individual differences or situational constraints are expected to impact on user acceptance, but only as far as they are mediated by perceived usefulness and perceived ease of use.

The role of attitude towards using a technology as an important determinant of behavioural intentions or intentions to use was initially ignored. The reasoning behind this exclusion was that organisations do not consider the attitude of people when they deploy a technology in the workplace. Thus, in the original version of TAM, perceived usefulness and perceived ease of use impact directly on the behavioural intentions and not via attitude towards use. Lee's (2006) results also support these TAM research findings that perceived usefulness and perceived ease of use are important variables affecting acceptance. Hence, the basic model of TAM still reflects a direct link between perceived usefulness and behavioural intentions. In this case the definition of intention to use, which states that intention to use is the strength of one's intention to perform a specified behaviour, is used.

However, further studies revealed that overall attitude toward using a technology is a major determinant of whether or not a consumer will use it (Davis, 1993). The argument in these studies is based on the notion that favourable attitudes will result in technology usage and unfavourable attitudes result in rejection of technology usage (Liker and Sindi, 1997). As a result, attitude was included as a determinant of behavioural intentions and forms part of TAM (Davis *et al*., 1989). The basic technology acceptance model, which includes an attitude-intention relationship, is displayed in figure 1 below:

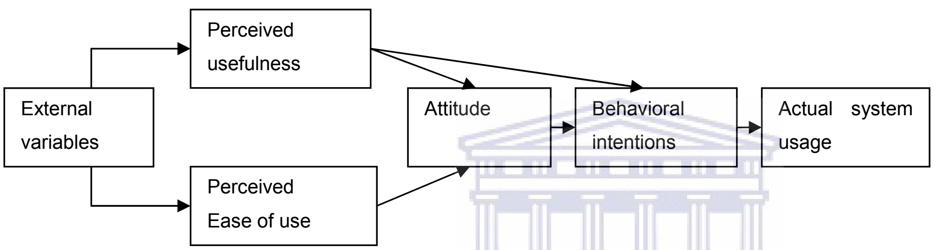

Figure 1 Basic TAM (Davis, 1989)

The above model has been extended to accommodate research on the impact of new technologies in the workplace in the field of information technology (Agarwal *et al*., 1998; Adams, 1992; Davis, 1989; Bertot, 2004), telework (Trembley, 2002; Pérez, 2004) and the internet (Abukhader, 2003; Kinder, 2000). As far as computer-based technology is concerned, Deng *et al*. (2005) demonstrated cases where TAM was applied to a range of computer-based technology situations, both general (e.g., e-mail, PC office suite applications, online shopping) and specific (e.g., accounting services). These findings are of particular importance to the current study because FDF is a computer-based technology.

Davis *et al*. (1992) modified the basic TAM to include perceived enjoyment in their study on extrinsic and intrinsic motivation to use computers in the workplace. Perceived enjoyment is defined as the degree to which the usage of

FDFs is perceived as being enjoyable by the user, irrespective of its expected performance (Fishbein and Ajzen, 1975). They found that acceptance is influenced by increased enjoyment derived from using a computer. The inclusion of this construct in a TAM renders this model the most suitable framework, as compared to innovation theory and TRA, for the purpose of the present study.

There is another factor that makes TAM more useful – its consistency. TAM has been widely applied across different application types with consistent results (Dillon, 2001). In fact, De Hoyos *et al*., (2006) describe TAM as being the most widely used among the theories of individual behaviour related to the question of new technology application. As an example, TAM has been credited by several studies (Davis, 1989; Davis *et al*., 1989; Adams *et al*., 1992; Davis, 1993) with the ability to explain attitude towards using an information system far better than TRA and TPB. The same sentiment is shared by Hong (2006), who stated that substantial theoretical and empirical support has accumulated in favour of TAM compared to alternative models such as TRA and TPB. TPB is a model in which attitude, perceived behavioural control (defined as the perception of how easy or difficult it is to perform a behaviour) and subjective norm (defined as one's beliefs about whether others think that one should engage in the activity) dictate behavioural intention to perform an activity. According to Pikkarainen (2004), TAM consistently explains a significant fraction of the variance (typically around 40 percent) in usage intentions and behaviour. This is the reason why it is widely used by information systems researchers (Ndubisi, 2006). Therefore, TAM becomes the most relevant model to study the acceptance of FDFs because of its consistency across a wide range of different technologies.

In conclusion, a literature review has shown that TAM is particularly suitable for the purpose of this study.

2.8 The proposed model for this study

Figure 2 presents the model for the current study, which presents relationships among perceived usefulness, perceived ease of use, perceived enjoyment, attitude towards use and intention to use.

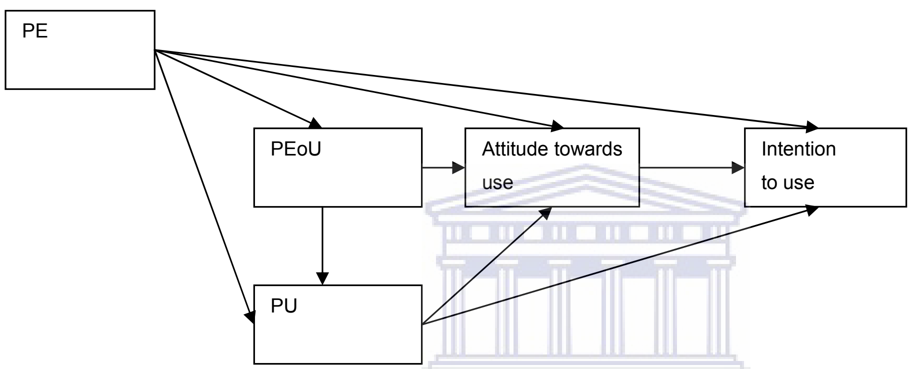

Figure 2 Research model adapted from basic TAM

2.8.1 Hypotheses development

Di Benedetto (2003) proposed and proved that if the effect resulting from the adoption of a technology (technology-related benefits such as improved product quality, production quantity, worker productivity, or minimised production problems) is perceived as being of positive value, the attitude (or effect) toward the adoption itself is likely to be more positive. The formulation was found to be consistent with TAM in which the relationship between perceived usefulness and attitude develops through learning and affective-cognitive consistency mechanisms (Davis *et al*., 1989). Similarly, an increase in attitude towards use would be expected if the perceived usefulness is viewed as positive. Therefore, a hypothesis directly linking perceived usefulness to attitudes toward use is suggested:

H1: People who perceive FDFs as useful are more likely to have a positive attitude towards using them.

According to Daamen *et al*. (1990), people form attitudes toward specific technologies and these attitudes can be adequately measured. TRA suggests that a positive attitude toward a behaviour tends to lead to a greater intention to perform that behaviour (Fishbein and Ajzen, 1975; Ajzen and Fishbein, 1980). The greater the ease of use in the users' view of FDFs, the more positive the attitude towards use they would have, because using FDFs would require less physical or mental effort on their part and save them time. This is consistent with TAM (Davis *et al*., 1989); this model anticipates a direct positive effect of perceived ease of use on attitude towards use. A hypothesis is therefore developed:

H2: People who perceive FDFs as easy to use are more likely to have a positive attitude towards using them.

Perceived enjoyment was found to have direct effects on attitude towards using mobile chat services for both males and females (Nysveen *et al*., 2005). Similarly, perceived enjoyment would, therefore, be expected to have direct effects on attitude towards using FDFs for both current and non-current FDFs users. Therefore, a hypothesis directly linking perceived enjoyment to attitude towards using FDFs by both categories of participants is suggested:

H3: People who perceive FDFs as enjoyable to use are more likely to have a positive attitude towards using them.

According to TAM (Davis *et al*., 1989), perceived usefulness should have a direct positive effect on behavioural intention, while perceived ease of use has a direct positive effect on both perceived usefulness and attitude toward use, both of which have direct effects on intention to use. Therefore, the following hypotheses that directly link perceived usefulness to intentions to use, perceived ease of use to perceived usefulness and attitude towards use to intentions to use are suggested:

H4: Positive attitude towards using FDFs is more likely to generate a positive effect on intentions to use FDFs.

H6: People who perceive FDFs as easy to use are more likely to find them useful.

H9: People who perceive FDFs as useful are more likely to have positive intentions to use FDFs.

Dias (1998) found that perceived enjoyment and perceived ease of use had positive effects on perceived usefulness. He also found that perceived enjoyment had a positive relationship with ease of use of computers by managers. Therefore, two hypotheses directly linking perceived enjoyment to perceived ease of use and perceived enjoyment to perceived usefulness are suggested:

H5: People who perceive FDFs as enjoyable to use are more likely to find them easy to use.

H7: People who perceive FDFs as enjoyable to use are more likely to perceive them as useful, too.

Perceived enjoyment has been found to have significant effects on intention to use a word processing program (Davis *et al*., 1992). Several other studies were conducted on the impact of enjoyment on the use of computers in the workplace (Webster and Martocchio, 1992; Webster, 1989). Therefore, a hypothesis directly linking perceived enjoyment to intention to use is suggested:

H8: People who perceive FDFs as enjoyable to use are more likely to have positive intentions to use FDFs.

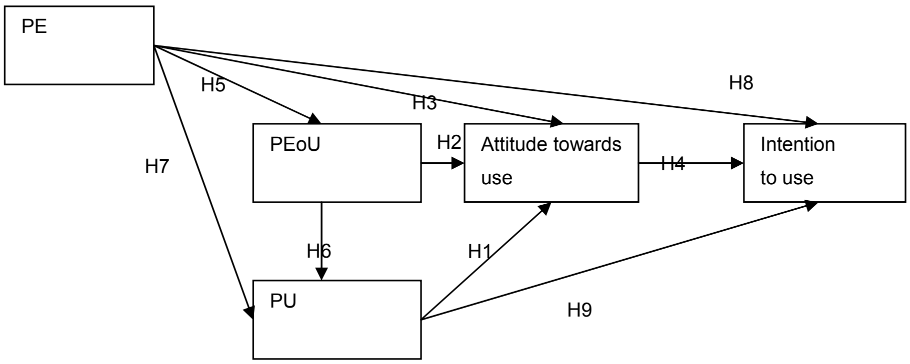

Figure 3 Research model with hypotheses fitted

2.9 Summary

In this chapter, innovation theory, TRA and TAM, and their relationship to the current study were discussed. The next section on proposed hypotheses started with a brief outline of the framework and then went on to provides eight hypotheses that were derived from the framework.

Chapter 3. RESEARCH METHODOLOGY

3.1 Introduction

This chapter firstly describes the instrumentation (questionnaire and validation) used to capture data; secondly, it narrates how sampling was done, and lastly, it describes the data collection. Two research designs were used, namely quantitative and qualitative.

In the qualitative research phase, exploratory personal interviews were conducted with four monitoring officers and a manager from the Cape Town regional office. The data from these interviews were supplemented with further data that were gathered from a telephonic interview that was done with two officers from the Durban regional office. These interviews were conducted before the actual research in order to establish the research problem. It was found that there was mixed and non-usage of FDFs.

In the quantitative research phase, questionnaires were distributed to 21 monitoring officers from five regional offices. Nineteen of the 21 officers completed and returned the questionnaires. These were the questionnaires from which the actual data used in this study were drawn.

3.2 Instrumentation (the questionnaire and validation)

A quest for clarity – as far as items in the questionnaire are concerned – led to the use of previous questionnaire items which were slightly modified to ensure relevance to this particular study. The questionnaire was pre-validated because it was used in TAM as a measurement inventory (Davis, 1989). Items for the perceived ease of use and perceived usefulness, as well as the items for intentions to use, were adapted from Davis *et al*. (1989), while items for perceived enjoyment were adapted from a previous study by Davis *et al*. (1992).

The questionnaire used in this study was divided into different parts as follows:

- Part A, applicable only to those who are currently using FDFs, and
- Part B, applicable only to those who are not currently using FDFs.

(See the sample questionnaire, Appendix 1)

In both Parts A and B the respondents used a five point Likert-type response scale (1= strongly agree, 2 = agree, 3 = neutral, 4 = disagree and 5 = strongly disagree) to rate their perceptions of the FDFs used in the monitoring of the frequency spectrum. These two parts comprised randomly presented statements designed to measure the perceived usefulness, perceived ease of use, perceived enjoyment, attitude towards use and intentions to use. The Cronbach alpha values were calculated from the actual questionnaires that were completed and returned by 19 respondents. The data were fed into an SPSS program which computed the Cronbach alpha values automatically. The scales used for studying the perceptions of participants had the following Cronbach alpha values: perceived usefulness (0.823), perceived enjoyment (0.927), perceived ease of use (0.916), attitude towards use (0.936) and intention to use (0.704). According to Nunnaly's (1978) criteria on the reliability of a Cronbach scale, the constructs are believed to demonstrate sufficient reliability since their Cronbach alpha values are all above 0.70.

3.3 Population and Sample

The qualitative research and quantitative research methods were used in this study. Myers (1997) defines quantitative research as a well-planned and proper method with a distinctive aim of obtaining information about something using numerical data; and qualitative research as the use of qualitative data, such as interviews, documents, and participant observation data, to understand and explain social phenomena.

All five of ICASA's monitoring offices in five different provinces participated in the study. A total of 21 frequency monitoring unit employees participated in the study, six from ICASA's CMO in Sandton, five from ICASA's Port Elizabeth regional office, four from ICASA's Cape Town regional office, three from Bloemfontein regional office, and three from ICASA's Durban regional office. This number constitutes total number of monitoring unit employees available in the whole of South Africa. Two employees from Durban's regional office did not return their questionnaires, which brought the total number of participants who completed and returned their questionnaires to 19. The population and sample are represented in table 1.

Table 1: Sample description

	Number of people
Population	21
Sample	21
Number of people from sample who completed and returned the questionnaire	19
CMO	6
Port Elizabeth	5
Cape Town	4
Bloemfontein	3
Durban	2

One respondent out of the nineteen that filled out and returned the questionnaire had over five years of working experience in ICASA's frequency monitoring department. Owing to the small population it was only proper that 100% of the population be sampled because that would best reflect the perceptions of monitoring personnel on the FDFs.

3.4 Data Collection

The questionnaire was emailed to each of the 21 participants. Nineteen participants out of a total of 21 participants, which constituted 90.5% of the total population, completed and returned the questionnaire. The findings are reported using descriptive statistics.

3.5 Summary

This chapter presented a description of how the literature was used to develop hypotheses, the questionnaire used to capture research data and how the constructs were validated. The procedure followed to draw a sample from the population was also described. Lastly, a description was given of how the data were collected.

The next chapter describes how the collected data were analysed and interpreted.

Chapter 4. FINDINGS AND INTERPRETATIONS

4.1 Introduction

The first section of this chapter describes the individual ratings of motivational measure, construct validity (factor analysis is used to investigate whether the motivational factors used in this study constitute five distinct perception constructs) and the intercorrelation matrix between motivational factors.

The second section outlines three stages of hypotheses testing (hierarchical regression analysis was used since it allows for the study of the effects of various variables separately). These three stages are as follows: model summary, analysis of variance (ANOVA) and analysis of model parameters. In the model summary stage, a description of the statistical method used is described, and the reasons for choosing this method are also given. In the ANOVA stage, an investigation is made to determine the ability of the final model to improve significantly the ability to predict the outcome variable. Lastly, betas are calculated and their values are used to show why the various hypotheses are supported or rejected.

4.2 Motivational measures

A path analysis model was used. This model states that the basic aim of any science is to establish causal relations and, as far as a theory is able to show a logical connection between two variables, one may make the intellectual leap to a causal interpretation (Blalock, 1972). Thus, the correlation test between antecedent variables exhibits multicolinearity if the correlation coefficients are above 0.80. A multiple regression on the statistical program SPSS was used to test the research model. The results are shown in table 2 below:

Table 2: Motivation levels (current FDF users and non-current FDFs users)

Item description	**Current FDFs users**		**Non-current FDFs users**	
	Mean	Std. Deviation	Mean	Std. Deviation
Perceived Usefulness	1.69999	.838135	1.37036	.512185
Perceived Enjoyment	1.76665	.889585	1.29628	.388873
Perceived Ease of Use	1.76665	.916909	1.44442	.645493
Attitude towards Use	1.76665	.943451	1.37036	.654987
Intention to Use	1.85000	.973253	2.61111	.740683

Note: All questions for each category of users are stated in a 5-point Likert scale (1=strongly agree and 5=strongly disagree)

4.2.1 Perceptions of participants on the usefulness of FDFs

Three affirmative questions were designed and dedicated to establish the respondents' perceptions on the usefulness of FDFs used at ICASA's monitoring offices for frequency spectrum monitoring purposes. The findings revealed that FDFs were rated very useful, with a mean rating of 1.700 (sd=0.838) by people who are currently using them, namely current FDFs users (Table 2). People who are currently not using them(non-current users) rated this technology even better, with a mean rating of 1.370 (sd=0.512).

4.2.2 Perceptions of participants regarding the enjoyment of using FDFs

Three affirmative questions were aimed at ascertaining the respondents' perceptions on the enjoyment of using FDFs. The findings revealed that participants who are currently using FDFs rated the technology as being very enjoyable to use, with a mean rating of 1.767 (sd=0.890), while those who are currently not using FDFs perceive them as extremely enjoyable to use, with a mean rating of 1.296 (sd=0.389). Among the participants who are currently using them, people were slightly more motivated by perceived usefulness (1.700) than perceived enjoyment (1.767), while those who are currently not using them view perceived enjoyment (mean=1.296) as a greater motivator compared to perceived usefulness (mean=1.370). These results can be seen in table 2.

4.2.3 Perceptions of participants regarding the ease of use of FDFs

Three affirmative questions were designed to determine the respondents' perceptions on the ease of use of FDFs. The findings show that people who are currently using FDFs rated the technology as being easy to use, with a mean rating of 1.767 (sd=0.916), whereas people who are currently not using them perceive this technology as extremely easy to use, with a mean rating of 1.444 (sd=0.645). Among the people who are currently using the technology, perceived usefulness (1.700) emerged as the strongest motivator, with perceived ease of use (1.767) and perceived enjoyment (1.767) motivating users to the same extent (Table 2). Among the people who are currently not using the technology, perceived ease of use (1.444) emerged as the least motivating of the three factors.

4.2.4 Attitude of participants towards using FDFs

Three affirmative questions were designed to ascertain the respondents' attitude towards using FDFs. The findings show that people who are currently using FDFs have a fairly positive attitude towards using this technology, with a mean rating of 1.767 (sd =0.943). People who are currently not using the technology have a stronger positive attitude towards using the technology than those who are currently using the technology, with a mean rating of 1.370 (sd =0.655).

4.2.5 Participants' intentions to use FDFs

Two affirmative questions were used to establish the respondents' intention to use FDFs. The findings show that people who are currently using FDFs have positive intentions to use this technology, with a mean rating of 1.850 (sd =0.973). People who are currently not using FDFs seemed not keen to use this technology despite their stronger positive attitude toward using it, recording a mean rating of 2.611 (sd=0.740).

In summary, perceived usefulness emerged as the strongest motivator by both current user and non-current user groups, ahead of perceived ease of use and perceived enjoyment. This implies that the main reason people opt to use or would want to use FDFs is that they view them as useful for their jobs. Secondly, the positive attitude towards use and positive intentions to use FDFs by current users indicates that current users are likely to use FDFs. Lastly, the non-current user group shows fewer intentions to use FDFs as compared to the current user group which implies that the former, despite having a positive attitude towards using them, would prefer not to use FDFs.

4.3 Construct Validity

A factor analysis with varimax rotation was done to validate whether the participants perceived the five constructs (the statements for usefulness, ease of use, enjoyment, attitude towards use and intention to use) to be distinct. The results showed only one factor solution with eigenvalues greater than 1.0 and the variance explained was 82.7% of the total variance. Igbaria *et al*. (1995) stated the criteria to identify and interpret factors as: each item should load 0.50 or greater on one factor and 0.35 or lower on the other factor. It could therefore be confirmed (for current FDF users) that only one construct is unidimensional and factorially distinct, and that all items used to measure perceived usefulness loaded on a single factor. The results of the factor analysis are shown in table 3.

Table 3 Factor Analysis (Current FDF users)

Component	Eigenvalues		Eigenvalues greater than 1.0	
	Total	Cumulative %	Total	Cumulative %
Perceived Usefulness	4.133	82.662	4.133	82.662
Perceived Enjoyment	.442	91.500		
Perceived Ease of use	.323	97.956		
Attitude towards use	.095	99.861		
Intention to use	.007	100.000		

In the case of non-current users, the results showed a two-factor solution with eigenvalues greater than 1.0 and the variance explained was 86.3% of the total variance. The result of the factor analysis is shown in table 4.

Table 4 Factor Analysis (Non-current users)

Component	Eigenvalues		Eigenvalues greater than 1.0	
	Total	Cumulative %	Total	Cumulative %
Perceived Usefulness	3.016	60 .313	3.016	60.313
Perceived Enjoyment	1.299	86.298	1.299	86.298
Perceived Ease of use	.478	95.859		
Attitude towards use	.194	99.747		
Intention to use	.013	100.000		

It is clear from table 4 for non-current users that two constructs are unidimensional and factorially distinct, and that all items used to measure perceived usefulness and perceived enjoyment loaded on a single factor.

In summary, the results of a varimax rotation indicate that participants in the study understood the five constructs to be distinct. This implies these participants did not have difficulty in understanding and answering the questions.

4.4 Intercorrelation Analysis

Table 5 Intercorrelations of the variables

	Perceived Usefulness	Perceived Enjoyment	Perceived Ease of use	Attitude towards use	Intention to use
Perceived Usefulness	1.000 (1.000)				
Perceived Enjoyment	0.972** (0.984**)	1.000 (1.000)			
Perceived Ease of use	0.718*(-0.014)	0.789**(0.018)	1.000 (1.000)		
Attitude towards Use	0.916** (0.741*)	0.913**(0.715*)	0.801**(0.416)	1.000 (1.000)	
Intention to use	0.733*(-0.397)	0.640*(-0.418)	0.641*(-0.465)	0.664*(-0.525)	1.000 (1.000)

*p<0.05 **p<0.01

(Values in brackets are for the non-current FDFs users)

As can be noticed from table 5 above, perceived enjoyment showed a stronger positive relation with perceived usefulness (r=0.972) than it did with perceived ease of use (r=0.718) in the case of current FDF users. It may be assumed that enjoyment is a factor more strongly linked to the idea of usefulness than ease of use. Among the non-current user group, perceived enjoyment showed an even stronger positive relation with perceived usefulness (r=0.984), implying that non-current users link the idea of enjoyment to usefulness more than those who are currently using the technology. The correlation between perceived enjoyment and intention to use (r=0.640) has the lowest of all four correlations perceived enjoyment has with other factors, namely attitude towards use (r=0.913), perceived ease of use (r=0.789) and perceived usefulness (r=0.972). This implies that when it comes to a point where the participants need to decide whether or not to use FDFs, enjoyment is the least important factor to be looked at. Among the non-users, enjoyment has a strong positive relationship with both usefulness (r=0.984) and attitude towards using (r=0.715); however, it shows virtually no correlation with perceived ease of use (r=0.018). This implies that no matter how much they could enjoy using the technology, there would not be any impact on how difficult or easy to use they would view this technology.

In general, participants who are currently using FDFs tend to associate attitude towards using the technology more with usefulness (r=0.916) and ease of use (r=0.913) than with enjoyment (r=0.801). Among non-using participants, the usefulness (r=0.741) and enjoyment (r=0.715) emerged as the top factors accounting for the positive attitude towards using the technology, ahead of ease to use (r= 0.416). The small value of the correlation between ease of use and attitude towards using FDFs among non-users demonstrates that attitude is – to a lesser extent – linked with the idea of ease of use. The relatively strong correlation between attitude towards using and intentions to use (r=0.664) that exists among current users implies that participants with a positive attitude towards using the technology tend to have a fairly high probability of having positive intentions to use. Similarly, participants with a negative attitude towards using the technology would tend to have negative intentions to use.

Perceived usefulness appears to be positively correlated with attitude towards use (r=0.916) and intention to use (r=0.733), thereby implying that participants who are currently using FDFs tend to use the technology because they believe that it is useful. The results again show a strong correlation between perceived enjoyment and perceived usefulness (r=0.972) which implies that participants who are currently using FDFs view this technology as useful, most probably because they enjoy using it.

In summary, enjoyment emerged as a factor more strongly linked to the idea of usefulness than ease of use amongst the current FDF user group. However, the non-current user group links the idea of enjoyment to usefulness to a greater extent. This leads to a conclusion that people link enjoyment and usefulness positively. A further finding that is also noteworthy is the weak link that enjoyment and intention to use FDFs have amongst the current user group as compared to the strong positive relationship enjoyment has with both usefulness and attitude towards use amongst non-current users. Thirdly, the current user group tends to associate attitude towards using the technology more with usefulness and ease to use than with enjoyment, while amongst the non-current user group usefulness and enjoyment are the top factors responsible for the positive attitude towards using the equipment, ahead of ease to use.

The small value of the correlation between ease of use and attitude towards using FDFs among the non-current user group demonstrates that attitude is – to a lesser extent – linked with the idea of ease of use. The relatively strong correlation between attitude towards using and intentions to use that exists among current users implies that participants with a positive attitude towards using the technology tend to have a fairly high probability of having positive intentions to use. Similarly, participants with a negative attitude towards using the technology would tend to have negative intentions to use.

4.5 Hypotheses testing

4.5.1 Model Summary

Multiple regression analysis was used to test the research hypotheses because it allows us to examine the effects of various variables separately. Under the multiple regression analysis an ordinary least squares method is chosen because its use will ensure that the objectives of this study are reached. The Perceived Usefulness (PU), Perceived Enjoyment (PE) and Perceived Ease of Use (PEoU) data obtained from current FDF users were entered to study their effect on the attitude towards using the technology. PU alone accounts for 82.0 percent of the variance in attitude towards using FDFs. PE account for 0.9 percent of variance in attitude towards use after controlling for PU. PEoU accounts for 3.3 percent of variance in attitude towards use after PU and PE were partialed out from PEoU. In general, about 88.2% of the variance was explained by PU (82.0%), PE (0.9%) and PEoU (3.3%). The same procedure was repeated for participants who are currently not using FDFs. About 75.5% of the variance was explained by PU (54.8%), PE (0.6%) and PEoU (20.1%).

Secondly, PU, PE, and attitude towards use (current FDF users) were entered to study their effect on the intentions to use. PU alone accounts for 53.8 percent of the variance in intentions to use. PE account for 9.7 percent of variance in intentions to use after controlling for PU. Attitude towards using the technology accounts for 0.3 percent of variance in intentions to use after PU and PE were separated from attitude towards use. In general, about 63.8 % of the variance was explained by PU (53.8%), PE (9.7%) and attitude towards use (0.3%). The same procedure was repeated for participants who are currently not using FDFs. About 38.4% of the variance was explained by PU (15.7%), PE (2.4%) and attitude towards use (20.3%).

Thirdly, PE and PEoU (current FDFs users) were entered to study their effect on Perceived Usefulness (PU). PE alone accounts for 94.5 percent of the variance in PU. PEoU accounts for 0.6 percent of variance in PU after controlling for PE. In general, about 95.1% of the variance was explained by PE (94.5%) and PEoU (0.6%). The same procedure was repeated for participants who are currently not using FDFs. About 96.9% of the variance was explained by PE (96.8%) and PEoU (0.1%). The results are shown in table 5.

In summary, the very high percentage score that PU has on the total variance implies that PU has the greatest effect on the formation of attitude towards use, by both current user and non-current user groups, as compared to PE and PeoU. This further implies that people would have a more positive attitude towards use if they view FDFs as being useful. Secondly, PU emerged again as having the greatest effect on the intention to use ahead of PE and attitude towards use. Thirdly, the high percentage of variance which PE has on the total variance, as compared to PeoU, in determining PU implies that people start to regard FDFs as useful because they enjoy using them, rather than that they are easy to use.

4.5.2 Analysis of variance (ANOVA)

Table 6 for current users shows that the initial model has an F-ratio of 49.170, while the second model's F-ratio is 19.715, and the final model has an F-ratio of 14.985.

Table 6: ANOVA for current FDF users

Model		Sum of Squares	Mean Square	F
1	Regression	6.728	6.728	41.970
	Residual	1.283	.160	
	Total	8.011		
2	Regression	6.803	3.402	19.715
	Residual	1.208	.173	
	Total	8.011		
3	Regression	7.068	2.356	14.985
	Residual	.943	.157	
	Total	8.011		

Table 6 is described as follows:

- The first column lists different models used
  - ❖ Model 1 - Predictors: (Constant), Perceived Usefulness
  - ❖ Model 2 - Predictors: (Constant), Perceived Usefulness, Perceived Enjoyment
  - ❖ Model 3 - Predictors: (Constant), Perceived Usefulness, Perceived Enjoyment, Perceived Ease of Use

❖ Dependent Variable: Attitude towards Using

It is clear from table 6 that the F-ratios are all greater than 1, which implies that the improvement owing to fitting the regression models is much greater than the inaccuracy within the values of these models. This analysis is in concurrence with Field (2005) who stated that the F-ratio represents the ratio of improvement in prediction that results from fitting the model (labeled ‘Regression’ in the ANOVA table), relative to the inaccuracy that still exists in the model (labeled ‘Residual’ in the ANOVA table). These results, therefore, mean that the final model significantly improves the ability to predict the outcome variable. Similarly, for non-current FDFs users, shown in table 7, the fact that the F-ratios for the initial model (8.498), second model (3.730) and final model (5.130) are all greater than 1 implies that the improvement as a result of fitting the regression models is much greater than the inaccuracy within the values of these models.

Table 7 ANOVA for non-current FDFs users

Model		Sum of Squares	Mean Square	F
1	Regression	1.882	1.882	8.498
	Residual	1.550	.221	
	Total	3.432		
2	Regression	1.902	.951	3.730
	Residual	1.530	.255	
	Total	3.432		
3	Regression	2.590	.863	5.130
	Residual	.842	.168	
	Total	3.432		

Table 7 for non-current FDFs users above is described as follows:

- The first column lists different models used

❖ Model 1 - Predictors: (Constant), PerceivedUsefulness

❖ Model 2 - Predictors: (Constant), PerceivedUsefulness, PerceivedEnjoyment

- Model 3 - Predictors: (Constant), PerceivedUsefulness, PerceivedEnjoyment, PerceivedEaseoofUse
- Dependent Variable: AttitudetowardsUsing

It is clear from both table 6 and table 7 that the final model significantly ($p< 0.05$) improves the ability to predict the outcome variable.

4.5.3 Model Parameters

In this study the entire population was used and, therefore, no generalisation will be made. This implies that the t-values which indicate the significance of beta, and hence help to decide whether the results obtained from the sample are a true reflection of the whole population, are not important and, therefore, will not be included in the results. A statistical coefficient beta (β) of between 0 and +1 implies that variables under consideration have a positive relationship with each other while a beta (β) of between 0 and –1 implies a negative relationship.

Current FDF users' perceived enjoyment and perceived usefulness displayed a significant positive relationship with attitude towards use (Beta, β=0.891, 0.314, respectively). Non-current FDF users' perceived enjoyment and perceived usefulness also displayed significant positive relationships with attitude towards use (Beta, β=1.625, 0.455, respectively). Therefore, H1 and H3 are supported. The relationship between perceived ease of use and attitude towards use for both current users (Beta, β=-0.109) and non-current users (Beta, β=-1.502) is negative, implying that H2 is not supported.

Current FDF users' attitude towards use shows a positive relationship with intentions to use (Beta, β=0.143), supporting H4. However, the relationship between attitude towards use and intentions to use in the non-current users' category is negative (Beta, β=-0.545), rejecting H4. Therefore, H4 is only partly supported. The relationship between perceived enjoyment and intentions to use for current FDFs users (Beta, β=-1.383) and non-current users (Beta, β=-1.103) are both negative, implying that H8 is not supported. On the other hand, the relationship between perceived usefulness and intentions to use for current FDFs users (Beta, β=1.946) and non-current users (Beta, β=1.092) are both positive, implying that H9 is supported.

The relationship between perceived ease of use and perceived usefulness for both current FDF users (Beta, β=-0.128) and non-current users (Beta, β=-0.032) is negative, implying that H6 is rejected. On the other hand, perceived enjoyment is positively related to perceived usefulness for both current FDF users (Beta, β=1.073) and non-current FDFs users (Beta, β=0.985). Hence, H7 is supported.

Lastly, perceived enjoyment is positively related to perceived ease of use for current FDF users (Beta, β=0.789), but does not show any relationship for non-current users (Beta, β=0.018), implying that H5 is only partly supported. These results are also shown in table 8 below:

Table 8: Results of regression analysis

		Perceived Usefulness	Perceived Enjoyment	Perceived Ease of use	Attitude
Research Variables					
Attitude towards use	Current Users	β=0.792 r^2=0.840	β= -0.103 r^2=0.849	β=0.314 r^2=0.882	
	Non current users	β=1.625 r^2=0.548	β=-1.502 r^2=0.554	β=0.455 r^2=0.755	
Intentions to use	Current Users	β=1.946 r^2=0.538	β=-1.383 r^2=0.635		β=0.143 r^2=0.638
	Non current users	β=1.093 r^2=0.157	β=-1.104 r^2=0.181		β=-0.546 r^2=0.384
Perceived Usefulness	Current Users		β=1.073 r^2=0.945	β=-0.128 r^2=0.951	
	Non current users		β=0.985 r^2=0.968	β= -0.032 r^2=0.969	
Perceive Ease of use	Current Users		β=0.789 r^2=0.622		
	Non current users		β=0.081 r^2=0.000		

*p<0.05, **p<0.01

All the beta coefficients are represented in the figure 3.

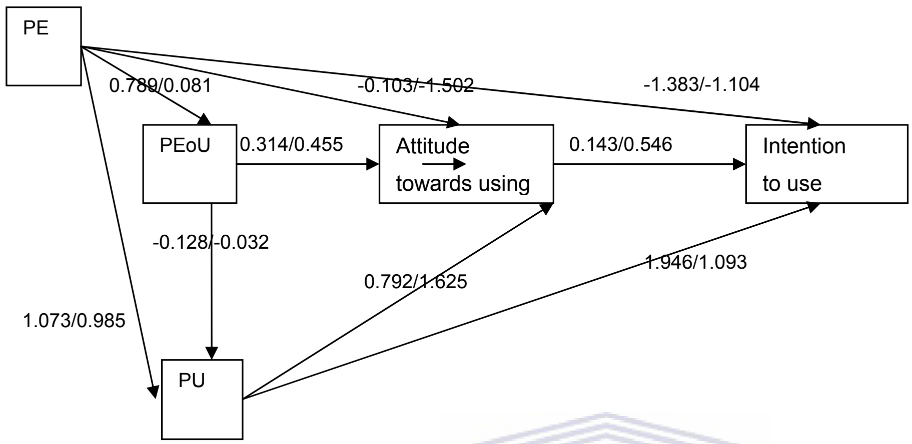

Figure 3: Research model with beta coefficients

The first numerical value in figure 3 represents the beta coefficient for current users while the second one, after the forward slash, represents the beta coefficient for non-current users.

4.6 Summary

The results of this study revealed that PE and PU affect frequency spectrum monitoring officers' intentions to use FDFs positively, both directly and indirectly (through attitude towards use).

Therefore, the successful transfer of FDFs to monitoring officers will most probably depend on the technology's usefulness in accomplishing monitoring work and the enjoyment the officers derive from using this technology as compared to other monitoring technologies.

For all demand conditions, PU has a greater influence on the intentions of monitoring officers to use FDFs more than their perceived enjoyment. This implies that PU motivates employees the most and, therefore, would require more attention if the prevailing mixed usage of FDFs is to be addressed.

The most important and unexpected finding of this study was that enjoyment of use was found to be a facilitator of the FDFs acceptance by monitoring officers. One would have thought that PEoU would feature ahead of PE because in most cases people are reluctant to use or to do something that they generally view as difficult.

The negative relationship between PEoU and attitude towards use for both current users and non-current users implies that FDFs might be easy to use, yet might not be accepted by monitoring officers. This clearly demonstrates that ease of use is not a barrier in the FDFs' adoption process.

This chapter presented motivational measures and intercorrelation analysis, both of which were aimed at revealing factors that are more motivating to FDF users than others and secondly, for showing whether there are any relationships between different constructs.

The second section of this chapter presented a procedure followed to test proposed hypotheses stated in the research methodology chapter. Three stages used in this hypotheses testing chapter were also described. An emphasis was also placed on the analysis methods in order to show the ability the multiple linear regression method has to produce significant and reliable results.

The next chapter provides conclusions and recommendations drawn from all the results obtained from this and the previous chapter.

Chapter 5. CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction

The deployment of any technology in a workplace presents challenges for the workers and the organisation; the deployment of FDFs at ICASA has not been an exception. The factors responsible for mixed and non-usage have been investigated, and the impact of these factors on the adoption of FDFs has been established. Owing to the small sample population, recommendations that are suggested in this chapter serve only as guidelines for achieving acceptance of FDFs at ICASA. The chapter furthermore details an overview and limitations of the study based on the results of the study.

5.2 Overview of the study

The study placed an emphasis on specific factors that are directly or indirectly related to the acceptance of different technologies in the workplace and, in this particular case, on the acceptance of FDFs by ICASA's frequency spectrum monitoring officers. The assumption was made that there are certain factors (in this particular case the factors are PU, PEoU, PE, attitude towards use and intentions to use) that influence acceptance of FDFs. All the participants in this study were either currently using FDFs, or they had used them before, or were prospective users of FDFs. The mixed and, in some cases, non-usage of FDFs was investigated with prior theories on innovation, and TRA together with TAM were used to formulate a research model. Both quantitative and qualitative research designs were used in this study. The quantitative method consisted of questionnaires, whose data were analysed using SPSS. The qualitative method, on the other hand, consisted of semi-structured interviews done both personally and telephonically, to explore the area of interest.

The analysis of the survey and the interviews suggest that there are certain factors that contribute significantly to the mixed and non-usage of FDFs. These are the factors that if dealt with correctly could lead to improved FDF acceptance levels. The factors, in order of their influence, are:
- Perceived usefulness;
- Perceived enjoyment; and
- Perceived ease of use.

The personal and telephonic interviews also indicated other factors that can also be classified as being responsible for mixed or non-usage:
- Inability of FDFs to point to the exact location of a transgressing transmitter; hence, many officers prefer to mix FDFs with handle antenna;
- The perception in some regions such as Durban that FDFs are not reliable (FDFs at Durban's regional office have been out of order for such a long time that monitoring officers have lost faith in them, and they now prefer to use alternative methods).

5.3 Recommendations

In light of the outcomes of this study, the following recommendations can be made:

- Findings have shown that monitoring officers attach more importance to usefulness of an FDF than enjoyment and attitude towards use as can be seen from table 8 when it comes to choosing which technology to use. Therefore, ICASA needs to embark on a project that will vigorously market the usefulness of FDF technology, e.g., workshops, and scenarios to compare usefulness of old as opposed to new technology, etc.

- Enjoyment appears, from the findings, to be the second most important factor after usefulness that the monitoring officers consider when choosing which technology to use. Therefore, ICASA needs to market the amount of enjoyment that the officers can derive from using FDF technology.
- Findings also revealed that ease of use leads to positive intentions to use through its positive correlation with usefulness. It can, therefore, be said that any effort to boast ease of use by ICASA will result in increased usage of FDF technology.
- The study needs to be repeated on an organisation with bigger population, as compared to the 21 that we had with ICASA.

5.4 Limitations and further research

Although the results can be considered statistically significant, the study has several limitations that affect the reliability and validity of the findings. The first limitation concerns the sample. Although the sample size is representative, it is quite small compared to sample sizes of other TAM studies and consisted of ICASA employees only. This has an effect on the generalisation of the findings. The second limitation is the relatively high beta coefficients of the regression model developed in this study. This could also be attributed to the small sample used in this study.

5.5 Conclusions

The results of this study revealed that PE and PU have the greatest impact on monitoring officer's motivation to use FDF technology. This implies that if monitoring officers perceive FDF technology to be enjoyable and useful for their work, they would be more receptive to them. This is contrary to McKechnie et al. (2006), Lee (2006) and others who did research on the acceptance of new technologies, and found PU and PeoU to be the two most essential factors affecting acceptance. The results of this study shows PeoU coming closely behind PE as far as their impact on acceptance is concerned, which could mean that we could see a different scenario where the results are backed by theory if the study is repeated with larger sample.

The results of this study dictates that if ICASA's managers want to enhance monitoring officers' use of FDF technology, they would have to ensure that this technology is more enjoyable to use and more useful than other available technologies.

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APPENDIX 1: QUESTIONNAIRE

PART A – (for those who are currently using FDFs)

Please indicate your agreement or disagreement with the following statements related to the usage of FDFs in the workplace, using a five-point scale ranging from: 1 = Strongly Agree (SA) to 5 = Strongly Disagree (SD).

		Strongly Agree		Strongly disagree		
1	I find FDFs useful for my job	1	2	3	4	5
2	I enjoy using FDFs to do my job	1	2	3	4	5
3	I find FDFs difficult to use	1	2	3	4	5
4	I feel good about using FDFs	1	2	3	4	5
5	I am likely to use FDFs in the future	1	2	3	4	5
6	Using FDFs enhances my effectiveness of monitoring frequency spectrum	1	2	3	4	5
7	I find it pleasant to use FDFs	1	2	3	4	5
8	It was easy for me to become skilful at using the FDFs	1	2	3	4	5
9	I think FDFs are beneficial	1	2	3	4	5
10	I am likely to use FDFs frequently in the future	1	2	3	4	5
11	Using FDFs enables me to do monitoring more quickly	1	2	3	4	5
12	Using FDFs is exciting	1	2	3	4	5
13	I find it easy to do what I want to do using FDFs	1	2	3	4	5
14	I like using FDFs	1	2	3	4	5

PART B – (For those who are NOT currently using FDFs)

Please indicate your agreement or disagreement with the following statements related to the usage of FDFs in the workplace, using a five-point scale ranging from: 1 = Strongly Agree (SA) to 5 = Strongly Disagree (SD).

		Strongly Agree		Strongly disagree		
1	Fixed direction finder could be useful for my job	1	2	3	4	5
2	I would enjoy using FDFs to do my job	1	2	3	4	5
3	I would find FDFs difficult to use	1	2	3	4	5

4	I would feel good about using FDFs	1	2	3	4	5
5	I am likely to use FDFs in the future	1	2	3	4	5
6	Using FDFs will enhance my effectiveness of monitoring frequency spectrum	1	2	3	4	5
7	I would find it pleasant to use FDFs	1	2	3	4	5
8	It would be easy for me to become skillful at using the FDFs	1	2	3	4	5
9	FDFs could be beneficial	1	2	3	4	5
10	I am likely to use FDFs frequently in the future	1	2	3	4	5
11	Using FDFs would enable me to do monitoring more quickly	1	2	3	4	5
12	Using FDFs could be exciting	1	2	3	4	4
13	I would find it easy to do what I want to do using FDFs	1	2	3	4	5
14	I would like to use FDFs	1	2	3	4	5