UNIVERSITY OF KWAZULU-NATAL

A SOCIO-TECHNICAL UNDERSTANDING OF INFORMATION AND COMMUNICATION TECHNOLOGY (ICT) INTEGRATION IN EDUCATION − A CASE STUDY OF THREE SECONDARY SCHOOLS IN MOZAMBIQUE

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DECLARATION

I Lucia Joaquim Ginger, declare that:

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DEDICATION

To my husband and our two daughters

ACRONYMS AND ABBREVIATIONS

ANT - Actor Network Theory

CIUEM - Centre of Informatics at the University of Eduardo Mondlane

CPRD - *Centro Provincial de recursos Digitais*

DTPB - Decomposed Theory of Planned Behavior

ECTIM - *Estratégia de Ciência, Tecnologia e Inovação de Moçambique*

GovNet - Government Electronic Network

HDI - Human Development Index

ICT - Information and Communication Technology

IDI - ICT Development Index

IDRC - International Development Research Centre

INTIC - *Intituto nacional de Tecnologias de Informação e Comunicação*

IS - Information System

IT - Information Technology

MDG - Millennium Development Goals

MM - Motivational Model

MoRENet - Mozambique Research and Education Network

MPCU- Model of Personal Computer Utilization

NEPAD - New Partnership for Africa Development

NREN - National Research and Education Network

OPP - Obligatory Passage Point

PARPA - *Plano de Acção para Redução de Pobreza Absoluta*

PARP - *Plano de Acção para Redução de Pobreza*

SCT- Social Cognitive Theory

SISTAFE - *Sistema de Administração Financeira do Estado*

TAM - Technology Acceptance Model

TPB - Theory of Planned Behavior

TRA - Theory of Reasoned Action

UIS - UNESCO Institute for Statistics

UNDP- United Nations Development Programme

UNESCO - United Nations Educational, Scientific and Cultural Organization

UTAUT- Unified Theory of Acceptance and Use of Technology

UTICT - ICT Policy Implementation Unit

VIF - Variance Inflation Factor

VSAT - Very Small Aperture Terminal

WSIS - World Summit on the Information Society

ABSTRACT

The implementation and use of Information and Communication Technology is seen as a vital strategy for boosting the educational sector (Glowa & Goodell, 2016; Kamei, 2015; Tolica, Sevrani, & Gorica, 2015). The integration of technology in education is associated with the promise of enhancing quality and efficiency in teaching and learning activities, particularly in developing countries. Monitoring and assessing the extent to which technology is integrated into the education system, so as to maximize the outcomes, affects decision-making processes. Moreover, the effective implementation of technology in the education sector must align with the contextual background, which involves political, cultural, technical, and social entities. An understanding of technology implementation in which the socio-technical context influences the acceptance and usage of technology is limited in Mozambique.

A key aim of this thesis is to understand the effective implementation and use of technology in secondary schools in Mozambique, which is a developing country. In order to gain insight into the implications of this use, a blend of Actor Network Theory (ANT) and elements of the Unified Theory of Acceptance and Use of Technology (UTAUT) have been employed to evaluate the process of technology integration into the education system as a package, in which the mutual dependence between the social and technical is highlighted.

Maputo province in Mozambique was chosen as the site for this research. Both qualitative and quantitative data approaches were employed. Empirical data was drawn from three public secondary schools from different localities that comprise the research case study. For the contextualization of the research topic, data were collected by employing interview-based case studies, document analysis, observation, and a questionnaire-based survey to complement and explore the views of students and teachers.

The findings revealed that technology implementation in secondary schools is a dynamic process which is impacted either positively or negatively by the surrounding contextual situation. The study emphasizes that the role of non-human actors such as the ICT curriculum guide, the time-

table and the schools' basic infrastructure and its relationship with human actors, such as the heads of schools, teachers, and students, is gradually shaped by technology and its related network entities. Therefore, acceptance and use of technology in the education system may be observed through a successful translation of technology into schoolwork practices.

The thesis hopes to contribute to the theoretically based framework by providing an alternative perspective to research technology implementation in education, in which socio-technical assumptions are considered. The thesis captured salient actors in the integration of technology, both human and non-human, relevant to user acceptance and use of technology.

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CHAPTER ONE

INTRODUCTION

Information and Communication Technology (ICT) is the subject of much research in many sectors of the government such as Health and Education, and it has become a central issue in the socio-economic development of a country. Education is seen as a vehicle for creation, dissemination and application of knowledge in society. Afgan and Carvalho (2010) explain social development as being based on four pillars which are: production of knowledge, transmission using education as a means of dissemination, and using ICT tools to sustain technological innovation. This has been encouraging countries and governments the world over to promote and keep track of the progress of a technology-driven education system for its citizens. Tolica et al. (2015) considered ICT as enabling the promotion of innovation and educational initiatives, while Heeks and Stanforth (2015) considered it a promoter of socio-economic development. The education sector, however, is challenged, to integrate and use technology in schools for serving multiple contexts embedded in differing social, cultural, political, and infrastructural environments.

This study draws attention to the integration and use of ICT in the education sector, within the context of secondary schools in a developing country. It is argued that ICT has a great impact on education, thereby promoting knowledge creation to sustain technical and professional capacity (Cekera & Uzunboylub, 2016; Deb, 2014). Therefore, various expectations have been developed around the implementation of ICT into the education system. Significant investment has been made by governments globally, in an attempt to integrate technology into schools effectively (United Nations Educational Scientific and Cultural Organization [UNESCO], 2015). Technology is seen as a promise to boost the education sector as it can offer quality and efficiency in delivering academic activities. However, in order for the education system to benefit from the immense potential of technology, ICTs must be integrated appropriately into the curriculum, so as to enhance the quality of teaching and learning activities (Ertmer & Ottenbreit-Leftwich, 2013).

Although the benefits of ICT are observed across various sectors, such as health (Organisation for Economic Co-operation and Development [OECD], 2016), public administration, and economic development (Cordella & Tempini, 2015), implementation of ICT and its full potential has not been realized in the education sector. The success of ICT integration into education is characterized by constraints which are heightened in developing countries. Research has been conducted to monitor the integration process and the outcomes of ICT investment in the education sector. Researchers have revealed a variety of factors constraining the effective use of ICT in education. For example, a study conducted by Tay, Lim, and Lim (2013) indicated that technological infrastructure, and teachers' beliefs and practices, are the most challenging factors in integrating ICT into schools. Costs related to factors such as acquisition and maintenance of ICT infrastructures, teachers' skills and leadership are the challenges constraining the adoption and integration of technology into public secondary schools in Kenya (Mingaine, 2013). In addition, the use of appropriate policies to support the use of ICT in the schools is underlined in implementing ICT into the education system (UNESCO, 2015). A plethora of studies has been published regarding the use of ICTs in education, globally, including studies undertaken in sub-Saharan countries. Some of the studies assess ICT integration in education by addressing the numerical picture of technology use in schools, and others outline factors affecting the effective acceptance and usage of technology in assisting academic activities. However, few studies have been conducted in Mozambique, a developing country. It has been noted that integration of ICT into education has been successful to varying degrees. Therefore, it is crucial to understand why Mozambican schools are still lagging behind in the use of ICT in education. It gives this study impetus to focus on the socio-technical aspects of ICT integration ─ understanding the use and acceptance of the technology in secondary schools. The socio-technical perspective is used to understand the interdependent relationship between social and technical actors in a given context. Complementing the socio-technical analysis with user acceptance and use of technology analysis models, factors contributing to intention to use and adoption of technology, were investigated.

1.1 Research background

ICT integration in the education system has been under discussion globally for many years. However, there is still a need for the improvement of technological pedagogical activities in the sector, particularly in developing countries. It is believed that in order to enhance the quality of education, ICT should play a major role in the education system. Although much research has been conducted in the domain of ICT implementation in several developing countries, it is still difficult to find studies conducted within the Mozambican context.

Mozambique is one of the developing countries in the world which acknowledges the role of technology as a facilitator of the teaching and learning process. Mozambique is reported to be among the poorest countries in the world, ranked with a low human-development index of 180th out of 188 countries and territories (United Nations Development Programme [UNDP], 2015). According to a *2015 Human Development Report*, about 60.7 % of the population is still living below the income poverty line. However, the Mozambique's Human Development Index (HDI) increased from 0.238 to 0.416 between 1980 and 2014. This value represents an annual increase of about 1.66 per cent (UNDP, 2015). The HDI is an average summary measure used for assessing the dimension of human development in a country, which comprises indicators based on people's life expectancy, their level of education and literacy, and the gross domestic income per capita.

Driven by the impact of ICT in society, and by the challenges posed by the country's development strategy, such as the reduction of poverty, the improvement of socio-economic conditions, the enhancement of quality education, the government has, inter alia, developed the national ICT policy. In 2000, in acknowledgement of this policy, the government of Mozambique developed the National ICT Policy, which was seen as a framework for the introduction of ICT in the country (Intituto Nacional de Tecnologias de Informação e Comunicação [INTIC], 2010). The implementation strategy plan followed two years later. This plan provides guidelines for the introduction of technology into schools, thereby promoting the development of human resources in the country. Thereafter, the government, through the Ministry of Education, approved the education sector technological plan, which, by means of technology implementation, intends to promote improvements in the education sector, while

sustaining economic and social development in the country. To highlight the government objectives, the Ministry of Education introduced ICT as a subject in the secondary school curriculum. The impact of the integration and use of technology was expected to be felt by the year 2010 (Matavele & Chamundimo, 2009). Therefore, computers and the Internet were introduced into 60 secondary schools for the first time, as a pilot project, by the Ministry of Education. Three years of lower-secondary school and two years of upper-secondary school, comprises the five years of secondary schooling in Mozambique. Seven years after the introduction of technology in schools, the question arises: to what extent has the objective of the education sector technology plan been met? In the Mozambican context, however, far too little attention has been paid to the level or extent of implementation of technology in secondary schools. The country's background and the current status of ICT penetration in education is seen as affecting directly the integration of technology in the public secondary schools, which is the focus of this study. To give the reader a better understanding of Mozambique and its characteristics, a historical overview of the country is presented next.

Historical background of Mozambique

Mozambique is officially a Portuguese-speaking country, however, there are several Bantu languages spoken across the country. The Portuguese came to Mozambique in 1498, thereafter it became a colony of Portugal, remaining so for many years. Finally, in June 1975, after 10 years of fighting, the country became independent. However, from the independence period up to today, Mozambique has been battered by civil war, which has resulted in weak economic growth, poor infrastructure, and famine.

During the period of devastating civil war, which lasted for 16 years (1976-1992), public facilities such as schools, hospitals, and road access were destroyed, especially in rural areas, which were already marginalized by Portuguese colonial rulers. About 50% of primary schools and 13 % of secondary schools were destroyed, and some forced to close (Eduardo, 2012). According to Machirica (2014), in 2014, the country's illiteracy rate was about 48.1 per cent of the population.

After the period of civil war, the economy of the country was considered one of the fastest-growing among sub-Saharan African countries, with an average rate of 7.4% between 1993 and 2012 (Salgado, 2016), and expected to become even stronger. The country's gradually growing development is also derived from investment in the exploitation of natural resources (International Monetary Fund [IMF], 2016).

The provision of education services is one of the government's priorities, and improvements in the sector were noticeable after the civil war period, especially in the number of schools and pupil enrolments. The illiteracy rate was reduced to 48% by 2014, compared with the 90% illiteracy rate immediately post independence (Eduardo, 2012). The enrolment rate in primary schools increased to 81.3% in 2009. Although the pupil-teacher ratio was reduced from 69 in 2009 to 62 in 2014, the quality of education is still poor, with qualified teachers not having been retained (Eduardo, 2012). The status of education in Mozambique is still a concern, as Eduardo (2012, p.5) notes: "there are still few teacher to pupil contact hours, and problems of scarce and inappropriate teaching and learning materials continue unabated". The current education system which was introduced in 1983 and revised in 2004, is structured as follows (Ministério da Educação e Desenvolvimento Humano [MEDH], 2013): seven years of primary school divided into three learning cycles – 1st cycle (1st and 2nd grade), 2nd cycle (3rd to 5th grade) and the 3rd cycle (6th and 7th grades). Primary education is compulsory for all children from the age of 6, and books are free of charge. Thereafter follow three years of lower-secondary school, comprising the 8th, 9^{th,} and the 10th grades; and two years of upper-secondary school, which are the 11th and 12th grades. Given the demand of students for entering secondary schools, the Ministry of Education has introduced secondary education as a distance-learning programme (MEDH, 2013). In addition, the education system comprises technical and vocational education, as well as the higher-education subsystems.

Focused on poverty reduction and economic growth, including enhancing the quality of education in the country, the government has pursued several instruments from the end of the civil war. These instruments include the current Poverty Reduction Action Plan (PARP), for the years 2011 – 2016, which was approved by the council of ministers in 2011 (IMF, 2011). This document was conceived as a continuation of the previous strategic action plan, PARPA II,

which was implemented in the period 2006 – 2009, and extended to 2010. In 2013, Mozambique was reported as one of the top 20 countries in accelerating progress for 16 of 22 indicators accessed by the Millenium Development Goals (MDG) report (United Nations Economic Commission for Africa, 2013). Fighting poverty implies the involvement of a variety of sectors in which education plays a critical part. Another instrument focused on the alleviation of poverty, thereby meeting the MDG, is the policy regarding the educational sector. The goal of the current strategic education plan, designed for five years, (2012-2016), is to promote education as a human right and as an instrument for citizens' integration into social, economic, and political life (Ministry of Education, 2012).

To this end, the government of Mozambique acknowledges the potential of ICT in enhancing the quality of education and noted: "significant advances have been made in the country in recent years in terms of access to information and communication technologies" (Ministry of Education, 2012, p.47). This follows the launching of policies to promote the use of technology in the country. The most relevant documents for the expansion of ICT in the country are the ICT policy; the ICT policy implementation strategy; and the education technological plan launched in 2011.

1.2 Problem statement

Given the contributions of ICT in diverse areas of social development, and the recurrent number of studies highlighting the benefit of technology in education − in both developing and developed countries, it is imperative to explore and harness its beneficial effects for Mozambican schools. Much has been said about the use of ICT, and its application and contribution is noticeable in our everyday activities. Mozambique, a country which acknowledges the role of technology in assisting teaching and learning activities to improve the quality of education, has not experienced fully the benefits of ICT in education yet. Technology use in education has been piloted in secondary schools in Mozambique from 2010; however, it seems that ICT has not been effectively integrated so as to deliver innovative pedagogical practices. The use of technology in public secondary schools is still limited. A search of the literature revealed few studies which have examined the integration of ICT and usage of technology in Mozambican education. The

present research, therefore, was conceptualized to fill this gap, by investigating the level of implementation of technology in secondary schools in Mozambique, in which the surrounding social context is taken into account. In so doing, the research assessed the extent to which ICT integration is shaped by the social context at each of the research sites.

1.3 Research questions

The aim of this study was to understand the implementation of ICT in secondary schools, underpinned by Actor Network Theory (ANT) and Unified Theory of Acceptance and Use of Technology (UTAUT) for tracing ICT integration activities and assessing the factors that influence user acceptance and use of technology in Mozambican schools. This aim, in line with the research background context, led to the formulation of the research questions to guide the study. The research questions are framed according to socio-technical aspect of technology using ANT, while the acceptance and use of technology are framed under UTAUT. The research questions are as follows:

- RQ1 ─ How does the '*translation process*' of integrating ICT within secondary schools in Mozambique take place?
- RQ2 ─ How does performance expectancy influence behavioural intention regarding the integration of ICT into secondary schools in Mozambique?
- RQ3 ─ To what extent does effort expectancy influence the behavioural intention to integrate ICT into secondary schools in Mozambique?
- RQ4 ─ How does social influence affect the behavioural intention to integrate ICT into secondary schools in Mozambique?
- RQ5 ─ How do the facilitating conditions influence the intention to integrate ICT into teaching and learning activities in the schools?

1.4 Research objectives

In order to address the research questions, the following research objectives have been formulated.

- To understand the moments of translation process of ICT integration into teaching and learning activities in secondary schools in Mozambique;
- To determine the influence of performance expectancy, effort expectancy, social influence, and facilitating conditions on teachers' and students' behavioural intention to integrate ICT into the teaching and learning; and
- To ascertain how well the set of constructs (performance expectancy, effort expectancy, social influence and facilitating conditions) is able to predict the use of ICT in teaching and learning in the Mozambican schools.

1.5 Significance and contribution of the study

A review of literature on ICT implementation in the education system globally, and in developing countries, reveals a gap in the body of knowledge at which technology and social aspects intersect. The socio-technical characteristics of the technology provide the impetus for the current research. The limited amount of research examining the implementation of technology in Mozambican schools, taking a socio-technical approach, motivated the thesis. The thesis addresses this knowledge gap by focusing on socio-technical characteristics of technology, in which all the related entities, including the non-human and surrounding context are considered as influencing the integration process. From the review of literature and fieldwork observations it became clear that the role of certain actors or aspects, and their interaction with the actor technology and other entities in the school, can determine the success or failure of the ICT translation. This research illustrated the importance of the negotiations of socio-technical entities as envisioned by the approach of the Actor Network Theory. In so doing, the research assessed the extent to which ICT integration is shaped by the social context at each of the research sites. To complement the socio-technical understanding of ICT integration into the education system, user acceptance and use of technology was examined. In this way, the thesis has made contributions to research in the domain of technology implementation in schools in developing countries, more specifically, in Mozambique. Therefore, the study is of significance to the development of teaching and improvement of the use of ICT in the education sector.

As mentioned earlier, the research was conducted combining two well-established theories for data gathering, analysis, and interpretation of the results. In so doing, the study provided both a theoretical and a practical contribution. The thesis has contributed to the research conceptual framework for ICT integration into secondary schools by combining the two theories for a deeper understanding. The thesis provided an alternative research conceptual framework.

Another contribution is related to the elucidated challenges regarding the socio-technical characteristics of technology when implemented into a socio-material environment such as a school. The schools comprise heterogeneity of actor networks; and the adoption, and coherent establishment of any technology within the education system is considered a complex process which depends on the compatibility of the school context and work practices. The Actor Network Theory approach provided an understanding and identification of ways in which the actor networks, including technology, should be created and sustained over time. The analysis highlights the linkage between the local context in which the technology is to operate, and the extent to which the user is likely to adopt and use technology in school.

1.6 Overview of methodology

The thesis examines the socio-technical context of technology integration for the identification of relevant factors which may affect the acceptance and use of technology in secondary schools. As stated in Sawyer and Jarrahi (2014), the introduction of technology in a given organization causes the interaction between social and technical aspects, which must be jointly considered. The assumption underlying a socio-technical approach is that both the social and the technical should be regarded as having the same significance in the process of technology integration. This approach emphasizes the existence of a dynamic relationship which is gradually shaped by technology and the organization. The association between technology and its background context has led to the research on technology integration into schools from a socio-technical perspective. The socio-technical approach is therefore appropriate in understanding the interdependencies existing between technology, people, and the schools' contextual backgrounds. The interactions between technical components and social context in which the technology is situated, were examined according to the Actor Network Theory (ANT). As per the socio-technical approach,

the ANT perspective does not differentiate the social from the technical, paying equal attention to the properties of technology as well as to the context in which it operates. Therefore, the thesis conceptualized the integration of technology into the education system as a process in which a network is created, with various entities and objects influencing one another to maintain a cohesive relationship. User acceptance and use of technology is therefore conceived as an effect of a successful network of human and non-human actors in which technology is included. Therefore, to assess the level of user acceptance and use of technology in Mozambican secondary schools, the Unified Theory of Acceptance and Use of Technology (UTAUT) model was applied. The UTAUT model has been used in many studies (for example, Kolog, Sutinen, Vanhalakka-Ruoho, Jarkko, & Anohah, 2015; Thomas, Singh, & Gaffar, 2013; Wong, Teo, & Russo, 2013) for the understanding of user acceptance or rejection of technology in various fields.

While the translation process from ANT was applied for the understanding of the connection between social context and the technical component of technology, UTAUT was used to complement the understanding of the case study, assessing the factors influencing both teachers' and students' intention to use the technology. This led to the identification of related entities, including the socio-technical factors interacting with one another, in the implementation of technology into secondary schools; and the way in which factors related to performance expectancy, effort expectancy, social influence, and facilitating conditions, influence the acceptance and usage of technology in schools.

To fulfil the research objectives, the researcher has developed a conceptual framework which promotes the understanding of technology implementation in the education system. Therefore, two well-established theories were used to frame research data collection and interpretations of the findings. For understanding the socio-technical aspects which have an impact on the introduction of technology into schools, a translation process from the Actor Network Theory (ANT) was deployed; whilst the Unified Theory of Acceptance and Use of Technology (UTAUT) provided the theoretical basis for the examining of factors affecting user intention to use technology in schools.

In addressing the research questions, a mixed methods approach was applied, in which qualitative and quantitative data were jointly used. The research design and methods is fully discussed in Chapter Four. The research attempts to delineate the process of ICT implementation in schools, through the use of theories for the tracing of ICT integration activities, and by assessing the level of teachers' and students' acceptance and use of technology. Therefore, a combined use of qualitative and quantitative approaches was adopted for framing data gathering, analysis, and interpretation of results. A multiple-case-study strategy was used for data collection, in which the study sites and participants were selected purposively, in accordance with Creswell's (2014) recommendations. The data were collected from schools that are implementing technology use for teaching and learning activities. The research explored the research participants' views and experiences, which were obtained through a process of field visits for data collection; at the same time examining user behaviour on the use of technology in schools. The purpose of case studies is to investigate the real-life situation from various perspectives, using multiple techniques of data collection (Sekaran & Bougie, 2016). Therefore, the qualitative section of the research enabled the contextualization of the research topic, exploring participants' experiences by employing interview-based case studies, analysis of documentation, and observations; while the quantitative aspect was intended to explore the views of students and teachers through questionnaire-based surveys. The use of multiple techniques of data collection allowed comparison and identification of similarities and differences across research sites, which helped to triangulate and validate data collected by means of each technique.

1.7 Research scope and delimitations

The research is focused on the process of ICT implementation in the secondary schools in Maputo province, Mozambique. To gain an insight into the way in which technology was introduced into the schoolwork practices, the researcher explored views and experience of heads of schools and teachers through interviews, which were complemented by data obtained through documentation analysis and observations. In addition, questionnaires were administrated to the students and teachers to assess the level of their intention to use technology in schools. The study

was conducted only in three public secondary schools in Maputo province which lies in southern Mozambique.

1.8 The structure of the thesis

The introductory chapter outlines the background, stating the problem and questions of the research, as well as the context and methods used in addressing the objectives.

Chapter Two presents the literature review. The use of ICT is reviewed globally in various sectors of society, followed by an overview of the use of ICT in education. ICT in developing countries is then discussed, followed by ICT in the Mozambican education context.

Chapter Three explains the theories underpinning the study. These include analysis of the socio-technical approach, which is considered for the understanding of ICT integration in the education system. For this purpose, the Actor Network Theory (ANT) is used as a theoretical guide for qualitative data collection, analysis and interpretation. The chapter also addresses models and theories developed and used for the understanding of user behaviour and intention to use technology. Unified Theory of Acceptance and Use of Technology (UTAUT) combining previous models and theories used for prediction and explaining of user acceptance and use of technology, is considered a theoretical basis on which to analyse the quantitative data findings. The conceptual framework which guided the research is elaborated on.

Chapter Four describes the methodology in detail, including the adopted research strategies. The research paradigm and approach are discussed, followed by the research design and techniques used for data collection. The chapter also provides a description of the research site, selected research population and sample used. Lastly, the chapter elaborates on the techniques used to analyse the data, followed by the ethical considerations observed during the study.

Chapter Five presents the qualitative research findings. The analysis and discussion of the qualitative data are provided, based on the ANT. The analysis follows the four moments of translation concept from the ANT framework.

Chapter Six presents the quantitative data analysis. It reports on the examined factors affecting teachers' and students' intention to use technology, hence contributing to the integration of technology into teaching and learning activities. UTAUT provided a framework for the quantitative data analysis.

Chapter Seven provides a discussion of the research findings, synthesizing the results obtained in Chapters Five and Six. The discussion reflects on the research questions by triangulating data collected from interviews with heads of schools and teachers, analysis of documents, observations, and questionnaires.

Chapter Eight presents the conclusion, and describes the contributions of study. The chapter argues that implementation of technology into schools should be considered an innovative translation process in which user acceptance and use of technology are effects of the successful creation of a network of actors.

CHAPTER TWO

LITERATURE REVIEW

This chapter describes the context within which the research was conducted, by examining the literature on the research topic. The chapter first presents a foundational review concerning the impact of ICT in society. It goes on to highlight ICT integration into the education system, outlining its effects on students and teachers. The chapter then elaborates on ICT integration in education in developing countries, followed by a review of ICT integration in the Mozambican context. For the purpose of this research, the concept of Information and Communication Technology (ICT) is confined to computers and to Internet use in schools; the terms 'ICT' and 'technology' will be used interchangeably.

2.1 ICT in society

Given the increased power of technology and its relatively low cost, the use of Information and Communication Technology (ICT) is progressively observed in various spheres of human life. The world is noticing a rapid development and use of mobile technologies, including by populations living in rural areas. About 84 per cent of the global population is reached by mobile-broadband network of 3G or above, with 67 per cent of the population living in rural areas (International Telecommunication Union [ITU], 2016). The term ICT has been used to indicate the diversity of technologies that enable people to create and receive information and communicate with others in society (Anderson, 2010). However, the term ICT has emerged from the previously used concept of Information Technology (IT) referring to the technological devices which can create, store, process, and disseminate information. Therefore the concept of ICT was regarded as including the Internet, World Wide Web, and email services. The advance of ICT enables a new means of distributing knowledge, affecting the way in which various domains within society perform their related activities. The presence of ICT and its impact have been discerned in many fields. For example, governments of various countries (developed and developing) use the advances of ICT to create a huge database, thus organizing and monitoring statistical information to keep citizens more informed (Deb, 2014). The use of ICT in government extends to the areas of security and intelligence agencies. In this regard, Deb (2014)

states that the weapon of technology, resulting from the advances of ICT and encryption technology, has increased the effectiveness of governments' armed forces and security. Beyond the observed changes in the way governments operate, ICT also has a significant impact on the field of business activities. Today, there are innovative ways of conducting business in which ICT plays an important role. E-business or e-commerce is the term used to indicate the way in which goods and services are supplied and delivered using technology. ICT benefits e-commerce in that industries can use various means provided by technology to advertise their services (Deb, 2014). An example of e-commerce involves the provision of real-time transactions in which an Internet payment of goods or service is performed without the physical contact between the buyer and the supplier. In the same vein, another important and noticeable benefit of ICT in people's lives is that collaborative work may be performed in which communications infrastructures are used. As such, technological devices enable continuous and synchronized interactions between the involved entities (Deb, 2014). While the benefits derived from the advances and applications of technology in people's lives are immeasurable, aspects of privacy, however, are cause for concern in both the public and private sectors. The main concern is that, in an online transaction, nobody knows who collects the data and how the information is handled, which results in a lower consumer confidence in electronic commerce (Deb, 2014).

Given the aforementioned discussion, it is remarkable the relevance of ICT in today's society. The opportunities offered by ICT development over the last decades, including the Internet, email, mobile phones, personal digital assistants, global position systems, and social networking services have changed the way in which people communicate. However, Deb (2014) notes that the proliferation and use of ICT will divide people of developed countries into groups of either technophile or technophobe. The technophile group comprises individuals who embrace the opportunities offered by ICT. Technophobic individuals do not see direct profit from the advances of technology. This is particularly true of people living in rural areas. The benefits of ICT in society are highlighted in Deb's (2014) study and are reiterated here for emphasis:

- Access to information: the availability of information is considered the most positive effect on people, influencing them to use opportunities offered by ICT. The use of technology, particularly the Internet, by means of which information may be

accessed, has resulted in new opportunities for business, entertainment, communication, and also for education.

- Job opportunities: using mobile and flexible employment in virtual offices and e-learning facilities are salient examples of the applicability of ICT.
- New tools opportunities: the existence of new technological tools represents the second impact on individuals. Stand-alone systems are examples of ICT tools used to attain gains which were not possible before the emergence of technology.

Additionally, the distribution and dissemination of news by media has been made easier as ICT tools such as the Internet and satellite television have improved. However, negative aspects such as job losses, reduced personal interaction and reduced physical activities are also mentioned (Deb, 2014).

This discussion indicates changes in the way of performing activities which were not possible prior to ICT development. Many projects have been conducted in attempting to exploit technology and to promote innovation in diverse fields that include the agriculture, health, and education sectors. The agriculture sector is considered to have great potential for improving standards of living and livelihoods in rural areas, thereby reducing poverty in most developing countries. Therefore, given the contributions of technology, governments around the world are implementing ICT projects in the agricultural sector in various rural areas (Sousa, Nicolay, & Home, 2016). Agricultural informatics or e-agriculture, is a relatively new concept involving the contribution of ICT development to the enhancement of the agriculture sector (Chauhan, 2015). Developments include the use of technological devices and systems to disseminate information accurately to farmers. An example is reported in Cole and Fernando's (2012) study, in which findings revealed that the use of mobile phones in agriculture increased the adoption and use of effective pesticides in replacing those less effective and more hazardous. Similarly, the use of videos per mobile phone was revealed as beneficial to agricultural extension, enabling the intensification of land use in developing countries (Sousa et al., 2016). Chauhan (2015) stated that e-agriculture refers to a process in which innovative ways are conceptualized, designed, and developed to attend to the needs of farming practitioners. Therefore, technology is designed to be user-friendly, easy to access and cost-effective in meeting the needs of people in rural areas. In

Chauhan (2015) study, the contribution of technology to the agricultural sector included the provision of timely information on weather forecasts and calamities; better agricultural practices and marketing; reduction of risks, which improved agricultural outcomes; better awareness of environmental and agricultural information; and improvement in communication and networking which facilitated online trading and e-commerce. However, some challenges are also mentioned related to the limited knowledge of farmers to operate the technology: limited infrastructure, and lack of institutional capacity to deliver specific services to the farmers.

As with the agriculture sector, ICT integration in the health sector contributes towards the improvement in the provision of diverse health-care services. Commonly referred to as e-health, the use of ICT to deliver quality health care in a cost-effective manner is increasing the world over (Ross, Stevenson, Lau, & Murray, 2015). For example, in Europe, the use of ICT in health includes electronic health records − real-time and centred patient records, providing an easy and secure use of information; *telehealth* – the use of technology for the delivery of health services from a distance; mobile health – referring to the use of mobile devices to assist health information and medical practice; e-learning in health – the use of technology and media for training in the health sector; and social media in health, which is the use of online communication technology to share information and communication between health-care provider and patients (World Health Organization [WHO], 2016). Additionally, improvement to the quality of life of the citizens, patients, and also the health providers are reported examples of e-health achievement in Europe (Ross et al., 2015). Despite the potential benefits of ICT use in the health sector in general, its application in the context of developing countries constitutes a challenge. Lewis, Synowiec, Lagomarsino, and Schweitzer (2012) analysed technology-enabled health programmes in sixteen low- and middle-income countries. The findings indicated that the extreme dependence on donors to run the e-health programmes is a major concern. This is added to the problem of limited infrastructure to provide reliable electricity and Internet connectivity which faces developing countries. Additionally, culture, and incentive to adopt and use e-health, as well as lack of confidence in technological devices, is reported as contributing to a low level of user acceptance of health-care services based on technology. However, in extending geographical access through the use of video conferencing, help-lines, and instant messaging between patient and health practitioner, ICT has penetrated the health sector in developing

countries (Lewis et al., 2012). The application of these technological programmes in delivering health-care services results has led to mobile phones and Internet technologies being widely used in developing countries nowadays. For example, the recent report on ICT facts and figures showed that the majority of Internet users are located in developing countries − about 2.5 billion − while one billion users live in developed nations (ITU, 2016). According to Lewis et al. (2012) other aspects relating to the purpose of ICT use in assisting the delivery of health-care services in developing countries include the need to: facilitate patient communication, improve diagnosis, treatment, and data management; make the financial transaction easier; and mitigate fraud and abuse, for example in situations in which there is a need to confirm whether a health worker has visited a patient.

With regard to the education sector, the use of ICT in delivering academic activities has pervaded the world. In addition to computers, mobile phones and the Internet in the education sector, radio and television and other electronic devices are used in place of computer-assisted instruction to extend educational opportunities (UNESCO, 2015). Examples of using radio or television versus the computer in delivering educational activities, specifically in developing countries, are presented in this UNESCO study. Technology use has penetrated people's everyday lives. The recent report on ICT facts and figures showed that 95 per cent of the population worldwide live in a mobile phone covered area (ITU, 2016). Therefore, mobile phone technology, for instance, has been successfully used as a means of communication worldwide. Moreover, a number of global mobile learning initiatives and programmes aimed at exploring opportunities offered by mobile technologies have been undertaken (Gikas & Grant, 2013). The development of technology over the last three decades has been used to address the challenges within the education sector. Examples include the implementation of ICT to: enhance teaching and learning activities, thereby providing learners with new skills; expand access to the students living in geographically distant areas; enable an easy and improved training programme for teachers; and decrease the cost, lessening the gap between such learning and instruction without the use of technology (UNESCO, 2015).

As mentioned in Afgan and Carvalho (2010), knowledge society represents a human-structured organization in which globalized and up-to-date knowledge represents a better and newer quality

of life. The researchers emphasize the relevance of gaining knowledge that transforms societies permanently. This implies that the process of information gathering and knowledge distribution is fundamental to the creation of a knowledge-based society, with education representing permanent and lifelong learning. As noted in Deb (2014), technology is important for the functioning of the knowledge-based society − its relevance is equally highlighted in the delivering of teaching and learning activities. Therefore, developments in ICT are being used to help improve the quality of education, thereby contributing to knowledge-based societies. According to Afgan and Carvalho (2010), technology, combined with educational strategies, promotes knowledge dissemination in the human-structure organization. The principal component of innovation is knowledge, which, combined with technological innovation is used to promote knowledge creation through its application to educational activities. Technology is considered relevant and as positively impacting on education; the understanding of the extent to which ICT is integrated into academic activities defines the scope of the present thesis. What follows is a review of ICT in education.

2.2 ICT in education

Technology in the education system has been used for a long time; however, only in the course of the last century did it become a subject for study and research (Clifford, Friesen, & Lock, 2004). Pelgrum and Law (2003) note that it was at the end of the twentieth century that many governments in developed and developing countries undertook initiatives to rejuvenate the education sector. Therefore, much research into ICT in the education sector is being conducted: teaching and learning activities are dramatically changing as a result of the use of technology (Cekera & Uzunboylub, 2016). As such, teachers, students, and schools in general, are required to change work practices so as to accommodate the opportunities offered by ICT. As technology has become part of the system over the past four decades or so, education decision-making is remodelling educational practices and formalizing ICT implementation policies (UNESCO, 2014).

As in other sectors of social development, the education sector is experiencing a considerable increase in technology use to assist teaching and learning activities. However, there are still

uncertainties regarding the objectives and the use of ICT in these areas, particularly in developing countries. The need for further research into baselines to guide educational policy and decision-making is still needed (Kozma & Vota, 2014; Meenakshi, 2013). Therefore, decision-makers cannot settle on a particular policy without assessing the actual situation in which goals and the means of attaining such goals should be specified. According to Meenakshi (2013), even in the developed countries, technology is not always considered central to teaching and learning activities. However, as in other fields of society, technology has been regarded as a promoter of significant changes within the education sector. Technology has the potential to stimulate the development of the learning and teaching process (Cekera & Uzunboylub, 2016).

From the review of literature study on ICT and its implications in education, Fu (2013) has identified numerous benefits of using technology in this sector. This includes assistance to the students in acquiring more knowledge in an efficient and effective manner, thereby using technology as a tool. Sustainability of a student-centred learning approach in that students may access, select, organize, interpret, and critically assess the quality of the obtained information is also a benefit. The use of ICT produces a creative learning environment in which technological devices and applications are used in the provision of innovative ways of gaining knowledge. The promotion of distance learning, enabling students to acquire, share, and disseminate knowledge in a collaborative learning approach is another vital benefit as is the provision of opportunities for students to develop critical-thinking skills as it is believed that there is a relationship between studying with technology and the ability to develop critical thinking. The improvement of the quality of teaching and learning activities is cited as studying with technology promotes autonomy, capability, and creativity in students. Finally it is beneficial in giving assistance to teachers, in that the available technology may be used to facilitate access to course material.

Additionally, Meenakshi (2013) discussed factors that contribute to the introduction of ICT in the education system, identifying rapid implementation of ICT in education. She argues that the education system needs to be reformed, and technology must therefore be integrated into the schools' work-practices. Furthermore, Meenakshi (2013) believes that the influence of technology, particularly the Internet, on students' lives has meant that teaching and learning activities have to be adjusted to suit a student-centred approach facilitated by ICT tools. In the

student-centred approach, the focus of the learning activity is shifted from teacher to students, and technology is used to facilitate this, while the lecturer is to guide the process of knowledge creation. There is no doubt that students of today are digital natives and as such are inclined to a more technologically facilitated curriculum to be effectively engaged in (Govender & Govender, 2014).

Pelgrum and Law (2003), in their study, maintained that government needs to make provision for continuous learning with the introduction of technology into the education sector. They further argued that, with the use of technology, many societies will become information societies. As a result, citizens in information societies will need competencies which have not been targeted in a traditional learning process. Following these discussions, technology may be used freely and creatively by students and teachers in the accomplishment of their diverse activities. Therefore, ICT will not only be used to expand learning beyond the classroom, it will also promote administrative management and facilitate decision-making based on collaborative work. Pelgrum and Law (2003) recommendation is that, in order to accomplish the information society assumptions, the education sector needs to be more focused on creating opportunities for students by promoting autonomous learning, which may be achieved by using technology. Thus, the use of technology or ICT in the education system enhances the schools' organization and the planning of activities, while benefiting the learning and teaching process.

The opportunities offered by ICT which include communication skills, collaborative work, problem-solving, and decision-making, are important elements fostering technology adoption in educational activities in the 21st century (Albion, Tondeur, Forkosh-Baruch, & Peeraer, 2015). Moreover, these competencies are essential for citizens living in an information society. This results in the need to integrate technology and its pedagogical use into teaching and learning activities. Thieman (2008) gives examples of the many ways in which technology may be integrated into education. For example, he cites the extending of teaching and learning beyond what could be achieved without technology and the use of ICT to give the students opportunities of studying the existing relationships between science, technology, and society. Promoting the development of ICT skills and knowledge, promotes the citizens' participation in a democratic society. This however, only happens if the Internet is freely accessible in an unmediated form.

Technology integrated into education, contributes to the research field. Another benefit of technology use is that of digital inclusion in education and in other sectors (Rhinesmith, 2016). Given the availability of diversity of ICT tools to access, adapt, and create knowledge, technology is considered important for digital inclusion. Thus teachers, ICT coordinators, as well as the teacher-education programmes, are seen as change agents for the promotion of technology in education (Pelgrum & Law, 2003). Even though the use of technology such as the Internet by people with disabilities lags behind that of people without disabilities, technology is still considered important in promoting digital inclusion (Stendal, 2012). Thus, ICT may be strategically used as a valuable tool for enhancing academic activities, thereby promoting equity in education. However, in order for ICT to reach the classroom effectively, fostering the teaching and learning activities, there is a need for careful planning, an aspect which concerns most developing countries. As Rhinesmith (2016) noted, it is difficult to understand the value of digital inclusion in developing countries, where cultures and poverty shape individuals' experience with ICT usage.

ICT implementation is not considered an easy task, as barriers to its adoption and effective use in the education system are not only related to technical aspects of technology, but related to human resources and competence as well. For example, the relevance of the teacher as an active change agent in the process of ICT integration in schools has been disregarded in some countries. As Du Toit (2015) notes, there are countries embracing integration of technology in schools, yet little, and in some cases no teacher training related to the use of technology is provided. In this regard, Albion et al. (2015) contend that little has been done to promote teachers' use of technology when accessing the necessary knowledge for enhancing teaching practices. Du Toit (2015) links this to the fact that teacher-training programmes in most cases are solely designed for computer literacy, instead of taking a wider approach to promoting effective teaching practices in which technology is used. For example, Du Toit (2015) mentions that in some European countries about 70 per cent of students are instructed by teachers who are trained in ICT, while in other countries teachers trained in ICT comprise only 13 per cent or less of the teaching population. Therefore, various factors contribute to the complexity of the ICT integration process in different technical and social contexts − these must be considered.

As mentioned earlier, a knowledge-based society demands changes in the paradigms of education, specifically in the teaching and learning processes. Therefore, the teaching and learning process is focused on lifelong learning in which the information received should be transformed into knowledge over a short period of time. ICT use in the education system affects the nature of teaching and learning processes. For example, in the student-centred learning approach which is gaining attention, ICT adds value to the process of information gathering (Fu, 2013). To the extent that education is integrated into the creation of an information-knowledge society, it should contribute to the training of teachers and students who are able to connect their lives in society, thereby promoting lifelong learning. The next sections elaborate on the effects of technology use in benefiting students as well as teachers.

2.2.1 Students and the use of technology

The proliferation of technology in today's society is affecting the way in which students access information and use it for their knowledge. The majority of students nowadays have access to a technological device either at school or at home. The use of technology is evolving worldwide and its provision to the population, including rural areas, is increasing. About 95 per cent of the global population is living in an area covered by a mobile network (ITU, 2016). Faber, Sanchis-Guarner, and Weinhardt (2015) based on a UK report, stated that the majority of students from primary and secondary public schools use the Internet at home for studying and for performing their homework, while others use it for downloading, streaming videos, and playing games. However, a controversial result exposed by their study is that the availability of computers and high-speed Internet connection has little or no effect on educational attainment. This result is consistent with Vigdor, Ladd, and Martinez (2014), in which administrative data from public school students in grades five to eight in North Carolina were measured based on access to a computer at home, and the availability of a high-speed Internet connection. Even in the developed world in which networked computers have been available in schools for over 30 years, students still use the computer mainly as a delivery tool (Ertmer & Ottenbreit-Leftwich, 2013). This is because there is no clear vision on integrating technology as an enabler and supporter of pedagogical activities. As such, teachers primarily implement the use of technology as a requirement for the students to accomplish their homework assignments, which include

searching for online material and writing reports, as well as the assigning of practice work using a specific programme (Ertmer & Ottenbreit-Leftwich, 2013). The findings of the above-mentioned studies indicated no significant evidence that the availability of technology at home or at school improves students' pedagogical outcomes. Vigdor et al. (2014) added that access to a computer and broadband Internet reduces the efficiency of the time students spend on homework, thereby introducing distraction and new options for leisure time. However, Fairlie and London (2012) had previously found some evidence of positive effects of a computer for home use and the educational outcome of the students. Their findings are based on two years' field experiment in which cost-free computers were distributed to students in low-income communities. This discrepancy of findings reveals the complexity associated with the integration of technology to benefit the education sector. As Albion et al. (2015) noted, the effects of technology integration into education, for instance, on students' outcomes, are limited compared with the impact of ICT adoption in other sectors. In Fu (2013) review of literature, the researcher pointed out that student mobility, special needs, and limited technical skills which reduce the interaction with technology in the classroom, and the lack of timely feedback from the teachers, were some of the main constraints related to the implementation of technology from the perspective of students. However, the recommendation is to strategically focus on more induction and orientation, thereby supporting capacity building, curriculum development, policies, and government support to facilitate learning in a technological context.

The availability of technology provides students with greater information, which shapes their way of thinking, acting, communicating, and learning. In this context, it is important that students receive information using technology, dynamically translating it into knowledge. One of Vigdor et al.'s (2014) interpretations of their findings is that the access to and use of computer technology at home demands an effective parental monitoring in which parents should assist as instructors for the creation of knowledge. Given the potential of technology, the roles of students and teachers in the classroom are changing, to the extent that new approaches to teaching and learning are aggregated to schoolwork practices. Students are no longer receivers of information from their teachers; with technology they may create their own knowledge in which teachers act as facilitators. According to Glowa and Goodell (2016), students should become responsible for their own learning: teachers and parents or guardians support the process of knowledge creation.

Therefore, they use technology to focus their learning on accessing resources, as well as on communication, thereby demonstrating evidence of their achievements. In the education system, technology is a tool for learning, used for constructing collaborative knowledge, thereby developing new forms of learning, in different contexts. Roberts and Rees (2014) point out that, in today's societies, students acquire technological knowledge for their daily life at home, for leisure, studying, and for work. The most-used devices taken to school to accomplish students' academic activities include smartphones, tablets, and laptops. Therefore, it seems important to reformulate the education system and to train the teachers, in order to accommodate the use of technology. For effective integration of technology into the classroom, teachers are required to be receptive to continuous learning of ICT integration, thereby creating innovative learning strategies to enhance the construction of knowledge for the students. Glowa and Goodell (2016) challenge teachers to produce college-and-career-ready graduates. The next section discusses the use of technology for the benefit of teachers.

2.2.2 Teachers and the use of technology

The proliferation of technological resources and its potential to enhance teaching and learning activities poses challenges to teachers, who are supposed to take on the role of learning facilitators. According to Kamei (2015), the role of teachers is to enable students to become collaborative, creative, and problem-solving through the use of technology, thereby preparing them for the needs of a knowledge-based society. To fulfil this purpose, additional skills, apart from ICT competencies, are required from the teachers. From this perspective, teachers become change agents in the process of technology implementation. As such, the provision of adequate training for teachers to effectively and appropriately integrate technology into the educational process becomes relevant. Gilakjani, Leong, and Ismail (2013) state that computer self-efficacy, personal technology use, positive attitudes and beliefs regarding technology, and the promotion of teacher professional development are factors hindering the effective integration of technology in the classroom. It is suggested that teachers' ICT skills should go beyond the personal use of technology, as teachers are supposed to integrate technology into the classroom thereby improving the quality of the teaching and learning process. Du Toit (2015) recommendation is that effective training for teachers' technology use should model appropriate teaching practices

in which ICT tools are aggregated. Given the differing levels of technology penetration in various countries, Du Toit (2015) underlined that information needs for training will also differ in each local context. He argued that countries with a higher level of ICT penetration, which is the case in developed countries, have a greater need for renewed teacher training, while significantly less training is required in countries in which few schools are implementing ICT integration. Therefore, it becomes important to consider the local context in which technology is to be operating, because teachers and students may behave differently within different contexts of ICT integration. As Ghaffarian (2011) notes, context should be considered as dynamically defined, and not taken as a static or fixed environment in studies in which technical issues interact with social aspects of the context.

The process of ICT integration in the academic activities is a challenge for the teacher, who must become proficient in the use of a computer or a certain programme for the purpose of increasing the quality of teaching and learning activities. For example, Ertmer and Ottenbreit-Leftwich (2013) stated that in developed countries, networked computers have been available in schools since the year 1980, however, teachers are not still using them to support meaningful outcomes in students. Even though teachers recognize the relevance of integrating technology into the classroom activities, the use of the computer is still limited to searching for information online, and writing and checking assignments online (Albion et al., 2015). Researchers have pointed out the need for extensive action in order to provide effective training for teachers with the intention of encouraging appropriate integration of technology, thereby improving the quality of teaching. This recommendation results from the teachers' reports of inappropriate training in the integration and use of technology demanding innovation in teaching and learning activities. In this regard, Ertmer and Ottenbreit-Leftwich (2013) recommended the adoption of an innovative integration approach in which the use of technology is considered a cognitive tool serving as part of the teaching and learning process. Barriers such as lack of time and inflexible curriculum, as well as the lack of support and access to technology are mentioned as constraining the transformation of educational activities in integrating technology (Albion et al., 2015). Therefore, with the use of technology, the teacher is expected to be a learning facilitator instead of an authority on knowledge in the classroom. Glowa and Goodell (2016) suggested that

teachers should use technology to differentiate from the traditional instruction, thereby customizing teaching practices, and engaging students in innovative processes of learning.

Technology could facilitate teaching by allowing an easy and efficient preparation of class material, research for additional information, the performing of administrative tasks, and primarily, the supporting of learning, thereby providing meaningful outcomes as well as fostering a collaborative learning environment. Therefore, for the effective integration of technology in educational activities, the teacher is considered a change agent in the process. In the view of Glowa and Goodell (2016), teachers must facilitate learning in alignment with the needs of the current knowledge-based society. However, a teacher using the traditional approach poses a challenge in changing the previous methods and integrating technology into teaching activities. In their study, Flanagan and Shoffner (2013) revealed that teachers, regardless of their experience in teaching, valued the integration of technology to enhance educational activities. However, novice teachers are more willing to integrate technology in the classroom as they believe in its potential, therefore they plan and deliver their instructions based on the available technology. By contrast, the experienced teachers consider the available technology as having a secondary role in teaching. In the view of Ertmer and Ottenbreit-Leftwich (2013), teachers have different beliefs underlying the use of technology in the classroom. They argue that there is a significant relationship between the teachers' beliefs about pedagogical achievements and the use of technology in classroom. Teachers who believe in the benefits of the student-centred approach are more likely to use technology effectively to accomplish pedagogical goals. Conversely, teachers who believe in a conventional learning approach have a negative attitude towards the integration of technology in the classroom. In this context, Albion et al. (2015) contended that, in most cases, teachers use ICT to replace the traditional teaching and learning approach. Therefore, technology integration into education should not be assessed separately from the pedagogical goals (Ertmer & Ottenbreit-Leftwich, 2013). This discussion indicates the complexity of integrating technology into educational activities, with a view to enhancing the quality of teaching and learning activities. Ertmer and Ottenbreit-Leftwich (2013) note that the availability of technology in a teacher's classroom, does not imply an automatic achievement of the planned goals in terms of the students' outcomes. This substantiates the claim by Faber et al. (2015) that rushing to make technology available has no significant effect on students'

achievement in terms of productivity, nor on time spent studying whether online or offline. In a review of literature by Albion et al. (2015), supplemented by four cases studies, the researchers highlighted the crucial role the teacher plays in the integration of technology in transforming the classroom activities. The researchers emphasized the need for training programmes which focus on pedagogical use of technology, and a balanced vision of ICT use and other aspects surrounding educational activities. In a similar vein, Kamei (2015), stressed that the development in technology and its adoption in educational activities demands a teacher trained in both technical and pedagogical skills. As Du Toit (2015) stated, the level of technology penetration in the education sector in a specific country determines the information required for policymaking. The next section presents an overview of ICT use in education in developing countries.

2.3 ICT and education in developing countries

There is today increasing interest in ICT integration into education, justified by numerous studies conducted evaluating its pedagogic impact on various countries of the world. The use of ICT in the education sector should be valued, education playing a relevant role in the framing of the economic development of countries (Tolica et al., 2015). ICT is a catalyst which increases economic productivity, enhancing the delivery of services in a variety of social development sectors, including education (UNESCO, 2015). ICT both promotes the quality of education, and enhances economic development. Countries and governments of the world therefore should encourage educational reform to accommodate the integration of technology into the sector (Ali & Al Hinai, 2013). However, data to support the desired benefits of ICT usage in education, and evidence of positive impact on student performance outcomes are limited, specifically in developing countries. Moreover, different understandings have been used to contextualize the integration of ICT in education. The next section discusses the various contexts of the ICT integration domain.

2.3.1 Contextualization of ICT integration in education

Punie, Zinnbauer, and Cabrera (2008) contextualize ICT integration in education within three domains: ICT as an education enabler, which requires that the learners use ICT as a principal resource of instruction – enabling a better quality of the teaching and learning process; ICT as an

auxiliary means to education, which includes use of technology to deliver learning material to learners – an example of which is the e-learning strategy; and ICT use in education comprising the creation of skilled manpower capable of meeting technological needs and thereby improving the country's social development. In this regard, Herselman (2003) points out that ICT implementation in schools should be regarded as an enabler. In the sense that it influences how activities are performed, it is a driving force for current and future changes required in schools' work-practices.

Another recent study contextualizes ICT use in education as an enabler of teaching and learning so as to engage meaningful student performance outcomes, rather than technology integration as an activity isolated from the pedagogical goals (Albion et al., 2015). However, Meenakshi (2013) considers only two perspectives in integrating ICT into education. The first is teaching ICT as itself, that is, as an appendix to the curriculum, while the second perspective includes the use of ICT as a tool additional to the existing strategies of teaching. This necessitates the involvement of governments and decision-makers investing in technology as an enabler of educational activities. Wang and Woo (2007, p.148) assert that ICT integration into education is a process which may be observed in three areas: "curriculum (macro), topic (meso), and lesson (micro)". ICT integration in the macro area is related to the use of technology in schools as an auxiliary means of teaching and learning activities of the whole course. In the meso area, integration of ICT consists of the use of technology in supplementing student learning in certain topics. Technology is used in certain lessons to help students obtain a better understanding of specific concepts. From the review of literature, a contentious issue regarding ICT integration into education, specifically in developing countries, has been highlighted (UNESCO, 2015). Some researchers contend that the integration of technology into the education system could change the nature of classroom activities and expand access to education, thus increasing the performance of students. Other researchers claim that technology is solely the auxiliary means of delivering pedagogical services; not necessarily adding benefit − what matters is the foundation of pedagogy in the sector. Other researchers state that, if properly integrated, the use of technology has great potential to enhance the delivery of effective teaching and learning activities within the education system, thereby supporting the student-centred learning approach (Al harbi, 2014; Albion et al., 2015; Fu, 2013; Glowa & Goodell, 2016). Regardless of the

differing positions of the researchers, a better understanding of the technology integration process in education is considered a priority for all countries, with more emphasis on developing countries, where few statistics are available (UNESCO, 2015). Furthermore, "literature on ICT and impact on outcomes is replete with inconsistencies and contradictions making simple cause-effect statements problematic" (UNESCO, 2015, p.7).

Although there is scant research to prove a positive correlation between use of ICT and student performance achievement, the integration of ICT in the education sector has been supported by researchers and decision-makers in developing countries. A more detailed account of ICT integration in the education system is given in the following section.

2.3.2 ICT enhancing education in developing countries

In the competitive society of the 21st century, the integration of ICT in the education system plays a role in addressing the needs of individuals and in securing jobs, as Glowa and Goodell (2016, p.1) note: "educators must produce college- and career-ready graduates that reflect the future these students will face". Therefore, decision-makers do not doubt the benefits of technology implementation in schools and in the workplace. Kamei (2015) argues that the implementation of ICT has the potential to promote transformation in the education system thereby enhancing the quality of teaching and learning activities. Therefore, the challenge is how to integrate technology effectively to gain maximum advantage from its use. Contributing to this discussion, Albion et al. (2015), note that the challenge related to technology integration is the lack of guidelines on how ICT integration in educational activities should be carried out. In a very recent study, Meyer, Marais, Ford and Dlamini (2017) developed a framework to assess the readiness of an environment or community before implementing any technology innovation. The authors contend that technology implementation projects should be designed in such a way that technology intervention meets the needs and the readiness of the community in which the innovation is to be adopted. Effective ICT integration into the educational context is a gradual, reflexive, and complex process, which goes beyond the provision of computers and Internet connections in the schools (Al harbi, 2014; Ertmer & Ottenbreit-Leftwich, 2013).

Research evidence suggests that technology in education supports educational activities such as expanding access to information; supporting teaching by facilitating access to course content; offering more opportunities to develop critical thinking skills; overcoming a shortage of teachers thereby promoting a distance-learning approach; engaging students in creative and collaborative learning; and enhancing the quality of education (Fu, 2013). Many rational reasons have been linked to the adoption and use of technology in education. However, Kamei (2015) states that technology has been used in the education system for four main reasons. The first is the social since technology plays a relevant role in today's society, students need to be prepared to meet the requirements of a knowledge-based environment. Second is the vocational aspect – technology is integrated into education as a way of preparing students to secure jobs in the future. Next comes the catalytic, where technological resources are used as tools to enhance the performance and effectiveness of academic and social activities; and finally the pedagogical − this relates to the use of technology to facilitate learning, thereby enhancing flexibility and efficiency of the curriculum. In the review of research on technology penetration, Kozma and Vota (2014) indicated the need to support social progress, economic development, and educational transformation, as the rationale for the adoption of technology use in the education system in developing countries. However, challenges related to limited infrastructure, its maintenance, contents, and teachers having appropriate training, were also identified as shaping the implementation and use of technology in developing countries.

Other important issues related to the process of ICT implementation in developing countries are limited financial resources, and the lack or deficiency of formal policies or plans to accomplish the integration project (UNESCO, 2015). The UNESCO Institute for Statistics (UIS) refers to an ICT policy as a governmental document which delineates the principles, guidelines, and strategies for ICT usage in education. Although Kamei (2015) considered ICT policy as an important tool for the provision of hardware and software, transformation of teaching and learning activities occur in the classroom and in the schools without a close linkage to the national policy. ICT policies are being used as relevant to the provision of equipment and training of teachers rather than focusing these policies on the educational purpose or goal of using technology (Kamei, 2015). Along similar lines, Jhurree (2005) stated that integration is a process which requires preparation, implementation, and evaluation of plans at the level of

classroom, school, district, province, and across the nation. Furthermore, policies and plans should be realistic, achievable, and effective, in accordance with school conditions and the needs of the country. The USI report on ICT in education in sub-Saharan Africa reveals that the situation varies between countries (UNESCO, 2015). While some countries have policies and national plans, other countries have only policies; yet others have no documents, and from the majority of countries there is no information. The introduction of ICT implementation policies is a necessary but insufficient condition for a successful integration process. According to Fenwick and Edwards (2013), the environment, which includes the basic infrastructure, influences the use of ICT in schools more than the possession of an ICT policy. For example, in many developing countries, specifically in the rural areas, the availability of electricity is problematic, as thus noted: "even when schools are connected to an electrical grid, power surges and brownouts are common in both rural and urban areas further impeding the reliable usage of ICT" (UNESCO, 2015, p.11). While ICT policies promote the effective integration of ICT into schools, the involvement of all the actors in the process is also considered relevant. For example, teachers, school administrators, and parents play a relevant role in effecting changes to the teaching and learning activities (Fenwick & Edwards, 2013). The problem of underqualified teachers, their lack of skills in operating with computers, their lack of motivation and confidence, and the lack of relevant local content and an inflexible curriculum, have been pointed out in the literature of developing countries as impeding the integration of ICT into education (Kozma & Vota, 2014).

Likewise, ICT implementation in other sectors such as health (Lewis et al., 2012), and technology implementation in the education system in developing countries is also constrained by excessive dependence on donors. Kozma and Vota (2014) considered the overall cost of technology implementation in education in developing countries as the most challenging, specifically for support and training which are more costly than the provision of hardware and software in schools. The researchers therefore deplored the limited research on the impact of ICT on the education system in developing countries. For example, in researching ICT implementation in rural areas in South Africa, a developing country, Herselman (2003) indicated the need to set distinctive goals for the development of ICT capacity, and the need to conduct research. Much research has been conducted for decades on the impact of ICT on education in developed nations, and literature on the impact of technology on teachers and students is

available. In the developing countries, however, what is dominant in the literature, is the focus on evaluation of ICT implementation in education initiatives in which results are mostly published as reports. Therefore the question still remains, related to whether or not ICT implementation has the desired impact on society, the economy, and educational reform in developing countries (Kozma & Vota, 2014). However, in a study evaluating the impact of ICT integration into education in developing countries, Jhurree's (2005, p.469) findings revealed positive insights, with technology providing the following benefits:

- An enhanced learning environment for students – the use of technology provides an opportunity for the student to be constructively engaged in learning;
- A powerful tool supplementing teachers' instructions in the classroom − technology is a potential means of making teaching activities easier and at the same time more challenging and motivating for the teachers;
- An administrative tool for both teachers and administrators – technology is useful in performing administrative tasks for both teachers and administrative staff;
- Increasing access to education and inclusive education – the use of technology offers increased access by reaching disaffected and indigent students, including those in rural and geographically distant areas;
- A communication platform – students, teachers, and administrators use the technology to communicate, sharing knowledge and work in collaborative ways; and
- A confidence-booster to employment and in gaining advantages in the global economy – job markets are recruiting technologically-savvy employees; the use of technology is intended to prepare students for more self-satisfaction and in the finding of good jobs in the future.

Despite the mentioned benefits of technology usage in education, its effective integration into schools in developing countries is still deemed to be a daunting and challenging process (UNESCO, 2015). For example, in developing countries, particularly those located in sub-Saharan Africa, school administrators prioritize issues of increased enrolment rates, a decreasing number of out-of-school children, and sufficient number of trained teachers, above the integration of ICT into teaching and learning activities (UNESCO, 2015). In an earlier study, Herselman (2003) identified three types of constraints facing schools in rural areas in South

Africa. Some of the basic constraints are lack of school buildings and stationery, and experienced and skilled teachers. In addition, their transport and road facilities are problematic, being situated in isolated areas. The lack of facilities such as telephones, the Internet and the attendant hardware and software creates communication barriers. Moreover, technical training for the rural schools to benefit from the use of the Internet, chatrooms, academic websites, and other related facilities is compromised. Other barriers comprise secondary facilities that constrain the implementation of technology in schools, such as the lack of library and transport facilities, as well as the high student - teacher ratio. Nchunge, Sakwa and Mwangi's (2012) study revealed that penetration of technology in secondary schools in Kenia is very slow resulting from inadequate technology literacy, lack of psychological and technical readiness, user complexity perception and insufficient policy guidelines in the country.

Given the aforementioned discussion on ICT in education and its implementation in developing countries, the effective and observable changes in the education system when introducing ICT comprise a set of interrelated factors requiring special attention. Thus, considering the existence of such complexity surrounding the process, leading to the unpredictability of an ICT contribution to the education sector in developing countries, its integration is to be regarded as a socio-technical process (Sawyer & Jarrahi, 2014). In this approach, social and technical, human and non-human factors are considered important to the process of ICT integration into schools. The following section presents the ICT implementation in Mozambique, a developing country.

2.3.3 ICT in Mozambique

The use of ICT has been part of the referential framework of the Mozambican government in the last decade. The government recognizes the influence of technology to sustain the country's social, economic, political and cultural development (Muianga et al., 2013). Driven by the impact of ICT in societies, the government has developed the national ICT policy which acknowledges education as one of the pillars of the country's development. The effort to design an ICT policy began in 1998 with the creation of an official commission for designing the national ICT policy. Thereafter, two years later, the ICT policy, which was seen as a framework for the introduction of ICT into the country, was approved by the government through *Resolution*

no. 28/2000, of 12 December (INTIC, 2010). The resolution was based on the need to enhance the country's development projects, which, it is believed, may be boosted by the introduction of ICT in many sectors. The ICT policy aims to:

- Contribute to the fight against poverty, and to enhance the basic living conditions of the citizens;
- Improve the governance and public administration;
- Raise awareness in the population of the role played by ICT for sustained development;
- Increase the quality and efficiency of the services provided by public and private institutions;
- Provide universal information access to all Mozambicans; and
- Facilitate the integration of the country into the Global Information Society.

To achieve the aforementioned objectives, the national ICT policy prioritized some areas, including: education and development of human resources, the health sector, and universal access to information, infrastructures, and governance. The use of ICT in education, thereby improving the development of human resources, has been regarded as a promoter for the development of other priority areas. The national ICT policy considered higher education and research institutions as a means of promoting the use and deployment of ICT services. In this context, ICT has been seen as one of the crucial elements for the improvement of pedagogical activities and research, thereby improving the Mozambican living conditions. Muianga et al. (2013) state that the national ICT policy has contributed to the development of other policies, allowing educational and research institutions to acquire and import technological infrastructure so as to facilitate economic development. In the report on evidence regarding the national ICT policy action, Mabila (2013) claimed that the measuring instrument was outdated and needed to be aligned with the actual national priorities as the new development and global trends. However, the policy is still in use and the necessary review process has not yet been realized. Given the role played by ICT in the country's development aspects, the commission of ICT policy, developed and approved the implementation strategy in 2002 (Comissão para a Política de Informática, 2002), which is briefly discussed.

ICT implementation strategy

The ICT policy implementation strategy is an action plan conceived for the gradual implementation of objectives established in the ICT policy. The materialization of the ICT policy's objectives depends on the involvement and commitment of all relevant stakeholders and partners, and was intended to be introduced gradually and concomitantly with the availability of financial resources and infrastructures (Comissão para a Política de Informática, 2002). Thereafter, the implementation strategy document identified and designed priority projects in each of the areas identified in the ICT policy. The projects were estimated to be implemented in the short, medium, and long term, in order to deploy the use of ICT in the country, contributing to a sustained development. A total of 37 programmes and projects was identified within the priority areas, and some were related to the introduction of ICT into the education system and development of human resources as described in the following subsection. One of the important policies is the education sector technology plan, which was developed under the umbrella of the education strategic plan. The education technology plan is a policy focusing on identifying priority actions to promote improvement in the education system and also to enhance the country's economic and social development (Ministry of Education, 2012). The education sector technology plan is briefly discussed next.

Education sector technology plan

This is an integrated policy with priority actions guiding the introduction of ICT into the education sector. The plan provides guidelines for the introduction of technology into schools; for the setting up of sponsorship programmes for provision of computers for teachers; and for the training and designing of digital contents which integrate technology into the curriculum. The education sector technology plan was approved and officially launched by the government in 2011. Implementation was intended to promote improvements in the sector, and also to sustain economic and social development in the country. The plan set three strategic objectives which are: to increase the number of students attending school by reducing dropout rates; to empower citizens with critical skills for the economy; and to promote interaction among school communities. These objectives were designed to be achieved in three phases, given the resources and the strong involvement of partners required for the implementation of ICT in the country.

The necessary logistics were intended to be completed in the first year of the implementation of the plan. The second phase 2012 – 2016, which coincides with the first five years of the educational strategic plan, was intended to reinforce the initial ICT coverage by providing more teacher training, equipping more secondary and technical schools, and thereby promoting a speedier technological impact on the labour market. The final phase is expected to last for two five-year periods (2017-2026), consolidating the use of technology and promoting interactive teaching (Ministry of Education, 2012). The operation of the current technology plan is ambitious, as the use of ICT in Mozambique is still in the initial stages and most of projects are dependent on the sponsorship of partners. For example, the projection plan was that by the end of 2013 teachers across the country would be using teachers' portals for sharing knowledge and 100 per cent of teachers would have been trained in the use of ICT by the end of 2016. However, the current situation of ICT implementation in the education system has proved daunting and too challenging for the country's contextual background (Ginger & Govender, 2016).

In an earlier study that analysed the state of implementation of institutional policies, technological infrastructure, access and use of technology in Mozambican higher education institutions, Muianga et al. (2013) indicated that there is no legislation in the country stipulating the mandatory use of technology for teaching and learning activities or for conducting research. Muianga et al. (2013) also stated that even the most experienced teachers had never been trained in the use of technology for teaching and learning activities. However, the national ICT policy considers higher education and research institutes as focal points for implementing solutions and strategies for expansion and use of technology allowing for the production, provision, and improvement of ICT services and educational activities.

To achieve the final phase of the plan, that is, the effective, iterative teaching in schools, all the necessary entities and the surrounding contexts must be taken in account in order to implement technology in teaching and learning activities (Ginger & Govender, 2016). Furthermore, statistically, the level of technology access is still low in the country, as is evident in Table 1-1. The statistics are based on the ICT Development Index (IDI), which consists of eleven ICT indicators developed by the International Telecommunication Unit (ITU) for measuring an information society. The indicators are grouped in three categories which measure ICT in a given

country: the “availability of ICT infrastructure and access”, the “level of ICT use” and the “capability to use ICTs effectively, derived from relevant skills” (ITU, 2015, p.39). However, the ICT access and use are considered the major components of this measurement tool, in which the Mozambique values are presented in Table 1-1. The reference values for the IDI indicators are 20 per cent for ICT access, 33 per cent for ICT use, and 33 per cent for ICT skills. Despite the gradual progress on the ICT access indicator, the penetration of ICT in the country is still ranked low. There is a significant increase from 1.28 to 1.82 per cent for the IDI rating; 1.70 to 2.74 per cent for IDI access; 0.16 to 0.30 per cent for IDI use; and 2.68 to 3.00 per cent for IDI skills, which were registered for Mozambique in the period between 2010 and 2014.

Table 1-1: Indicators of ICT access and use in Mozambique

ICT indicator		2010	2012	2013	2014
ICT access	Fixed-telephone subscriptions per 100 inhabitants	0.4	0.3	0.3	0.3
	Mobile-cellular telephone subscriptions per 100 inhabitants	30.1	34.9	48.0	69.7
	International Internet bandwidth (bit/s) per Internet user	1’281	2’046	2’867	7’755
	Percentage of households with a computer	4.9	5.9	6.7	7.3
	Percentage of households with Internet access	2.4	4.7	4.6	6.2
ICT use	Percentage of individuals using the Internet	4.2	4.8	5.4	5.9
	Fixed-broadband subscriptions per 100 inhabitants	0.1	0.1	0.1	0.0
	Active mobile-broadband subscriptions per 100 inhabitants	0.6	1.8	1.7	3.0

Source: (ITU, 2015).

According to Muianga et al. (2013) the country has made major progress in terms of telecommunication infrastructure covering all provincial capitals and the villages. However, more remote areas are still uncovered by telecommunication infrastructure, electricity still being unavailable in many of these areas of the country.

2.3.4 ICT in education in Mozambique: situation analysis

The UNESCO Institute for Statistics (UIS), which is responsible for assessing the use and effects of ICT in education, established relevant indicators in order to capture how well countries are performing in terms of the level of ICT integration into education (UNESCO, 2015). Monitoring the technology integration and the evaluation of its outcome has been concerning policymakers. The appropriate selection of priorities will lead to development of policies that take account of the context and background of the country. UNESCO (2015) noted that policymakers can benefit from the UIS indicators in relation to the decisions on a country’s capacity or infrastructure levels. This includes, amongst others:

- The availability of electricity, Internet, broadband, and other facilities needed for integrating ICT into education;

- Availability, applicability, and affordability of other types of ICT, such as radio and television, which are being neglected for instruction;
- Capturing how well ICT is strategically distributed nationwide, and the accessibility between genders;
- Assessment of the existence or otherwise of the resources to support ICT;
- The assessing of the level of teacher training provided in order to assist the use of technology in the classroom.

The UIS refers to ICT in education as the education strategy that uses all or a combination of tools, such as radio, television, the computer and the Internet, to support and improve the delivery of academic activities. The development of UIS indicators is aimed at monitoring the progress of the country in accomplishing international goals, which includes the World Summit on the Information Society (WSIS) (UNESCO Institute for Statistics [UIS], 2009). The WSIS action plan focuses on measuring the achievement of ICT objectives for development; the Education for All goals − which contends that in all countries that signed the agreement in 2000, learning needs should be provided for all children, youth, and adults, regardless of gender and economic status by the year 2015; and the Millennium Development Goals (MDG). Mozambique is a signatory to the already-mentioned international goals, and adheres to these international aims. To accomplish these goals national policies have been developed.

The UIS's study conducted in 2015, focused on analysing the status of ICT in education, and, comparing sub-Saharan African countries, revealed that Mozambique is among the countries that possess a national plan on ICT for education. This accomplishment indicates the level of the country's commitment to the adoption and use of technological innovation to improve the quality of education, thereby enhancing citizens' development. However, the availability of computers for teaching and learning needs is still poor, as in other sub-Saharan African countries (UNESCO, 2015). For example, the study report stated that New Partner for Africa Development (NEPAD), found that about 55 per cent of secondary students who participated in the e-school project have no experience with computers, and technology was unavailable for teaching and learning activities. However, the same study considered Mozambique as a politically committed country regarding the use of ICT in education. Conversely, an effective strategy for integrating

ICT into the curriculum was reported as non-existent. The study was based on 2013 and 2014 available data. However, attempts to introduce and spread the use of technology in the country, thereby improving the quality of academic activities, are noticeable in the education sector. National and international initiatives, to support the use of ICT in schools are underway. Some projects that have been initiated to promote the use of technology are discussed next.

SchoolNet Mozambique

This is a project aimed at promoting education, thereby enhancing the quality of teaching and learning activities in primary and secondary schools. The SchoolNet Mozambique was launched by the Ministry of Education in the framework of the national ICT policy, in order to increase the access of ICT at schools. Supported by the International Development Research Centre (IDRC) and World Bank Institute's World Links Program, the project was piloted in 1997 as *Internet for Schools*, with the introduction of computers in 10 secondary schools (Isaacs, 2007). Of note, is one specific study by Cossa and Cronjé (2004). Their study on the introduction of computers in secondary schools in Mozambique highlighted a number of issues, particularly the lack of infrastructure and skilled teachers in computing. Given the lack of capable human resources on the Ministry of Education site, the *Internet for Schools Project*, in its initial stage (1998-2001), was managed by the Centre of Informatics at the University of Eduardo Mondlane (CIUEM) – the project initiator (Cossa & Cronjé, 2004). Later the pilot project became a national programme – SchoolNet Mozambique, the ownership of which was given to the Ministry of Education. In its pilot form, the project was intended to advance the interchange of information in the sector, by providing email and Internet educational tools in secondary schools. It was hoped that schools would be stimulated to become centres of information sharing and communication. Computers were distributed to 75 secondary schools, and in 2006 about 25 schools were provided with Internet access (Isaacs, 2007). However, schools with computers are still few in the country, particularly at the primary level of education, as depicted in Table 1-2.

Table 1-2: Schools with ICT infrastructure

Type of school	Number of public schools	Percentage of schools with computer rooms
Primary schools (1st and 2nd) cycle	8700	0.02
Primary schools 3rd cycle	1320	1.14
Secondary schools	156	9.62
Upper secondary schools	35	91.43

Source: Adopted from Santos, Nhane, and Sitoi (2010)

In the evaluation of the project outcomes, Cossa and Cronjé (2004) concluded that the SchoolNet Mozambique project was reasonably successful in that computers were in installed in some schools. However, problems such as the high cost of Internet connection, unreliable connectivity, limited telecommunication infrastructure, low quality hardware (as second-hand computers were allocated to the project) and some problematic applications, constrained the project. Fifteen years later Mozambique is still lagging behind in the integration of ICT into schools. Yet, the majority of upper secondary schools in Mozambique have a designated room with computers installed (see Table 1-2). This study, examines closely the concerns/issues regarding ICT integration in schools by examining three secondary schools in Maputo province.

Mozambique Research and Education Network (MoRENet)

This is the Mozambican network of higher education and research programme initially coordinated by the Ministry of Science and Technology, Higher Education, and Technical-Vocational, and was established in 2005 (Ministério da Ciência e Tecnologia, Ensino Superior e Técnico-Profissional [MCTESTP], 2015). MoRENet, with a bandwidth of 301 Mbps, is connected to the SEACOM submarine fibre-optic cable which improved the quality of Internet access for the connected institutions. Currently, Mozambique is connected to the international undersea cable through SEACOM and EASSy, which were installed in 2009 and 2010, respectively; however, the cost of the Internet bandwidth for many end-users it is still very high (Mabila, 2013).

MoRENet, which aimed at integrating public and private higher education and research institutions on a national high-speed network, is currently connecting with 19 institutions in Maputo province (Jornal Noticias, 2015). However, it has been reported that the programme

team is planning by the end of 2016, to have 83 institutions connected countrywide, of which 48 are already technically connected, barring only the provision of terminal equipment.

Within the framework of the national ICT policy and under the umbrella of *Strategy for Science, Technology, and Innovation of Mozambique (ECTIM)*, the MoRENet programme represents a tool for scientific development and information-sharing between academics, institutions, and researchers. The MoRENet programme was intended to be a collaborative tool for Mozambican institutions through the interchange of academic and research resources. Moreover, MoRENet is part of a board which founded the Alliance for UbuntuNet networks of education research, and is being similarly implemented in other countries as *National Research and Education Network (NREN)* (MCTESTP, 2015). In Mozambique, the MoRENet programme has reduced the cost of communication and improved the Internet access speed between the interconnected institutions (Chemane, 2014). It is also expected to facilitate the access to online libraries countrywide, as well as abroad, by interconnecting MoRENet with other global academic networks. In analysing the state of ICT integration in the education sector in the context of Mozambican Higher Education Institutions, Muianga et al. (2013) claim that the country has advanced with regard to the implementation of ICT policies, and telecommunications infrastructure. Their study was conducted in four provinces in which nineteen institutions participated. The outcome of the study showed that this programme supports ICT capacity building in the Higher Education Institutions through the use of MoRENet across the country.

Mobile ICT Unit

Funded by United Nations Development Programme (UNDP) and other partners, the Mobile ICT Unit project is coordinated by the National Institute of Information and Communication Technology (INTIC). The INTIC replaced the ICT Policy Implementation Unit (UTICT) made redundant in 2011 by the council of Ministers (INTIC, 2010). The Mobile ICT Unit is targeting the reduction of the digital divide, also mentioned in the national ICT policy. The project operates differently from the other initiatives; for example, in terms of target people, it intends to provide technology training particularly for districts which are isolated from ICT facilities. In other words, the project is focused on the provision of ICT facilities for a populace living outside the capital and provincial capitals. Currently, the project is located at the Provincial Centre of Digital Resources (CPRDs) in each province participating in the project. The Mozambican

mobile ICT unit is a vehicle in which 10 computers are installed, together with shared resources, such as a printer. All are connected to the Internet via VSAT − a satellite communication system. From the CPRD, the vehicle circulates through the rural and isolated areas, promoting digital inclusion and thereby attempting to accomplish the WSIS recommendations and the MDG. According to INTIC (2010), the mobile ICT facility offers access to ICT knowledge for various groups of people, promoting the development of communities, as indicated in the following listed objectives:

- Promoting broader access to ICT infrastructure and the Internet for the rural communities;
- Supporting the empowerment of rural women, youth, and people with disabilities through the use of technology;
- Facilitating access to the relevant information through the Internet, and particularly through community radio;
- Promoting sharing and the exchange of information between public institutions such as schools, health facilities, organizations of civil society, and others at the provincial and district levels; and
- Disseminating the availability of resources to the population for daily activities, thereby contributing to the development of the community.

In 2006, the Mobile ICT Unit was used for the first time in the country at the CPRDs of Inhambane province (INTIC, 2010). Within the Mobile ICT Unit, various services, such as ICT training, distance learning, adult educational activities, promotion of workshops, and information exchange through the use of email facilities, were performed for a variety of groups in the provinces. The project has trained 5,449 people in several different provinces, of which about 43 per cent are women (INTIC, 2010). The advantages of this project are noticeable at the district level: improvement in communications, better management of documents, provision of digital reports, including statistical data, and other achievements which were unimaginable in the rural area, where even power supply is still problematic.

NEPAD e-schools Mozambique

Implemented by NEPAD e-Africa commission, the e-school project was launched in 2003, and is being supported by the private sector, comprising ICT companies such as Cisco, Hewlett Packard, Microsoft, and Oracle (Farrell, Isaacs, & Trucano, 2007). The NEPAD initiative aims to provide ICT knowledge and skills across African countries. The project provides ICT infrastructure to the selected primary and secondary schools, and is connected to the NEPAD network and the Internet. The e-Africa commission estimates that it will connect about 650,000 schools to the NEPAD e-schools' network by 2020 (Farrell et al., 2007). According to Kinyanjui (2006), the objectives of the e-schools' project are:

- To enable learners to operate in the emerging information society and knowledge economy by provision of ICT skills and knowledge to learners;
- To support the use of ICT as a tool to enhance the quality of classroom activities by providing teachers with the required skills;
- To underpin efficient management and administration in schools by providing the schools' management with ICT infrastructures as the required knowledge and skills; and
- To make every learner health-literate. The project was intended to be undertaken in phases, in which the first was as a demonstration of the project.

In the beginning, the NEPAD e-school project was implemented as a demonstration (Demo) (Farrell et al., 2007). The demo project was intended to last for 12 months, and was carried out in the six selected secondary schools within sixteen participant countries (Moeng, 2006), including Mozambique. In Mozambique, the Demo project was sponsored by Microsoft and Hewlett Packard private sector ICT companies, and was implemented at secondary-school level. Each school was supplied with a computer room consisting of 20 computers, a printer and an Internet connection (Isaacs, 2007). In each school, training was provided for the teacher. The e-schools' project contributed to the implementation of the national ICT strategies, thereby supporting the education sector in the introduction of ICT, which collaborated with the government efforts to meet the MDG. However, the main objective of the introduction of the ICT infrastructure to enhance the education sector in the country is dependent on other actors and actions in achieving the global goals.

The Demo project was to inform the next phase. Accordingly, in 2007, a study was conducted for synthesizing the lessons learned from the participating schools within the selected countries. A study conducted by Farrell et al. (2007) revealed a variety of constraints facing the demonstration phase of the project. For example, not all the countries were prepared to participate, which delayed the implementation timeline. Nevertheless, in the evaluation of outcomes related to the use of computers in the schools, the study findings revealed that:

- E-schools' projects had an impact on students and teachers – students and teachers reported positive results such as the increasing of abilities and confidence to use a computer. However, the integrating of ICT to enhance pedagogy across the curriculum was scarcely in evidence;
- Teachers and school administrators reported technical problems experienced in the Demo phase; however, they were very pleased with the use of ICT;
- Teachers and school administrators became enthusiastic as they were being trained, and educational software and content were supplied by ICT sponsor companies. Teachers were electronically producing their own learning material; and
- Schools become ICT centres for the provision of technology services to the community.

Provincial Centre of Digital Resources (CPRDs)

Coordinated by INTIC jointly with the provincial governments, the CPRDs have been established at the provincial level, where ICT services are provided to the community. CPRDs are part of the ICT implementation strategy. The CPRDs concentrate knowledge and investments in one access point to serve communities. CPRDs locate ICT infrastructure, including computers and Internet access, as well as technical support to supply and stimulate the use of technology in rural areas, where the majority of the Mozambican population is located (INTIC, 2010). Funded by UNDP, the first CPRDs were established in 2004 in Inhambane and Tete provinces (INTIC, 2010). Given the need to provide ICT services in other provinces jointly with other agencies including government, Microsoft, the Italian government, and others, from 2005 to 2009 UNDP sponsored the expansion of CPRDs to the Nampula, Gaza, Sofala, Zambezia, Cabo Delgado, and

Niassa provinces (INTIC, 2010). Currently, eight CPRDs are functioning across the country, with the exception of Maputo and Manica provinces. Guided by national ICT policy as well as by its strategy implementation plan, and by demonstrating the potential of ICT use to enhance country development, CPRDs provide the communities with a variety of services, including training on the use of technology, computer maintenance, network administration, database and Web design, multimedia services, amongst others.

In order to maintain the functioning of CPRD and to provide quality of service, training has been provided systematically for the trainers and technicians allocated to centres. For example, in 2015, training on network administration was provided by INTIC for eight staff (INTIC, 2010). The training was within the scope of human resources' development for the period of five years from 2015 to 2019. In attempting to maintain CPRD as a single point providing multi-functions and connecting multi-sectors, INTIC intends to introduce a wireless Internet service to provide increased Internet connectivity in the rural areas. This statement was made by Momed Cadir, manager of CPRD of Inhambane province at the *III advisory council of INTIC*. The event was organized in November 2015 (INTIC, 2016). With this initiative, it is expected that students and the population living nearby the centres will take major advantage and improve their academic performance, thereby enhancing the development of the surrounding communities. The service will be available within two kilometres of the CPRDs.

Besides these initiatives which affect the education system, some progress has been achieved by the government. The government's efforts towards strengthening the foundation for the information society have been evident from 2004, since the beginning of the implementation of the Government Electronic Network (GovNet) (Mabila, 2013). GovNet was established to provide a secure and trusted network connectivity to the citizen, a cost-effective access, a governmental portal, a centralized email system, and an effective exchange and management of documents (Macueve, 2008). The e-government strategy, which is an action plan for the GovNet and an important tool for the country's development (Macueve, 2008), was approved two years later (Mabila, 2013). According to Mabila (2013), the e-government strategy was developed to be implemented in three phases: a pilot phase (2004-2005), a provincial phase (2007-2009) and a district phase (2010-2014). The pilot phase was aimed at providing basic ICT services such as

email and the Internet. This phase covered aspects related to connectivity, ICT infrastructure, and technical support. These were to be addressed in order to support the provincial phase, focusing on the deployment of the network at provincial level, providing contents and applications to support the gathering of useful information for civil servants and citizens through a government portal. The district phase aimed at further deployment of GovNet at the district level. However, effective implementation of GovNet has been constrained by lack of financial resources, lack of infrastructure and lack of specialized technicians, resulting in a delay in accomplishing the three phases (Mabila, 2013).

The e-government strategy was designed, combining the objectives of PARPA, the Public Sector Reform Programme and the national ICT policy, which are policies aiming at the development of the country as an information-based society (INTIC, 2005). Examples of implementing e-applications are currently ongoing countrywide. Such e-applications include the government portal, the integrated financial management information system (e-SISTAFE), the biometric ID card and passport system, the criminal registration system, the national system of civil registration, among others. This represents an achievement towards the goal of the e-Government strategy, that of bringing the public service closer to the citizen through the use of technology. According to Dulce Chilundo, the director of INTIC, a total of 567 sites were connected to the GovNet from the beginning of the project up to 2015, in which 183 are public institutions from central, 252 from provincial, and 111 from district levels, 9 from municipalities, and 12 district offices (INTIC, 2016). A systematic understanding of how ICT integration takes place in education, specifically at the secondary school level, is still lacking.

2.4 Chapter summary

The chapter provided an understanding of ICT penetration in various spheres of society, including the education sector. The chapter further elaborated on ICT implementation in education, and more specifically in developing countries. ICT introduction in the Mozambican context, in which projects aimed at integrating ICT in education, were described. Studies that examined ICT implementation in the education system also highlighted the challenges posed by its social context. The discussion presented in this chapter has suggested that the introduction of

ICT in a specific organization is challenged by its surrounding social context. Therefore, socio-technical characteristics of technology will be taken into consideration and addressed in the next chapter that elaborates on theories underpinning the study. These include the Actor Network Theory (ANT) as the framework for understanding the socio-technical aspects of ICT integration in the education system; and the Unified Theory of Acceptance and Use of Technology (UTAUT) model to complement the understanding of the case study.

CHAPTER THREE

THEORIES UNDERPINNING THE STUDY

The chapter first addresses the theoretical overview of technology integration in a socio-technical context, which includes a description of the actor network theory (ANT). The ANT frames the study for understanding the socio-technical interactions among the participants involved in the use of ICT, technology, and the educational social context. Thereafter, models and theories developed and used for the understanding of user behavioural intention and actual usage of technology in different fields will be examined. Justification for the selection of the theoretical guide for the thesis is presented. The chapter ends by presenting the conceptual framework for the study.

3.1 The socio-technical perspective and ICT integration into the education system

As previously stated, technology has been introduced into the education system in an attempt to promote quality of teaching and learning (Cekera & Uzunboylub, 2016). However, various constraints have been identified as contributing to the failure of technology integration into the education system, with focus on schools in developing countries (UNESCO, 2015). These factors are often related to the complexity of the ICT integration process in a social, cultural, and political context. It is important to consider the context when integrating ICT into schools because teachers and students may behave differently within different contexts. According to Sanfilippo and Fichman (2014), technology is introduced for specific purposes in a given context, therefore it should not be planned, designed or implemented disregarding the surrounding variables shaping the local social context. It follows that the social context in which technology is being used, should be considered in the evaluation of technological outcomes.

In socio-technical studies, context is dynamically defined rather than taking it as a static or fixed environment (Ghaffarian, 2011). The appropriate ICT integration process and an effective use of technology in the educational system is characterized by changes in work practices (Glowa & Goodell, 2016) whilst technology is considered the cause of the changes. The introduction of technology into certain organizations produces unpredictable changes in people's behaviour,

which affect the organizational structure, work practices, and performance (Sawyer & Jarrahi, 2014). The changes occur because organizations act in certain contexts commonly surrounded by social aspects that have an impact on the integration of ICT (Meyer, 2014). Furthermore, technology, whether Information System (IS) or ICT, is also situated within a social context in which mutual adaptation must occur, determining the success of the integration process (Sawyer & Jarrahi, 2014). For example, in Toro and Joshi (2012) review of literature, organizational changes such as awareness regarding the importance of ICT, top-level commitment, motivation and confidence to use technology, play a vital role in the success of technology integration within an organization.

Similarly, the ICT integration into the education system leads to social and technical changes in the teaching and learning processes. According to Meyer (2014), the changes involved in the integration of technology into the education system are constructed by multiple and complex factors which require special attention. Therefore, the complexity surrounding the adoption and use of technology in the education sector demand the examining of the entire structure of the school, comprising various components. Such multiplicity of complex factors includes technical elements, such as availability of adequate computers, networks, and other related ICT infrastructure; social components, for example, people's behaviour, culture, politics, and school organizational structure and background; and the relationship resulting from the interactions between the technical and the social settings. Hence, an investigation of the social perspective or possibly the understanding of the technical components separately, may partially explain the process of ICT implementation, in light of the organizational context or technical characteristics (Sawyer & Jarrahi, 2014).

ICT integration is regarded as a socio-technical process, involving as it does people who interact with technology to achieve goals that are not possible to obtain either by the people or the technology working separately. Fenwick and Edwards (2013) draw attention to the importance of understanding the school's socio-cultural context underpinning ICT integration. The heterogeneity of the aforementioned factors hindering the process of technology integration in the educational activities leads to unpredictability of the expected outcomes, specifically in developing countries (Kozma & Vota, 2014). The complexity of these interrelated factors or

variables represents the socio-technical characteristics of ICT integration into the education system. The socio-technical approach emphasizes the complexity of factors and the unpredictability of results involved in the process of integrating ICT into schools.

Given this multiplicity of differing and interconnected variables, an understanding of ICT integration into the education system suggests a need for researching ICT as a socio-technical system in which the interplay of human behaviour, school environment, and technical aspects, is considered mutually dependent. The socio-technical perspective from which one may examine ICT integration in general, and in particular into the education system, can make a contribution to the effective adoption and use, taking into account factors that determine the success of the integration process (Sanfilippo & Fichman, 2014). According to Ghaffarian (2011), socio-technical approaches complement technical perspectives by emphasizing the context in which the heterogeneity of actors, including technology itself, is embedded. In the school context, actors could include curricula, teachers' attitudes and skills, school infrastructure and working practices and culture, and other social relationships. The next section presents the foundation of a socio-technical approach in understanding ICT integration.

3.2 The socio-technical approach as a research framework

The socio-technical perspective was initially used by researchers in London during the 1950s and 1960s at the Tavistock Institute of Human Relations, to emphasize the interconnectedness and interdependence of organizational, social, and technical characteristics of a system (Sawyer & Jarrahi, 2014). The technology was perceived as machines connected to work practices. According to Sawyer and Jarrahi (2014), firstly, the Tavistock Institute mission was to compose a connected whole by combining the social and psychological sciences in order to reduce in society the impact of the effects of the Second World War. In this mission, various researchers and consultants, including therapists, were involved. These collaborators offered two characteristics of the socio-technical approach. The first relates to the interconnected association between technology and social aspects of an organization. The second characteristic reveals the importance of worker involvement in the design, development, and deployment of a particular technology. From this period the socio-technical approach has been applied by researchers in

various domains in the field of Information Systems (IS) (Ghaffarian, 2011). The connection between IS development, its usage, and the interactions resulting from social settings and organizational changes are outlined in socio-technical approach studies. In other words, the socio-technical approach recognizes the interaction between people and technology, as well as the correlation between social infrastructures and human behaviour in a given workplace. Ghaffarian (2011, p.1504) differentiates the socio-technical approach to studying IS from others, in terms of "specific views on context and perceived boundaries; underpinning rationalities; and ways they conceptualized the interaction of ICT and social orders and processes". Sawyer and Jarrahi (2014), on the other hand, distinguish the socio-technical approach within IS research, placing it in three dimensions: first, some IS research approaches focus attention on the technology to the detriment of social roles and structures; second, some IS approaches describe the workplace in terms of generalities and best practices; third, other IS approaches emphasize the cognitive and behavioural aspects of people's involvement with technology. The assumption underlined in the socio-technical approach by comparison with other IS research strategies, is that it provides for an easier understanding and validating of the rationales that cause changes to the process of technology integration in a given context.

Researchers have used the socio-technical approach to analyse the process of design and implementation of IS, as well as, for example, ICT adoption and use in organizations (Fenwick & Edwards, 2013; Williamson & Parolin, 2013). These studies share the same assumptions, emphasizing the contextual situation in which the technology is operated, and in which technical and social factors are valued in the same dimension. The socio-technical approach has been used to examine the association between technology and its social context, and to explain the factors that influence ICT integration into organizations. Considering the implementation of technology in the education system as a socio-technical process helps to explain the school environment, the infrastructure, the socio-cultural, political aspects, and teachers' attitudes, beliefs and feelings that shape effective technology integration into a school (Fenwick & Edwards, 2013). The premise is that technology is socially constructed, it being situated and acting within a given social environment, which affects its implementation. Kincsei shares the same belief, describing technology as "not a self-propelled monster unleashed into society to which one has no other choice than to adjust to, but is rather a social construct which – besides transforming our lives –

is also shaped by society" (Kincsei, 2008, p.48). Thus, technology may be seen as one of the elements within a complex and interconnected system of networks. Ghaffarian (2011) further argues that the socio-technical perspective was established to examine the interconnection between human actions and technology. This point is shared by Sawyer and Jarrahi (2014), who underlined the socio-technical principles as follows:

- The common constitution of people and technologies – both human and technology when they interact, provide the ability to act reciprocally;
- The contextual aspect surrounding the common constitution of technology and people – all technologies being situated in a given social context, and;
- The importance of collective action – the integration and use of technology is influenced by, and shapes the collective action.

The foundation of the socio-technical approach is that both social and technical should be regarded as having the same impact and importance in the process of integrating technology in a given organization. The socio-technical approach represents the main framework guiding the present thesis.

The underlying assumption in the successful implementation of technology is that it is a process mutually dependent on social and technical subsystems. This approach emphasizes the existence of a dynamic relationship which is gradually shaped by technology and the organization. As with ICT integration into organizations in general, the process of integrating technology into the education system may be considered a subsystem of a larger social system surrounded and influenced by its context. Even in the context of developed countries, the integration of ICT into schools has been reported as having been influenced by differing cultural, social, and organizational contexts (Ertmer & Ottenbreit-Leftwich, 2013; Thomas, Singh, & Gaffar, 2013). This is justified by the fact that schools are open systems which interact with their environmental variables. Furthermore, ICT users such as teachers and students are considered social actors in a socio-technical approach to education (Sanfilippo & Fichman, 2014). The process of ICT integration into schools must be examined as a socio-technical system, since it is dependent on variables such as teachers' attitudes, school infrastructure, working practices, and culture, as well as other social relationships. It is the interdependence between technology and its social context

that is critical to the understanding of technology implementation in the schools. The socio-technical approach is therefore suited to describing the interdependencies existing between technology, people, and the school contextual background.

Given the inseparable association between ICT and its related social network, research based on the socio-technical perspective focuses attention on the diversity of entities comprising the networks that collectively shape the success of the ICT adoption and use. The emerging interest of researchers in the contextual influence of the IS implementation process determined the use of the socio-technical approach to the studying of technology in organizations from 1990 (Ghaffarian, 2011; Sawyer & Jarrahi, 2014). The socio-technical approach is focused on the interdependency between IS development and use, and social and organizational changes resulting from the technology integration into organizations. Nevertheless, the approach was criticized for mingling technology with the social, which is considered as overestimating the human capacity (Ghaffarian, 2011). Consequently, the use of socio-technical principles in assisting a technical design was abandoned. The approach was intended to be used to obtain a broader view of the technology implementation process rather than focusing on systemic developmental practices (Sawyer & Jarrahi, 2014). Hence, greater interest emerged in theoretical analyses using a socio-technical approach (Ghaffarian, 2011). Research into ICT in education is one of the fields in which a socio-technical perspective is adequate to the understanding of the interrelated components (Fenwick & Edwards, 2013). There is strong argument around the need for further research so as to understand technology implementation in education as a whole, in which social and technical components are considered relevant and interdependent (Hammond, 2013; Kozma & Vota, 2014). This research takes the socio-technical perspective in understanding the socio-technical interaction of factors resulting when ICT was introduced into the Mozambican education system. The association between technical factors and social components in which the technology is situated, are examined under the Actor Network Theory (ANT) approach. The ANT shares the principles of the socio-technical perspective, in not differentiating the social from the technical, paying equal attention to the properties of technology as well as to the context in which it operates. ANT illustrates the socio-technical characteristics of technology when it is introduced in a given context.

Latour (1996b, p.302) advocates a symmetrical treatment of technical, such as computers, and the social aspects, for example, organizational structure and infrastructures, noting that "it is not no longer clear if a computer system is a limited form of organization or if an organization is an expanded form of computer system". The way in which different entities are embedded and transformed in the aligned network make an ANT approach relevant to a study situation in which the connection between human, technical, and social is not clear. The hybrid characteristics of entities is salient within the process of technology implementation in which human and non-human should not be viewed in isolation (Garrety, 2014). In the same perspective, Law (1992) noted that it is neither the human nor the non-human entity that determines the characteristics of social changes or its stability, but the combination of both in creating heterogeneous networks. This is justified by the fact that each of the actors, regardless of size, form, or competency that makes their presence felt in the network, delineates the same network. Furthermore, Law (1999) pointed out that ANT is a research framework used to study situations in which the actors under research know what they do, and the researchers have to learn from them what, how, and why they do it. The methodological principle of ANT studies is that the researcher should follow the entities' actions, by tracing "how networks spread, who or what was enrolled, and how interests were translated" (Garrety, 2014, p.15).

An ANT aiming to understand the complexity involved in the ICT integration process has been used to research IS and ICT integration into organizations. The assumptions underlined in both socio-technical and ANT approaches have helped to develop the context-sensitive and socio-technical characteristics upon which the understanding of technology integration into the education system depends. This study closely examined the social context, technological components, and the interaction of both in ICT integration in secondary schools. The study emphasizes the role of non-human entities and their interactions with the surrounding contextual situation, in contrast to the technical thinking in which the technical issues of hardware and software are considered primarily impacting upon the technology integration in organizations. A review of the literature suggested that it is not only the technical aspects of hardware and software that lead to successful integration and use of technology in schools, but also the social aspects and their interactions (Al harbi, 2014). The basic concepts of ANT in understanding the

socio-technical aspects of ICT integration in the education system are outlined in the following section.

3.2.1 Actor network theory

The use of the socio-technical approach in studying ICT integration into the education system has offered an initial understanding of the research domain. The ANT is used jointly for further understanding of the shaping of socio-technical and contextual situations of the technology integration. This theory may be used to explore the various and dependent factors related to technical, social, and organizational aspects that surround and influence technology integration into a given setting. The ANT was initiated in the 1980s by (Callon, 1999b) and Latour (2005) in the sociology of science (Garrety, 2014). The use of ANT was extended and further developed by its proponents and other followers (Callon, Law, & Rip, 1986; Garrety, 2014). The deployment of ANT has been extended beyond science and technology, incorporating information technology implementation, management, and organizational studies (Garrety, 2014; Walsham, 1997).

The ANT was developed for the understanding of the process of information technology implementation and knowledge creation in science, taking into consideration that the actors' networks are built combining human, technical, and social aspects. However, the theory has proved flexible – it is applied as an alternative social theory in studies of social construction of a technology implementation process (Lee & Hassard, 1999). The ANT proposes that there are no social settings not influenced by technology, nor is there a technology not influencing social settings when a technical innovation is introduced. Furthermore, economic, social, political, and cultural considerations should be taken into account right from the beginning of the implementation of an innovation (Callon, 1987). According to Latour (2005), the ANT is a framework which studies the establishment, transformation, and sustainability of heterogeneous actor-networks, resulting in ways in which entities translate the interests of others. Callon (1999a) asserts that the ANT was developed and has been used in the understanding of situations in which the separation of the human and non-human entities is not clear; and in which the entities assume various forms and competencies.

The ANT is used in elucidating social phenomena, emphasizing no distinction between human, technical and social. The notion of differing characteristics of entities and an equal treatment in networks is explained through the concept of power and agency (Garrety, 2014). The ANT indicates that power and agency are not properties of entities − they should not be categorized according to these features, but only by the reflection of their actions in the built actor-network. In the ANT approach, power is related to the capacity of the entity to mobilize other humans and non-humans, assisting in the creation and maintenance of the network (Garrety, 2014). Hence every entity, either human or technical, should be analysed in the same manner as any other object in the network that is analysed. The ANT approach advocates the use of the same explanatory power for every entity, regardless of size, form, or competency in the created relationship. This distinctive property of ANT makes its use appropriate for studies in which the local social context should be considered as important as other components in the process of technology integration in organizations. Callon (1999a, p.181) stated that "…neither the actor's size nor its psychological make-up nor the motivations behind its actions are predetermined". Furthermore, an ANT approach provides language with which the researchers may explore to what extent technology innovation influences or changes human actions (Tatnall, 2014). The ANT is also described as a methodological approach "to investigate how something becomes 'true', routine or accepted" (Garrety, 2014, p.15). This underscores the ANT approach in socio-technical studies in exploring the emergent associations resulting when a particular ICT infrastructure is introduced into a given context. Furthermore, Tatnall (2014) noted that the success of technology integration is not determined either by technical aspects or social context alone; it is related to the emerging association resulting from the interaction of both entities.

From the perspective of the theoretical framework of ANT, it is argued in this research that ANT could provide a sound understanding of the interconnection of heterogeneous actors' networks in the process of ICT implementation in the education system. Therefore, ANT is the frame of reference for the understanding of the socio-technical characteristics of technology in this research. This study has drawn upon the key concept of translation, to examine ways in which diverse actor-networks are established and sustained over time, in the implementation of ICT in education. Researchers such as Walsham (1997) do not consider the ANT a stable body of

knowledge, since its proponents have frequently revised or extended its concepts. The ANT key concepts have, however, remained stable and are widely used. Latour (1999) set out the basic concepts of the ANT approach, which are outlined in the following section.

3.2.1.1 ANT concepts

According to Latour (1999), four components constituting ANT – 'actor', 'network', 'theory' and the 'hyphen' are the subjects of confusion and meaninglessness, resulting in the inappropriate use of the term 'actor-network theory'. Hence, some years later, Latour (2005, p.9) accepted the acronym 'ANT' which it is argued is "perfectly fit for a blind, myopic, workaholic, trail-sniffing, and collective traveller". According to Latour (1999), the word 'network' should not be used more technically or as in the World Wide Web sense, a collection of fixed nodes traced and inscribed by network designers. In the ANT view, an actor does the tracing and the inscribing, creating and transforming a network influenced by and influencing the other actors. The concept of 'network' in the ANT approach is related to the dynamic and active process in which human and non-human entities are associated in order to attain a particular goal. Latour (1999) further argues that the term 'network' is used to designate a summing up of various interactions that occurs when alliances between entities are shifted; and it does not represent a society. The network concept represents the mixing of human and non-human entities, and the generalized symmetry between them. Latour (1996a) claims that in the ANT perspective, a network is not an object but the recorded movements of an object, which lead to the transformation and translation of the network. In the ANT view a network of actors may represent a collection of humans, institutions, texts, and technical facilities, each with their own interests.

Similarly, Latour (1999) argued that the word 'actor' in the ANT perspective is used to describe an object that acts, flows, or circulates in the network influenced by other actors, and not a fixed entity. In addition, Latour (2005) suggests that the term 'actant' is preferred in ANT studies since the term 'actor' is mostly used in relation to human roles. Latour (2005) considers that the term 'actant' expresses the same language, granting equal agency to both human and non-human

entities. However, in this research, the term ‘actor’ will be used to represent the various characteristics of entities involved in the network.

An actor is conceived through its connections and actions exerted with other actors in the built actor-network. ANT also proposes an actor as an outcome of heterogeneous relationships resultant from the associations between human and non-human, or between technical and social entities. Callon (1987) stated that an actor may at the same time be an actor-network, provided that its activities are networked by a heterogeneity of elements. With the same assumption, Hanseth, Aanestad, and Berg (2004, p.119) claim that “an actor is also a network, whether this actor is a human carrying out an action using some tools or instruments, or it is a technology supported by an organization”. Therefore, an actor is defined through interactions with other actors, which then may also be a network, from an ANT perspective. This characteristic is explained by the appearance of a black box, that is, a stage at which a relatively stabilized network becomes an actor (Callon & Law, 1997; Garrety, 2014).

Thus, an actor may also be considered a black-box – an entity difficult to understand which “contains a network of black-boxes that depend on one another both for their proper functioning as individuals and for the proper functioning of the whole” (Callon, 1987, p.89). Therefore, a black box refers to an actor or a network of actors relevant for the creation, transformation or maintenance of the actor-network, however, disregarding its internal characteristics and functioning. In addition, an actor may represent a human being, or an object, assuming that it acts within the created network or within an association of heterogeneous components. Therefore, the information owned by a text or an artefact entity, is captured and voiced by the human being in the process of actor-network creation. Accordingly, non-human entities act by their presence, while they are enrolled in the network, and their attributes are employed by human entities. The undefined characteristics of an actor in the ANT approach make it difficult to be identified in the network. According to (Callon & Law, 1997, p.167), actors are “entities - human, non-human, and textual – are not solid. They are not discrete, or clearly separated from their context. They don’t have well-established boundaries”. Thus, an ANT rejects identification of entities into “micro or macro, social, legal, scientific, political, human or technical” categories (Garrety, 2014, p.16).

Latour (1996a) clarifies the ANT concepts. Actor-network is a key concept that represents an outcome of an entity's interactions and association in which an actor acts in contrast to the engineering networks – which are static relations topologically established. Therefore, the actor-network concept describes the way in which the associations among the actors are networked, resulting from the translation of entities' interests through negotiations in the network (Rhodes, 2009). This is the process of actors' interest alignment through creation, maintenance, and transformation of actors' interests that determine the success of the actor-network. Hanseth et al. (2004) consider an actor-network as consisting of and jointly linking both technical and non-technical entities which enter into negotiations to align their interests.

Lastly, Latour (1996a, p.373) argues that an ANT is built from the mixing of three unrelated perspectives, namely, "a semiotic definition of entity building; a methodological framework to record the heterogeneity of such a building; and an ontological claim on the network character of actants themselves". Furthermore, Latour (1999) claims that, in the ANT view, the word 'theory' is used to represent the connections between differing and complex domains of reality, as a whole package. According to Callon (1987), the various and complex problems of the technical, economic, social, political, and cultural are considered in the process of innovation. Therefore, an ANT is a theoretical approach suitable for studies in which there is mixing of various and complex domains composed of human and non-human entities.

Another key concept to supplement an ANT is that of translation or the sociology of translation from Callon (1999b). The translation process describes the diversity of strategies in which actors, dynamically, are able to interest other entities in the building of heterogeneous actor-networks. This process emphasizes production of knowledge and the creation of a network relationship mutually dependent on the identity of the entities. Each of the involved entities in the network participates in the translation, with a view to guaranteeing the proper functioning of the built network. The non-human actors participate in the construction of the network by taking on some functions of humans, translating their interests in order to achieve the predefined goal. Translation is a process which is achieved when entities translate or enrol in the interests of other entities through negotiation (Callon, 1999b). Negotiations are to include identification, definition

and allocations of roles between the involved entities, and the delimitation of a scenario; definitions of actions in which actors propose themselves indispensable to others in the created network; and the reordering of actors' actions enforced by others in the built network to follow the defined strategies (Callon et al., 1986). It follows that translation is a dynamic process of negotiations in which actors and their interests are gradually transposed in order to achieve consent for other entities' interests in the actor-network. The translation process results in a situation in which enrolled actors' interests are transformed, and changes are observed in the built network.

The way in which the translation process takes place determines the trajectory and success of ICT integration into a certain context (Sarker, 2013). Therefore, translation is a helpful approach for the understanding and interpreting of the relationship between ICT and the school workplace. In addition, Callon (1987) refers to the non-human entities such as texts, graphs, technology, and other artefacts as intermediaries in the creation of actor-networks, given that they participate in the translation process. Therefore, successful translation depends on the way in which actors define and enrol entities in the actor-network. The translation process is deployed over time and space – in Callon's (1999b) work, translation is constructed in four moments consisting of problematization, *interessement*, enrolment, and mobilization phases.

The translation moments represent various stages of actor-network building, in which the identity of actors and their interactions are negotiated, and transformation and displacement are observed. Based on Bengtsson and Lundström's (2013) work, a graphical representation of translation, the process by which an actor-network is created, is illustrated in Figure 3-1.

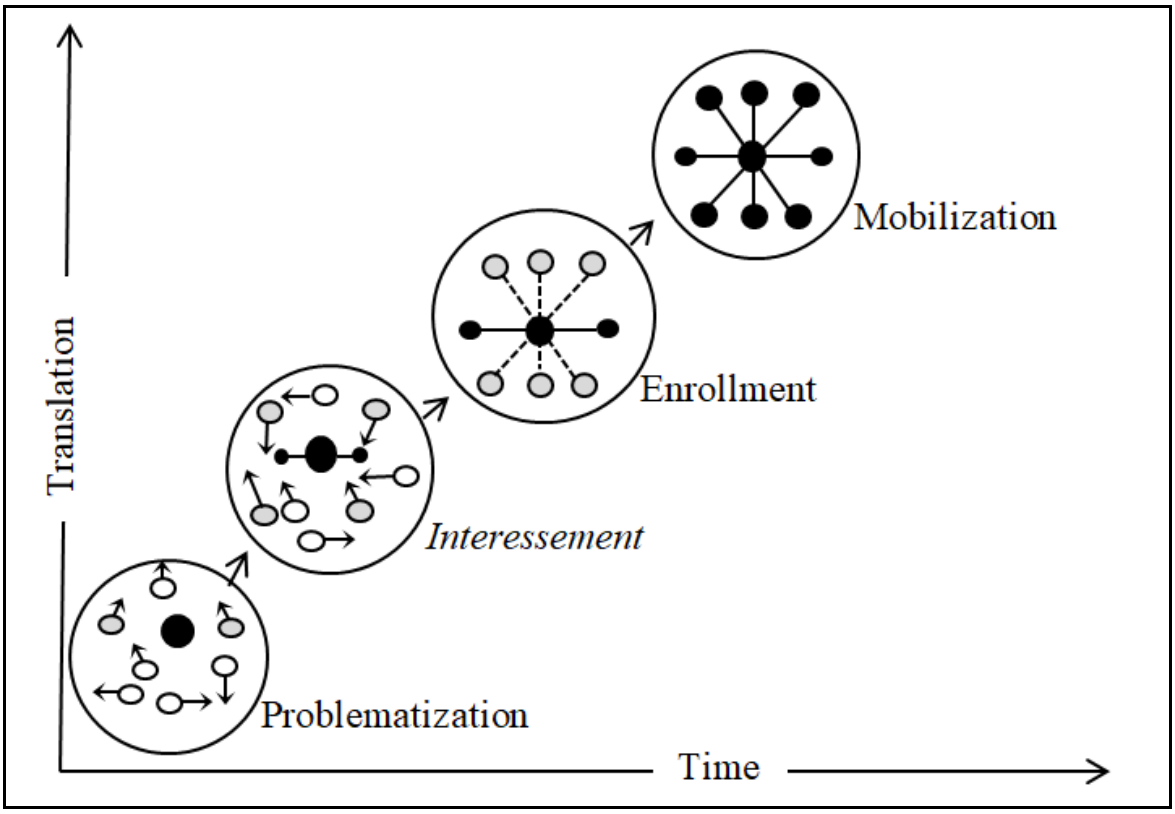

Figure 3-1: Translation moments
Source: Adopted from Callon (1999b) and Bengtsson and Lundström (2013)

The weak ties – depicted in Figure 3-1 by broken, thinner, and more disconnected lines, represent the earlier moments of translation, in which the actors' interests are not connected. As the network develops, the actors' interests become progressively connected, a situation which is depicted by strong lines, and the actor-network begins to solidify. The translation process is initiated by the main actor-initiator or focal actor in the problematization moment, which is represented by a dot (•). The four moments of the translation process are outlined as follows:

Problematization or how to become an indispensable actor

This represents the first stage of the translation process in the creation of an actor-network. The focal actor problematizes an issue and acts as a key entity to other actors by adopting their definition of the situation and demonstrating its quality to achieve a solution. The focal actor identifies and defines the problem, and uses a set of strategies to convince other actors to accept the identified solution. The problematization moment also represents the situation in which an Obligatory Passage Point (OPP) is established in the building of an actor-network. An OPP is

achieved by enrolling other entities, adopting their interests for the solution of problematized issues. Thus, a proposed OPP is viewed as a solution to the problem, affecting future relationships between actors' interests. The establishment of an OPP is considered key to the problematization stage, guaranteeing the creation of an actor-network. Garrety (2014, p.17) stressed that an OPP will "discipline actors in a network, and coerce them into adopting the 'facts' as legislated by the central network builder". Problematization is achieved by defining actors' identities and by the establishing of an OPP in the new network under construction. Problematization defines the negotiable identities, relationships, and goals for the various actors' interests.

Interessement, or the way in which the allies are locked into place

This moment consists of negotiations in which the focal actor establishes and stabilizes the definitions and roles identified in the moment of problematization. In this stage "a group of actions by which an entity attempts to impose and stabilize the others actors it defines through its problematization" (Callon, 1999b, p.71). Callon further argued that, in this moment, the focal actor builds an *interessement* device, which is placed between all other actors to strengthen the continuation of the network. Fundamentally, the *interessement* moment is achieved by making the focal actor indispensable to the network under creation, and vital to the solution of the problematized issue. Therefore, successful *interessement* validates the problematization moment and the established connections between actors.

Enrolment, or how to define and coordinate the roles

This represents the moment in which other actors accept the definitions and the attributed roles proposed by the focal actor. In this phase, the defined and distributed roles are agreed to by other actors, resulting from multilateral negotiations in which the identity of those actors is determined and tested. However, Callon (1999b) pointed out that the built device of *interessement* does not necessarily lead to the enrolment moment. This may suggest that, for an entity to be enrolled, he must be willing. In this regard, Garrety (2014, p.15) noted that actors connect to the network "because it is in their own interests, as well as the interests of the network builder". Enrolment is achieved through strategic negotiations by which the focal actor convinces others to join a solution defined in the early stage of translation. The enrolment moment might represent a

successful effect of the *interessement* device, as Callon (1999b, p.74) stressed that "interessement achieves enrollment if it is successful".

Mobilization of allies

This moment consists of methods that a certain actor applies to ensure that enrolled entities follow definitions and roles established in the network under construction. In the mobilization moment the defined solution to the problematized issue is expanded and extensively accepted by others, with innovation becoming part of the organization. With the development of the translation process, certain entities – mainly the focal actor − become important as representative spokespersons for other actors constituting the network. Mobilization is effected through a series of displacement and transformation processes rendering entities mobile, unlike at the beginning of the translation process. The focal actor gradually convinces other actors to join the network and mobilizes them. These actors express themselves, using their voices, thoughts, and interests as network representatives. To translate means that an actor will "express in one's own language what others say and want, why they act in the way they do and how they associate with each other" (Callon, 1999b, p.81). Thus, mobilization represents the end of a process of creating a network of relationships in which the defined solution becomes part of the work practices. The enrolment moment is transformed into active support for mobilizing actors' interests.

Based on Figure 3-1, the translation moments represent the various phases in which a given technology is introduced, transformed, and aligned with a certain space and time. In other words, translation shows how an actor, such as a new technology, not part of the network, becomes aligned with the process of creating a cohesive actor-network. A strategy is used to understand ways in which various entities with diverse characteristics and interests are coordinated, to build a stable network of actors.

3.2.1.2 ANT and socio-technical research

The potential of ANT to research situations in which the technical is considered as relevant as the social has been recognized by researchers in the IS field (Fenwick & Edwards, 2013; Sarker, 2013; Tatnall, 2014). The ANT is considered applicable to IS research, addressing as it does all

objects which participate in the network, as hybrid actors both human and non-human. Furthermore, the theory examines the associations resulting from the interaction of actors. The socio-technical studies are characterized by the dependency between the social and technical entities (Sawyer & Jarrahi, 2014), each with different proprieties. Conversely, IS studies are concerned with the interaction of human and non-human entities, such as a technology integration process itself. According to Tatnall and Gilding (1999), IS researchers are commonly focused on technical and social entities as seen in the context in which the technology is used. In this regard, Callon (1987, p.78) draws attention to this interaction by stating that: "it is often believed that at the beginning of the process of innovation the problems to be solved are basically technical and that economic, social, political on indeed cultural consideration come into play at a later stage". Furthermore, Callon (1987) stated that the heterogeneity and complexity of every entity, which in most cases are considered separately, are part of any innovation from the beginning of the process.

On the one hand, there are technological approaches to research into IS, which assume that the success of innovation is linked to the aspects of the technical instead of the social character of the technology. On the other hand, some social approaches assume that the social character of the technology may be used to understand the technical changes. Based on this contradiction, Brey (1997) uses the knowledge of social-constructivist approaches, which are close to socio-technical, in understanding the way in which social influence is affected by the technology. In the social constructivist approach, technology is referred to as a social construction (Tatnall & Gilding, 1999). Social constructivism studies are used to relate the sociological aspect connected to the technology research which includes technological changes and innovations. According to Brey (1997), the process of technological changes may be explained with reference to various aspects such as technological controversies, disagreements, and difficulties involved; however, technology innovation is perceived as something new or an idea introduced in a particular context. Therefore, technological changes and innovations include various actors with their own interests. Thus, the implementation of an IS in any field may be seen as technological change or innovation by its users, and is better researched under social constructivist approaches. Social constructivist approaches are categorized into three groups (Brey, 1997):

- Strong social constructivism, which is perceived as supporting the division between social, natural, and technical entities, attributing no properties or power to the technology itself;
- Mild social constructivism, which assumes a difference between social, natural, and technical entities, and considers that social factors shape the technology; and
- ANT, which does not differentiate between social, natural, and technical elements, giving all entities the same view, variety, and circulating existence in the network (Latour, 1996a).

The ANT approach, which rejects a difference between human and non-human actors, assuming however, each entity as having its own interests in the network, is widely used to understand socio-technical studies (Fenwick & Edwards, 2013; Garrety, 2014; Walsham, 1997). For example, Callon (1999b) applied ANT to his studying of domestication of scallops and fishermen of St. Brieuc Bay in Northern France. Callon used the four moments of the translation process to explain the generalized symmetry – same treatment for human and non-human actors − which should be guiding socio-technical research. Translation moments, for example, have been used subsequently as a framework on which to understand technology implementation (Heeks & Stanforth, 2015; Macueve, 2009). In the same way, the ANT approach has been used to examine the interaction emerging when a technical system is introduced in a certain social environment (Sanfilippo & Fichman, 2014). In socio-technical studies, ANT has been used as both theory and methodology.

Over the years, technology implementation has become crucial to organizational operations and more complex and deeply interlinked with society. Researchers have therefore turned to and adopted ANT concepts as a methodology for describing the complexities regarded in the technology implementation process. According to Sanfilippo and Fichman (2014), boundaries between people and technology are dynamically created in the course of actor-network construction, transformation, and maintenance. ANT offers one way of investigating the issues regarding world transformation, thereby interpreting the association between technology and its social context. Given the applicability of ANT to diverse domains of the social context, the use of the ANT concept on ICT studies was expanded into different fields. For example, a research was undertaken to clarify political issues in ICT project implementation (Walsham & Sahay,

1999); understanding the barriers and challenges facing e-government implementation projects (Sarker, 2013); the tracing of ICT implementation trajectory (Rhodes, 2009); the elucidation of technological changes in developing countries (Heeks & Stanforth, 2015); and the understanding of ICT implementation in the health-care sector (Cresswell, Worth, & Sheikh, 2010).

The power of the ANT approach in describing implementation of technological innovation projects in diverse fields lies in its stressing of the dependent relationship between social and technical entities. For example, Heeks and Stanforth (2015) claimed that projects adopting ICT implementation in developing countries result in failure as they disregard technological changes; hence the use of ANT to examine closely the local context in which technology is to operate. Brey (1997) underlined the application of ANT as a framework on which to examine interactions between social, organizational, technological, and political issues surrounding ICT implementation. In addition, Tatnall (2014) emphasized the advantages offered by an ANT approach over traditional IS research methodologies, particularly in situations in which heterogeneous entities are considered important. According to Callon (1987, p.89), in the ANT perspective, "not only are the association composed of heterogeneous elements but their relationships are also heterogeneous".

Thus, in the context of this research, ANT helped to elicit a better understanding of the mutual connection between social and technical in the process of integrating ICT into the education system. The research considers ICT integration in the education system as a complex network of actors, with differing interests. The use of an ANT translation concept helped to delineate the current stage of the ICT integration, and to understand the way in which the technology interacts with people in the school context. The interpretation of interviews, field notes, official background documentation, and observation, was the basis for understanding the roles and interests of social and technical actors involved in the process. Thus, the theory was used to answer research questions regarding the understanding of the contextual situation of technology integration, particularly in the identification and description of the actors, which included:

- The examination of the actors' interaction with the technology;
- The understanding of actors' interests; and

- The identification of the alignment stage, as well as to the identification of the OPP in the created network of actors integrated into the ICT within the education system in Maputo province in Mozambique.

However, some criticisms of ANT have been reported. The next section discusses some of the criticisms levelled against ANT studies.

3.2.1.3 Limitation of ANT

Despite ANT being applied as a research framework in various domains of technology implementation, it has its critics and limitations. McLean and Hassard (2004), in their study of the use of ANT in management and organization pointed out some key issues and problems which must be accounted for when adopting an ANT approach. The above-mentioned research focused on what has been considered important in studies applying ANT in the managerial and organizational fields. These include the issues of including or excluding actors in the traced network; the handling of both humans and non-humans entities; the socio-technical privileging and status of actors; the distinction between agency and power of entities; and the process of creating 'heterogeneous engineering'. Walsham (1997) underlined the ANT limitation in the field of IS in a similar manner, including its disregard for social structures; its levelling and neutralizing of the role of human actors; the absence of political and ethical analysis; and the favourable descriptive power of ANT contrary to its ability to explain. The analysis and the arguments on these issues are presented as follows.

The issue of inclusion or exclusion of actors

Essentially, this criticism, which is also regarded as a limitation, implies that an ANT approach does not give a guideline on the selection of actors to participate in the studies. The ANT approach is a descriptive tool in which the selection of actors to include in the network is dependent on the tracing of their actions in the accomplishment of the actor-network goal. The identification of which actors the researcher should follow in ANT studies and which to exclude, and on which premise the decision to choose should be based, is a concern (McLean & Hassard, 2004). It is noted that an ANT approach is focused on movements traced by actors' actions in the

creation of an actor-network which comprises both human and non-human entities. Therefore, the identification and definition of actors is related to their actions and interactions with others in the network. Actors are considered part of the network if they are connected in such a way that they make other actors take action (Latour, 2005). In addition, an ANT approach does not give priority either to global or local contexts; neither does it select the greater or more powerful actor at the expense of the powerless. Based on Law's (2007) notes, there are no predefined characteristics of a network, such as size, form, or power, and the structure of a network is considered as emerging from an association of actors, while power is an effect of actors' actions. In the ANT approach, power and agency are not considered properties of any entity, and are not explained by categories of entities; they are only effects of the network (Garrety, 2014). Power is obtained as a result of the capacity of an actor to negotiate and to mobilize others to join the network, regardless of their identities. The more connections the entity has, the more power may be exerted in the network. An ANT indicates that entities have no inherent qualities; they only take forms, gaining attributes through associations with other actors in the built network. To be a human is an effect of network associations in which entities derive human attributes in relation to other entities, human or non-human. Garrety (2014, p.15) pointed out that "non-human 'actants' participate in networks by taking on some functions of humans". Law (1992, p.384) considered this characteristic as relational materialism with this justification:

> "thinking, acting, writing, loving, earning - all the attributes that we normally ascribe to human beings, are generated in networks that pass through and ramify both within and beyond the body. Hence the term, actor-network - an actor is also, always, a network".

Based on these assumptions, an ANT approach indicates that the researcher should focus on what actors do in the network, whether human or non-human, and not in an a priori sense. It is what the actors do in connection with other actors that makes the entity identifiable as an actor exerting power in the network (Fenwick & Edwards, 2013). An actor producing no movement in the network, with the absence not noticed by others, is likely to be excluded from the study, as Latour (2005, p.79) stressed: "… if no trace is produced, they offer no information to the observer and will have no visible effect on other agents. They remain silent and are no longer actors: they remain, literally, unaccountable".

This criticism leads to another discussion relating to the boundaries of an actor-network. McLean and Hassard (2004) refer to this criticism as a difficulty for the researchers to answer the question of the limits of an actor-network since this is defined during negotiations and interaction between entities. Cresswell, Worth, and Sheikh (2011) discussed this criticism in terms of defining and identifying the micro or the macro actor-network. These authors pointed out that the selection of actors to include or to discount, which part of the network to focus on without neglecting the others, should be determined by the research questions, the study context, and the study focus. An additional input into this issue is provided by Law (1992), who argues that researchers cannot follow actors everywhere, and should employ certain practices of ordering, sorting, or selection. Furthermore, the identification of actors, and the definition of network boundaries, has been considered a continuous process of decision-making, as has been the dynamic creation of actor-networks. In addition, the perceived "macro-structure of society" is generally constituted of the same material as "the micro-structure" (Latour, 1991, p.118). Therefore, in socio-technical studies, the researcher should use an ANT approach in shifting between levels of analysis, since the macro network may be investigated with the same tool as the micro. As outlined by Latour (1991, p.119),

> "…the socio-technical world does not have a fixed unchanging scale, and it is not the observer's job to remedy this state of affair. The same innovation can lead us from a laboratory to a world and from a world to a laboratory …"

The neutralization of the concepts of power and social structures of actor-network led to a criticism of the ANT as being amoral and apolitical, as pointed out by Walsham (1997). For Heeks (2013), actor-networks should be categorized based on Law and Callon's (1992) distribution of global and local networks. Technology implementation projects commonly result in a connection of two main types of network: local and global, in which a global network represents the political part of the actor-network and influences the way the local network is constructed. As Heeks (2013, p.15) notes: "a global network that is essentially outside the project with actors that provide the space and resources (money, expertise, political support) for the project to take place". In this view, the local actor-network is composed of project-implementer actors, whose actions depend on resources provided by the global network. This knowledge attains value in the understanding of technology integration in organization initiatives in which

the success or failure of the project depends on "the strength of the global and local networks and the ability to create a strong, single point of passage between the two" (Heeks, 2013, p.5).

The proponents of ANT explain this criticism by means of the principle of free association, that an ANT approach imposes an a priori categorization of actors, therefore, no entity is either inherently strong or weak. Therefore, from an ANT perspective, power or domination is an effect of entities' associations, not a cause of an actor-network (Latour, 1991). An ANT replaces characteristics of actor and actor-networks as effects of associations, in that it rejects the categorization of being social, natural, or technical. Walsham (1997) asserts that an ANT does not offer explicit help for studies in which ethical and moral implications are concerned. Furthermore, an ANT should be complemented by other social theories that focus on broader social structures (Heeks & Stanforth, 2015; Walsham, 1997).

The issue of human and non-human actors

The ANT has been criticized for assuming the same treatment for both human and non-human actors in the network. An ANT approach indicates that each entity, provided that it acts in the network, should be given the same treatment, whether social, natural, or technical. Callon (1999b) describes this as 'generalized symmetry'. The recommendation is that a researcher use the same explanation to describe both human and non-human entities, assuming that actors' attributes are acquired during the network creation. The symmetrical treatment is applied not only for both human and non-human entities, but for both dichotomies of ANT elements, such as "society and nature, and the social and technical" (McLean & Hassard, 2004, p.502). In ANT studies, the researcher should learn from the interactions between actors, without assuming an a priori definition of actors' capacities or their qualities, by employing the generalized symmetry concept.

In the review of the literature this issue has been considered the most critical aspect of ANT, as it does not distinguish human actions from those that are non-human. Latour (2005, p.76) regards the symmetrical treatment of actors in the following way: "to be symmetric, for us, means not to impose a priori some spurious asymmetry among human intentional action and a material world of causal relations". Thus, an ANT approach does not strictly deny the distinction between

'human and non-human', 'society and nature', and also between 'social and technical' entities (McLean & Hassard, 2004). However, these attributes should not be considered as a priori, neither should they be used to sort the hierarchy of actors. An ANT approach indicates that characteristics of actors are acquired in the process of network building, therefore the difference between them should be considered effects or outcomes of their associations with others. As McLean and Hassard (2004) stress, in an actor-network approach, an actor takes form according to its associations with others in the created network.

3.2.1.4 ANT supporting education research

The socio-technical components characterizing the integration of technology in the education system lead to the use of the socio-constructivist approach to the understanding of how the social and technical are mutually related. Accordingly, the understanding of a relationship between technology and the education system is framed in the socio-constructivist approach. The adoption and coherent establishment of any technology in the education system is considered a complex process and dependent on the compatibility of both the school context and work practices (Al harbi, 2014; Fenwick & Edwards, 2013). Thus, researchers have been using socio-technical approaches, considered as a socio-materialist perspective, in educational studies such as the ANT, for the understanding of various artefacts integrated into the education system Fenwick and Edwards (2013). These authors, sharing the ANT proponents' views, argue that aspects such as environment and various artefacts are part of social life assigned to human existence, and not to the context background.

Educational activities such as integration of technology, school-improvement initiatives, curriculum development and implementation, introduction of a teacher-evaluation system, inter alia, are also affected by both social and non-human components (Fenwick & Edwards, 2013). Thus, under an ANT approach, educational entities, including human and non-human, are identified through their interactions with the defined actor-network. As such, the educational entities are connected with the surrounding social context. The use of the ANT approach in the educational research field has grown considerably of recent years (Fenwick & Edwards, 2013), and is being used in both a theoretical and methodological manner. Educational investigators

Fenwick and Edwards (2013) share a common understanding with other researchers (Elgali & Kalman, 2010; Johannesen & Habib, 2010; Mulcahy, 2012), arguing that ANT concepts are suitable for framing socio-material aspects of educational studies, which comprise heterogeneous actor-networks. The particular emphasis in these studies is the focus on social constructivism of the educational context, without assuming actors' attributes, nor their interests, before examining their interconnection with the built network (Latour, 2005). For example, Fenwick and Edwards (2013) highlighted the relevance of an ANT approach by showing how actors, their roles, the associations between them, and policies, are assembled and transformed, in the exercise of power and knowledge generation. In the education sector, an actor-network could be constituted of teachers, technology, timetables, workplaces, curricula, teaching resources, students, policies, managers, administrators and other artefacts related to the teaching and learning process. The principle of ANT studies is that the researcher should follow actors' movements in the created network and focus on how relationships between entities are maintained and transformed over a period of time and space (Callon, 1999b). This characteristic of ANT makes it relevant for the investigation of the process of actors' mobilization, including a variety of artefacts comprising education studies (Fenwick & Edwards, 2013). An ANT perspective investigates the way in which actors are included or excluded from networks, which connections are strong and which are weak, and how the built network is stabilized and made durable in educational settings by the association of the various actors. According to Callon (1987), the stability of an actor-network results from the durability of each of its points or actors, as well as from the robustness of their connections.

Drawing up ANT concepts, Mulcahy (2012) conceptualized teachers' professional learning and teaching standards as preformed knowledge constituted and enacted not only by social structures but also by material objects. The study argued that standards are best understood as shifting assemblies of practices in which society defines and enacts teachers' identity and teachers' professional knowledge differently in different places. Similarly, Johannesen and Habib (2010) used the ANT concepts to investigate the use of ICT at the University of Sweden. The research was conducted in three different faculties; the same technology was perceived as unpredictable in the various settings. The use of ANT concepts in Johannesen and Habib's (2010) study revealed that effective use of technology in an education system is dependent on perceptions of

teachers and faculty context and culture. Likewise, Elgali and Kalman (2010) used the ANT approach to understand the constructed concept of failure in the implementation of ICT in schools. Their findings underlined the identification of actors and actors' roles, including technology, tracing of information flow, and actors' associations, as relevant factors influencing the investigation of technology integration into an education system. Kamei (2016) employed ANT in combination with grounded theory to identify key actors and themes in a study of ICT for education in India's higher education system. Govender and Chitanana (2016) used ANT to investigate teachers' perceptions and understanding of e-learning technology in a socio-technical perspective in a university in Zimbabwe. The researchers employed the concept of translation from ANT for tracing the trajectory of e-learning technology, thereby identifying associations between human and non-human actors in the actor-network. Their findings revealed that teachers' perceptions of e-learning technology are influenced by the way in which relationships between human and non-human entities are created.

A socio-technical approach could be used to investigate the interaction between social and technical aspects which are required for the creation of an actor-network in the educational sector. The integration of ICT into an education system is a process of actor-network creation by translating actors' diverse interests in the promotion of a solution to the identified problem. ANT is also used for the tracing of the ICT integration process in secondary schools in Mozambique. However, examining technology integration in one direction only is considered inadequate for understanding the factors impacting on ICT outcomes in schools, which require additional data on usage (UNESCO, 2015). One of the factors impacting the success of technology implementation in organizations is users' acceptance and use of technology (Davis, Bagozzi, & Warshaw, 1989). Moreover, the question of why teachers and students decide to accept or reject a given technology is of concern to educational researchers (Oye, A.Iahad, & Ab.Rahim, 2012b). Thus, for technology to be effectively integrated and therefore to achieve planned goals, it should be considered a socio-technical system in which user acceptance is an effect of the created actor-network. This study therefore argues that user acceptance and use of technology should be assumed as an effect of the associations made between various actors in the built network. The more solid or cohesive the network, the more the user is likely to accept and use the innovation introduced. The durability of an actor-network influences the user acceptance and use of

technology. To assess the level of user acceptance and use of technology in secondary schools in Mozambique, the UTAUT model is considered appropriate. An overview of the models and theories that contributed to the UTAUT model is presented in the next section.

3.3 Technology acceptance models

The use of an Actor Network Theory (ANT) framework provided a useful starting point for the understanding of the social and technical interaction of Information and Communication Technology (ICT) integration into the education system. The translation process helped to examine the existing network by following ICT as an actor, tracing and identifying associations with other actors in the process of integrating technology into secondary schools. The benefits of implementing ICT in the education system have been receiving attention from literature (Albion et al., 2015; Wong, Teo, & Russo, 2013). Elgali and Kalman's (2010) study found that the success of technology integration into teaching and learning activities is strongly related to the involvement of relevant actors, such as teachers and students, with the ICT. However, user behaviour on acceptance and use of such ICT within the context of secondary schools in Mozambique has not been studied. According to Davis et al. (1989), the understanding of user acceptance or rejection of technology has been challenging researchers on ICT implementation in organizations. Taking into account the vital role played by teachers and students in the process of ICT integration, and the scant number of studies in the Mozambican context, measuring the level and understanding of user intention to use technology is prompting this research.

In attempting to understand the process of ICT implementation for predicting and explaining user acceptance of technology, various theoretical models have, over time, been developed and tested by researchers. Models and theories, to a large extent, have resulted from studies on user intention to participate in certain behaviour in an Information System (IS), or in the domain of psychology or sociology (Venkatesh, Morris, Davis, & Davis, 2003). This study applied a Unified Theory of Acceptance and Use of Technology (UTAUT) model to complement the understanding of the case study, and to assess the level of technology acceptance and use in the education system in the context of secondary schools in Mozambique. The UTAUT model is a research tool enabling an understanding of user acceptance and use of technology in

organizations (Venkatesh, Thong, & Xu, 2012). The UTAUT is a research model deploying behavioural intention as a predictor for actual technology use. This theoretical model is an integration and analysis of eight prominent models and theories used to predict and explain user acceptance of technological innovation in a variety of domains. This includes the Theory of Reasoned Action (TRA), the Technology Acceptance Model (TAM), the Motivational Model (MM), the Theory of Planned Behavior (TPB), the Model Combining the Technology Acceptance Model and the Theory of Planned Behavior (C-TAM-TPB), the Model of PC Utilization (MPCU), the Diffusion of Innovation theory, and the Social Cognitive Theory (SCT). The specifics of the most-used research models are discussed in the following sections.

3.3.1 Theory of reasoned action

User acceptance or rejection of technology in organizations has become an important issue in the domain of IS research. In an attempt to understand factors determining user behaviour in acceptance and use of technology, various studies were conducted over time (Davis et al., 1989). Derived from other studies, the earliest theoretical model, the Theory of Reasoned Action (TRA), for the predicting of user-behavioural intention, was developed from social psychology by Icek Ajzen and Martin Fishbein in 1980 (Davis et al., 1989). The assumption underlying this theory is that a particular behaviour is dependent on the user intention to accomplish the behaviour in question. The proponents of this model argue that there is a high correlation between intention and behaviour, hence, user action is predictable from the attitude towards that act (Ajzen & Fishbein, 1977). Thereafter, attitude toward behaviour is based on the individual's evaluation of salient results fitting the behaviour in question. In other words, the model posits that behaviour is determined by user intention to perform that behaviour and not by attitudes toward objects, people, or organizations. The theory is constituted by behavioural intentions, which is dependent on a person's attitude regarding the behaviour, and a subjective norm concerning user-behaviour constructs, as depicted in Figure 3-2. Thus, any factor impacting user behaviour does so by influencing attitudes and subjective norm constructs. A person's attitude is perceived as extended to beliefs and feelings which lead to the performing of a particular behaviour. If a user evaluates the outcomes satisfactorily, and perceives that important actors believe that a certain behaviour should be performed, the user may consequently intend to

participate in such behaviour (Ajzen, 1985). The subjective norm is perceived as expectations of normative social beliefs regarding the person's behaviour. The user intention to participate in any behaviour is influenced by pressure of key individuals around the person. Fishbein and Ajzen (1975) refer to the subjective norm as the perception that entities who are significant to the user believe that the target behaviour should be performed. Thus the subjective norm construct is associated with motivations to comply with other people's beliefs. Such significant people may include family members, friends, experts, colleagues, and others important to the person.

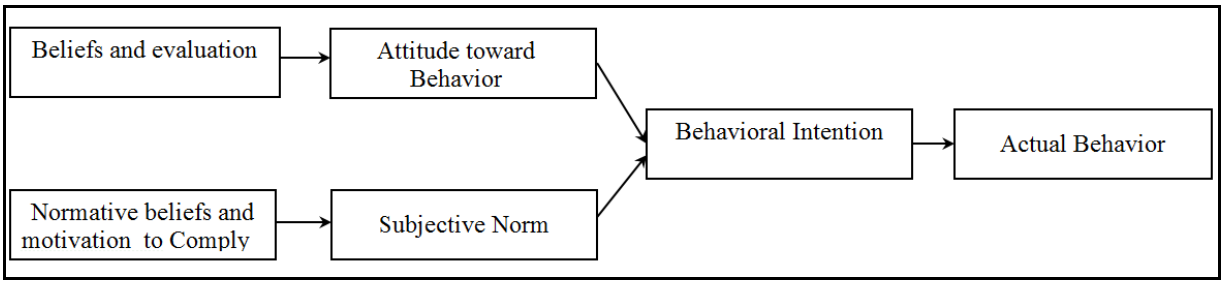

Figure 3-2: Theory of reasoned action
Source: (Davis et al., 1989, p.984)

The TRA has been used widely in various domains, and has been found to have a strong behaviour-predictive validity (Davis et al., 1989). However, the theory has been criticized for not including spontaneous actions. The theory applies to predicting user behaviour based on the previously elicited salient beliefs in a given context. The proponents of this theory considered the salient beliefs as the ones that the user provides as answers when asked open-ended questions in pilot studies. As Ajzen (1985, p.15) emphasized: "it is necessary to elicit salient behavioural and normative beliefs in a pilot study, and use these beliefs, among other things, to construct a standard questionnaire". Therefore, the researcher should identify the beliefs that are most pertinent regarding the behaviour under study, selecting the beliefs most frequently afforded by the sample. It follows that for each research context, the user's conspicuous beliefs are provided anew. However, there is no guarantee that the listed beliefs are in fact salient, since they are based on a qualitative free-response-elicitation procedure (Davis, 1986). Therefore the behaviour which is not under the individual's control cannot be explained by this theory. In addition, the theory is not likely to predict user behaviour if the technology in question is not a general technological system, which is less determined by social influence. Davis et al. (1989) suggested more research into understanding the nature of social influence and the conditions more

determinant in predicting user behaviour. In previous research, Davis (1986) pointed out that the TRA model is not suitable for studies assessing the impact of system design on user beliefs.

3.3.2 Technology acceptance model

In studies conducted in a variety of domains, various theoretical perspectives were applied in an attempt to provide an understanding of the determinants of technology usage in organizations. Most of these models and theories were developed as general product-design methodology with object-oriented constructs (Davis, 1986). In attempting to provide a specifically theoretical model which predicts and explains the user acceptance of computer-based IS organizations, the Technology Acceptance Model (TAM) was proposed in 1986 by Davis. The model is based on the TRA (Fishbein & Ajzen, 1975) as a theoretical framework, using variables suggested in previous research dealing with contributing factors to the understanding of user acceptance and use of technology (Davis et al., 1989). TAM was introduced by Davis (1986) and further expanded in Davis et al. (1989). The assumption underlying this model is that two specific beliefs: perceived usefulness, and perceived ease of use, are the main factors contributing to the explanation of user acceptance and use of technology behaviour. Davis (1986) believes that in a given workplace, individuals form intentions towards behaviour which suggest that technology will increase their job performance, and in which the amount of effort required to make use of that technology is relatively less compared with the user's frame of reference. The original model indicates that individuals' actual use of a technology is somehow determined by the user's behavioural intentions, attitude, perceived usefulness, and perceived ease of use of the system. In addition, the model includes external variables which influence attitude, intention, and actual system use, through user perceptions. The model also suggests a causal relationship between the two main constructs: perceived usefulness, and perceived ease of use. Moreover, the perceived usefulness construct is considered as directly influencing user behaviour of intention to use. Figure 3-3 illustrates the TAM structure. The perceived usefulness construct is defined by Davis (1989, p.320) as "the degree to which a person believes that using a particular system would enhance his or her job performance". Davis further adds that a user is more prone to believe in a positive relation between use and performance of a system, only if he or she perceives the usefulness of the same system. Perceived ease of use refers to "the degree to which a person

believes that using a particular system would be free of effort" (Davis, 1989, p.320). This follows that the acceptance and use of a system is relatively dependent on the user's perceptions of the ease of use of the system.

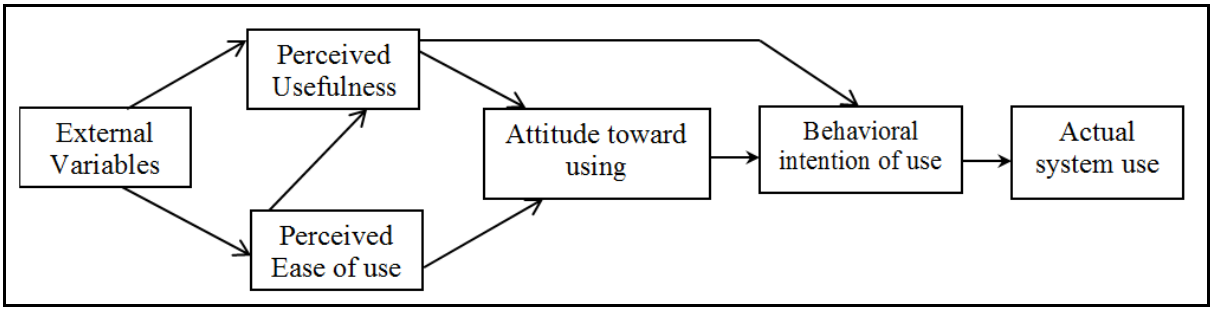

Figure 3-3: Technology of acceptance model
Source: (Davis et al., 1989, p.985)

As with the antecedent TRA, this theoretical framework has been widely used in the understanding of user behaviour in the domain of technology implementation. TAM is the most cited framework of IS studies for predicting the user acceptance and use of technology based on user perceptions (Bradley, 2009; Venkatesh & Davis, 1996). Both TRA and TAM suggested that behavioural intention to use a system is the determining factor of usage behaviour. Any other variable that has an impact on user behaviour does so by influencing the behavioural intention of use. The perceived usefulness and perceived ease of use are specified previously, impacting positively or negatively on the attitude variable; the three constructs could influence system design and usage behaviour. It is believed that perceived ease of use and perceived usefulness are the constructs over which a system designer and implementer has some degree of control. Basic elements such as features of the system, user training, its participation in system design, and the selected strategy for the technology implementation in a given organization, are considered external variables affecting user behaviour (Venkatesh & Davis, 1996). These external factors are perceived as a bridge between the user beliefs, attitude toward using, and the intention to use. Davis et al. (1989) tested the TAM in a longitudinal study at two different times of technology usage, finding that perceived usefulness is a key factor contributing to user behaviour of intention to use. The study findings indicated that the perceived ease of use construct significantly impacts user intentions in the first one hour of technology introduction, with the effect becoming non-significant three weeks after system use. It is assumed that a user would be

willing to tolerate difficulties of using the technology, providing that access to very important functionalities from the system will be gained. In the same study, the attitude toward using was found not to be a better predictor of user behaviour.

Given a direct linkage between perceived usefulness and intentions, and its weak relationship with attitude, it was proposed to omit the attitudinal construct from the model. It follows that a model which aims to explain key factors contributing to user acceptance of technology, and also to assess and predict the significance of the determinant elements influencing the use of such technology, should be based on three theoretical constructs: behavioural intention, perceived usefulness, and perceived ease of use (Davis et al., 1989). Thus, as a result of their study, Davis et al. (1989) suggested that the subsequent researches on the TAM should test the generality of the key constructs: perceived usefulness, and perceived ease of use, assessing the impact of external variables on the user behavioural determinants. From this period onwards, TAM was continuously studied and used in various contexts, and ten years later was considered a well-established, powerful, and efficient model for examining user acceptance and usage of technology (Venkatesh & Davis, 2000). However, the model focuses on its key constructs as determinants of user acceptance and use of technology; not providing insight into the way in which such perceptions are formed in order to guide a system development which could increase acceptance and usage of technology. However, the model considered design features as influencing the perceived usefulness and perceived ease of use perceptions. It follows that, without a better understanding of the antecedents of the basic TAM constructs, practitioners are less likely to intervene in system design and implementation strategies in order to influence usage through user perceptions. As Venkatesh and Davis (1996) noted, a better understanding of factors contributing to the perceived usefulness construct, would enable the redesign of relevant interventions in order to increase user acceptance and usage of technology in organizations.

Another issue raised in studies testing TAM is related to the generalization of findings based on a student sample, or sample of professional users which could lead to different results depending on the setting, examined system, and choice of respondent (Taylor & Todd, 1995). Another limitation reported in studies employing TAM is that they have not measured the actual usage; therefore the measure of the actual use of the technology relied on the research subject (Bradley,

2009). In addition, Venkatesh and Davis (1996) reported that studies based on user perceptions for predicting technology usage have found that TAM explains only about 40% of system acceptance and usage. Therefore, in 2000, an expanded model, TAM2, which is theoretical, based on TAM, was developed and introduced by Venkatesh and Davis (2000). TAM was extended in an attempt to improve the explanatory power of the model. The assumption underlying the expanded model is that social influence and cognitive instrumental factors are fundamental to the understanding of usage behaviour. Thus, TAM2 adds to the original TAM concepts integrating social influence determinants, namely subjective norm, voluntariness, image, and cognitive instrumental influences, which are job relevance, output quality, result demonstrability, and perceived ease of use. The TAM2 structure is represented in Figure 3-4. Another factor influencing the perceived usefulness and usage intention constructs depicted in the model is experience. The experience determinant is related to a social-influence process, it being argued that the direct effect of a subjective norm on perceived usefulness and intention to use is influenced over time by system experience (Venkatesh & Davis, 2000). Although the subjective norm construct was perceived as not affecting behavioural intention to use, and hence was omitted in the original TAM, in the expanded model this determinant was found relevant, and theorized as a social-influence determinant.

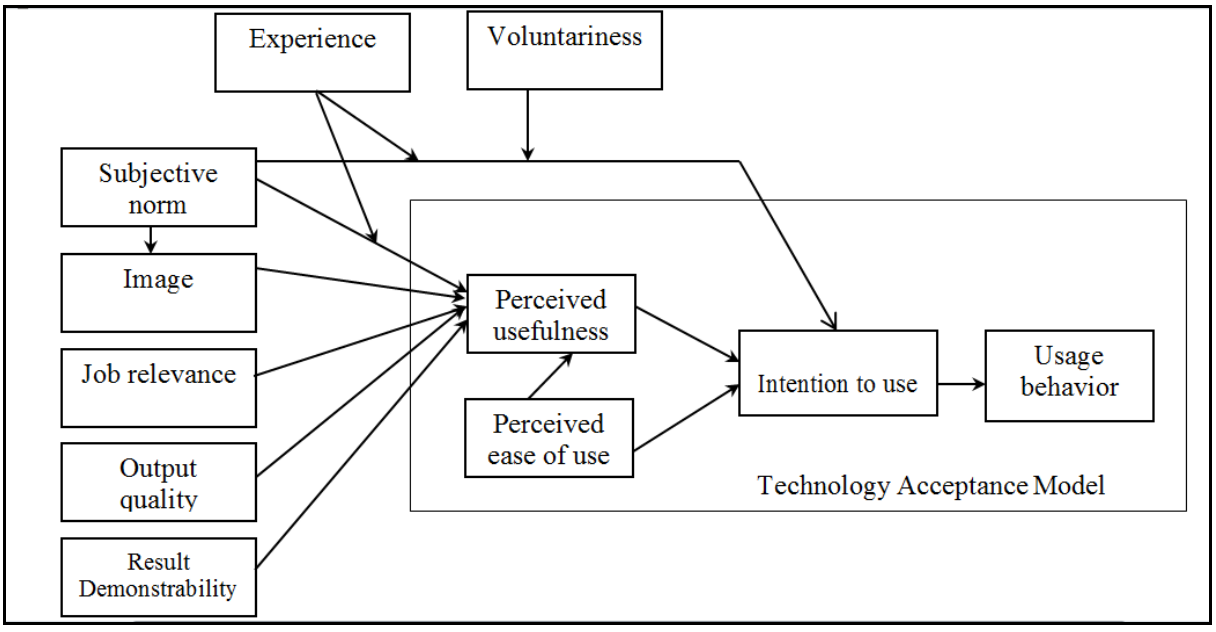

Figure 3-4: Extended technology acceptance model – TAM2
Source: (Venkatesh & Davis, 2000, p.188)

Venkatesh and Davis (2000) tested and validated TAM2 in the voluntary and mandatory technology usage context at three different times, including the time before system implementation, one month after, and three months after system use. The study findings indicated that the subjective norm construct significantly influenced the perceived usefulness and the intention to use in the early phase of the system implementation. However, over time, the effect of a subjective norm became non-significant, and was replaced by experience in using the system. Similarly, the subjective norm was found to be a determinant in the intention to use in a mandatory system usage, but not in a voluntary context. The model theorizes voluntariness as a moderating variable to differentiate between a mandatory and voluntary technology-usage context. Voluntariness is defined as "the extent to which potential adopters perceive the adoption decision to be non-mandatory" (Venkatesh & Davis, 2000, p.188). TAM2 reflects the impact of social influence and cognitive instrumental determinants on the user acceptance or rejection of technology. The social influence construct is defined as "influence to accept information from another as evidence about reality" (Venkatesh & Davis, 2000, p.189). The cognitive instrumental process is perceived as the matching of elements that users use for evaluating the important job opportunities and their perceptions on the acceptance and use of the technology. This set of determinants is composed of four factors defined by Venkatesh and Davis (2000, p.191) as follows: job relevance − "an individual's perception regarding the degree to which the target system is applicable to his or her job"; output quality − the "individual perceptions regarding how well the system performs the required tasks"; result demonstrability − the "tangibility of the results of using the innovation" Venkatesh and Davis (2000, p.192); and perceived ease of use, which is related to the person's perception of ease of use of a given technology. In summary, Venkatesh and Davis (2000) reported that the user acceptance and use of technology are complex and elusive phenomena strongly impacted upon by social influence and the cognitive process. The extended model reports a powerful explanation, accounting for 60% of the variance of user intention, however, less efficient than the original TAM (Bradley, 2009).

3.3.3 Theory of planned behavior

In 1985, in an attempt to improve TRA so as better to predict and explain user behaviour, the Theory of Planned Behavior (TPB) was proposed by Icek Ajzen (Ajzen, 1985, 1991). In the

TRA model, intention to perform the behaviour is considered predicting of user behaviour based on user evaluation and beliefs, in a situation under volitional control. However, user intention could change over time, which constrains the accuracy of measures obtained before the changes took place. According to Ajzen (1991) factors such as time, opportunity, and dependence on others, may lead to the intention to change. Volitional control denotes situations in which the user decides at will to accomplish a certain behaviour (Ajzen, 1991). Thus, if the behaviour is not under volitional control, required resources and opportunities should be available for the user to perform that behaviour. Therefore, perception of the availability of the required resources could affect the user intention to participate, and, in turn, the behaviour under study. Thus, including consideration of situations not entirely under volitional control as determinants of user behaviour, perceived behavioural control constructs were added to the TRA model. The TBP structure is diagrammatically represented in Figure 3-5. The TBP suggests that only specific attitudes toward the behaviour in question may be expected to predict that behaviour. For Ajzen, goals and plans guide the user behaviour. In addition, Ajzen (1991) contends that people's intentions, jointly with attitudes toward the behaviour, subjective norms, and perceived behavioural control, predict behaviour with greater accuracy than any existing intentional models.

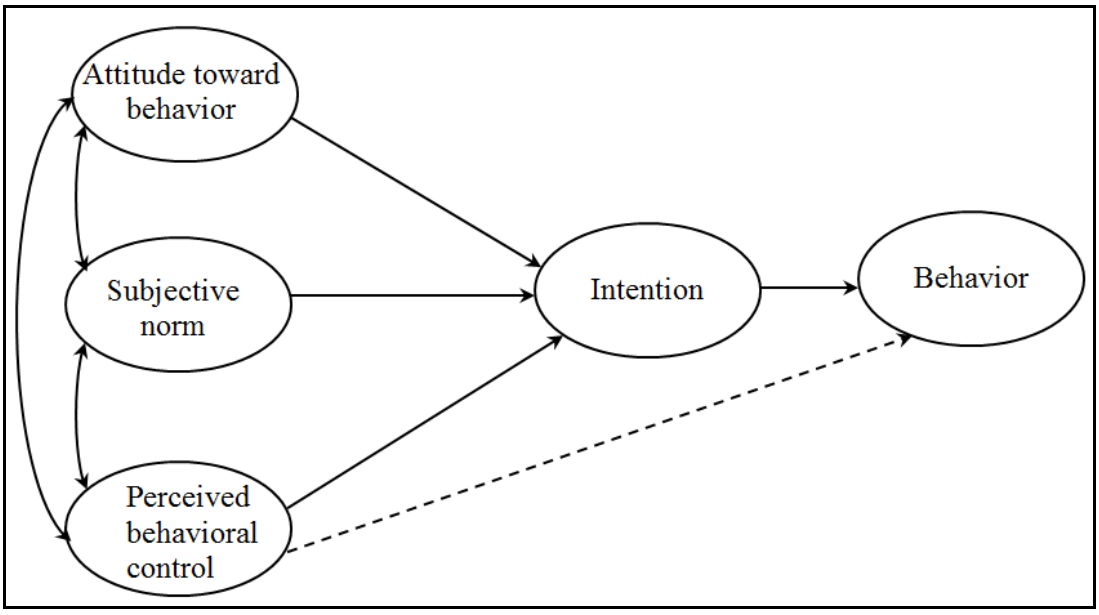

Figure 3-5: Theory of planned behaviour.
Source: (Ajzen, 1991, p.182)

The perceived behavioural control is measured to determine both behavioural intention and the behaviour under question. Ajzen (1991) defines perceived behavioural control as users' perceptions of the ease or difficulty of accomplishing the behaviour in question. Perceived behavioural control is considered as reflecting users' previous experience, thereby predicting the possible obstacles. As with the antecedent TRA, this theoretical framework relies on elicited salient beliefs as determinants for predicting actual user behaviour. Behavioural beliefs, which are considered beliefs with reference to the consequences of performing the behaviour, determine the user attitude toward the behavioural construct. Normative beliefs, which refer to the beliefs regarding the pressure of others, determine the subjective norm construct. Lastly, salient control beliefs, which are associated with one's perceptions of a set of determinant factors related to the performance of a given behaviour, are held to explain perceived behavioural control constructs. Behaviour is dependent on the salient beliefs, which influence human intention; Ajzen (1991, p.189) notes that "it is these salient beliefs that are considered to be the prevailing determinants of a person's intentions and actions". TBP suggests that, given certain conditions, perceived behavioural control, combined with behavioural intention, would account for accurately predicting actual behaviour. It is also noted that both perceived behavioural control and intention are important predictors of behaviour, however, in a given context; one may be more relevant than the other. For example, Chang (1998), on predicting user behaviour and comparing TRA and TPB models, found that perceived behavioural control is the key factor determining user behavioural intention. TPB is a widely used model for predicting human behaviour and has been well supported in empirical studies (Ajzen, 1991). Intention to perform behaviour is predicted by attitude toward using, subjective norm, and perceived behavioural control, which in turn are explained by user salient beliefs. The salient beliefs are obtained through conducting a prior elicitation study. However, the belief elicitation phase has been less considered in researches Sutton et al. (2003), which makes the use of a TBP model difficult (Taylor & Todd, 1995). The underlying assumption is that beliefs give the detailed descriptions about the information which determine the behaviour (Ajzen, 1991). However, the exact form of the relationship between beliefs and their related constructs is not well explained. Furthermore, some research refers to TBP as a model that adds very little explained variance beyond that given by its antecedent model TRA (Sutton, 1998). Prior to the introduction of TBP, the diffusion of

innovation theory by Rogers (1995) which is discussed in the next section, was available, and, from 1983, considered useful to IS researchers.

3.3.4 Diffusion of innovation theory

Research on understanding the variables that determine how and why users adopt an innovation has been considered significant in the literature. Various studies were conducted, with some models proposed in an attempt to explain the factors promoting or not the adoption of a new technology. The spotlight falls on Rogers who has been studying the innovation process for over 30 years, before formulating the diffusion of innovation theory (Sahin, 2006). Rogers' framework is the most referred to innovation theory, focusing on the way in which an innovation is adopted and diffused through society. This theory differs from the previously presented acceptance theories, assuming that in the diffusion of any innovation, it is not the user who changes, but the innovation that affects the user as it diffuses. As Rogers (1995, p.204) noted:

> "…much effort has been spent in studying 'people' differences in innovativeness (that is, in determining the characteristics of the different adopter categories) but that relatively little effort has been devoted to analyzing 'innovation' differences (that is, in investigating how the properties of innovations affect their rate of adoption)".

For the diffusion of innovation framework, users are "individuals, organizations, agencies, groups, and networks that adopt, implement, and maintain an innovation" (Peterson, Rogers, Cunningham-Sabo, & Davis, 2007, p.522). Innovation is defined as "an idea, practice, or project that is perceived as new by an individual or other unit of adoption" (Rogers, 2002, p.990). Hence, innovation is a user perception of newness features of any adoption, regardless of its time of invention. It is the characteristic of an innovation itself that influences its adoption. The user perceptions of newness are related to the first three of five stages of the Rogers' (1995) innovation-decision process, which are depicted in Figure 3-6. The innovation-decision process is a trajectory through which a user passes from firstly, gaining knowledge from an innovation; then developing an attitude toward innovation; following the decision to adopt or reject an innovation; resulting in the accomplishment of a decision; and lastly, the approval of the decision taken. The theory investigates the way in which the characteristics of an innovation affect the

possibility of its adoption. This theory is rooted in rural and agriculture sociology fields; however, Rogers found commonality in other settings such as medicine, marketing, political science, history, technology, and education (Sahin, 2006). Rogers' theory is widely used in a variety of studies as a theoretical framework in the area of technology diffusion and innovation. According to Rogers (1995), the diffusion of innovation theory was used mostly to investigate diffusion in studies which are technological ideas. In view of this, Rogers adopts the words "technology" and "innovation" as synonyms. In addition, Rogers (1995, p.35) refers to technology as "a design for instrumental action that reduces the uncertainty in the cause-effect relationships involved in achieving a desired outcome". Diffusion is further perceived as a process by which technology innovation influences the likelihood of diffusion through certain channels over time in a given social system. Rogers (1995) defines a social system as a set of interconnected components that jointly participate in solving problems to achieve a particular goal. Therefore the four elements composing a diffusion process are innovation; communication channels; time; and the social system (Rogers, 2002).

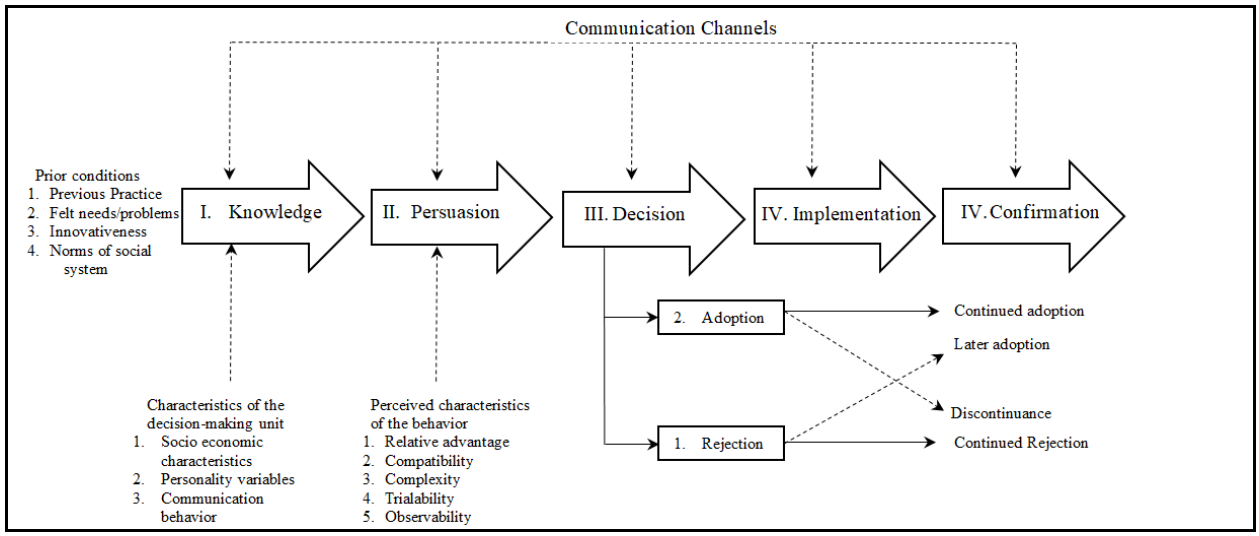

Figure 3-6: Diffusion of innovation theory
Source: (Rogers, 2003, p.170)

Rogers (2003) describes the five characteristics of the innovation-decision process as follows: The knowledge stage represents the first phase of the process in which the user seeks information and learns about the existence of a given innovation. This occurs when a user is introduced to an innovation, becoming somewhat familiar with the way in which it operates. According to Rogers

(1995), once the user perceives the extent of the innovation, questions such as: “what is the innovation?”, “how does it work?” and “why does it work?'” are critical. These questions lead to three different types of user knowledge: (a) awareness-knowledge, which represents the knowledge of the existence of an innovation, motivating the user to learn more about the other types of knowledge; (b) how-to knowledge, consisting of relevant information needed to operate an innovation appropriately, and (c) principle knowledge, which refers to acquiring information related to the principles of functioning underlying the way in which the innovation works.

The persuasion stage is an affective or emotional stage, at which the user forms perceptions, whether positive or negative, vis-à-vis the innovation, hence taking decisions affecting the adoption or rejection of the innovation in question. Rogers stated that at the persuasion stage, the user is psychologically involved with the innovation. The lack of confidence about the innovation’s functioning (from knowledge stage) and the social pressure from others (colleagues, peers, etc.) affect the individual’s attitude and beliefs about the innovation of interest. At this stage, the user decisions are linked to the place at which the user seeks information, the messages the user receives, as well as the way in which to interpret the received information (Rogers, 1995).

The decision stage represents the moment when the user chooses either to adopt or to reject the innovation. For Rogers (1995), adoption is referred to as the phase in which the user makes a decision effectively supporting the use of an innovation as the pre-eminent option offered, while rejection is a decision not to use the available innovation. The innovation which was previously tried is more likely to be adopted. Rogers (1995) view is that the user will not adopt an innovation without trying it first on a probationary basis to determine whether or not it is useful for his or her own context. Despite the importance of a trial phase for decreasing the uncertainty of the innovation, in some situations the trial may not be possible to perform, leading to adoption or rejection after the initial awareness. Rejection could occur at every stage of the innovation-decision process in two different ways: active or passive rejection (Rogers, 1995). Active rejection refers to situations in which the user considers the adoption, which could include its trial, however, later decides not to adopt it. This situation can lead to the discontinuance decision, which relates to the rejection of an innovation after its earlier adoption. Passive

rejection, also called non-adoption, implies that the user does not consider the adoption option at all. Rogers expressed the view that in some cases, the order of knowledge-persuasion-decision stages may be transposed to knowledge-decision-persuasion, however an implementation phase follows in both situations.

The implementation stage is the moment in which the user puts into practice an innovation. However, the usefulness of an innovation is predisposed to some degree of uncertainty. Rogers (1995) notes that, even after the decision to adopt an innovation has been made, the user may experience a certain degree of uncertainty about technology outcomes. Thus, the user may seek further information about the innovation of interest. Therefore, the questions of "Where do I obtain the innovation?", "How do I use it?", and "What operational problems am I expected to encounter, and how can I solve them?" are more likely to be observed. To answer these questions, Rogers (1995) suggests that technical assistance from the change agents should be available to decrease the degree of uncertainty in the implementation phase. It is also noted that, over time, the innovation loses its quality as the identity of the new idea disappears (Rogers, 1995), which in some situations, leads to the end of the implementation stage, and in others, to the end of the innovation-decision process. Rogers also presents the concept of reinvention, which refers to the "degree to which an innovation is changed or modified by a user in the process of its adoption and implementation" (Rogers, 1995, p.174) as an important part of this phase. This concept differs from innovation, as it refers to the process of creating or discovering new ideas, while adoption is a decision to make use of an existing idea, that is, of an innovation.

The confirmation stage represents the last phase of the innovation-decision process, which reflects the user's decision regarding adoption or rejection, which may change if uncertainties or problems with the innovation occur. At this stage, the user actively seeks support for confirmation of the innovation decision already made. From Figure 3-6 it is noted that, after the decision to adopt or reject an innovation, this stage continues for an indeterminate period of time. According to Rogers (1995), the presence of the change agent is fundamental at this stage, as the agent might provide supportive messages to the user who has already decided to adopt an innovation. The deficiency of the support and the attitude of the user could lead later either to adoption or discontinuance at the confirmation stage. Discontinuance occurs in two differing

situations: replacement, and disenchantment. In the case of replacement discontinuance, the user rejects the innovation under question, replacing it with a better innovation. Disenchantment discontinuance, however, refers to the decision of the user to reject an innovation because of user perception that its performance was not satisfactory.

As with the earlier presented theoretical frameworks, the diffusion of innovation theory has been criticized. Rogers (1995) acknowledges the role and contribution of this theory to understanding human behaviour over a period of time in various research fields. The diffusion of innovation theory is relatively easy to implement, and has been successfully applied in many disciplines and topics (Sahin, 2006). In the same way, Rogers acknowledges the criticisms, remarking that the absence of critical views may have been disadvantageous to all diffusion research conducted in the early development of the theory. According to Rogers (1995), had the adjustments resulting from critics and debates been made earlier, the potential of the diffusion of innovation theory would have been greater and would not have been characterized by shortcomings and biases. Accordingly, Rogers compiled and presented contributions and criticisms, which include the pro-innovation bias, the individual-blame bias, the recall problem, and the issue of equality. The pro-innovation bias implies that innovations have positive features which should be adopted and diffused to all users. However, technological failures are observed; and researchers are required to examine potentially negative consequences, rather than accepting uncritically the promise of innovation. The individual-blame bias refers to the trend to blame individuals for not adopting the innovation, ignoring the surrounding network structure. Nevertheless, many variables could contribute to non-adoption of an innovation; which include system-blame factors and change agencies playing a significant role in the provision of required assistance to the user. The recall problem is related to the fact that innovation studies are usually conducted in an environment in which the innovation has either been adopted or rejected, rather than during the active adoption of the decision-making process. Diffusion of innovation studies are conducted by asking users to remember information about the time at which the innovation was introduced. Rogers (1995) notes that the user is asked to reflect on and to reconstruct his or her past history of innovation based on personal experiences. Innovation diffusion is a function of time which affects the accuracy of information obtained after adoption or rejection of technology over a long period. Lastly, the issues of equality relate to the existing socio-economic gap between the users of

differing social systems. The way in which the benefits of an innovation are distributed among various users' socio-economic status is an important concern. The issue of equality affects the adoption rate, users from indigent nations being more likely not to see technology as beneficial, in turn bypassing the diffusion process. This results from limited financial resources and lower levels of formal education in developing countries. Such limitations impact negatively on the users' self-determination to implement their own innovation decisions. According to Rogers (1995) there is a tendency for the diffusion of innovation to increase the socio-economic inequalities between the higher and the lower status segments of a system. In the next section, a discussion of the Unified Theory of Acceptance and Use of Technology (UTAUT) is presented, which is a concatenation or a chain linking the aforementioned theories and other tools used in the domain of IS studies.

3.3.5 Unified theory of acceptance and use of technology

The earlier discussed technology acceptance and motivation models together with other models, have evolved over a period of time. Discussion and debates on the best framework explaining the user acceptance of technology have dominated studies in the IS literature (Venkatesh et al., 2003). In an attempt to provide a tool which incorporates both human and social variables, or an integrated view of user acceptance, Venkatesh et al.'s (2003) study explored and synthesised the extant models and theories. As a result of the study, comparing similarities and differences in the eight extant tools, Venkatesh et al. (2003) developed and validated the Unified Theory of Acceptance and Use of Technology (UTAUT). As with the aforementioned theories and models, the UTAUT is aimed at explaining user intentions to use technology, and usage behaviour. The theory is considered a more complete framework for understanding the technology acceptance process than any previous individual model. UTAUT is widely used in a variety of technology acceptance studies in both organizational and non-organizational contexts (Venkatesh et al., 2012). In an attempt to enhance the accuracy of the framework explaining and predicting user behaviour, Venkatesh et al. (2003), reviewed and addressed the limitations identified in studies, using previous technology acceptance tools. The five limitations addressed are as follows:

- The type of technology studies were considered simple and focused on the individual, in contrast with more complex and developed organizational technology; the study

was conducted using historical data from four organizations, and cross-validated using data from two additional organizations;

- The respondents in these studies were students, with few exceptions; Venkatesh et al.'s study used data collected from employees;
- The time of measurment was general; most of the studies being conducted at some time during users' experience, leading to approval or rejection of technology usage, rather than throughout the process of decision-making; UTAUT was tested at three different times, that is, from the time of initial introduction to phases of greater experience of technology usage;
- The nature of measurement was cross-sectional and/or between subjects compared in previous studies. In Venkatesh et al.'s study, respondents were tracked through various stages of technology usage experience, comparing all models on every participant; and
- The usage context, in which the previous models were tested was voluntary, making the generalization in mandatory settings not straightforward. UTAUT was validated using data in both a voluntary and mandatory research context.

From the technology-acceptance literature, each model revealed different advantages in understanding user acceptance and use of the technology process; however, there are some commonalities among these models which were explored in formulating UTAUT. UTAUT proponents found seven constructs significantly determining factors of user intention or technology usage, adopting one or more tools. However, they theorized that only four (performance expectancy, effort expectancy, social influence, and facilitating conditions) of the constructs have a direct effect on user acceptance and usage behaviour; therefore, the remaining four (computer self-efficacy, anxiety, and attitude toward using) were discarded from the model. Although attitude toward the use of technology was considered important in the previous models, TRA and TAM, this factor is not included in UTAUT because its effect occurs only when performance and effort expectancies are omitted from the model. In addition, Venkatesh et al. (2003) examined the impact of the moderating variables identified in previous studies on the four constructs influencing usage intention and behaviour. The moderating variables are experience, volutariness, age, and gender. The theory is diagrammatically shown in Figure 3-7.

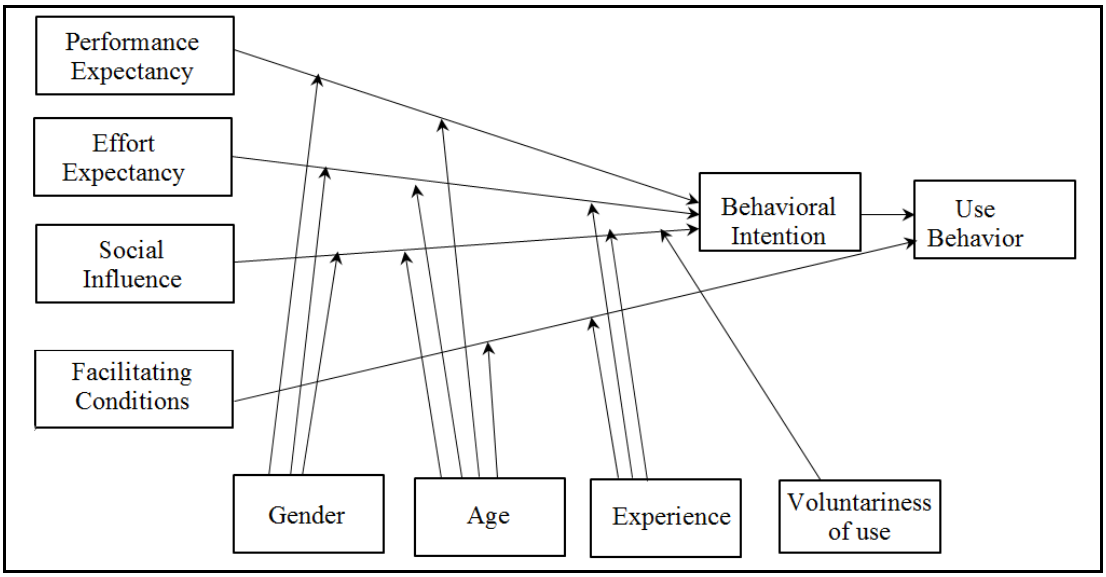

Figure 3-7: Unified theory of acceptance and use of technology
Source: (Venkatesh et al., 2003, p.447)

Performance expectancy is defined as "the degree to which an individual believes that using the system will help him or her to attain gains in job performance" (Venkatesh et al., 2003, p.447). This construct was derived from similar variables used in previous models or theories, such as perceived usefulness from TAM and from C-TAM-TPB, extrinsic motivation from MM, job-fit from MPCU, relative advantage from innovation diffusion theory, and outcome expectations from SCT. The performance expectancy construct is held to be the strongest determinant factor of intention within each of the integrant models, remaining significant at all times in both voluntary and mandatory contexts. The effect of performance expectancy on user intention and then usage behaviour is moderated by gender and age variables. The effect of the moderators was more prominent for younger workers, particularly men.

Effort expectancy is "the degree of ease associated with the use of the system" (Venkatesh et al., 2003, p.450). This construct was conceived as capturing three concepts from other models, such as perceived ease of use from TAM, complexity from MPCU, and ease of use from IDT. Effort expectancy was found to be a significant determinant within each integrant model in both voluntary and mandatory research contexts. However, it was more significant only with limited usage of technology. Therefore, the effort expectancy seems to be replaced by experience over time, since practice increases one's comfort with technology usage. The influence of effort

expectancy on behavioural intention is also moderated by gender, age, and experience. Such influence was revealed as more conspicuous for women and older workers.

Social influence refers to "the degree to which an individual perceives that important others believe he or she should use the new system" (Venkatesh et al., 2003, p.451). Similar concepts, such as the subjective norm from the TRA, TAM, TPB/DTPB, and C-TAM-TPB theories, social factors from MPCU, and images from the innovation diffusion theory, comprise the social influence construct. This construct is related to user perceptions regarding the pressure of others, as Venkatesh et al. (2003, p.451) note: " each of these constructs contains the explicit or implicit notion that the individual's behaviour is influenced by the way in which they believe others will view them as a result of having used the technology". Behaving in the same manner in each of the individual models, the social influence construct was found not to be significant in voluntary settings, becoming relevant when used in mandatory contexts. However, in mandatory use, the social influence effect appears to be important only in the early stage of technology use. Such relevance decreases over time, with sustained use of the system. The social influence construct in determining behavioural intention is influenced by variables such as gender, age, voluntariness, and experience, with stronger effects for older women.

Facilitating conditions are defined as "the degree to which an individual believes that an organizational and technical infrastructure exists to support use of the system" (Venkatesh et al., 2003, p.453). Facilitating conditions represent the constructs of perceived behavioural theories from TPB/DTPB, C-TAM-TPB, facilitating conditions from the MPCU model, and compatibility from the innovation diffusion theory. The UTAUT validation process revealed that facilitating conditions are significant in both voluntary and mandated research contexts in the initial experience of usage; however, its significance disappears in the second period of the test, which is one month after system implementation. In addition, the UTAUT validation revealed that the facilitating conditions' construct is influenced by the performance and effort expectancies, such that when both are included in the model, facilitating condition factors become irrelevant in determining the intention to use technology. Hence, the facilitating conditions construct is theorized to be moderated by age and experience on influencing usage

behaviour. Facilitating conditions' effects are determinant for older workers, with increased experience on the system use.

As mentioned earlier, UTAUT was tested using historical data collected from four organizations; and cross-validated adding data from two more surveys, which conferred more credibility on the research model. This theory was able to account for 70 per cent of the variance, the result being assumed as beneficial in terms of prediction and explanation improvement over any of the individual models. The explanatory power of the eight models varied from 17 to 53 per cent of the variance in user intention to use a technology. The expanded TAM and UTAUT models have stronger explanatory powers compared with any of the previous models. The UTAUT proponents acknowledge limitations to the model, recommending future studies, including development and validating of measurement scales for each construct. These studies should include validity and reconfirmation of the results or expanding UTAUT model with the new measurement variables (Venkatesh et al., 2003). Additionally, Venkatesh et al. (2003, p.470) suggested the need for examining the linkage between user acceptance and individual usage outcomes, as noted: "…future research should study the degree to which systems perceived as successful from IT adoption perspective (i.e. those that are liked and highly used by users) are considered as success from an organization perspective".

3.4 Technology acceptance models toward educational research

The successful implementation of technology in an organizational structure is dependent on the user acceptance of any technological system. On the other hand, the user decision on the use of a given technology is affected by a number of factors with reference to how and when the technology will be used. Factors include technology type, organizational context, and culture (Im, Hong, & Kang, 2011; Thomas et al., 2013). Technology acceptance models have been used across heterogeneous research contexts including education, in examining user behaviour. In the education context, the user's behavioural intention has been studied in various ways, however, amongst the most-used technology acceptance models, TAM and UTAUT have been models principally referred to in the literature. Some of the studies focus on the association of technology acceptance models with the understanding of user behaviour intention on the use of

technology. For example, Oye, A.Iahad, and Ab.Rahim (2011), used TAM in association with UTAUT to gain an understanding of teachers' behavioural intention with reference to the acceptance and use of ICT in a higher-education institution. Findings from this study have revealed that the use of technology may increase users' opportunities, such as in finding more propitious employment in the future, promotion in the current job, and consequently, an enhanced salary. Other studies focus attention on one of the model constructs in investigating factors surrounding user acceptance and use of the technology in the educational context. For example, Wong, Teo, et al. (2013) applied the UTAUT model in investigating student teachers' intention on the use of smart-board technology. The researchers found that the user will engage in the use of the new technology only if he or she can see the benefits or value of using it. The researchers also claimed that the findings of their study supported decision-makers and curriculum designers in identifying and designing curricula which might suit technology use, promoting user training. Teo (2009) surveyed one-hundred-and-fifty-nine student teachers based on the TAM framework, analysing their intention to use technology in the National Institute of Education in Singapore. Findings revealed that users develop positive attitudes towards computer use when they believe that the technology will improve their performance and increase their efficiency. Similarly, Wong, Osman, Goh, and Rahmat (2013) validated TAM constructs, and perceived usefulness was found as the most determinant factor influencing the user attitude towards technology use and behavioural intention among student teachers, in the integration of technology into their teaching and learning context.

Apart from joint and separate utilization of technology acceptance models, researchers have suggested some adaptations of acceptance models, such as including new variables or excluding some, in examining the acceptance of new technology. For example, Alharbi and Drew (2014) conducted a study ascertaining factors that influence user technology acceptance at the Saudi Arabia University. The researchers adopted the TAM model to discover some other relevant factors such as the lack of technology availability, prior experience of technology usage, and job relevance. Their findings showed that the added variables affect behavioural intention to use the technology. Accordingly, Teo and Zhou (2014) used an extended TAM to examine students' behaviour regarding the use of technology. The study focused on constructs such as the intention to use technology, attitudes towards technology use, perceived usefulness, and perceived ease of

use, computer self-efficacy, subjective norms, and facilitating conditions. The findings revealed that perceived usefulness and attitude toward technology use are the most determinant factors of students' intention to use computers. Thomas et al. (2013) used the modified version of the UTAUT model in testing mobile learning technology adoption and use in higher education in a developing country. The study found that culture and country level differences influence the behaviour of the user of technology. The researchers claimed that the inclusion of an attitude construct in the model could increase the explanatory power of the UTAUT framework. Similarly, Im et al. (2011) applied the UTAUT model in a study comparing technology adoption and use in two different countries. The study was focused on ascertaining the way in which the constructs of the model are affected by the culture of the two countries participating in the study. The researchers concluded that the impact of the UTAUT constructs differs across countries, and they noted that the level of the country's economy and socio-economic status influences the way in which technology is adopted. The study conducted by Mtebe and Raisamo (2014), which extended the UTAUT model to suit the context under research in East Africa, found that effort expectancy is the most influential factor in students' behavioural intention to use the technology. The study recommended that developers should provide usable technology, students believing that they have the required skills to operate a clear, understandable, and easy-to-use technology. The study by Im, Kim, and Han (2008) applied the UTAUT to investigate moderating variables such as perceived risk, technology type, user experience, and gender, in the education context. Findings revealed that technology type, perceived risk, and gender are determinant factors for teachers to use technology. Similarly, determinants such as computer self-efficacy, attainment value, utility value, and intrinsic value, were shown to affect the prediction of the students' intention to continue using a technology (Chiu & Wang, 2008).

From the previous discussion, it is evident that there are various factors that affect the acceptance and use of technology in the education context. In most of the cases, the factors depend on the local characteristics of the context in which the technology is to operate (Bwalya & Mutula, 2014). On the other hand, Wong, Teo, et al. (2013) claimed that the UTAUT model has received limited validation in the research regarding technology acceptance and use in the educational context, particularly in developing countries. In order to accommodate the local context that may influence the implementation of technology in education, variables and relationships not extant

in the original UTAUT model have been added. As a result, these studies show inconsistency in the findings, which could be owing to the different analysis techniques employed, added to the culture and social structure of the countries (Thomas et al., 2013).

There is therefore a need to apply technology acceptance models in association with other socio-technical frameworks to the understanding of the surrounding artefacts that affect the user's behavioural intention and technology use on the education site. The need for considering a broad range of technological characteristics, and the social interactions toward user's behavioural intentions to use the technology has been recognized (Bwalya & Mutula, 2014). In this regard, the present research posits a conceptual framework based on the actor network theory and UTAUT model to understand the factors affecting user acceptance and use of ICTs in the given school social context. Justification of the selected theoretical research strategy is presented in the next section.

3.5 Justification for the selection of the theoretical research

Sections 3.3 examined literature on the technology acceptance models and theories adopted by researchers in an attempt to explain factors that affect user behavioural intention and use of technology. From this discussion, it could be noted that UTAUT, which combines similarities of the eight antecedent models, offers the more comprehensive explanation. Compared with other acceptance models, such as TAM, the most-used in education research, UTAUT is considered more efficient and comprehensive, explaining about 70 per cent of the variance in usage intention (Venkatesh et al., 2003). TAM has been criticized for its relatively lower power of explanation, at about 40 per cent Venkatesh and Davis (1996); and its extended version is deemed less efficient (Bradley, 2009). Some other models and theories, such as the Decomposed Theory of Planned Behavior (DTPB), the task-technology fit model, and the coping model of user adaption, have been examined for the understanding of user acceptance and technology usage studies. However, these models are considered complex and have been revealed to be impractical in their application within a single research (Bradley, 2009). Given this discussion, the use of the UTAUT model has been increasing; researchers are testing its suitability, validity, reliability, and its predictive power with reference to the understanding of technology acceptance

in the education context. This research adopts a UTAUT framework, enabling a better explanation of factors determining students' and teachers' behavioural intention and use of technology in schools. The researcher believes that this model is the one best suited to complement the actor network theory in further understanding behavioural intention to use technology in this study.

However, as explained in the preceding section 3.1, the socio-technical characteristics of technology implementation in the education system must be considered. The critical review of the existing literature pointed out various actors that hindered the implementation of technology in the education system. When a particular ICT is introduced in a given social settings, technical actors interact in the creation of a cohesive relationship. This interaction between the social and the technical, which determines the success of technology implementation Al harbi (2014), should be investigated in a broader way. It follows that the implementation of any ICT is a process of network creation in which actors with different interests influence other entities to enrol in the network, and hence promote the user acceptance of technology as part of the solution to the problem (Williamson & Parolin, 2013). In this research, user acceptance and use of technology are considered effects of the built actor-network with different but aligned interests.

The user acceptance and technology usage has been considered relevant to the effective integration of technology in education. Oye, A.Iahad, and Ab.Rahim (2012a) argued that the reason behind the user attitude relating to the acceptance or rejection of an ICT is of concern to technology implementation studies in the education context. Teachers and students must willingly accept the use of technology in order for it to be successfully implemented in the education system. On the other hand, a variety of factors whether social or technical influence the user attitude to the usage of technology. For example, Fenwick and Edwards (2013) stressed that, in ICT integration in education, the surrounding school environment, including objects and artefacts, should be seen as integrated into the human existence, rather than as a contextual background. Based on this discussion, the socio-constructivist approach, such as ANT, in the understanding of interrelationships between social and technical factors impacting the user acceptance and technology usage has been presented in the education context. The ANT has been used as a guideline in the identification of relevant actors which include technology, and its

roles, and the tracing of information flow in the creation, transformation, and stability of the network. This research investigated the socio-technical aspects which affect user acceptance and usage of technology through a translation process, from the ANT perspective. The two theoretical approaches, ANT from socio-technical, and UTAUT from technology acceptance models, were considered as complementing each other. Their joint application may also be found in the study conducted by Williamson and Parolin (2013) on the application of socio-technical research methods in understanding the potential and sustainability of planning a support system. The question raised in their study was how the application of socio-technical research methods enhances the understanding of technology implementation, such as the planning of a support system. Williamson and Parolin (2013) applied the two theories as a framework for data collection, analysis, and reporting. The ANT was used for qualitative data collection through interviews, while the UTAUT was used to obtain quantitative data via questionnaires. The findings from the ANT framework provided insights into the interaction between social and technical factors that are relevant to the technology implementation. The UTAUT results revealed that performance expectancy and facilitating conditions should be addressed, with priority given to the user acceptance of the introduced technology. Following this perspective, the technology is not a simple innovation introduced into a given context, but a non-human actor that translates within the work practices, and is translated by other actors in the process of technology implementation. The researcher believes that the advantages of the two approaches could contribute to an extensive understanding of the process of technology implementation in the education system.

In summary, the translation process from the ANT presented in section 3.1, and the UTAUT model discussed in the section 3.3, helped to develop a sensitive context which informed the understanding of the socio-technical characteristics of technology. The implementation of technology is challenged by the contextual background of the sector in which technology is to be implemented. For example, social, cultural, and political structures are significant determinants for the success of technology implementation in a specific sector in a country. The next section presents the theoretical overview which guided the research.

3.6 The conceptual framework

Sections 3.1 and 3.2 addressed the theoretical assumptions underlying the present research. The socio-technical characteristic of technology integration into the education system was discussed. The school environment and contextual background influence the process of technology integration and usage. The review of the literature indicated factors that affect the integration of technology into schools. Furthermore, the introduction of technology in a given context causes the interaction between social and technical aspects, which must be jointly considered (Harbi, 2014; Kozma & Vota, 2014). In this regard, the integration of technology into the education system is conceptualized as a process in which a network is built and different actors influence one another to maintain a cohesive relationship. It is believed that the creation of a cohesive network could promote the user acceptance and usage of technology in schools (Williamson & Parolin, 2013). Therefore, user acceptance of technology is conceptualized as an effect of a successful network of human and non-human actors in which technology is included. To address the socio-technical characteristics of technology integration, ANT was used. ANT was useful for the tracing of actors' interests, including the technology itself. The ANT discussion indicated that the understanding of the school context is crucial to the successful integration of technology.

In section 3.3 theories and models which are used to assess user behaviour for technology acceptance and usage were addressed. Although the discussed methods, such as TRA, TAM, and TBP, the most used theories, showed relevance to the understanding of user behaviour and usage of technology in the education system, the researcher selected UTAUT for explaining technology acceptance in schools. UTAUT was selected for its powerful explanation of factors affecting user acceptance and usage of technology. The proposed UTAUT model reveals an explanatory power of about 70 per cent (Venkatesh et al., 2003).

Much research has been conducted on the understanding of technology implementation in the education system using either ANT or UTAUT. However, few studies have been conducted utilizing both ANT and UTAUT, with the exception of Williamson and Parolin (2013). However, Williamson and Parolin (2013) combined ANT and UTAUT for the comparison of the two methodologies in understanding the genesis of planning support systems. The current research uses ANT for the understanding of the socio-technical context of technology integration

and for identification of relevant actors for the creation, transformation, and maintenance of a stable network of actors. The translation process from ANT was used for the tracing of actors' interests, to gain an insight into the way in which technology was introduced and aligned with the schoolwork practices. The translation process comprises what Callon refers to as moments of actors' *problematization*, *interessement*, *enrollment*, and *mobilization*, for the creation, transformation and stabilization of the network of actors (Callon, 1999b). The UTAUT model is used to examine factors related to performance expectancy, effort expectancy, social influence, and facilitating conditions, in the understanding of user behaviour for the acceptance and use of technology.

The research proposes a model, in which performance expectancy, effort expectancy, social influence, and facilitating conditions influence teachers' and students' behavioural intention to use technology. However, in the original UTAUT model, as indicated in Figure 3-7, performance expectancy, effort expectancy, and social influence constructs have a direct effect on the behavioural intention, while facilitating conditions and behavioural intention affect technology usage. Because of the limited use of technology in teaching and learning in Mozambican schools, (the motivation for this study), for the purposes of this research, it was decided to associate the facilitating conditions with the intention to use technology as proposed in the Figure 3-8.

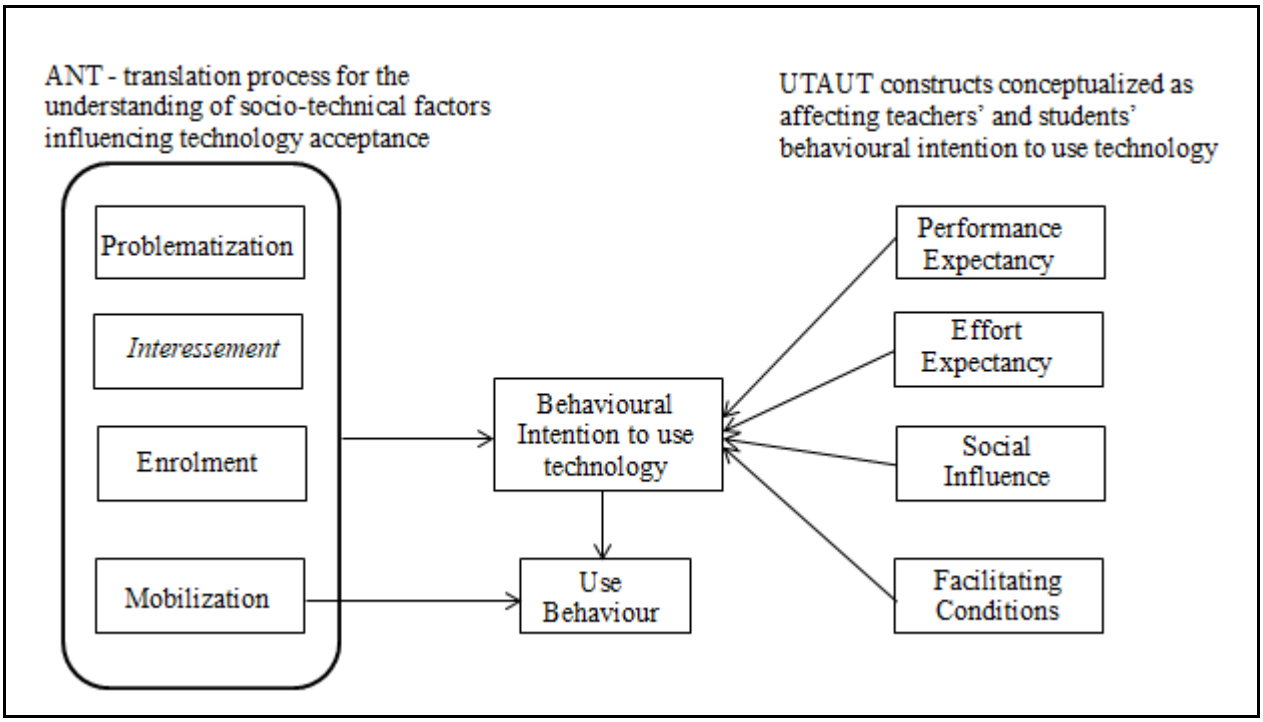

Figure 3-8: Diagrammatic illustration of the conceptual framework for the understanding of ICT integration into the education system.

The proposed framework is intended to address the research questions developed based on the two theories. The research questions pertaining to the socio-technical aspect of technology are framed under ANT, while for the understanding of the intention to use and use of technology, UTAUT constructs are examined. The use of ANT is aimed at understanding ways in which various stakeholders, including socio-technical components, interrelate in the integration of technology into teaching and learnig activities. In terms of ANT propositions, the research question is articulated as follows:

- RQ1 − How does the '*translation process*' of integrating ICT within secondary schools in Mozambique take place?

As discussed in Section 3.1, social context has a considerable impact on the integration of technology. Therefore, the connection between social context and the technical component of technology is examined using a translation process from ANT which emphasizes the equal dimensions of technology and the context in which it operates. Furthermore, the success of the translation process leads to the success of ICT integration in any given context (Stanforth, 2007).

When technology is introduced into a certain context, the translation process is intended to occur as follows:

Problematization − refers to the first moment of building the actor network in which technology is intended to be seen as a solution to the problematized issue. The expectation is that technology was able to be established as an Obligatory Passage Point (OPP), a stage during which the enrolled actors (human and non-human) are forced to accept the way forward – integration of technology for learning and teaching activities.

Interessement – indicates the stage during which a built *interessement* device is placed between the actors to make the network stronger. The assumption is that the integration of technology into the school practices became recognized as an OPP. It is the successful *interessement* that confirms the validity of problematization and the created relationship.

Enrolment – represents the moments during which the focal actor defines and distributes the roles played by other actors in the network. Enrolment represents the outcome of *interessement*, in which the defined and allocated roles are agreed to by other actors. In the enrolment, the required negotiations are expected to be taking place, and the involved actors are to be using technology in an intentional manner.

Mobilization – this is the stage during which the defined solutions become part of the work practices. It is supposed that technology is translated to the schools' work practices. As the translation process evolves, the network becomes stronger and certain actors become important in such a way that they may be representative of others. The actors comprising the created network should dedicate themselves to mobilization, in order successfully to translate their interests and to maintain a stable heterogeneous network. At this stage it is envisaged that, once the actors are mobilized, they will use the technology to accomplish academic activities.

With the accomplishing of a translation process, in which all the necessary activities have been taken into account, the use of technology is likely to be effective. Therefore, for the

understanding of factors impacting on teachers' and students' use of technology, UTAUT constructs were used. The following set of research questions was addressed:

- RQ2 − How does performance expectancy influence behavioural intention regarding the integration of ICT into secondary schools in Mozambique?
- RQ3 − To what extent does effort expectancy influence the behavioural intention to integrate ICT into secondary schools in Mozambique?
- RQ4 − How does social influence affect the behavioural intention to integrate ICT into secondary schools in Mozambique?
- RQ5 – How do the facilitating conditions influence the intention to integrate ICT into teaching and learning activities in the schools?

Performance expectancy – this construct is used to predict behavioural intention. The UTAUT authors acknowledged that performance expectancy is moderated by gender and age in the prediction of behavioural intention to use technology. In this research, performance expectancy is measured by the perceptions of using technology for the academic benefit of students and teachers. Items such as improvement of academic performance and quality, increasing of productivity, and saving of time and effort were measured in the performance expectancy construct.

Effort expectancy – this is defined as the degree of ease in relation to the use of a system (Venkatesh et al., 2003). In the original UTAUT model, effort expectancy is moderated by gender, age, and experience variables in the explanation of behavioural intention. In this research, the effort expectancy construct measures the perception of ease of use of technology to accomplish academic activities in schools. The construct is measured by items such as ease of learning and understanding the technology for teaching and learning in class.

Social influence – refers to the degree to which others influence the use of a new system (Venkatesh et al., 2003). Social influence is a key construct for a UTAUT proponent and is influenced by variables such as gender, age, experience, and voluntariness of use. The

assumption underlying this research is that the social network, such as friends, colleagues, family, teachers, as well as the school administrators, positively influences behavioural intention to use technology.

Facilitating conditions – This is the degree to which one believes that there are organizational and technical infrastructures to support the use of the system (Venkatesh et al., 2003). The original UTAUT model established a direct link between facilitating conditions and the usage behaviour. In the tested original UTAUT model, the facilitating conditions construct does not influence behavioural intention, when performance and effort expectancies constructs are used (Venkatesh et al., 2003). However, the linkage between facilitating conditions and behavioural intention has been tested; and some researchers, for example Twining and Henry (2014), found positive effects of facilitating conditions in predicting behavioural intention to use technology. In this research, the facilitating conditions construct is measured by the user perceptions of the availability of resources and the required knowledge to perform learning and teaching activities using technology. The study conceptualized that if there is provision of facilitating conditions the human actors will deliberately use technology. Based on the two theories, and on review of literature, the research indicated that, even though there are computers and Internet connection in schools, teachers are likely to use technology, provided that more appropriate training is in place. The facilitating conditions includes availability of the technological infrastructures – Internet connection and computers that are working, ICT skills including competence on integrating technology in the pedagogy, an ICT technician to help when a technical problem occurs, and other related artefacts for the appropriate functioning of the actor network which includes the use of technology. It follows that if all the necessary resources for the functioning of the network are provided, the human actors will be inclined to use technology, which subsequently will lead to their use of it for academic activities.

The facilitating condition construct was used in the prediction of the dependent variable − behavioural intention to use technology. Therefore, the conceptual research model, which was adapted from Venkatesh et al. (2003) captured the four constructs that may affect technology usage in the schools.

3.7 Summary

The chapter elaborated on the theoretical overview of ICT integration in a socio-technical context. ANT is the theoretical framework used for understanding the heterogeneity of actors' connections in the process of technology integration in schools. The chapter also presented technology adoption and acceptance theories and models which have been used for explaining user behaviour toward technology usage. UTAUT was the selected model for framing the present research. To conclude, the chapter presented the mapping of the two theories in a conceptual framework which guided the research.

CHAPTER FOUR

RESEARCH METHODOLOGY

This chapter describes the methodology used to guide the research presented here. The chapter presents an overview of research paradigms, followed by a discussion on research approaches. Quantitative, qualitative, and mixed methods approaches are discussed. Based on the research objectives and questions, a selection of suitable research approaches to guide the current study is presented. This is followed by a complete description of the research design and the data-collection techniques. The chapter also addresses issues pertaining to research site, population and sampling. Finally, the chapter presents the strategy used for data analysis, followed by the issues related to research ethics.

The aim of the study is to understand the process of ICT implementation in the education system, in which socio-technical aspects are considered relevant to the acceptance and use of technology in teaching and learning. The study was conducted under the framework of the Actor Network Theory (ANT) in obtaining an in-depth understanding of the socio-technical aspect of technology and Unified Theory of Acceptance and Use of Technology (UTAUT) when investigating the intention to use ICT. The research questions that were constructed to guide the research process are reiterated here.

- RQ1 − How does the '*translation process*' of integrating ICT within secondary schools in Mozambique take place?
- RQ2 − How does performance expectancy influence behavioural intention regarding the integration of ICT into secondary schools in Mozambique?
- RQ3 − To what extent does effort expectancy influence the behavioural intention to integrate ICT into secondary schools in Mozambique?
- RQ4 − How does social influence affect the behavioural intention to integrate ICT into secondary schools in Mozambique?
- RQ5 − How do the facilitating conditions influence the intention to integrate ICT into teaching and learning activities in the schools?

4.1 Research paradigm

The assumption underlying the choice of an appropriate research approach is related to the nature of the study. Research is regarded as a systematic investigation in which the researcher collects data, analyses and interprets them, in an attempt to understand the psychological phenomenon in a given context (Mackenzie & Knipe, 2006). A research approach is a plan which a researcher follows as a guide to conducting a study in determining the philosophy behind the study, the research design, and methods. According to Mack (2010), social science and educational research are philosophically framed on ontological, epistemological, and paradigm assumptions. Ontology is related to people's view of reality, while epistemology refers to a view of the way in which people acquire knowledge. Mack (2010, p.5) noted that ontology refers to a study based on "what we mean when we say something exists" and epistemology relates to "what we mean when we say we know something". Following this view, ontological and epistemological assumptions form the research paradigm, which is "a loose collection of logically-related assumptions, concepts or propositions that orient thinking and research" (Mack, 2010, p.6). Moreover, Mackenzie and Knipe (2006) suggest that the choice of paradigm is the first step for conducting research into a given topic. The choice of an appropriate research paradigm influences the research to be conducted and must be identified in advance (Creswell, 2014).

Positivist, interpretivist, and critical, are some of the epistemological research paradigms used to conduct educational and social science research (Mack, 2010). Research paradigms are philosophical guides assisting researchers in conducting studies. These may be applied to various research approaches. The positivist paradigm, also called the scientific method, refers to philosophical determinism, in which causes define effects or outcomes in a given study (Creswell, 2014). According to Mack (2010), a positivist research is generally conducted to test a well-developed, given theory, by assessing its hypotheses. The underlying assumption in a positivist paradigm is that one can understand a phenomenon based on existing values and facts. In an interpretivist paradigm, also referred to as constructivism, a researcher intends to understand the phenomena through the meaning assigned by other research participants. According to Creswell (2014), the interpretivist researcher makes use of people's views through his or her conceptual background and experience. Therefore, multiple interpretations may be assigned based on the researcher's point of view of the reality under research. Walsham (1995) refers to the interpretive paradigm for research in the Information

System (IS) field as a method aimed at generating an understanding of the research context. Since IS has an influence and is influenced by the surrounding context, interpretive studies are iterative processes of knowledge creation. Walsham's (1995) advice is that, when a theory is used, the interpretivist researcher should have a certain degree of openness to the field data so as to modify initial assumptions. A critical paradigm is an emerging philosophical research in which the researcher is intent on critiquing the status quo, by exposing what are considered historically deep-seated beliefs within a social system (Orlikowski & Baroudi, 2002). Another important research paradigm is that of pragmatism, in which the researcher is free to select methods, techniques, and procedures that are adequate to the needs and purposes of the study. Creswell (2014) refers to pragmatism as an approach that does not commit to any one system of philosophy and reality, but rather focuses on the research problems using all available approaches that best address the problem, rather than focusing on methods.

From the foregoing discussion, interpretive paradigms seem suited to the present research. The research is focused on the participants' views and experiences of the use of technology for academic activities. The researcher, therefore, attempted to understand the phenomena under study by assessing the meaning assigned by the participant. People's experiences and interpretations were the source of field data, which is a philosophical foundation of interpretivist studies. The suitability of the philosophical assumption could be explained by Walsham's (1995, p.77) study, in which the researcher is attempting to acquire knowledge by "accessing other people's interpretation, filtering them through their own conceptual apparatus". On the other hand, the current research responds to the needs of the positivist research paradigm. The research purpose reflects the need to assess factors that influence the user acceptance and use of technology in schools. A theoretical framework was used to assist the researcher in examining the user-behavioural intention in relation to the use of technology, which is in line with the philosophical assumptions of positivist paradigms. However, other research strategies were jointly used to answer the research questions best, which sustain the epistemological justification offered by pragmatist research. Therefore, the current research was conducted under pragmatist research assumptions. Johnson, Onwuegbuzie, and Turner (2007) argue that the combined use of methods and ideas in order to frame and answer the research questions is the foundation of the pragmatist research paradigm. The research explores the research participants' views and experiences, obtained through a process of field visits for data collection and analysis and in the same way

examines user behaviour on the use of technology in schools. According to Mackenzie and Knipe (2006), research paradigms and questions determine which approaches should be used for collecting data and analysis. They further noted that each of the paradigms lay emphasis on the specific research methodology, thereby focusing on specific techniques of data collection and analysis. A positivist paradigm research gives importance to quantitative research approaches, however, not exclusively, focusing on the quantitative data collection techniques and analysis. An interpretivist paradigm is applied mostly to a qualitative research approach in which qualitative research instruments are used. A pragmatic research paradigm applies to studies in which different methods and data-collection techniques are combined to best address the questions and the purpose of the research. Quantitative, qualitative, and a mixture of both approaches, provide the basis for conducting studies in different research fields, the criteria for the choice are discussed in the next section.

4.2 Research approach

The choice of the appropriate research approach is determined by the characteristics of the gathered data and its corresponding method of analysis (Mackenzie & Knipe, 2006). However, in some cases, the researcher is likely to use both quantitative and qualitative approaches at different stages of the study. Each of the research approaches represents different ways of conducting research, on which the researcher should rely. The section presents the different research approaches, including justification of the selection of research strategy that guided the current research.

4.2.1 Quantitative research approach

Quantitative studies are aimed at understanding the phenomena under research, based on statistical or numerical data. From the literature, a quantitative approach is considered consistent with the positivist research paradigm (Creswell, 2014; Mackenzie & Knipe, 2006) which aims to test and validate hypotheses. However, quantitative research is not exclusively used with the positivist paradigm. For example, Johnson and Onwuegbuzi (2004) state that promoters of quantitative studies postulate that the researcher is separate and distinct from the research field in which participants are subject to observation. Therefore, in quantitative studies, the researcher is focused on attesting, rather than discovering facts using statistical measurements. According to Creswell (2014), in quantitative studies, the researcher collects

field data based on predetermined instruments designed to produce numerical data. It follows that the researcher should select the appropriate research approach before data collection and analysis. Creswell (2014) notes that research using quantitative approaches may be conducted using both experimental and non-experimental instruments. Experimental research is suggested when the researcher seeks to ascertain whether or not a given treatment influences an outcome. Therefore, both true experiment and quasi-experiment instruments could be employed for conducting experimental research. On the other hand, a survey instrument is employed to study a sample in which the aim is a quantitative description of trends and attitudes of a given population.

4.2.2 Qualitative research approach

Unlike quantitative approaches, qualitative research is intended to explore and understand an issue related to social life in a given research field. Data generated from qualitative studies are generally not numerical. A qualitative approach which is mostly used with an interpretive paradigm (Mackenzie & Knipe, 2006), is an inductive process in which the researcher and the research context are generally not separated. Qualitative studies tend to be related to context descriptions and are therefore influenced by the local context under research. Denzin and Lincoln (2003, p.13) state that in qualitative studies, the researcher "stresses the socially constructed nature of reality, the intimate relationship between the researcher and what is studied, and the situational constraints that shape inquiry". Additionally, Miles, Huberman, and Saldana (2014) posit qualitative data as emphasizing social life experience, with the researcher connecting people's views with their local context. There are various research strategies which may be used to conduct a qualitative study, depending on the type of social settings and the daily life of the research context. However, Creswell (2014) recommends the narrative inquiry, phenomenological studies, ethnography, case study, and grounded theory strategies as the most commonly used for conducting qualitative research. Accepting Creswell's (2014) assumptions, narrative inquiry and phenomenological studies are appropriate if the researcher is intending to study an individual. In this case, the setting in which human events and experiences occur may be presented as a narrative study. Ethnographical strategy is used when the research is intended to learn about people's everyday lives, and it involves a great deal of fieldwork to capture the field culture and routines in detail. Case studies are strategies employed to explore a given research setting by studying "a phenomenon (the case) in its real-world context" (Yin, 2011, p.17). Grounded

theory is a useful strategy if a researcher is intending to "derive a general, abstract theory of a process, action, or interaction grounded in the views of participants in a study" (Creswell, 2003, p.14). The choice of qualitative research strategies sets the stage for selecting research instruments to be used for collecting field data. Likewise, for the quantitative approach, qualitative data are collected, based on predefined instruments, which are widely applied in the participant settings. Creswell (2014) notes that researchers generally rely on multiple sources of data, when conducting qualitative studies, including interviews, observations, documents, and audio-visual information.

As mentioned earlier, each of the research approaches represents a different way of conducting research, on which the researcher should rely. Therefore, the research approach influences collection, analysis, and interpretation of data. However, Creswell (2014) contends that approaches are not separate or divergent from one another, and may not be seen as distinct categories. For instance, in some cases, a research study indicates more characteristics of the qualitative approach than the quantitative, and, in other cases, this situation is reversed. As a result, the use of both approaches at different stages of the research is applied to a single study, which is referred to as a mixed methods research approach.

4.2.3 Mixed methods research approach

The mixed methods research approach is founded on the use of both the quantitative and qualitative research approaches. Therefore it represents characteristics of both. The strengths and weaknesses that characterize each research approach have led to the combined use of quantitative and qualitative methods to strengthen the research findings. The assumption of mixed methods is that combining the strengths of quantitative and qualitative approaches to develop a strong understanding of the problem under study, will overcome the weaknesses attached to each of the research methods (Creswell, 2014; Johnson & Onwuegbuzi, 2004). The mixed methods research approach is philosophically conducted under the pragmatist research paradigm (Creswell, 2014).

The mixed methods research approach is a relatively new way of conducting studies. However, it is being used increasingly in different fields of research. Johnson et al. (2007, p.112) explain that this methodology "is becoming increasingly articulated, attached to research practice, and recognized as the third major research approach". According to

Johnson et al. (2007), researchers have referred to the use of combined approaches (quantitative and qualitative) by different names, such as multiple operationalism, triangulation, combined research, integrated research, multi-method research, mixed research and triangulated research. However, aligned with the objectives of the present research, the term mixed methods research will be used.

Whilst there is a consensus regarding the definition of both quantitative and qualitative research approaches, definitions of the mixed methods approach reveal certain discrepancies. In attempting to offer an inclusive definition, Johnson et al. (2007) claimed that, in the combined use of quantitative and qualitative research approaches, when and where to mix the methods should be considered regarding the approach. For example, mixed methods researchers should decide at which stage of research the mixing process is carried out during a study. On this subject, Johnson et al. (2007) stated that researchers are somewhat divergent in selecting the most appropriate phase at which the mixture of research approaches should be implemented. Some researchers suggest that mixing occurs at the data-collection stage, while others state that it also occurs at the data-analysis phase. Yet other scholars claim that the combined use of quantitative and qualitative research approaches can take place at any or all of the stages of research. In addition, another important argument, less mentioned, however, is to use both methods to investigate the same research questions. Following their study in the provision of the mixed methods approach definition, Johnson et al. (2007) also pointed out reasons underlying the use of both methods as a research approach to:

> "(a) Validate and explicate findings from another approach and produce more comprehensive, internally consistent, and valid findings; (b) provide more elaborated understanding and greater confidence in conclusions; (c) handle threats to validity and gain a fuller and deeper understanding; and (d) provide richer/more meaningful/more useful answers to research questions" (2007, p.122).

From the aforementioned discussion, Johnson et al. (2007) recommend that researchers base their choice on the use of the mixed methods research approach, taking into account both characteristics. Therefore, they proposed a general definition of mixed methods research, referring to it as:

> "…the type of research in which a researcher or team of researchers combines elements of qualitative and quantitative research approaches (e.g., use of qualitative and quantitative viewpoints, data collection, analysis, inference techniques) for the broad purposes of breadth and depth of understanding and corroboration" (Johnson et al., 2007, p.123)".

Furthermore, Johnson et al. (2007) contend that a mixed methods research approach could be used within a single study or a programme of research, and could also be applied across a set of related studies. The various ways of using a mixed methods research approach led to the concept of triangulation.

In line with the definition of the mixed methods approach, triangulation is referred to as an attempt to obtain a broader and better understanding of a phenomenon under research. Yin's (2011, p.313) definition is that triangulation is "an analytic technique, used during fieldwork as well as later during formal analysis, to corroborate a finding with evidence from two or more different sources". Furthermore, triangulation has been referred to as a combined use of two or more sources of data, research approaches, theoretical assumptions, or methods, within the same research (Thurmond, 2001). The combined use of different perspectives, that underline validation of the studies, results in what Thurmond (2001) refers to as:

(a) – data triangulation, in the sense that time, settings, together with from whom the data is gathered, add more strength and assurance to the study findings;

(b) − investigator triangulation, which refers to the use of more than one researcher (observer, interviewer, coder, or data analyst) in the same research;

(c) − methodological triangulation, indicating the use of multiple methods in the same study, which further is classified as "within-method triangulation and between or across-method triangulation"(2001, p.254);

(d) − theoretical triangulation, referring to researches in which more than one theory is used to investigate a phenomenon; and

(e) − data-analysis triangulation, to describe situations in which two or more types of data analysis are used. Accordingly, based on these characteristics of triangulation, a researcher may select more than one type of triangulation, resulting in a multiple-triangulation study, which will further validate the study.

The assumption underlying the concept of triangulation is the joint use of quantitative and qualitative research approaches in assisting mixed methods researchers. Creswell (2014) indicates three different types of basic mixed methods research design, which are:

- Convergent parallel mixed methods – using corresponding instruments, a researcher collects quantitative and qualitative data, conducting analysis separately, comparing results for the purpose of findings confirmation;

- Explanatory sequential mixed methods – comprising two stages of data collection, in which quantitative data are collected and analysed, the results being used to inform qualitative data gathering; and
- Exploratory-sequential mixed methods – contrasting with the explanatory method, the researcher begins by exploring, collecting, and analysing qualitative data, using the results to conduct the quantitative aspect of the study. This research design may be used strategically for generalization purposes, as few data are collected using qualitative instruments to develop a broader measurement instrument for a larger sample of participants.

In addition, Creswell (2014) mentioned three advanced mixed methods research designs which combine convergent, parallel, explanatory, and exploratory-sequential mixed methods. The first is an embedded mixed method, indicating a research design in which quantitative or quantitative or both forms of data are embedded in a large design before, during, or after quantitative or qualitative research. This research design is generally applied in a narrative inquiry, or in an ethnographic study or experiment. The second advanced research design, transformative mixed methods, refers to the use of the basic research design or the embedded mixed methods to help a marginalized group in a given social justice framework. The last is the multiphase mixed method which is generally applied along a multiple-phased project. The researcher conducts many studies comprising a project, in which combinations of mixed methods' perspectives are used in one study, to inform the subsequent research in a given longitudinal study.

Additionally, Creswell (2014) sees the choice of a mixed methods research design as consisting of six related factors. The researcher may decide to use mixed methods' research based on:

- Expected outcomes, which demand the determination of anticipated outcomes at the end of mixed-methods research, linking them to the study type;
- The way in which the data will be used jointly, requiring the selection of the strategy used to integrate qualitative and quantitative data. New strategies may be achieved through merging, connecting, and embedded strategies. A merging procedure means a combination of data offering side-by-side comparison, data transformation, or a combined display procedure. Connected strategy refers to the use of data analysis of one type to build the other data set. Embedded technique

means that one data type (quantitative, qualitative, or combined data) is embedded into a larger design research;

- Timing of data collection, which may be conducted concurrently, means that quantitative and qualitative data are collected at almost the same time, or sequentially, in the sense that one type of data gathering informs the other;
- Emphasis is laid on each data set considered to be difficult to determine: the emphasis placed on each data set may be useful for informing the research strategy. The convergent-approach strategy is suited to research in which both data sets are equally emphasized. Therefore, the explanatory-sequential method is suitable for research with stronger emphasis on quantitative data, while the exploratory-sequential is indicated for studies with a qualitatively strong emphasis;
- Type of design suited to the field in which the selection of the research strategy is dependent on the field under study. Accordingly, an explanatory-sequential strategy is indicated for the quantitatively oriented research fields, while the exploratory-sequential approach is best suited for a qualitatively oriented field. Convergent mixed methods are mostly used when the study is aimed at efficiently collecting data, in which quantitative and qualitative data are collected more or less at the same time; and
- A single researcher, or a team of researchers, is related to the practicability of research activities; and a research conducted by a single researcher is best suited to either the explanatory or the exploratory sequential approaches, in which the study may be divided into two manageable parts. However, when time is a concern, Creswell (2014) recommends an embedded-research design. If a study is conducted by a team of researchers, involving the use of multiple techniques of data collection at the same time or over a period of time, then embedded research procedures are the most suitable.

The discussion regarding the different research approaches aforementioned, presents specifications related to the methods used for data collection, analysis, and interpretation of results. Based on research methods, Creswell (2014) presented a summary of the specifications framing each of the approaches, which is depicted in Table 4-1.

Table 4-1: Characteristics of research methods (quantitative, qualitative, and mixed methods)

Quantitative Methods	Qualitative Methods	Mixed Methods
Predetermined	Emerging methods	Both predetermined and emerging methods
Instrument-based questions	Open-ended questions	Both open- and closed-ended questions
Performance data, attitude data, observational data, and census data	Interview data, observation data, document data, and audio-visual data	Multiple forms of data drawing on all possibilities
Statistical analysis	Text and image analysis	Statistical and text analysis
Statistical interpretation	Themes, patterns interpretation	Cross-database interpretation

Source: (Creswell, 2014)

4.2.4 Justification for the selection of a research approach

Section 4.1 presented the research paradigm, and later sections discussed the various research approaches used for conducting studies in different fields. Based on discussions presented in the previous sections, the present research was conducted under the umbrella of the mixed methods research approach. The suitability of the mixed methods research approach is prompted by the research topic and questions. In addition, the theoretical assumptions presented in Chapter Three, justified the use of the combined research approach. The thesis attempts to understand the process of Information and Communication Technology (ICT) implementation in schools, employing a conceptual framework that is derived from the theories of ANT and UTAUT. Therefore, a combined use of qualitative and quantitative approaches was adopted for framing data gathering, analysis, and interpretation of the results. The research strategy was divided into two (but not separate) study sections. The research questions are best answered by the combined use of qualitative and quantitative perspectives. The qualitative part of the research enabled the contextualization of the research topic, exploring participants' experiences by employing interview-based case studies, and analysis of documentation and observations, whilst the quantitative aspect was intended to explore the views of students and teachers through questionnaire-based surveys. Therefore, the mixed methods approach was adopted in this research for the purpose of complementing the data and method. With the use of mixed methods, the study provided an integrated contextual background by mixing findings obtained from each research strategy. Based on Creswell's (2014) classification of mixed methods research design, the current research followed convergent parallel mixed methods assumptions. The research used a convergent parallel mixed methods design, in the sense that quantitative and qualitative methods are considered

independent for data collection. The thesis research questions were designed to address two theoretical assumptions. Qualitative data, consisting of participants' points of views, experiences, and expectations were collected and analysed, with the quantitative data related to factors affecting user acceptance of technology.

Researchers are recommended to elaborate the purpose of using mixed data, justifying why and how the quantitative and qualitative data are selected and mixed throughout the study. Based on Creswell's (2014) list of purposes in using the mixed methods research approach, the following led to the selection of the current study. First, the expected outcome was to compare and complement findings. From the Actor Network Theory (ANT) perspective, the inter-action of social and technical actors was highlighted, and findings were compared and complemented by research on factors affecting technology acceptance and use of technology. Second, qualitative and quantitative data were used in an embedded strategy, in which corresponding research findings were combined to inform the study. Data were simultaneously used with the purpose of finding complementary factors within one another. Third, data collections were achieved concurrently, and qualitative and quantitative data were gathered more or less at the same time, however, with limited interaction between the two processes. Fourth, with the theoretical assumptions of ANT in understanding the process of technology integration into a socio-technical local context, the research was predominantly qualitative. Qualitative assumptions were used to gain a better knowledge of the situations under study. However, both data sets are equally emphasized in the thesis. Fifth, access to the research field was somewhat limited. Therefore, the researcher strategically collected both qualitative and quantitative data simultaneously. Sixth, the study was conducted by a single researcher, but with the help of one other researcher during the field visits for data collection.

Therefore the pragmatist paradigm and the mixed methods research approach framed the present research. However, researchers are advised to indicate the research design underpinning the research under study (Creswell, 2014). Consequently, the following section discusses the research design or strategy of inquiry as presented by Denzin and Lincoln (2003).

4.3 Research design

A research design refers to a description of procedures used as guidelines within a quantitative, qualitative, or mixed methods research study. Denzin and Lincoln (2003) state that research designs are conceived to provide directions or guides which situate researchers in the empirical world and connect them to the research field. The selection of research design is related to the research questions, and to the purpose of study in the sense that it should provide a response to "what information most appropriately will answer specific research questions, and which strategies are most effective for obtaining it?" (Denzin & Lincoln, 2003, p.36). The research design guides researchers in the selection of a specific research method of data collection and analysis. The current research is intended to understand and describe the socio-technical interactions between the social settings and technical actors impacting on the process of ICT implementation. Consequently, the researcher believed that the level of user acceptance and implementation of technology in secondary schools in Mozambique is influenced by the way in which the actors have been tied together and have evolved in the process. As for the purpose of the current study, and based on Creswell's (2014) research strategies, the case-study research design was adopted as a strategy for underpinning data collection and analysis in the present research.

A research design indicates guidelines linking theoretical paradigms to the research questions and purposes. Yin (2011) refers to research design as a logical plan in which the researcher is focused on four sets of research issues, such as which questions to address, which data are relevant for the study, the data to be collected, and how to analyse the results. Accordingly, a case study is a research-design strategy, used for conducting studies by connecting the process of data collection with the research questions and analysis. In addition to the focus on the data collection, its proportions and unit of analysis, an adequate research design indicates the theoretical assumptions underlying the research topic (Yin, 2011). Therefore, theory development as a complement to research design, is useful for guiding the process of data collection in order to facilitate the analytical generalization of findings. A theoretical framework of a study is " used as a template with which to compare the empirical results" (Yin, 2011, p.38). As with other research-design strategies, a case study represents an approach to conducting research into fields such as health, education, social work and organizational development (Yin, 2011). In addition, Yin (2011) notes that a case study is a research approach traditionally used within qualitative research, However, a case study goes

beyond this and has been used in studies combining qualitative and quantitative procedures. Therefore, the distinctions between quantitative and qualitative procedures do not affect the selected research method and could include both single and multiple-case studies. Consequently, a case study may be applied to *explain* complexity surrounding real-life situations; to *describe* interventions and the real-life context; to *illustrate* topics in an evaluation research and to *enlighten* others on situations in which the evaluated intervention has unclear outcomes. Regardless of the application purpose, a case study is a research approach related to the investigation of a phenomenon in its real-life context. Yin (2011, p.18) refers to case-study research design as "an empirical inquiry that investigates a contemporary phenomenon in depth and within its real-life context, especially when the boundaries between phenomenon and context are not clearly evident". However, focusing on technical characteristics of case studies such as data collections and analysis, Yin's (2011) second definition is as follows:

> "…the case study inquiry: copes with the technically distinctive situation in which there will be many more variables of interest than data points, and as one result; relies on multiple sources of evidence, with data needing to converge in a triangulating fashion, and as another result; benefits from the prior development of theoretical propositions to guide data collection and analysis" (2011, p.18).

The assumptions underlying a case-study research design are the understanding of a social phenomenon in its natural setting, consisting of the following components (Yin, 2009):

- The study's research question − a case-study research design is suitable for studies seeking to answer how and why questions;
- Its propositions, if any – propositions generally derived from previous research or from theory, establish the right direction to look for relevant information and indicate the data to collect;
- Its unit of analysis – units define the structure of the case, in which each unit of analysis and the related questions and propositions sets the corresponding research design and data collection techniques;
- Links, which attach the data to its propositions – as an indicator of the data-analysis procedures, various techniques such as "pattern matching, explanation building, time-series analysis, logic models, and cross-case synthesis" (Yin, 2009, p.34) − may be used as a connector of data to its theoretical prepositions; and
- The criteria for interpreting the findings − in conducting case studies, the researcher is advised to address criteria of interpreting findings during the

research-design stage. Statistical techniques or explanations for findings are used as part of data-collection strategies.

In attempting to gain a better understanding of a phenomenon in a given context, researchers often conduct case-study research based on a single case, which might be adequate under some research circumstances. However, conclusions from single case studies are less convincing. Yin's (2011) recommendation is that, even when in a situation only two cases are involved, this is better than relying on a single-case study. Given the related quality of drawing compelling conclusions, the use of multiple-case studies has been increasing in the literature. The power of case studies' research in drawing comprehensive research findings is related to the appropriate use of theory which allows analytical generalization of the results. As the case-study research is aimed at investigating the phenomenon and also its context, the differences in settings of each case provide a background for the analytical generalizations and expansion of the findings. Additionally, Yin (2011) suggests that each case site constitutes the whole study in which convergent evidences are sought regarding the findings for the case study. Following these assumptions for each single case, the findings should indicate how and why the research prepositions were confirmed or not. Therefore, the findings for the whole study should indicate the extent to which the logical replication of case findings resulted in similar or contrasting outcomes. Yin (2011) notes that it is still a challenge for a researcher to conduct good case studies, therefore, overcoming this issue is imperative.

The main concern for case-study researchers, prior to the data-collection stage, is related to the selection of single or multiple cases. However, Yin (2011) subdivides the case-study strategy into holistic-single and embedded-multiple units of analysis. The difference between holistic and embedded case study resides in the characteristics of the phenomenon under research and in the addressed research questions. For example, if, in a given case study, the global nature of an organization is examined, then the case is characterized as an holistic design. However, if the case analysis includes outcomes of each unit or department within an organization, then this is referred to as an embedded case-study design.

4.3.1 Critique of case-study research

Although the strengths of case-study design have been presented in the present section, particularly focused on the use of multiple cases, the approach is also characterized by limitations. Yin (2011) presented some concerns regarding the use of case-study research design. First, case-study research has been reported as lacking rigour, in the sense that, often, the researcher does not follow systematic procedures and the research findings and conclusions are prone to researcher-view biases. In this regard, the case-study researcher is advised to report fairly the complete evidence of the case. Furthermore, the same concern has also been reported in other methods, such as in research experiments, questionnaire surveys, and in historical studies (Yin, 2011). Second, case-study research approaches have been considered a tool providing little basis for scientific generalizations, particularly when a single-case research design is used. In this regard, scientific generalizations based on theoretical assumptions are advisable, rather than generalizations based on the study population. Third, case-study research designs are considered time-consuming. This concern is assumed as relating to researcher misunderstanding, in which specific time-consuming methods of data collection, such as ethnography and participant observation, are applied in case studies. Another concern is related to the incorrect use of case studies as an alternative to experimental studies, rather than applying them as complementary to them.

4.3.2 Selection of the research design

Given the discussion related to research design, the current research adopted a multiple-case study strategy under the umbrella of the multiple methods approach. The study is concerned with the integration of technology into the education sector, investigating the phenomenon in three schools comprising the case study. The study was conceptually framed by ANT to inform the qualitative part of the study; the Unified Theory of Acceptance and Use of Technology (UTAUT) addressed the quantitative design. Data triangulation was employed, in the sense that varieties of data sources from different localities were used to inform the study. Methodological triangulation was used in which qualitative and quantitative approaches informed the study. Theoretical triangulation was used, as the research questions being theoretically framed under ANT and UTAUT assumptions.

From the qualitative approach under ANT theory, the researcher gained an understanding of the different actors aligned with the process of integrating ICT into education. Therefore,

how teachers and students have been using technology for teaching and learning activities was addressed qualitatively. Factors influencing their use, and to what extent computers and the Internet are integrated, were addressed using a quantitative approach. The multiple-triangulation strategy in this study provided a deeper understanding of ICT integration; and the analysis of the local context enriched the assessment of the integration and use of computers and the Internet in the school environment. The multiple-triangulation strategy, therefore, allowed the enhancement of the validity of the research instruments. Sekaran and Bougie (2016) state that convergent validity confirms the correlation of scores obtained from different sources of data measuring the same concept. In other words, convergent validity is the extent to which findings from different sources of data share or converge in explaining a certain concept. The overview of the case-study research design used in this research is depicted in Figure 4-1, adopting Yin's (2011) approach.

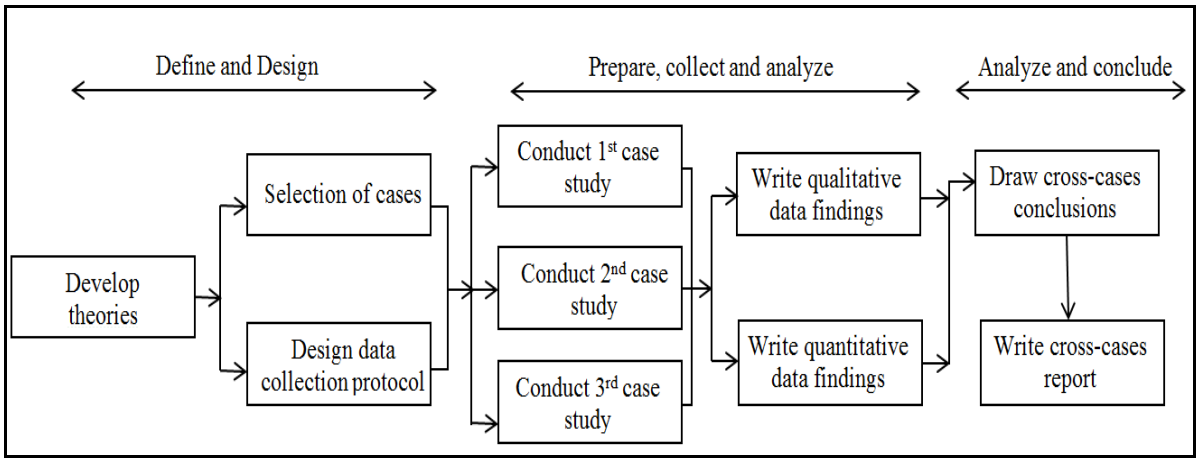

Figure 4-1: Case-study research design
Source: Adopting Yin (2011)

To characterize the settings where the study took place, the research site is presented in the next section.

4.4 Research site

The selection of sites and individuals in qualitative research in Creswell's (2014) view, involves the answering of four questions, namely: where the research will be conducted; who will be interviewed or observed; which activities of the interviewed or observed individuals will the researcher be interviewing or observing; and the nature of events the interviewed and observed are undertaking in a setting. In this regard, Miles et al. (2014) pointed out that the

qualitative researcher should not study everyone everywhere doing everything. It follows that the sample of qualitative studies should be based on the aims of research undertaken. Several types of sampling strategies to assist qualitative studies have been noted. However, they may all be categorized as purposeful sampling (Coyne, 1997). Therefore, qualitative research generally works with a limited number of participants selected purposively.

The research sites were in public secondary schools at three localities in the Maputo province. The schools participating in this study were chosen because they form part of the secondary schools selected by the Ministry of Education to implement a pilot project of technology integration into the education system. The technology integration project in secondary schools was initiated in 2010, in which 60 schools in the entire country were selected. In Maputo province, five schools were provided with computers and Internet connection in compliance with a project supporting technology integration into secondary education. The researcher believed that schools with computers and Internet connection would contribute to the understanding of the technology implementation process in the country, unlike those schools without ICT infrastructure and computers. Hence, the research sites were purposively selected in cooperation with the Provincial Directorate of Education and Culture. Maputo province in Mozambique was chosen as the research site for this study. Mozambique is located in southern Africa. The Tanzanian border lies to the north, Malawi, Zambia, and Zimbabwe lie to the west, Swaziland, and South Africa lie south of Mozambique, which is bounded by the Indian Ocean to the east. The country is administratively divided into 11 provinces. Each of the provinces is divided into districts and then into administrative areas and municipalities. Mozambique occupies an area of about 801,590 square kilometres, with a population of 26.423.623 (Instituto Nacional de Estatística [INE], 2015). Maputo province is the southernmost province of Mozambique, with an area of 26,058 km² and a population of 1,782,380, based on the National Census of 2007 (INE, 2015). The combined data-collection methods used in the present research are discussed in the next section.

4.5 Data collection methods

As described in the research approach section, the research was conducted under the umbrella of the mixed method study. The study provided an understanding of the integrated contextual background by merging and highlighting differences in findings obtained from each research

strategy. The assumption of mixed methods is that by combining the strengths of both quantitative and qualitative approaches, a deeper understanding of the problem under study will be gained, rather than relying on the results from one approach alone. The weaknesses associated with each of the approaches will thus more readily be overcome (Creswell, 2014; Johnson & Onwuegbuzi, 2004). The current study used interviews, observation, document analysis and questionnaire surveys as data-collection methods. These are described in the following discussion.

4.5.1 Interviews

Interviewing is characterized by the interaction between the researcher and the interviewees. Therefore, the role of the researcher during data-collection activities is emphasized. Yin (2011) categorizes the interviewing activity into structured, and qualitative (semi- and unstructured) interviews. A structured interview, which is applied more often in survey research, uses a formal questionnaire which lists all questions to be asked, in the form of closed-ended questions. Structured interviews may be conducted telephonically or through face-to-face interviews. However, the same kind of question is asked to all participants in the study. Yin (2011) states that data collected using a structured interview are considered more accurate and valid in contrast with the use of the open-ended question format. However, structured interviews are considered limited in their ability to assess the contextual research setting.

Qualitative interview procedures are conducted with the aim of understanding participant's views "on their own terms and how they make meaning of their own lives, experiences, and cognitive processes" Yin (2011, p.135). Qualitative interviews are guided by the researcher's mental framework of research questions instead of by a structured list to be asked. Mostly, qualitative interviews comprise semi-structured and unstructured interviews (Edwards & Holland, 2013). During a qualitative interview, open-ended questions are verbally posed to the participants, in which context and setting of the interview are considered relevant. The researcher uses this technique to obtain detailed information about the events under research through access to the facts and views of the participants in their local context. Contrasting structured, qualitative interviews may also be employed for a group of participants in the form of a conversation in which interviewees may query the researcher. Therefore, qualitative interviews may also be conducted as in-depth or focused interviews. In-depth interviews

generally take place over an extended period of time in which open-ended question are emphasized. During in-depth interviews, the researcher could use insight from the interviewees to guide further inquiry, while in focused interviews a set of questions follows, derived from the case-study protocol. Yin (2011) defines case study interview protocol as a formal document which includes an overview of the case-study research, field-study procedures, case-study questions and guides for the research report.

In the current research, semi-structured interviews were conducted at each research site, guided by an interview protocol as suggested by Yin (2011). The interview protocol was used as a guide to the conversation with school administrators and ICT teachers. All the interviews were conducted in person either in the participants' offices or in the teachers' room. Within each research site, interviews were focused on exploring participant experiences, and assessing the way in which technology has been implemented, as well as the current usage status. Specific interview protocols facilitated the interviews with each of the participant groups. Questions covered in the interview protocols were framed by the qualitative segment of the study, in which the translation process from ANT assumptions were answered (Appendixes A and B). Accordingly, participants were selected based on the assumptions of their knowledge and relationship with the research topic. The school administrators and interviewed teachers had relevant experience and were to some extent involved in the process of integrating technology into the secondary education system at each of the research sites. Each interviewee (teacher participant) is labelled A1, A2,… , B1, B2,… , and C1, C2, etc., where A, B and C represent the different schools and the numbers represent the teachers at the schools.

4.5.2 Observations

Observations refer to the process of qualitative data collection in which the researcher takes field notes on the behaviour and activities of participants at the research site (Creswell, 2014). According to Yin (2011), observing is considered a valuable data-collection method in the sense that a researcher can see and perceive with his or her senses, in addition to what might have been reported. Sekaran and Bougie (2016) state that observation is a planned activity pertaining to the watching, recording, analysis and interpretation of participants' actions and behaviour in the particular scenario. Observation techniques may be used to verify the accuracy of the information gathered during the interviews (Denzin & Lincoln, 2003), and

also to complement qualitative and quantitative data obtained using other techniques (Yin, 2011). According to Yin (2011), observation techniques are categorized either as direct observation or participant-observation. Direct observation is conducted in the natural setting of the case through filed site visits. Direct observation gives the researcher the opportunity of collecting case-study evidence by observing the phenomena under research in which participants' behaviour and site environmental conditions are taken into account. Participant observation refers to the situations in which the researcher locates himself or herself in the field setting by assuming an active role within a case. Moreover, Sekaran and Bougie (2016) categorize the degree of participation into passive, moderate, active or complete participation. Observation may be descriptive, focused or selective. In active participation, the observer is practically involved in all the activities performed by the group under study as a way of learning about their behaviour. Moderate participant refers to a situation in which the researcher does not actively participate in the field setting, only occasionally interacting with the group under study. The lowest degree of participation – passive participation, occurs when the observer collects data without becoming an integral part of the organization under study. Descriptive observation occurs when the observer collects data to get an initial picture of the field setting which may be used as a basis for the development of a conceptual framework, theories or a set of concepts. In focused observation, which is usually supplemented by interviews, the observer concentrates on a particular aspect of the research field, while in selective observation, the researcher focuses on different issues and remains open to emerging patterns.

In the current research, direct observations were conducted during field site visits, which include observations during the data-collection phase. Direct observations are less formal, and consist of collection and recording of evidence in their natural settings without the use of specific techniques. In this research, field notes were used to record evidence on the occasion of field visits. Yin (2011) underlines relevant aspects regarding observation techniques, such as when and where the researcher should be observing, and decisions on what to observe during field visits. However, the relevance of items to be observed depends on the research topic (Yin, 2011), and where to start observing depends on the research question (Sekaran & Bougie, 2016). Accordingly, observations in the current research took place during and after the interviews, and additional observations were conducted during the ICT classes. In the first period, the observations were unstructured (Sekaran & Bougie, 2016) and general open-ended questions were asked, in which the participants provided their views candidly. The

observation schedule included observations of the participants' behaviour and the school environmental conditions, which comprised observations of teachers interacting with technology and with students during ICT class; students using computers and interaction between teacher, students, and ICT technicians. The school environmental conditions included observations on the availability of school basic resources for the implementation of ICT use and the availability of technological resources and an appropriate computer room.

The observations were useful to check and clarify the accuracy of what had been reported by the participants during interviews. In this sense, observed data were used to complement the data collected using qualitative and quantitative techniques. Additionally, observations were used to triangulate the data collected using other techniques. This followed Yin's (2011) assumption that a researcher could not mechanically record observations on a given field. Observed data should be in line with research concepts, participants' social behaviour, and their interactions in the natural settings.

4.5.3 Document analysis

This refers to the collection and examination of documentation related to the research topic as a complement of the interviewed and observed data during fieldwork (Yin, 2011). For better understanding of the research topic, as well as to complement each part of the data-collection process, public and private documentations were collected and examined. The examined public documentations included ICT policies launched in 2000, the ICT policy implementation strategy approved in 2002, and the education technology plan of 2011. The private documentation, which was provided by schools, included reports, ICT curricula, and manuals.

The use of different sources of data assisted in triangulation and validating data which were collected from each technique. Data from different sources were compared in order to identify similarities and differences across research sites. The use of triangulated evidence from multiple sources is emphasized by Yin (2011). Triangulation was employed to determine whether or not data from different sources led to the same finding. For example, data obtained from ICT class observations at one site differed from data from the other site, however, they corroborated the teachers' interview data. On the other hand, evidence resulting from interviewing the school principal, complemented data obtained from

documentation analysis, although this was somewhat different from certain aspects of the observed data.

The use of different sources of data is considered important in conducting qualitative research. However, each data-collection technique has its strengths and limitations (Creswell, 2014). Therefore, the ability of the researcher is relied upon when using data-collection techniques that will strengthen the research findings (Yin, 2011).

4.5.4 Questionnaires

Questionnaires represent a technique generally used for collecting quantitative or numerical data in survey research. In a survey research, the researcher intends to produce quantitative descriptions of trends, attitudes, or views of a given population by analysing a sample of that population (Creswell, 2014). In the current research, quantitative data were collected using questionnaires (Appendixes F and G). Therefore, questionnaires were filled in anonymously and voluntarily, with privacy and confidentiality assured. Two separate sets of questionnaires were designed for the teachers and students. The questionnaires consisted of two sections. The first section captured demographic data from 25 questions for teachers and 24 questions for students. The second section elicited measurement data, regarding the participants' degree of agreement based on a five-point Likert scale from 'strongly disagree' to 'strongly agree' for items of measurement of the constructs as indicated in the conceptual framework. These items of measurement were adapted from Venkatesh et al.'s (2003) study, with changes made to suit the research topic.

As stated before, the questionnaires were piloted between March and May 2015, during which period 72 students and 6 teachers participated. The pre-test was helpful in improving the instrument questions and in clarifying items before administration of the actual survey. Pilot studies have many advantages, including the testing of participants' powers of comprehension and the adequacy of the research instruments (Teijlingen & Hundley, 2001). The research instrument was originally developed in the English language (Appendix F and G) and then translated into Portuguese. The research context setting is a Portuguese-speaking country. Pre-testing was important, and the feedback served as a tool ensuring the accuracy and completeness of the questions in the questionnaire. The actual survey was conducted in

the period between September and October 2015. A summary of the overall data-collection process at each of the research sites is presented in Table 4-2.

Table 4-2: Summary of data-collection process at each of the research sites

Data collection technique	School A	School B	School C	Total
Interviews	1 Head of school	1 head of school	1 head of school	3
	3 teachers	3 teachers	3 teachers	12
Questionnaires	5 teachers	6 teachers	6 teachers	17
	Students from all three sites completed the questionnaire			376
Observations	• Participants' behaviour • School environmental conditions • Teachers interacting with students during ICT class	• Participants' behaviour • School-environment conditions • Teachers interacting with students during ICT class	• Participants' behaviour • School-environment conditions • Teachers interacting with students during ICT class	
Document analysis	• School reports • ICT curricula and • ICT manuals.	• School reports • ICT curricula	• School reports • ICT manual	
Qualitative data were collected between March and May 2015. The questionnaire was surveyed in September and October 2015				

4.6 Population and sampling

The population comprised three secondary schools, and included the students and teachers of these schools. The schools were chosen to represent three different localities. The selected schools are part of a pilot project of technology implementation in secondary schools initiated in 2010 by the Ministry of Education. The research is focused on the understanding of a technology-implementation process and its use in the selected schools, fifteen years after the pilot project. The sample comprised twelve interviewees. A school administrator and three teachers were selected from each of the secondary schools. The research sites were selected purposefully. Creswell's (2014) suggestion is that qualitative data-collection techniques be applied for the purposefully selected participants and sites. The sample comprised schools in the province that had computers and Internet connection.

Hair, Black, Babin, and Anderson (2010) were concerned that, although increased sample sizes are likely to produce greater powers of testing with statistical significance, the choice of sample size is based on other factors which must be considered at the initial stages of the research. In this regard, Voorhis and Morgan (2007) state that each statistical test has its corresponding sampling test. For example, for a correlation or regression analysis, which is the case of the present study, the rule of thumb is that at least 50 participants provide a reasonable number. However, the number increases with the complexity of the model used in the research. Gaur and Gaur (2009) suggestion is that, when testing correlation, the number of participants should be greater than 50 + 8 * (the number of independent variables used in the model), and greater than 104 + (the number of independent variables used in the model) for testing individual model predictors. Sekaran and Bougie (2016), however, recommend that samples be selected based on representativeness of population for generalizability of the research results. They further argue that either the sampling design – the technique used to select cases from the sample − or sample size, would be useful for the researcher to meet the objectives of the research for the adequate level of precision and confidence. Therefore, the authors suggested the use of Krejcie and Morgan (1970) table for easy determination of sample size when given a finite population. Krejcie and Morgan (1970) calculation formula of sample size (based on that of the National Education Association) is as follows:

$$s = X^2NP(1-P) \div d^2(N-1) + X^2P(1-P)$$

Where: s = required sample size;

X^2 = the table value of chi-square for 1 degree of freedom at the desired confidence level of (1.96 × 1.96 = 3.84);

N = Population size;

P = Population proportion (assumed to be .50 since this would provide the maximum sample size); and

d = degree of accuracy expressed as a proportion (i.e. .05).

In spite of the provided formula, no calculations are needed and the table is applicable to any study given a finite population (Krejcie & Morgan, 1970). Therefore, Krejcie and Morgan's (1970) scientific guideline for the choice of sample size is presented in Appendix H. On the other hand, Comrey and Lee (1992) suggest that, to increase the generalizability of research findings to the population, sample sizes of 500 or more, whenever possible, should be used.

Otherwise, the researchers are advised to bear in mind the sample size categories of: “50 – very poor; 100 – poor; 200 – fair; 300 – good; 500 – very good; 1000 or more – excellent” (Comrey & Lee, 1992).

Based on the previous discussion on the determination of an adequate sample size for the representativeness of the population, the sample size of 450 for the survey was decided on. The sample size was considered to be sufficient to fulfil the requirement of statistical tests, taking into account the complexity of the research model, and for representativeness of the population. A total of 450 questionnaires were distributed to the three research sites, with 130 questionnaires administered to students, and 20 questionnaires to the teachers at each site. However, only 385 completed questionnaires were received from students, of which only 376 were considered valid and usable for analysis. Nine questionnaire responses were rejected after a visual inspection, mainly because more than one answer was given to questions expecting only one, and some questions were not answered correctly. The questionnaires considered valid represented 96.4 per cent of student responses. However, for the teacher sample, the response rate yielded only about 28.3 per cent of participant response to the questionnaire. Saunders, Lewis, and Thornhill (2009) note that response rates are affected by research techniques adopted for data collection. Therefore, the use of combined methods of data collection is considered to be effective for creating more interaction between respondents and the researcher, hence enhancing the response rate. Particularly, data from teachers were obtained through initial interviews from a small number of participants, followed by the administration of questionnaires at each of the research sites. However, owing to the limited time of the teacher participants, the researcher was advised to leave the questionnaires at the site, returning on another set date to collect them. The researcher went to the research sites many times in order to collect the filled questionnaires. However, a total of only 28.3 per cent of responses was obtained.

4.7 Data analysis

Data analysis involves the application of rationality to make sense of the collected data, both qualitative and quantitative. Onwuegbuzie (2011, p.3) defines mixed-data analysis as a process that “involves the use of both quantitative and qualitative analytical techniques within the same framework, which is guided either a priori, a posteriori, or iteratively”. Onwuegbuzie (2011) adds that the researchers must be skilled at joint analysis of both

quantitative and qualitative data. Besides, researchers should integrate the results to produce generalizations within the study, which makes the process complex. However, this author advises that the process of mixed-data analysis should be designed based on the mixed methods research design. In so doing, convergent mixed-data analysis was used for convergent mixed methods design, in the same way that sequential mixed analysis was applied for a sequential mixed methods design.

Based on the arguments presented in Sections 4.2 and 4.3, for the selection of research approach and design and following Onwuegbuzie's (2011) assumptions, this research-data analysis process was based on convergent mixed-data analysis. Therefore, qualitative and quantitative data were analysed separately, the findings being collated as research findings. For the convergent mixed-method analysis, Creswell (2014) suggests the use of a side-by-side approach. This approach refers to a strategy in which the researcher uses either qualitative or quantitative analysis to confirm the findings produced by each set of data analysis. For example, the researcher may opt to perform quantitative analysis first, thereafter discussing the qualitative findings to verify the accuracy of the statistical results. Alternatively, quantitative analyses are performed, comparing them with the qualitative results which have been reported. In the current research, a side-by-side approach was used in which qualitative findings were presented first. Thereafter the quantitative results were offered.

4.7.1 Qualitative analysis

The qualitative data analysis was presented following theoretical propositions of Actor Network Theory (ANT), assisted by Miles et al. (2014) data analysis procedure involving data reduction, display, and conclusion drawing. Data reduction is the process whereby interviews, observations, field notes, and document analysis are reduced and organized in some form of coding. Data were organized according to specific themes in which theoretical propositions were used. The themes were developed prior to the data-collection process, as they relied on the ANT propositions which guided the qualitative part of the research. However, some themes emerged as a result of the literature review, data collection, and data analysis process. Most of the mentioned factors constraining the actual use of technology were dealt with in the research survey. The theoretical propositions, specifically, the

translation process from ANT, led to the research objectives and questions addressed in the research.

Researchers such as Yin (2011) and Creswell (2014) pointed out that computerized tools to assist in the analysis of qualitative data exist. However, they also argue that, no matter how powerful the tool, human interaction and expertise will always be required for efficient data analysis. In this regard, the researcher performed data analysis following the aforementioned techniques without the use of any software designed for data-analysis purposes. The adopted data-analysis strategy was helpful in the sense that data within the same site and from a different source were grouped representing a unit of analysis (Yin, 2011). Furthermore, data from the same unit were examined to understand the case study following the theoretical propositions. Thereafter, data findings from each site were analysed across research sites to perform the case-study findings. The use of this approach enabled the understanding of the socio-technical interrelation of ICT and its associated social network, in which the principle of generalized symmetry from ANT was highlighted.

4.7.2 Quantitative analysis

Unlike the strategy used for the qualitative data analysis, the analysis of quantitative data was performed using computerized tools. Theoretically, the questionnaire was based on the Unified Theory of Acceptance and Use of Technology (UTAUT) model. Questionnaire statements were related to performance expectancy, effort expectancy, social influence, and facilitating conditions constructs, in examining user behavioural intention for the acceptance and use of technology. Questionnaires also included demographic and other relevant information of the participant's background which could influence the level of acceptance and use of technology.

Statistical data analyses were performed using the Statistical Package for Social Sciences (SPSS), version 24. Univariate and bivariate analysis in the questionnaire data was performed to address research questions. Descriptive statistics were performed to test the general trend of the samples and reported in frequency distribution tables and graphs. Descriptive statistics included the mean which is a measure of central tendency and standard deviations to assess the existing variability of the data set. Furthermore, inferential analysis such as one-sample t-test, the binomial test, the Chi-square goodness-of-fit-test, the Chi-square test of

independence and regression were conducted to address the research questions. The analysis was conducted separately for the student and teacher data sets.

4.8 Ethics considerations

All ethical considerations (Creswell, 2009), were observed during the research. The research proposal was presented to the university research committee members and approval was granted. The researcher applied for ethical clearance which was issued by the university's Human and Social Sciences Research Ethics committee. The ethical clearance letter is presented in Appendix K. Accordingly, the researcher approached the Provincial Directorate of Education and Culture of the Maputo province and a research permit letter was provided, (Appendix C). In order to collect the data, permission was sought and approval was granted at the research site level. Additionally, permission for conducting interviews was sought from the schools, and all participants agreed to take part in the current study. Therefore, a cover letter concerning the purpose of conducting the research, and a statement regarding the voluntary participation in the research were provided to the participants. Participants' rights were observed and an informed consent form, (Appendix D and E), was signed by all interviewed participants before the interview took place.

The researcher had access to the schools and their computer rooms, and participated as an observer in some computer classes. At each of the research sites, the school principal was the first to be interviewed, thereafter the ICT teachers. During the interviewing activity, the researcher introduced herself, briefly explaining the research objective. Thereafter, the interview protocol was presented to the participants, in which technical terms were clarified. Interviews were conducted with the assurance that the information provided would be used for academic purposes only, and strict confidentiality was promised. The researcher had permission to audio-record the interviews. However, hand-written notes were also taken.

For the students, the questionnaire was administered at the end of their classes in which the researcher presented herself, and the questionnaire cover letter was read. The letter introduced the students to the research and asked them for their anonymous and voluntary participation. Unlike the students, some teachers preferred to complete the questionnaires at home before dropping them off at a predetermined place on a certain date, or handing them to a selected teacher. However, the teachers' questionnaires were presented to them with the

covering letter concerning the research and the anonymity and voluntary nature of participating in it.

4.9 Chapter summary

The present chapter described the research methodology, in which research paradigms, approaches and designs were discussed. In addition, the chapter discussed the chosen research approach for conducting the present research. The chapter also elaborated on the characteristics of research sites in which the dimension of educational status is outlined. The population and sampling strategies were also presented in the chapter. Lastly, a brief overview of data analysis was provided followed by the ethical considerations addressed. The next chapter presents the qualitative data analysis.

CHAPTER FIVE

QUALITATIVE DATA ANALYSIS

This chapter presents the analysis and discussion of the qualitative data (interview transcripts and observations) based on the Actor Network Theory. The analysis follows the concept of translation from the Actor Network Theory (ANT) for the understanding and interpretation of qualitative data. The translation concept was used as the theoretical basis for the understanding of technology implementation in the education system.

5.1 An interpretation of technology integration using the ANT perspective

Based on assumptions provided by the socio-technical perspective in Chapter Three, the introduction of an innovation in a certain context is shaped by the context in which the technology is to operate. In other words, to understand the technological interaction with its local setting, a socio-technical perspective was adopted. Therefore, this chapter presents the interpretation of data based on the ANT theory. Saunders et al. (2009) argued that problems addressed in business and management research should be examined through the interaction between the world of theory and the world of practice. In addition, Walsham (1995) contended that in IS research, theory provides a framework for the understanding of a phenomenon and for the interpretation, report, and generalization of results. Therefore, theories are used as a framework for the understanding and communication of research findings (Saunders et al., 2009). In this study, a framework of ANT was selected to assist with the understanding and interpreting and to describe the way in which technology was introduced and is used in the research setting. Therefore, the case-study data findings are described through the concept of translation from the ANT. That is, the findings from the case study are constructed and interpreted using the four moments of translation. A translation process has been used by researchers to perform analysis of actors within a network. Using a translation process, Callon (1999b) provided a framework for understanding ways in which actors are identified; how their roles are defined; how the actors' interests are aligned; and how certain actors become indispensable in such a way that they control others in a network. Tatnall (2010) argued that

translation is a powerful tool in combining the view of heterogeneity in explaining the process of technology adoption. Using the assumptions of the translation process and its capability of revealing the socio-technical characteristics of technology, the case study is presented in the following sections. The four moments of translation consisting of *problematization*, *interessement*, *enrollment*, and *mobilization* of actors are used as described in Chapter Three. Research question one is addressed in the section below. The thesis posed the following research question, leading to the conceptual framework of technology translation from ANT.

- RQ1 − How does the '*translation process*' of integrating ICT within secondary schools in Mozambique take place?

Tatnall (2010) argues that an innovation is likely to be adopted as the result of the translation process in such a way that is appropriate to the user. Key actors in the process of implementation of technology into secondary schools were interviewed. Therefore, interviews which are complemented by observed data informed the translation framework. The moments of translation are drawn up through ANT, and the concepts used for the analysis of data are summarized in Table 5-1. To illustrate relevant contributions to the mapping of translation moments, excerpts from interviews with participants are used. However, only the relevant interventions of the interviewees are included in the thesis.

Table 5-1: Summary of the ANT concepts used in analysing data

Concept	Description
Actor	An object that does the tracing, the inscribing, the creating and the transforming of a network, influenced by and influencing the other actors (Latour, 1999).
Actor-network	A heterogeneous network of aligned interests formed through translation of interests (Walsham & Sahay, 1999).
Black box	An entity difficult to understand which "contains a network of black-boxes that depend on one another both for their proper functioning as individuals and for the proper functioning of the whole" (Callon, 1987, p.89).
Translation	The process of actor-network creation through the four main phases: problematization, *interessement*, enrollment, and mobilization (Callon, 1999b).
Problematization	The focal actor "defines the problem, the solution and identifies the relevant actors" (Macueve, 2009, p.41).
Interessement	The focal actor "convinces other actors that its solution is better than other solutions" (Macueve, 2009, p.41).
Enrollment	An actor accepts the interests defined by the focal actor and sets out to achieve them through negotiations aligned with the actor-network.
Mobilization	Ensuring that enrolled actors follow definitions and interests established in the network. Actors become spokespersons.
Obligatory Passage Points (OPP)	A situation that has to occur in order for all actors to satisfy the interests of the created actor-network (Callon, 1999b).

The process of creation of the actor-network is described through the lens of the four moments of translation in the following sections.

5.1.1 Problematization

This represents the first stage of the translation process in the creation of an actor-network in which, actors were identified and their roles in the network defined. The focal actor Ministry of Education identified and defined the problem facing the secondary education system, and uses a set of strategies to convince other actors to accept the identified solution.

Technology was introduced into the local network comprising secondary schools as the principal non-human actor. The use of technology for teaching and learning activities was implemented as a pilot project in the secondary schools. As with any project, the implementation of technology involves an implementation plan or policy as a non-human actor in the interplay of actors in the network. The first policy for the integration of technology in schools was launched in 2008 by the Ministry of Education (Matavele & Chamundimo, 2009). This non-human actor, a strategic education plan, aimed at integrating technology into all secondary schools in Mozambique. Two years later, computers and the Internet were provided for the first time by the Ministry of Education in 60 secondary schools. The research settings comprise three secondary schools from different localities in the province of Maputo. Therefore, technology entered into each of the research sites in which other human and non-human actors were identified. Technology was introduced in the secondary schools to fulfil the government goal through the main actor − the Ministry of Education. Computers were provided and Internet access was established to be used as enhancement of the quality of teaching and learning activities in schools. It is noted that in the problematization moment, one or more actors – the initiator actor − generally makes efforts to define the problem and the roles of other actors in such a way that the initiator is seen as absolutely necessary to the solution of the identified problem. Therefore, the Ministry of Education successfully problematized a need for the secondary schools to implement technology, with a view to improving the quality of the education system. At this stage, the problematization was important for the presence of technology in the school environment. Subsequently, two networks were identified − the local network constituting actors in the school site, and the global network made up of actors from the Ministry of Education site. The Ministry of Education entered the network as a black box. In alignment with ANT concepts, an actor or a network of actors whose characteristics are not well known, however, relevant to the proper functioning of the network, is considered a black box (Callon, 1986). The Ministry of Education is identified as a black box in this research, within which other black boxes are involved, such as the various departments and other actors relevant to the functioning of the ministry. Therefore, the details of activities or the interaction of actors inside the black box – the Ministry of Education − are not relevant to this research. The identified actors and the mapping of the case study in ANT concepts are presented in Table 5-2, after problematization.

Table 5-2: Identified actors in the problematization stage

Actor	Case study entity	Entered at the beginning of network	Descriptions
Non-human actors	Secondary schools	Yes	Represent the three sites at which the technology was to be integrated
	Technology	Yes	Voiced by all human actors within the two networks. The benefits of technology were mentioned in the translation process
	ICT Policies	Yes	Voiced by actors in global network in which the Ministry of Education is represented.
	ICT curriculum-guide	Yes	Voiced by all of the human actors, as a point through which all the students must pass
	Implementation plan at the school level	No	Voiced by all human actors, however, none of the schools offers an implementation plan for the introduction of technology
	ICT infrastructures	Yes/No	Voiced by all human actors, however, only computers and access to Internet were provided, disregarding all the infrastructures required for the proper functioning of the actor network
	Secondary school curriculum	No	Voiced by the school principal, as well as by the ICT teachers. However, this was disregarded at the beginning of the project
	Time table	No	Voiced by all human actors, however, less attention was given from the beginning of the process
	Basic infrastructures such as electricity	Yes/No	Voiced by all of the human actors, however the focal actor disregarded precarious conditions present in some of the schools' classrooms.
Human actors	Head of schools	Yes	
	ICT technician	No	Voiced by all the human actors, however, not taken into account at the commencement of technology introduction into schools
	Teachers	Only ICT teachers	Voiced by the Ministry of Education, however, only one or two teachers were involved at each research site
	Students	Yes	Voiced by all human actors
Black box	Ministry of Education	Yes	The ministry was responsible for the implementation of the technology into secondary schools. The researcher did not interview at the ministry site, however the ministry presence is noticeable in the created network
	Donors	Yes	Attempts of donors to support the sustainability of the actor network are noticeable at some sites. However, the researcher did not meet with any of the donors.

Table 5-2 describes the actors who were initially involved in the network, as well as the disregarded actors, who, therefore, were identified as important to the satisfactory functioning of the network. Using ANT concepts, each of the elements comprising the network of actors has its own interests, which distinguishes one from another. For example, the Ministry of Education and donors are designed as black boxes; technology infrastructures as non-human actors; and all the users as human actors in the network. However, the ANT disregards the physical characteristics of entities and assigns to them the same status. It is noted that a network is established by forging durable relationships between the entities comprising the actor network (Tatnall, 2010). Therefore, the negotiation process between human and non-human actors took place so as to translate technology into the school context. Workshops and a set of training strategies were used by the initiator actor to deploy the project among the relevant actors. In attempting to translate technology into the schools' context, the Ministry of Education involved heads of schools and teachers in the workshops and training sections. From the literature, the technology actor network is viewed as promising for the enhancement of academic activities (Ali & Al Hinai, 2013). Selected human actors, in the translation of the technology process believe in the benefits of technology in schools as revealed by some of the human actors evidenced in the interview excerpt below:

> *Our school was included in the pilot project, and we attended workshops provided by the ministry […] as teacher, and as school-board member, I support the use of technology in schools, and I believe in the benefits of computers in the education system. Our teachers and students are encouraged to use technology in their teaching and learning activities. We also inform the community and the students' parents of the advantages of using technology for the students' future lives*. Participant A1.

Another participant said:

> *I appreciate greatly the use of computers for the teaching and learning processes. I focused my attention on the benefits of the use of the Internet in the education sector; the Internet is making our life easier. It seems that the actual world research is linked to the use of Internet. The students can use the Internet to embellish the material they obtain from teachers*. Participant B1.

The workshops and training were designed to enrol human actors with non-aligned interests to join and to link them to the created actor network, which includes the use of technology. Consequently, teachers and the heads of schools successfully problematized a need for the students to learn how to use technology. Thereafter, negotiations between the non-human actors,

namely computers and Internet access, the required school infrastructures for appropriate use of technology and the human actors, took place. It was noticeable that the non-human actor, technology, and its associated network, challenged the existing infrastructures in the school context. Some of the participants interviewed expressed this challenge as follows:

> *… There is only one room with a power outlet. In the reading rooms the sockets are not working, so even if a teacher wants to use his own computer, there is no way, for example to use data display for lectures. There is still a lack of basic provisions at this school. The computers were installed in the library because of the lack of appropriate room.* Participant C1.

> *… We cannot talk or teach what a computer is or does, if we do not have a computer to show our students. Some of the schools have computers, but the Internet connection is no longer there. In my own case, I have a class of 92 students in a computer room with 10 computers only. It is difficult to make sure that all students in my class have even touched a computer*. Participant C2.

> *…. To achieve this goal we need more investment in technology, starting from the availability of computer rooms. For this school, we have 60 classes of 60 students each on average, for one computer room. It is not possible to achieve the goals under these conditions*. Participant A2.

> *… The use of technology in schools is welcomed. However, I think there is something missing from the bid to use technology in secondary schools in Mozambique. No one can learn how to use computer or how to integrate technology into his teaching if computers are mostly unavailable for teaching*. Participant C3.

> *… The challenges are so many, there is a need to invest in the acquisition of computers in order to prepare computer rooms for our lectures. Another challenge is the provision of IT technicians to support the everyday use of computers. The third challenge is related to the dissemination of the technology in the education system. There are still teachers who don't see the importance of technology in education*. Participant C4.

A variety of human and non-human actors, such as the computer room, electricity, ICT technicians, computers, and an Internet connection, were identified. The researcher performed some observations in which the data-collection technique and field notes information were clarified and voiced by the human actors. It is noted that the introduction of an actor, or its

translation into the context, threatens the existing network (Tatnall, 2010). This is derived from the fact that the successful introduction of an actor into the network is also dependent on the way in which the existing actors are associated. Therefore, expectations derived from the non-human actor technology seem to be weakened by the existing local context. As Callon (1987) noted, the durability of an actor-network is influenced by the strength exerted by each of its points or actors, and which jointly build cohesive connections.

As the translation evolved, negotiations between actors took place so as to convince other actors to join the network. Attempting to make the network durable, a new non-human actor – the curriculum-guide − was introduced into the network. Thereafter, the integration of technology in secondary schools was established as an ICT module. The entering of this non-human actor interfered with the interests of other, non-human, actors, namely, the timetable and the existing curriculum. Technology has been taught as an appendix, albeit as compulsory for all students enrolled in the classes. This new actor became a powerful entity in the stronghold of the network. All of the actors had to coordinate and work together in order to make the integration of technology into the schools' context a success. However, it was observed that there were different ways in which each of the heads of schools implemented the technology. For example, in one of the schools, the ICT module was integrated into the curriculum for the students in Grade 9, while in another, the ICT course was taught in Grade 8. One of the teacher participants stated that,

> *Strategically, we prioritized grades with fewer students, as we had only one teacher trained in ICT*…. Participant A3.

This difference of strategies reveals the absence of another non-human actor, the implementation plan for the local network. One of the interviewed participants referred to the absence of this non-human actor as:

> *I don't have an official document for integrating ICT into the teaching and learning process. However, we were included in workshops for ICT integration training*. Participant A4.

Despite the obvious disregarding of the inclusion of some of the non-human actors, technology integration in the secondary education system was able to become the Obligatory Passage Point (OPP) for schools that participated in the study. The ICT curriculum guide, allied with requisite ICT classes for all students, allowed OPP to be visible in the network. The OPP represents the

situation in which the problem is redefined as a solution provided by some actors who appointed themselves as absolutely necessary to the appropriate functioning of the network. Therefore, the OPP needed to be negotiated as a key part of the problematized issue. Attempts by the Ministry of Education to establish the OPP were mentioned by the human actors. One of the participants interviewed stated that:

> "*the Ministry of Education is forcing the secondary schools to change their work practices, and we have to follow the procedures*." Participant A5.

This reveals the commitment of the enrolled actors in the actor network, while ensuring its functioning.

As the translation developed, all identified actors and their respective roles in the network were revealed. Therefore, to accomplish the creation, transformation, and durability of the network, the heads of schools and the trained teachers were transposed, and acted as initiator actors in each of the local networks. As a result, these actors redefined the problem, attaching more actors through the provision of training programmes for other teachers. The use of computers and the Internet assisted teachers and students to become visible in the local network. However, the use of technology was translated into the existing curriculum as another subject. The school principal, teachers, ICT curriculum-guide, timetables, students, technology itself, electricity, and the computer rooms comprised the local network. For the network to become stable, all of the identified actors had to work together, translating their interests into the actor network. Notably, the Ministry of Education (metaphorically the black-box) had imposed the translation of the non-human actor of technology. In turn, the heads of schools and trained teachers became key actors, imposing the translation of technology into the schools' context. From the observations conducted during fieldwork, the researcher realized that at each of the research sites decisions were taken, based on the needs and local conditions, including re-problematized issues. Therefore, the re-problematization moment was visible at the sites and the role of technology was recognized by all users, which led to the moment of *interessement* as described in the ANT framework.

5.1.2 *Interessement*

This translation moment represents a process in which efforts to impose the identities and roles of actors defined at the problematization stage takes place (Callon, 1986). The initiator actor strategically develops an *interessement* device, by which he or she convinces other actors to accept their roles and the identified solution in the problematization moment. As the schools were provided with computers and Internet access, the Ministry of Education enforced the use of technology in the schools. Additionally, an ICT curriculum guide was introduced into the local actor network. Consequently, all students were obliged to adhere to the proposed solution, the pilot project being successfully stabilized. Thereafter, two *interessement* devices were implemented into the research field. The excerpts below indicate this enforcement of the use of computers.

> … *We are teaching technology as a compulsory subject as any other subject in the curriculum. From the beginning of the project we are following a curriculum guide provided by the Ministry of Education, even though we do not have good infrastructure to accommodate the teaching of technology use*. Participant C5.

> … *Technology is a compulsory subject as is any other in the curriculum*. Participant A6.

> ...*We usually are trained from MINED on how to use computers; they emphasize the use of the computer in secondary school as a goal that we must achieve*. Participant C6.

> *… We usually promote the use of computers for our colleagues, especially the administrative officers; we offer training internally*. Participant B2.

With the implementation of the *interessement* devices, the Ministry of Education becomes indispensable to the solution of the identified problem in the problematization moment. Consequently, the provision of technology to assist in solving the identified problem was expected to be assured by the Ministry of Education in the actor network. From observations, the recognition, as well as the acceptance of the proposed solution, was confirmed. The observations were used to clarify the meanings in the interview excerpts. Participants spontaneously mentioned the recognition and use of the *interessement* devices, which confirms the success of the *interessement*. However, Callon (1986) notes that actor networks are not always reliable, therefore they may become unstable.

To ensure the durability of the created actor network, the Ministry of Education had to convince other actors to join the network. The human actors who participated in workshops and initial training were transposed to act as initiator actors in their local networks. Therefore, in the local network, the initiator actors had to convince other actors to enrol in the new network. Through the media and formal meetings, the Ministry of Education convinced international and national donors to join the actor network. This strategy was useful in enrolling other actors, and the created actor network became partly stable. However, during field visits, discrepancies at each of the research sites were noticed. For example, at one of the schools there are two computer rooms. One is equipped with an iterative board, a server computer, a printer, and ten other computers for use by students. This equipment was supplied by an international donor in coordination with one of the national entities. By contrast, in another school, ten computers which were provided by the Ministry of Education for student use were installed in the library. However, the same school was also able to enrol another actor, the Internet connectivity − supplied by a donor. In each of the sites, the initiator actors successfully gained the interest of other actors in the proposed solution. As a result, the enrolment moment was able to be realized.

5.1.3 Enrolment

Enrolment generally occurs through a process of negotiations and actions resulting from a successful *interessement* phase. Enrolment is derived from the need to ensure the establishment of solid and stable actor network associations (Tatnall, 2010). Enrolment represents the outcome of *interessement*, in which the defined and allocated roles are agreed to by other actors. In this research, enrolment represents the moment of translation in which, non-ICT teachers, students and other entities were enrolled to sustain the durability of the created actor-network.

The non-human actor of technology was introduced to establish a solid actor network at each of the research sites. The Ministry of Education was assumed as an entity responsible for the maintenance of each of the local actor networks through the implementation of the recognized OPP in the working context. Thereafter, local actor networks were rearranged and negotiations took place to accommodate the use of technology. The enrolment and acceptance of the non-human actor of technology into each of the local actor networks was partially addressed. The

initiator actor focused attention on the technical entities such as hardware and software. However, the enrolment and acceptance of these actors into the network involves provision of more than one set of actors. In other words, the Ministry of Education was focused on imposing its interests onto the other actors. However, for the enrolment to succeed, other actors must be willing to join the network. Callon (1999b) stated that enrolment is not a direct effect of a successful *interessement*. Therefore, negotiations involving different sets of actors must have been taken into account in order to secure a complete enrolment moment. From observations conducted during ICT classes, and interviews transcripts, other actors emerged. These included the non-tagged human and non-human actors, as reflected in the following participants' excerpts:

> … *We do not have any policy or a written plan to set up this project; however, we are working in order to get the project functioning. …. we have problems, there are no technicians working full time on this project. The two teachers who are acting as technicians are also teachers of other subjects. There is no technical maintenance of those few computers that we received*. Participant C7.
>
> … *I think that this school has the capacity to succeed in this project. Somehow, the school must use its own income and strategies to find and pay an ICT technician*. Participant A1.
>
> … *No one can learn how to use the computer or how to integrate technology into the teaching if most of the time the computer is not there for teaching*. Participant C3.
>
> … *The use of technology, to be effective needs provision of many resources, not just the computers and Internet access. This school has many problems regarding basic resources such as desks and blackboards; even the electrical network in the classrooms is not adequate for the use of computers*. Participant C6.

The initiator actor, the Ministry of Education and the transposed initiator in each of the local networks and the Heads of schools had successfully assumed the ownership of the project and all the users recognized the role played by them. In attempting to establish a solid actor network, other actors' interests were enrolled through a process of negotiation. In each of the research sites, training was provided to enrol other teachers into the network. Consequently, the use of technology in secondary schools is recognized by other teachers, rather than the teachers involved in the initial stage of the translation process. As Callon (1999b) notes, an actor-network is formed by the enrolment of both human and non-human entities' interests in the network. Therefore, other actors with emphasis on the non-human were partially omitted in the process of translation. For example, not all the required resources, such as guidelines or implementation

plans at the local level were tagged. However, even with differing backgrounds, the schools succeeded in enrolling more actors for the continuation of the translation and maintenance of the actor network. New enrolled actors are identified, as indicated in the interview excerpts below:

> *… The Internet connection was sponsored by the British Council for the first two years of the project … until last year we were sponsored by another organization. This year no one is paying for our Internet connection. However, we received last year from the Ministry of Education additional ten computers.* Participant C3.

> *…Our Internet connection is being paid for by a German partner. The technology is used to reduce the distance between the student and the source of information in far-off places. We believe that better days are coming. We are working with other organizations to acquire our computer room*. Participant A1.

During fieldwork, a clear acceptance of the new actor and attempts to incorporate technology when performing school activities were also evident. However, some of the users were reluctant and only partly enrolled in the actor network. For example, one of the school-board members, the coordinator of Grades 8 to 10, made himself inaccessible for the interview. Although approval from the school had been given for the researcher to conduct interviews with each of the coordinators, this actor was still not available. On every day which had been suggested by him, he substituted another actor to participate in the interview. This actor was cited as one who did not wish to learn how to use technology for personal benefits. One of the interviewees at this school said:

> *… It is difficult to measure the impact of technology use in this school; however, there are noticeable improvements for those teachers who are using technology. In this school there is a small group of teachers who do not use computers at all, and there are those who use the computer for some functions. Some teachers do not even want to learn, even for them to produce their class materials, including student transcripts. For example, one teacher who is also coordinator of the first level, does not want to use the computer at all. Therefore, how is he going to encourage those teachers under him to promote technology? ...This group of teachers have never give themselves time to attend to training provided locally in the school…. They prefer to use paper and pen as in the past*.

> *… We know that the teacher is a key for the implementation of this project; however, if teachers are not willing to use a computer, even with availability of resources, the project will fail*. Participant C7.

The above extract illustrates the incompleteness of the enrolment process. The observed situation may be referred to as resistance to change, which can influence the translation of technology into the working context. However, so as to increase the effectiveness of the enrolment moment,

resistance to change must be addressed during the previous moment − *interessement*. Therefore, the researcher understands that the initiator actor should have strategically adopted the use of technology as a means of extending teachers' professional development. In this way, there would be recognition of the OPP and the technology would have been used by all of the human actors.

The limited basic resources in the research sites, together with various reasons underlying the behaviour of the local human actors, are considered responsible for the partial enrolment of actors into the actor network. However, the researcher observed that interaction between human and non-human actors is visible in the schools' work practices. The benefits of using technology were spontaneously mentioned as indirectly contributing to the enhancement of the quality of teaching and learning. The enrolment in the local actor network, which includes technology, was also reported as improving performance expectancy. One of the interviewees stated that:

> *computers are making my life easier; I quickly perform my activities, and therefore improve my performance. With ICT competencies I am feeling powerful*. Participant C6.

The eagerness to become ICT-skilled has influenced the decision of enrolment into the actor network, thereby allowing the translation of technology in the school context to be mobilized.

5.1.4 Mobilization

Mobilization represents the moment in which the proposed solution to the problem identified in the early stage of translation is widely accepted. Callon (1999b) stated that mobilization occurs when a larger actor network is created, in which some actors are established as spokespersons acting and speaking on behalf of the other actors. In this research, mobilization represents the stage during which the defined solutions become part of the work practices. It is presumed that technology is translated to the schools' work practices.

In attempting to strengthen the actor-network, the actor in the role of spokesperson adopts a set of strategies through which actors with no aligned interests in the beginning of translation are merged into the created actor network (Rhodes, 2009). As such, the Ministry of Education attempted gradually to mobilize other entities, particularly international and national donors, who

could play a relevant role in the stabilization of a solid actor network. Consequently, the project of integrating technology into secondary schools is widely known in the country. The Heads of schools, who were transposed as initiator actors into their local networks, also mobilized other actors, apart from teachers and students. It was appropriate to enrol heads of schools, who entered the network with little or no experience of technology, but were led to the mobilization process. As a result, some other organizations, students' parents, and the community were mobilized into the actor network. One of the interviewed participants commented as follows:

> … *We had a meeting with students' parents, in which we explained the importance of technology in education. Some of the parents showed interest and indirectly are helping in the realization of this goal*.
>
> … *In the beginning of the project we offered ICT courses to the interested people from surrounding areas, including small organizations. The fees were used to maintain the project and cover our expenses*. Participant A1.

However, from the observations in the research field and judging by the comments of the participants, the limited basic resources for the effective use of technology are influencing the mobilization moment. Teachers and students recognized improvements in the basic conditions on all of the research sites. The provision of reasonable resources could have contributed to mobilization of actors and also to the stabilization and strengthening of relationships among them. Consequently, translation of technology should have been completed and effectively accepted into the schools' local contexts. Callon (1986) notes that translation cannot be effective if the entities are not strong and stable enough to keep the created actor network reliable and consistent. This note indicated that the successful creation of an actor network does not represent an effective translation. Therefore, actors need to become stronger to effect and maintain a credible network. The research context background threatens the credibility of the created actor network.

Nevertheless, the current infrastructures' negative effect on the created actor network use of technology in secondary schools in Mozambique was announced through the local media channels. To sustain the project long term, the Ministry of Education introduced the subject of ICT in all teacher-education institutions. Consequently, teachers from these institutions are skilled in using technology which assists teaching and learning activities. One of the participants said:

> *… for the first time, I heard about integrating technology into the secondary schools' curriculum when I was attending the teacher-education institution. I learned there how to use a computer. ICT skills were one of the requirements of any teacher at a secondary school*. Participant B4.

This indicates that the Ministry of Education and its school representatives are committed to the integration of technology into the secondary school curriculum. However, the current status of the schools' infrastructure is constraining the translation of technology into the schools' work practices. Technology use could have been widely accepted in assisting academic activities had all the existing actors in the local network been taken into consideration when accommodating the new non-human actor of technology. However, the translation process was incompletely installed and the use of technology as a solution to the identified problem is still being considered by the schools. From observations and from interviews, the use of technology as a solution to the problematized issue was spontaneously and repeatedly pointed out by actors, whose interests are already aligned with the network. Therefore, technology use in secondary schools is still considered beneficial to academic activities, thereby promoting the quality of education in the country.

The tracing of the non-human actor of technology suggested that ICT had not been completely translated into the schools' context. However, it revealed its potential to empower teachers and students and also to improve the quality of work and relationships within the schools. The use of electronic communication within the schools and among the actors involved in the network was repeatedly mentioned. Therefore, in order to further understand the use of ICT in Mozambican secondary schools, the factors affecting teachers' and students' behavioural intention, in respect of the integration of ICT into the education system, was examined to complement these findings. A summary of the key ANT concepts as used in this qualitative data analysis is presented in Table 5-3: Summary of key ANT concepts as used in this qualitative data analysis

Table 5-3: Summary of key ANT concepts as used in this qualitative data analysis

Key Concept	Concept Application in this Research
Actor (human and non-human) − Callon (1987) contends that actors in a network are identified when their presence is felt necessary to the proper functioning of the created actor network.	In this research, non-human actors included the ICT policies, ICT curriculum guide, schools' basic and mandatory infrastructure such as electricity and water facilities, ICT infrastructure, secondary school curriculum, time-table, computer room, the technology itself, ICT implementation plan at the school-level context, and other physical infrastructure. Human actors comprise the heads of schools, teachers, students, and the ICT technician.
Black box - Represents an entity difficult to understand which "contains a network of black-boxes that depend on one another both for their proper functioning as individuals and for the proper functioning of the whole" (Callon, 1987, p.89).	The black boxes included the Ministry of Education and donors that joined and supported the sustainability of the actor network through provision of technology and Internet connection.
Translation − Refers to the process of actor-network creation through the four main phases: problematization, *interessement*, enrollment, and mobilization (Callon, 1999b).	In the problematization moment, all actors were identified and their respective roles in the network were revealed. In this stage, the role of technology was recognized by all users and the technology actor became indispensable to the solution of the problem. In the *interessement stage*, as the schools were provided with computers and Internet access, the Ministry of Education enforced the use of technology in the schools through the implementation and a mandatory use of an ICT curriculum guide. In the enrolment stage, an attempt to establish a solid actor network was noticeable. As a result, other actors' interests (including other teachers, national and international donors) were enrolled through a process of negotiation. However, the limited basic resources in the research sites, together with various reasons underlying the behaviour of the local human actors, are considered responsible for the partial enrolment of actors into the actor network. In the mobilization moment, the Ministry of Education attempted gradually to mobilize other entities, particularly international and national donors in the stabilization of a solid actor network. Consequently, the project of integrating technology into secondary schools is widely known in the country.
Local network	Constitutes the local network, the research sites in which the resources provided by global network (Ministry of Education and donors) are to be used.

5.2 Chapter summary

This chapter presented the qualitative analysis of the participant interview transcripts of the teachers and heads of schools, describing the trajectory of the translation and diffusion of technology, based on the ANT. The ANT framework provided a lens through which an understanding of the ICT trajectory in the school environment could be understood. The findings that emerged via the ANT perspective indicated that technology is a powerful tool for the enhancement of the quality of schools' activities, but it is a complex and problematic translation process. The enrolment and acceptance of the non-human actor of technology into each of the research sites was partially addressed. The focal actor directed attention to the technical entities such as computers and the Internet connection. However, the enrolment and acceptance of these actors into the network is influenced by the social characteristics of the research context. In the problematization stage, actors were reported to be skilled in the use of technology at school, possibly as a result of the imposed translation of non-human actors into teaching and learning practices. The translation analysis also suggested that actors are eager to improve their performance through the use of technology, but not without its counterparts in the form of non-human actors. The ANT constructs indicated that, for the technology to translate, thereby being accepted into the school context, some other actors or aspects should be considered in the process of integrating technology into teaching and learning activities. The next chapter assesses such actors, as well as their relationship to the teachers' and students' levels of acceptance and use of technology for academic activities. Factors related to performance expectancy, effort expectancy, social influence, and facilitating conditions, are taken into consideration for acceptance and use of technology in studies such as technology integration into the education system.

CHAPTER SIX

QUANTITATIVE DATA ANALYSIS: USERS' INTENTION AND ACCEPTANCE OF ICT

To complement the understanding of the integration of ICT into secondary schools drawn from ANT in the previous chapter, quantitative data analysis is performed on the users' intention and acceptance of technology. This chapter presents the analysis of the quantitative data based on part of the conceptual framework.

To assist in the examining of factors affecting user intention to use technology thereby contributing to the translation of technology into the schools, the following research questions are considered:

- RQ2 − How does performance expectancy influence behavioural intention regarding the integration of ICT into secondary schools in Mozambique?
- RQ3 − To what extent does effort expectancy influence the behavioural intention to integrate ICT into secondary schools in Mozambique?
- RQ4 − How does social influence affect the behavioural intention to integrate ICT into secondary schools in Mozambique?
- RQ5 – How do the facilitating conditions influence the intention to integrate ICT into teaching and learning activities in the schools?

Creswell (2014) recommends a set of steps for quantitative data analysis and interpretation. This includes a report on the number of respondents, descriptive data for all the variables (such as the mean, standard deviations, and range of scores of the variables) and also a check for reliability to ensure the suitability of further analysis of the studies, where required. The final step involves the presentation and interpretation of results from which conclusions in relation to the research questions are drawn. Accordingly, descriptive statistics are first presented to elucidate and describe the characteristics of the population followed by inferential statistics to determine relationships and associations.

6.1 Analysis of student data

To complement the understanding of a qualitative perspective, students' data were also collected for the quantitative part of the study. The findings are presented as follows.

6.1.1 Demographics of student participants

Student demographics are helpful in understanding participants' acceptance of ICT, the participants being important actors in the translation of technology into teaching and learning practices. A summary of demographic information of the student participants is given in Table 6-1.

Table 6-1: Demographic information of student participants

Characteristics		Frequency	Percentage (%)
Gender	Male	141	37.5
	Female	235	62.5
	Total	**376**	**100.0**
Age	Under 15	293	77.9
	15-18	83	22.1
	Total	**376**	**100.0**
Access to a computer with Internet connection at home	I do not have a computer at home	177	47.0
	I have a computer without Internet	89	23.7
	I have a computer with an Internet connection	101	26.9
	Not reported	9	2.4
	Total	**376**	**100.0**
Access to a smartphone and its usage for the Internet connection	I do not have a smartphone	150	39.9
	I have a smartphone but I do not use it to access the Internet	32	8.5
	I have a smartphone and I use it to access the Internet	182	48.4
	Not reported	12	3.2
	Total	**376**	**100.0**
Use of own technology to perform school activities	Yes	271	72.1
	No	96	25.5
	Not applicable	4	1.1
	Not reported	5	1.3
	Total	**376**	**100**
The frequency of use of technology in class	Never	93	24.7
	Less than once a month	6	1.6
	At least once a month	51	13.6
	At least once a week	193	51.3
	At least once a day	33	8.8
	Total	**376**	**100**

An examination of the data in Table 6-1 indicated that females (62.5 per cent) comprise a higher percentage than males (37.5 per cent). The majority of the respondents are under 15 years old, representing 77.9 per cent of the sample.

A bivariate analysis was also conducted to determine whether or not there is a relationship between the students without access to a computer with Internet connection at home, and students who possess and use a smartphone for accessing the Internet. The results indicated

that a high percentage of the participants (47.1 per cent) do not have a computer at home. A similar percentage of 48.4 of the students use a smartphone with Internet connection.

Additionally, a chi-square goodness-of-fit test was applied, which is used to statistically test whether the observed pattern is due to chance or not (Sekaran & Bougie, 2016). A chi-square goodness-of-fit test was performed to test whether or not an equal number of students' responses from each of the categories related to access and usage of technology had been selected in the research. The minimum expected values were 122 for access to a computer with Internet connection at home and 121 for access to the Internet using a smartphone. A significant number (177) of students indicated that they did not have access to a computer at home, (χ^2 (2) = 37.232, p<.0005). The test also shows that a significant number of participants indicated that either they do not have a smartphone (150) or they have a smartphone which they use to access the Internet (182), (χ^2 (2) = 102.879, p<.0005).

Table 6-1 also indicated that 72.1 per cent of the participants use their own technology to perform school activities, while 25.5 per cent do not. Four students (1.1 per cent) indicated that the question was not applicable to them, while five of the participants did not specify anything for this question. A chi-square goodness-of-fit test indicated that there is statistical significance in the number of participants who use their own technology to perform school activities (χ^2 (2) = 297.515, p<.0005), with 271 of the students responding positively to the question.

The majority of the respondents (51.3 per cent) use technology at least once a week, followed by 24.7 per cent of students who never use technology in class. About 13.6 per cent of the respondents use technology in class at least once a month, while 8.8 per cent reported daily usage of technology and 1.6 per cent have been using technology in class for less than once a month. Given the compulsory use of technology proposed by the main actor – the Ministry of Education − the figures indicate an inadequate use of computers in schools. This may be because of the limited availability of computers for the use of students in class. For example, during observation in school 'A' only ten computers are available for a class of 60 students. Consequently, during the class some of the students did not even touch the computer.

A chi-square goodness-of-fit test indicated that the students' responses had not been equally selected in the research. The minimum expected frequency from the sample was 75. A

significant number of students reported that either they used technology in class at least once a week (193), or they had never used technology (93), (χ^2 (4) = 283.894, p<.0005).

A combined analysis on the use of their own computer and the Internet access in performing school activities, months of technology use in school, and the frequency of technology usage, is presented in Figure 6-1. While 51.3 per cent of the students use technology at least once a week, the survey also found that 86.2 per cent have never used technology at school, followed by 72.1 per cent of students who use their own technology to perform school activities. This result reflects an inadequate availability of resources for the use of technology in schools.

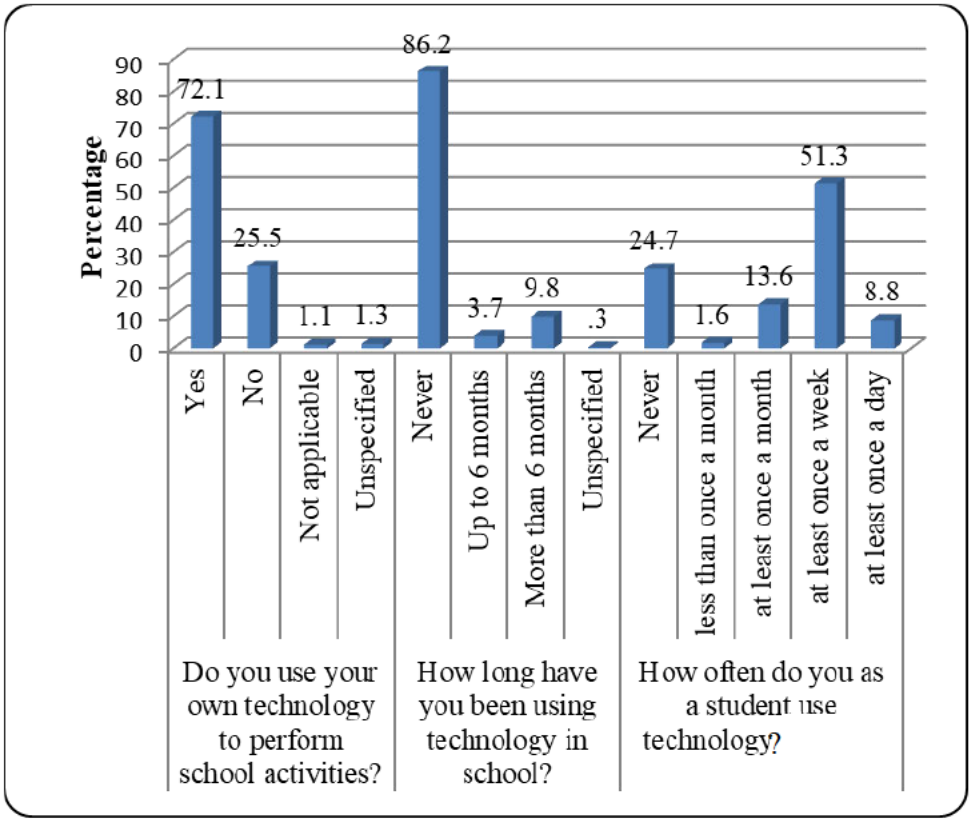

Figure 6-1: Responses relating to the access and usage of technology in performing academic activities.

A chi-square test of independence was performed to test for significant relationships between gender and students' experience on the use of technology. The results indicated that there is a significant relationship between gender and time using technology in school, (χ^2(2)=10.559, p<.0005). Significantly more than an expected number of the males (23) have been using technology in school for more than 6 months. The chi-square test of independence also revealed that there is a significant relationship between gender and frequency of using

technology, ($\chi^2(2)=12.458$, $p<.0005$). Significantly more males than expected (25) use technology at least once a month, while significantly more females than expected (70) never use it.

6.1.1.1 Factors preventing students from use of technology

To gain an understanding on how technology has been used and translated in the schools context, data was also collected to elicit the factors preventing the use of technology at school. A summary of the research data related to the factors preventing students from using technology is presented in Table 6-2.

Table 6-2: Factors preventing usage of technology at school - students

Factors preventing usage of technology		Frequency	Percentage (%)
I do not have skills	Yes	111	29.5
	No	265	70.5
	Total	**376**	**100.0**
I am not interested	Yes	3	.8
	No	373	99.2
	Total	**376**	**100.0**
I do not have time	Yes	35	9.3
	No	341	90.7
	Total	**376**	**100.0**
There are no computers available	Yes	199	52.9
	No	177	47.1
	Total	**376**	**100.0**
It is not compulsory	Yes	31	8.2
	No	345	91.8
	Total	**376**	**100.0**

A binomial test was conducted to test whether or not a significant proportion of students selected one of a possible two responses on factors. The test shows that a significant proportion of the student respondents indicated that the reason for their not using technology at school was not that they do not have the skills (70%, $p<.0005$), nor that they are uninterested (99%, $p<.0005$), nor that they do not have time (90%, $p<.0005$), nor that it is not compulsory (92%, $p<.0005$), but that "there are no computers available" This features as the possible major reason that students do not use computers at school. However, the results

suggest that there are other important reasons that participants may not be using computers apart from the factors examined in Table 6-2. The next section determines some uses of computers by the respondents.

6.1.1.2 Purpose of the students' use of technology at school

The survey was also designed to collect evidence from students on their technology experiences and its use in academic activities. The questionnaire included some aspects with reference to the students' use of technology at school, such as the use of technology for learning, Internet browsing, and for communication purposes. Table 6-3 indicates that a large majority of students have never used technology for any of the purposes mentioned in the study. About 80 per cent of students reported that they had never used technology for learning purposes, 7.2 per cent had used the technology sometimes, while 6.1 per cent had used it often, and 3.7 per cent rarely used technology. A number of students (11, representing 2.9 per cent), did not indicate anything on the use of technology for learning purposes. For Internet browsing purposes, it was indicated that most of the participants had never used technology. This represented 77.9 per cent of the sample. The data also indicated that 8.5 per cent of the respondents often used technology for Internet browsing, while 3.7 per cent rarely used this feature. However, 3.2 per cent sometimes do use technology for browsing the Internet. A total of 25 students, which represents 6.6 per cent of the sample, did not respond to the Internet browsing question. The data also indicated that 76.1 per cent of the students never used technology for communication purposes, while 8.5 per cent often used it for this purpose, and 6.1 per cent and 2.1 per cent sometimes and rarely used technology, respectively. Some 7.2 per cent of the respondents did not indicate anything for this purpose of technology use at school.

Table 6-3: Responses relating to the purpose of technology use in school

Purpose of technology use in school		Frequency	Percentage (%)
Learning	Never	301	80.1
	Rarely	14	3.7
	Sometimes	27	7.2
	Often	23	6.1
	Not reported	11	2.9
	Total	**376**	**100.0**
Internet browsing	Never	293	77.9
	Rarely	14	3.7
	Sometimes	12	3.2
	Often	32	8.5
	Not reported	25	6.6
	Total	**376**	**100.0**
Communication	Never	286	76.1
	Rarely	8	2.1
	Sometimes	23	6.1
	Often	32	8.5
	Not reported	27	7.2
	Total	**376**	**100.0**

A chi-square goodness-of-fit test was also conducted to examine whether an equal number of students' responses from each of the categories relating to the purposes of technology use in school had been selected. The minimum expected values were 91 for the use of technology for learning, 88 for browsing the Internet, and 87 for the purpose of communication. A chi-square goodness-of-fit test indicated that the four categories of responses had not been equally selected by the students (χ^2 (3) = 643.822, p<.0005), with the large majority (301) indicating that they never used technology for learning purposes. With regard to the use of technology for Internet browsing, the test showed that the number of students whose responses were rarely, sometimes, and often, were statistically significantly different (χ^2 (3) = 642.880, p<.0005) from (293) students who never used technology for this purpose. A chi-square test also showed that a significant number of students (286) never used technology for the purpose of communication, (χ^2 (3) = 607.023, p<.0005).

6.1.2 Reliability and validity – student participants

According to Sekaran and Bougie (2016), the reliability of a measure is assessed by testing its consistency and stability. Consistency refers to the degree to which items measuring a construct combine as a set. Consistency indicates how consistent the responses of participants are across the items measuring a construct. The reliability of the UTAUT constructs is tested using Cronbach's alpha (Hair et al., 2010). Cronbach's alpha is calculated based on average inter-correlations of items measuring the construct. Sekaran and Bougie (2016) indicated that a reliability of less than 0.60 is considered poor, 0.60 to 0.70 acceptable, while 0.80 and above is good. The high value of coefficients of Cronbach's alpha indicates that the construct is internally consistent and measures the same content. Correlation coefficient is one of the statistical methods used to estimate the degree to which any two constructs are related to each other. The internal consistency reliability and validity of the constructs was tested and the results of the students' data are presented in Table 6-4.

Table 6-4: Reliability of the measured constructs - students' data

Construct	Number of Items	Cronbach's alpha
Performance expectancy	6	0.773
Effort expectancy	2	0.661
Social influence	4	0.803
Facilitating conditions	5	0.811
Behavioural intention	3	0.686

The figures shown in Table 6-4 indicated that inter-items' consistency reliability of the measured constructs may be considered acceptable and adequate for other statistical analysis. Sekaran and Bougie's (2016) recommendation is that all negatively worded items in the questionnaire should be reverse-coded before the items are used for the reliability test. Therefore, in order to test reliability of the effort expectancy construct, the item "it is difficult to use technology in all subjects", question 33 in the questionnaire, was reverse-coded to face the same direction as the other items. In a similar way, items such as "the school infrastructure is not adequate to the integrating of technology into classroom learning" and "the curriculum in use is not suitable for the use of technology in class", representing, respectively, questions 40 and 41 in the questionnaire which were reverse-coded, were dropped from the inconsistency test. Given that the inter-item consistency is good for performance expectancy, social influence, and the facilitating conditions constructs and acceptable for effort expectancy and behavioural intention constructs, the new single scores

may be calculated based on scores on the items of each of the constructs (Sekaran & Bougie, 2016). Therefore, the sample data were considered adequate for further analysis. Pearson's correlation matrix was used for assessing the relationship between independent and dependent variables, presented in Table 6-5.

Table 6-5: Correlation between independent and dependent variables

	Performance Expectancy	Social Influence	Facilitating Conditions	Effort Expectancy	Behavioural Intention
Performance Expectancy					
Pearson's Correlation	1	.120*	.059	.157**	.151**
Sig. (2-tailed)		.020	.257	.002	.003
N	376	376	373	375	376
Social Influence					
Pearson's Correlation	.120*	1	.343**	.243**	.291**
Sig. (2-tailed)	.020		.000	.000	.000
N	376	376	373	375	376
Facilitating Conditions					
Pearson's Correlation	.059	.343**	1	.125*	.115*
Sig. (2-tailed)	.257	.000		.016	.026
N	373	373	373	372	373
Effort Expectancy					
Pearson's Correlation	.157**	.243**	.125*	1	.232**
Sig. (2-tailed)	.002	.000	.016		.000
N	375	375	372	375	375
Behavioural Intention					
Pearson's Correlation	.151**	.291**	.115*	.232**	1
Sig. (2-tailed)	.003	.000	.026	.000	
N	376	376	373	375	376

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

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

A correlation coefficient also enables the researcher to quantify the strength of a relationship between two variables. The correlation coefficient ranges from +1 to -1 with the value of +1 representing the perfect positive correlation, 0 indicating the perfect independence of the relationship, and -1 indicating a stronger negative association between the independent and dependent variables (Hair et al., 2010). Saunders et al. (2009) categorize correlation coefficients as weak if the absolute value of (*r)* is between (0.1to 0.3); strong if the value is between (0.3 and 0.7); and perfect if the value is above 0.7. The results indicate that there is a

positive relationship between independent and dependent variables. From this it may be concluded that there is: a statistically significant weak relationship between performance expectancy and behavioural intention (r =.151, p<.0005); a statistically significant and weaker association between social influence and behavioural intention (r =. 291, p<.0005); and a statistically significant weak relationship between facilitating conditions and behavioural intention (r =.115, p<.0005). The results also indicated that an increase in effort expectancy is weakly correlated with an increase of the student behavioural intention (r =. 232, p<.0005).

Before performing regression analysis, some descriptive statistics regarding the constructs are necessary. Descriptive statistics on the independent and dependent constructs were obtained. The results are presented in Table 6-6. The mean values ranged from 3.08 to 4.35 which indicate that students are somewhat positive towards the use of technology. For facilitating conditions, a mean of 3.08 is noted. This may suggest that conditions are not up to standard for the smooth translation of technology into teaching and learning practices.

Table 6-6: Descriptive statistics for independent and dependent variables

Construct	N	Minimum	Maximum	Mean	SD
Performance Expectancy	376	2.00	5.00	4.119	.577
Social Influence	376	1.00	5.00	3.416	.962
Behavioural Intention	376	1.33	5.00	4.358	.609
Effort Expectancy	375	1.67	4.33	3.088	.576
Facilitating Conditions	373	1.57	4.14	3.084	.564

6.1.3 Descriptive statistics of students' behavioural intention

The means and standard deviations for the items of measurement for each construct are presented next. The constructs included performance expectancy, effort expectancy, social influence, and facilitating conditions, in the determining of behavioural intention to use technology. A five-point Likert scale from (1) = 'strongly disagree' to (5) = 'strongly agree' was used to for the items of measurement for each of the constructs: performance expectancy, effort expectancy, social influence facilitating conditions, and behavioural intention to use technology. The following sections present the descriptive analysis of the factors influencing students' behavioural intention.

6.1.3.1 Performance expectancy - students

The descriptive statistics for performance expectancy is shown in Table 6-7.

Table 6-7: Descriptive statistics of performance expectancy items - students

Item description	N	Mean	SD
The use of technology will improve my studies	376	4.20	.819
The availability of ICT and the school infrastructure will improve my performance as a student	376	4.20	.854
Using the technology will enable me to accomplish school activities more easily	376	4.01	.922
The use of technology will enable me to gain academic information more readily	376	3.99	.916
The use of technology will help me to perform homework with greater ease	376	4.14	.727
Compared with traditional learning, learning using technology will increase my productivity	376	4.17	.812

A one-sample t-test was conducted on the performance expectancy items, to determine whether or not their mean was different from a scalar value of 3.0, the neutral score for the scale. The test indicated that there was a significant agreement in that: the use of technology will improve their studies (M = 4.20, SD = .819), t(375) = 28.341, p<.0005; the availability of ICT and the school infrastructure will improve student performance (M=4.20, SD = .854), t(375) = 27.369, p<.0005; the use of technology will enable students to accomplish school activities more easily (M = 4.01, SD = .922), t(375) = 21.306, p<.0005; the use of technology will enable students to gain academic information more readily (M = 3.99, SD = .916), t(375) = 20.878, p<.0005; the use of technology will help participants to perform homework with greater ease (M = 4.14, SD = .727), t(375) = 30.499, p<.0005 and; compared with traditional learning, learning, aided by technology, will increase students' productivity (M = 4.17, SD = .812), t(375) = 27.953, p<.0005. Compared with the scalar value of 3.0, the results suggest that students were somewhat positive regarding the use of technology for improving the way they learn.

6.1.3.2 Effort expectancy − students

The effort expectancy measured students' views of ease of use of technology to accomplish teaching and learning activities in schools. The descriptive statistics of the items measuring effort expectancy are presented in Table 6-8.

Table 6-8: Descriptive statistics of effort expectancy items - students

Item description	*N*	*Mean*	*SD*
Using technology is easy for me	376	3.34	1.122
My interaction with technology in class is clear and easy to understand	376	3.26	1.178
It is difficult to use technology in all subjects	375	3.33	1.078

A one-sample t-test was performed to test whether or not the average score was significantly different from a neutral score of 3.0 for the effort expectancy factor. The sample mean of 3.34 (SD = 1.122) was significantly different from 3, $t(375) = 5.837$, $p<.0005$. Therefore the use of technology is easy for the students. There is a significant agreement that students' interaction with technology in class is clear and easy to understand (M = 3.26, SD = 1.178), $t(375) = 4.290$, $p<.0005$. The test also indicated a statistically significant agreement that it is difficult to use technology in all subjects (M = 3.33, SD = 1.078), $t(374) = 5.892$, $p<.0005$. The results indicated that students consider the use of technology easy, compared with the average value.

6.1.3.3 *Social influence − students*

The social influence items are used to understand the way in which the students perceive their social network influences. The descriptive statistics on the social influence items are presented in Table 6-9.

Table 6-9: Descriptive statistics of social influence items - students

Item description	*N*	*Mean*	*SD*
My friends who use ICT think that I should use technology	376	3.56	1.163
My family think that I should use technology in class	376	3.55	1.223
My teachers encourage me to use technology	376	3.50	1.180

A one-sample t-test was conducted to evaluate whether or not social-influence items scores in the participant students were different from the average value of 3.0. The test showed that students reported a significant agreement on: friends who use technology think that the student should use technology (M = 3.56, SD = 1.163), $t(375) = 9.271$, $p<.0005$; family think that the student should use technology in class (M = 3.55, SD = 1.223), $t(375) = 8.685$, $p<.0005$; and teachers encourage the students to use technology (M = 3.50, SD = 1.180), $t(375) = 8.174$, $p<.0005$. These results show that students are influenced by their social network.

6.1.3.4 Facilitating conditions − students

Descriptive analyses were conducted to understand the students' perceptions on the availability of resources' use of technology in schools. Table 6-10 shows that every student scored higher than the average value of 3.0 on 'facilitating conditions'.

Table 6-10: Student mean scores for the items of measurement for facilitating conditions

Item description	*N*	*Mean*	*SD*
I have the necessary resources to learn how to use technology	376	3.51	1.148
My teachers are competent on technology use in class	376	3.59	1.011
The school infrastructure is not adequate to integrating technology into classroom learning	376	3.73	1.121
The curriculum in use is not suitable for the use of technology in class	375	3.57	1.099
An ICT technician is available to assist with the technology use in class	374	3.24	1.309
An ICT technician is available to help when I have difficulties using the technology	376	3.35	1.317
An ICT technician is available to help when the technology breaks down	376	3.21	1.353

Once again, a one-sample t-test was performed to determine whether or not facilitating-conditions items scores from the participating students were significantly different from the neutral average value of 3.0. The test results indicate a statistically significant agreement that: the students have the necessary resources to learn how to use technology (M = 3.51, SD = 1.148), $t(375) = 8.627$, $p<.0005$; teachers are competent to use technology in class (M = 3.59, SD = 1.011), $t(375) = 11.222$, $p<.0005$; the school infrastructure is inadequate to facilitate the integration of technology into classroom learning (M = 3.73, SD = 1.121), $t(375) = 12.695$, $p<.0005$; the curriculum in use is not suitable for the use of technology in class (M = 3.57, SD = 1.099), $t(374) = 10.102$, $p<.0005$; an ICT technician is available to assist with the technology use in class (M = 3.24, SD = 3.476), $t(373) = 10.102$, $p<.0005$; an ICT technician is available to help when students have difficulties using the technology (M = 3.35, SD = 1.317), $t(375) = 5.210$, $p<.0005$; and an ICT technician is available to help when technology breaks down (M = 3.21, SD = 1.353), $t(375) = 3.011$, $p<.0005$.

6.1.3.5 Behavioural intention to use technology - students

Descriptive statistics for behavioural intention of students to use ICT in future for academic activities is presented in Table 6-11.

Table 6-11: Descriptive statistics of behavioural intention items - students

Item description	*N*	*Mean*	*SD*
I intend to use the available technology in class in the future	376	4.24	.826
I want to learn how to use technology in order to improve my learning	376	4.48	.696
I want to improve my ICT skills	376	4.36	.804

A one-sample t-test was conducted on behavioural intention items scores to evaluate whether or not the students' mean was significantly different from the scalar value of 3.0, the neutral score for the scale used in the research. The test indicated that a sample mean of 4.24 (*SD* = .826) was significantly different from the neutral value, $t(375) = 29.028$, $p<.0005$. Therefore the students intend to use the available technology in class in the future. The test also shows that there is a significant agreement that students wish to learn technology in order to improve their learning activities ($M = 4.48$, $SD = .696$), $t(375) = 41.178$, $p<.0005$. The sample mean of 4.36 ($SD = .826$) was also significantly different from the average value of 3.0, $t(375) = 32.769$, $p<.0005$. The results reveal that students' scores relating to the use of technology in future is higher than the neutral value.

Since there is no single factor that can determine the use and acceptance of technology in schools, regression analysis was performed to determine how the different factors/constructs together influence the intention to use the technology among the students. The factors identified are the UTAUT constructs proposed in the research conceptual framework, Figure 3-8. The thesis considered four independent constructs and one dependent construct. Performance expectancy, effort expectancy, social influence, and facilitating conditions, were used as independent constructs, while behavioural intention was identified as a dependent construct. The next section presents the assumptions and results of regression analysis performed for the student data.

6.1.4 Regression analysis

Regression analysis was performed to determine how well each of the independent constructs (performance expectancy, effort expectancy, social influence and facilitating conditions) predict the intention to use ICT in learning among the students. However, before performing

regression analysis, basic assumptions should be observed to assess whether or not the data is suitable (Sekaran & Bougie, 2016). For example, there is a need to check whether or not there is a linear relationship between independent and dependent variables − linearity: the existence of values that are very different from the expected data; outliers: the extent to which data values of independent and dependent variables have an equal variance; homoscedasticity: the extent to which correlation between two or more independent variables is considered high; and multi-collinearity: the existence of random normal distribution residuals (errors). First, to test the strength of the assumed existing relationship in the proposed model, each of the independent variables (performance expectancy, effort expectancy, social influence, and facilitating conditions) was regressed on the dependent variable (behavioural intention). Second, all four measures of the independent variable were regressed as predictors of behavioural intention.

The adequacy of regression analyses was validated by visual inspection of the scatter plot which suggested a positive relationship between dependent and independent variables. The scatter plots are depicted in Appendix I. The data were also analysed for identification of any outlier, using standard residuals. The result indicated that five cases needed to be removed from the analysis. The assumption of collinearity was assessed through the coefficients' table output. The Variance Inflation Factor (VIF), which is related to the tolerance value, indicates the degree of collinearity or multicollinearity between the independent variables. If the coefficients' output indicates values of VIF greater than 10 or tolerance less than 0.1, then there is a collinearity problem with the data (Hair et al., 2010). The results of the test indicated that multicollinearity was not a concern (performance expectancy: *Tolerance* =. 95, *VIF* = 1.05; effort expectancy: *Tolerance* =. 92, *VIF* = 1.08; social influence: *Tolerance* =. 82, *VIF* = 1.21; facilitating conditions: *Tolerance* =. 86, *VIF* = 1.16). The data also met the assumption of independence of residuals (*Durbin-Watson value* = 1.93). Further assessment was carried out through the analysis of the histogram of standardized residuals and the expected normality P-P plot for the regression. The visual inspection on the histogram indicated that there was homoscedasticity and that residuals were normally distributed as assessed by the inspection of a normal probability plot. (See Appendix J).

Simple regression analyses were applied to each of the independent variables, with behavioural intention as a dependent variable. The analysis of whether or not performance expectancy influences the students' behavioural intention to use technology was tested.

Performance expectancy was regressed on the behavioural intention data. Results indicated that performance expectancy accounts for 8.7 per cent (R^2 =.087) of variance in behavioural intention: $F(1,360) = 34.346$, $p<.0005$. Performance expectancy significantly predicts students' behavioural intention: ($\beta = .295$, $p<.0005$).

Similarly, regression analysis was conducted to determine the effect of the effort expectancy on the students' behavioural intention. An analysis of variance indicated that the effect of effort expectancy explains 2.8 per cent of variance in students' behavioural intention: ($F(1, 359) = 10.506$, $p=.001$, R^2 =.028). The results also show that effort expectancy influences the students' behavioural intention: ($\beta = .169$, $p=.001$).

In like manner, social influence on students' behavioural intention was regressed. The results showed that social influence accounts for 6.1 per cent ($R^2 = .061$) of the variance in students' behavioural intention: $F(1,360) = 23.521$, $p<.0005$. Social influence, to some extent, does predict students' behavioural intention: ($\beta = .248$, $p<.0005$).

To determine the effect of facilitating conditions on students' behavioural intention, regression analysis was performed. The results of regression analysis found that facilitating conditions also account for 3.1 per cent ($R^2 = .031$) of variance in explaining students' behavioural intention: $F(1,358) = 11.608$, $P=.001$. Facilitating conditions also predict students' behavioural intention: ($\beta = .177$, $p=.001$).

Multiple regression analysis was performed to see how well the set of constructs (performance expectancy, effort expectancy, social influence, and facilitating condition) combined to predict the dependent variable (behavioural intention). A total of 359 cases were used for the regression analysis. The statistical values for assessing the overall fit of the model are given in Table 6-12. Performance expectancy, effort expectancy, social influence, and facilitating conditions variables account for 14.2 per cent ($R^2 = .14.2$) of the variance in behavioural intention, $F(4, 354) = 14.659$, $P< .0005$. The adjusted R squared value indicates that the model explains 13.2 per cent of the variability of behavioural intention toward the use of technology for teaching and learning activities. The value of R squared ranges from 1 to 0, with 1 indicating the stronger power of predicting the independent variable and 0 indicating the absence of prediction (Hair et al., 2010). The result from the proposed model reveals a relatively low explanatory power of the regression equation. However, according to Gaur and

Gaur (2009), this result is acceptable in social science studies. Positive and significant predictors of students' behavioural intention include performance expectancy: (β = .249, p<.0005) and social influence: (β = .161, p<.0005), see Table 6-13.

Table 6-12: Regression analysis: Model summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.377	.142	.132	.41753

Table 6-13: Regression analysis: Coefficients [a]

Model		Unstandardized Coefficients		Standardized Coefficients	T	Sig.
		B	Std. Error	Beta		
1	(Constant)	3.081	.186		16.581	.000
	Facilitating conditions	.050	.028	.094	1.770	.078
	Social influence	.076	.026	.161	2.965	.003
	Performance expectancy	.194	.039	.249	4.943	.000
	Effort expectancy	.038	.026	.075	1.454	.147

a. Dependent Variable: Behavioural intention to use technology

The regression equation for the students' data is

$$y = 3.081 + .038(effort\ expectancy) + .050(facilitating\ conditions) + .076(social\ influence) + .194(perfomance\ expectancy)$$

The analysis indicates that performance expectancy measures are the most important predictors of the students' behavioural intention to use technology for academic activities. The next sections present the results of statistical analysis for the teachers' data.

6.2 Analysis of teachers' data

In order to obtain a more comprehensive understanding of the process of ICT integration in schools, quantitative teachers' data were analysed as well.

6.2.1 Profile of teachers

It is important to determine the profile of teacher participants so that a more nuanced understanding of the results may be obtained. In this study, this complements the

understanding of the translation of technology into the teaching and learning practices. Following the qualitative data analysis from the Actor Network Theory (ANT), teachers were revealed as the main actors in the process of technology translation at school. Teachers' demographic data are presented in Table 6-14.

Table 6-14: Demographic information on teacher participants

Characteristic		Frequency	Percentage (%)
Gender	Male	14	82.4
	Female	3	17.6
	Total	**17**	**100.0**
Age	21-25	1	5.9
	26-30	10	58.8
	Above 30	6	35.3
	Total	**17**	**100.0**
Qualifications	Basic	2	11.8
	Middle	2	11.7
	Higher	13	76.5
	Total	**17**	**100.0**
Access to a computer with Internet connection at home	I do not have a computer at home	4	23.5
	I have a computer without Internet	5	29.4
	I have a computer with an Internet connection	8	47.1
	Total	**17**	**100.0**
How long have you been using technology in school?	Up to 5 years	1	5.9
	More than 5 years	16	94.1
	Total	**17**	**100.0**
Access to a smartphone and its usage for the Internet connection	I do not have a smartphone	6	35.3
	I have a smartphone but I do not use it to access the Internet	1	5.9
	I have a smartphone and I use it to access the Internet	10	58.8
	Total	**17**	**100.0**
Use of own technology to perform school activities	Yes	13	76.5
	No	3	17.6
	Not applicable	1	5.9
	Total	**17**	**100**

Unlike the students, the demographics of teachers indicate a higher percentage of males (82.4 per cent) than females (17.6 per cent). The data also revealed that the majority of the teachers who participated in the study have a higher degree qualification, (76.5 per cent), while 11.8 and 11.7 per cent of teachers have basic and middle degree qualification, respectively. Differing from the students' sample, the majority of teachers (47.1 per cent) have access to a computer with Internet connection, while 23.5 per cent indicated that they do not have access to a computer at home; while 29.4 per cent have access to a computer, but are without Internet. Similar to student data, the data indicated that the majority of teachers (58.8 per cent) possess a smartphone which they use for accessing the Internet. About 35.3 per cent of

the respondents do not have a smartphone, while 5.9 per cent do have a smartphone, but without Internet connection.

A chi-square goodness-of-fit test was performed to test whether or not the observed pattern is owing to chance. A significant number of participants (10) indicated that teachers do have smartphones with access to the Internet, (χ^2 (2) = 7.176, p<.0005). The test also revealed that a statistically significant number of teachers (13) use their own technology to perform school activities, (χ^2 (2) = 14.588, p<.0005). A significant number of teachers (16) have been using technology at school for over five years, (χ^2 (2) = 13.235, p<.0005).

6.2.1.1 Application software used by teachers

The analysis of translation of technology into schools indicated that teachers acknowledge the relevance of ICT to facilitate teaching and learning activities. The data obtained from teachers regarding applications which they use for teaching and learning activities are provided in Table 6-15. The table also indicates how often the application software is used for performing academic activities.

Table 6-15: Application software used by teachers

Application	Usage	Frequency	Percentage (%)
Word-processing	Sometimes	1	5.9
	Often	15	88.2
	Not reported	1	5.9
	Total	**17**	**100.0**
Spread-sheet	Rarely	2	11.8
	Sometimes	7	41.2
	Often	7	41.2
	Not reported	1	5.8
	Total	**17**	**100.0**
PowerPoint	Never	1	5.9
	Rarely	7	41.2
	Sometimes	4	23.5
	Often	2	11.8
	Not reported	3	17.6
	Total	**17**	**100.0**
Database	Never	3	17.6
	Rarely	4	23.5
	Sometimes	7	41.2
	Often	1	5.9
	Not reported	2	11.8
	Total	**17**	**100.0**
Graphics programmes	Never	7	41.2
	Rarely	5	29.4
	Sometimes	3	17.6
	Often	1	5.9
	Not reported	1	5.9
	Total	**17**	**100.0**
Internet	Sometimes	5	29.4
	Often	12	70.6
	Total	**17**	**100.0**
Social networking	Rarely	5	29.4
	Sometimes	3	17.7
	Often	9	52.9
	Total	**17**	**100.0**

It is apparent from the Table 6-15 that there is a decreasing trend of use from basic (such as word-processing) to the more complex applications. It is likely that most of the teachers are proficient in basic applications such as word-processing, but few are comfortable with

spread-sheets, which require more or a deeper level of technicality or cognitive thinking. Word-processing application was used often by 88.2 per cent of the teacher sample, followed by Internet browsing representing 70.6 per cent. This result suggests that these teachers may need more training on a more complex software package such as PowerPoint, Spread-sheet and databases. The training may be focused on promoting teachers' personal development and also on how to integrate ICT into the classroom.

A chi-square goodness-of-fit test was conducted to examine whether or not an equal number of teachers' responses for the usage of each software package had been selected. The results indicated that the large majority of teachers often used word-processing applications (15) for performing school activities, (χ^2 (3) = 40.500, p<.0005), and for browsing the Internet (12), (χ^2 (3) = 22.765, p<.0005). The test also indicated that the number of teachers (7) whose responses were 'often' and 'sometimes' were statistically significant, (χ^2 (3) = 9.500, p<.0005) for the use of spread-sheet application. With regard to the use of social-networking applications, the test indicated that a significant number of teachers (9) often used social-networking sites to facilitate teaching and learning activities (χ^2 (3) = 10.059, p<.0005).

6.2.1.2 Factors preventing teachers from using technology at school

A supplementary understanding on how technology has been used by the teachers and translated into the school context was obtained from data reporting factors preventing the use of technology at school. The results are presented in Table 6-16.

Table 6-16: Factors preventing usage of technology at school - teachers

Factors preventing usage of technology		Frequency	Percentage (%)
I do not have skills	Yes	1	5.9
	No	16	94.1
	Total	**17**	**100.0**
I am not interested	No	17	100.0
	Total	**17**	**100.0**
I do not have time	Yes	3	17.6
	No	14	82.4
	Total	**17**	**100.0**
There are no computers available	Yes	11	64.7
	No	6	35.3
	Total	**17**	**100.0**
It is not compulsory	Yes	2	11.8
	No	15	88.2
	Total	**17**	**100.0**

A binomial test was performed for the teachers' sample. The results show that a significant proportion of the respondents indicated that they are not using technology at school, not because they do not have skills (94%, $p<.0005$), or that they are not interested (100%, $p<.0005$), or that they do not have time (82%, $p<.0005$), or that it is not compulsory to use technology (88%, $p<.0005$), but because of the limited number of computers that are available (64.7, $p<.0005$). This finding is similar to that obtained in the analysis of students' reasons for not using the technology.

6.2.1.3 Purpose of the teachers' use of technology at school

Data related to the use of technology for teaching, performing administrative work, searching for academic material on the Internet and for communication purposes were collected in the survey. The results indicate that teachers are somewhat experienced on the use of computers, experience being a determinant actor in the translation and acceptance of technology in schools. The results are presented in Table 6-17.

Table 6-17: Teachers' use of technology in school

Purpose of using technology		Frequency	Percentage (%)
Teaching	Never	3	17.6
	Rarely	4	23.6
	Sometimes	7	41.2
	Often	3	17.6
	Total	**17**	**100.0**
Administrative work	Never	4	23.5
	Rarely	2	11.8
	Sometimes	1	5.9
	Often	9	52.9
	Not reported	1	5.9
	Total	**17**	**100.0**
Search for academic material	Rarely	1	5.9
	Sometimes	8	47.0
	Often	8	47.1
	Total	**17**	**100.0**
Communication	Never	1	5.9
	Rarely	2	11.7
	Sometimes	6	35.3
	Often	8	47.1
	Total	**17**	**100.0**

The data indicated that teachers often use technology to perform administrative work (52.9 per cent). About 47.1 per cent of participants often use technology for browsing the Internet in search of academic material; the same percentage use technology for communication, while only 17.6 per cent (3 teachers) often use technology for teaching purposes. A chi-square goodness-of-fit test shows that a significant number of teachers (9) use technology to perform administrative work (χ^2 (3) = 9.500, p<.0005). Interestingly, the pedagogic use of technology is missing.

6.2.2 Reliability – teachers

Similar to the student sample, composite measures for the constructs addressing the thesis objectives were identified for each of the constructs performance expectancy, effort expectancy, social influence and facilitating conditions. The Cronbach's alpha was used to test the reliability and validity of each of the measures. The results of the calculations of the inter-item consistency of the composite scores are presented in Table 6-18.

Table 6-18: Reliability of the measured constructs - teachers' data

Construct	Number of Items	Cronbach's alpha
Performance expectancy	6	0.805
Effort expectancy	2	0.819
Social influence	4	0.849
Facilitating conditions	5	0.859
Behavioural intention	2	0.596

The results of the test showed that the four constructs (performance expectancy, effort expectancy, social influence, and facilitating conditions) are reliable, with Cronbach's alpha value above 0.80, which indicates adequacy of the measures' instruments and good reliability (Sekaran & Bougie, 2016). However, behavioural intention shows reliability less than 0.60, which indicates poor consistency between the items. Following Sekaran and Bougie (2016) recommendations, all the negatively-worded items were reverse-coded and dropped from the reliability test. Therefore, the item "the students' ICT skills are very limited in the use of technology in class", representing question 29 in the questionnaire for the performance expectancy construct, was dropped, as it was not consistent with the other items comprising the measure. Similarly, items such as "the school infrastructure is not adequate for integrating technology into classroom teaching" and "the curriculum in use is not suitable for the use of technology in class" representing respectively questions 42 and 43 in the questionnaire for the facilitating conditions construct, were dropped from the measure, as they were worded negatively in comparison with the other items. For the behavioural intention construct it is noted that the items "I want to learn how to use technology in order to improve my teaching" and "I want to improve my ICT skills", which represent questions 48 and 49 in the questionnaire, respectively, are relatively consistent; however, they measure the wish to improve/learn and not the intention to use technology.

Overall, the data in Table 6-18 indicate that inter-item consistency of the constructs is acceptable for proceeding with statistical analysis. However, given the limited number of subjects required, for example, to perform regression analysis, the teachers' quantitative data sample size was not appropriate for regression analysis. While it has been suggested that as few as two subjects per variable are necessary for the estimation of regression coefficients, Austin and Steyerberg (2015), in linear regression analyses, claimed that at least 50 subjects for correlation or regression analysis are required. In the present research, the teachers were

not as responsive as expected. Therefore, a small number of responses was obtained from the teacher sample.

6.2.3 Descriptive statistics of teachers' behavioural intention

Descriptive statistics were conducted to examine factors influencing teacher behaviour on technology usage at school. Based on the UTAUT model, the constructs included performance expectancy, effort expectancy, social influence, and facilitating conditions in assessing the behavioural intention to use technology in school. The items under each of the constructs were based on a five-point Likert scale from (1) = 'strongly disagree' to (5) = 'strongly agree'. The results are presented in the following sections.

6.2.3.1 Performance expectancy − teachers

The items of measurement for the construct, performance expectancy were analysed, with the descriptive statistics given in Table 6-19.

Table 6-19: Descriptive statistics of performance expectancy items - teachers

Item description	*N*	*Mean*	*SD*
The availability of ICT and the school infrastructure will improve my performance as a teacher	17	4.59	.618
Using the technology will enable me to accomplish school activities more easily	17	4.53	.514
The use of technology in school will save me time and effort	17	4.41	.507
The students' ICT skills are very limited in use of technology in class	17	4.00	.935
The use of technology will help me to keep track of students' grades	17	4.35	.606
Technology will make my preparation of teaching material easier	17	4.18	.393
Compared with traditional teaching, using technology will increase my productivity	17	4.47	.624

A one-sample t-test was performed to find the statistically significant agreement/disagreement responses, using a neutral value of 3.0 for the scale (as was done for the student data). The test showed that there is a significant agreement that: the availability of ICT and school infrastructure will improve teachers' performance (M = 4.59, SD = .618), $t(16)$ = 10.590, p<.0005; using technology will enable teachers to accomplish school activities more easily (M = 4.53, SD = .514), $t(16)$ = 12.257, p<.0005; the use of technology at school will save teachers time and effort (M = 4.41, SD = .507), $t(16)$ = 11.474, p<.0005; the students' ICT skills to implement the use of technology in classroom are very limited (M = 4.00, SD = .935), $t(16)$ = 4.408, p<.0005; the use of technology will help teachers to keep track of students' grades (M = 4.35, SD = .606), $t(16)$ = 9.200, p<.0005; technology will make their preparation of teaching material easier (M = 4.18, SD = .393), $t(16)$ = 12.344, p<.0005; and compared with traditional teaching, using technology will increase teachers' productivity (M = 4.47, SD = .624), $t(16)$ = 9.713, p<.0005.

6.2.3.2 Effort expectancy − teachers

The teachers' perceptions about the ease of use of technology were gathered using effort expectancy items of measurement. The descriptive statistics of the items comprising the construct, effort expectancy are indicated in Table 6-20.

Table 6-20: Descriptive statistics of effort expectancy items - teachers

Item description	*N*	*Mean*	*SD*
Using technology is easy for me	17	3.76	.831
It is easy to use technology if one receives proper training	17	3.47	.800
It is easy for me to integrate technology into pedagogical activities	17	4.06	.659

A one-sample t-test conducted to find out whether or not the average score is statistically significant was based on the neutral value of 3.0 for the effort expectancy items. The sample mean of 3.76 (*SD* = .831) was significantly different from the neutral value of 3, $t(16) = 3.792$, $p<.0005$, therefore, using technology is easy for teachers. The test also showed that there is a significant agreement that it is easy to use technology if one receives proper training (*M* = 3.47, *SD* = .800), $t(16) = 4.290$, $p<.0005$; and that it is easy for teachers to integrate technology into pedagogical activities (*M* = 4.06, *SD* = .659), $t(16) = 6.628$, $p<.0005$.

6.2.3.3 Social influence - teachers

The perceptions on ways in which teachers' social networks contribute to their behavioural intention for acceptance and use of technology at school were examined using the construct social influence. Descriptive statistics are shown in Table 6-21.

Table 6-21: Descriptive statistics of social influence items - teachers

Item description	*N*	*Mean*	*SD*
My colleagues and friends who use ICT think that I should use technology in class	17	3.82	1.131
The head of school supports the use of technology in class	17	3.71	1.047
The Ministry of Education supports the integration of technology into the curriculum	17	3.65	.862

The results of the one-sample t-test, which was performed based on the neutral average value of 3.0, indicated that there is a statistically significant agreement that: teachers' colleagues and friends who use ICT think that teachers should use technology in class (M = 3.82, SD = 1.131), $t(16) = 3.002$, $p<.0005$; the head of school supports the use of technology in class (M = 3.71, SD = 1.047), $t(16) = 2.781$, $p<.0005$; and the Ministry of Education supports the integration of technology into the curriculum (M = 3.65, SD = .862), $t(16) = 3.096$, $p<.0005$.

6.2.3.4 Facilitating conditions - teachers

Descriptive statistics regarding facilitating conditions items are presented in Table 6-22. The analysis was conducted to gain understanding of teachers' views in relation to the availability of resources to support the use of technology at school.

Table 6-22: Descriptive statistics of facilitating conditions items - teachers

Item description	*N*	*Mean*	*SD*
I have adequate skills to use technology in class	17	4.12	.600
The school infrastructure is not adequate for the integration of technology into classroom teaching	17	3.76	1.200
The curriculum in use is not suitable for the use of technology in class	17	3.88	.600
An ICT technician is available to assist with the technology use in class	17	3.82	1.286
A technician is available to help when I have difficulties using the technology	17	3.65	1.115

The results of a one-sample t-test performed to discover whether or not facilitating conditions items scored values significantly different from the neutral value of 3.0, indicated

the following: There is a statistically significant agreement that: teachers have adequate skills to use technology in class (M = 4.12, SD = .600), $t(16) = 7.677$, $p<.0005$; the school infrastructure is inadequate for the integration of technology into classroom teaching (M = 3.76, SD = 1.200), $t(16) = 2.626$, $p<.0005$; the curriculum in use is not suitable for the use of technology in class (M = 3.88, SD = .600), $t(16) = 6.061$, $p<.0005$; an ICT technician is available to assist with the technology use in class (M = 3.82, SD = 1.286), $t(16) = 2.640$, $p<.0005$; and a technician is available to help when teachers have difficulties using the technology (M = 3.65, SD = 1.115), $t(16) = 2.393$, $p<.0005$.

6.2.3.5 Behavioural intention to use technology − teachers

Analysis of the factors affecting teachers' behavioural intention to use technology was conducted on the understanding that their intention to use technology in future was for academic activities. The descriptive statistics are indicated in Table 6-23.

Table 6-23: Descriptive statistics of behavioural intention items - teachers

Item description	*N*	*Mean*	*SD*
I intend to use the available technology in the classroom in the future	17	4.24	.437
I want to learn how to use technology in order to improve my teaching	17	4.24	.664
I want to improve my ICT skills	17	4.53	.624
I intend making as a priority the use of technology in class	17	4.29	.588

A one-sample t-test was performed on behavioural intention item scores to determine whether or not the mean was significantly different from the average scalar value of 3.0. The test indicated that a sample mean of 4.24 (SD = .437) was significantly different from the average value, $t(16) = 11.649$, $p<.0005$. Therefore, teachers agreed that they intend to use the available technology in class in the future. The test also showed that there is a significant agreement that teachers wish to learn how to use technology in order to improve their teaching activities (M = 4.24, SD = .664), $t(16) = 7.668$, $p<.0005$. The sample mean of 4.53 (SD = .624) was also significantly different from the average value, $t(16) = 10.101$, $p<.0005$. The results indicated a significant agreement that teachers wish to improve their ICT skills. The one-sample t-test also indicated that there is a statistically significant agreement that

teachers intend to make it a priority to use technology in their classroom, (M = 4.29, SD = .588), $t(16) = 9.077$, $p<.0005$.

6.3 Chapter summary

This chapter presented the findings of quantitative data and analysis of students and teachers. Demographic data were examined by employing the chi-square goodness-of-fit test. Reliability of the constructs was tested using the coefficient of Cronbach's alpha and descriptive statistics were conducted for both student and teacher samples. Regression analysis was performed for the student data. The descriptive statistics of both students and teachers show that the construct performance expectancy has a high mean. The participants believe that the use of technology (ICT) will improve their job performance. Although facilitating conditions indicated a statistical significance with only 3.1 per cent of variance on the intention to use technology, descriptive statistics suggested that participants perceived that there is limited availability of resources for successful translation of technology into schools. Descriptive statistics show that the construct, 'social influence' affects teachers and students use of technology – the mean being above the average. Regression analysis revealed a relatively low explanatory power of the regression equation, with the proposed model statistically explaining 14.2 per cent of variability of behavioural intention concerning the use of technology for the student sample. This result may suggest that other factors (in addition to those examined in the research) should be taken into account in order to augment the explanation of factors influencing the intention to use technology. The results also indicated that less effort (effort expectancy) is needed in the use of technology to perform academic activities. The next chapter presents the discussion of the findings reported in Chapters Five and Six of the study.

CHAPTER SEVEN

DISCUSSION

The aim of this dissertation was to understand and determine the factors that affect the integrative use of ICT in secondary schools in Mozambique, from a socio-technical perspective. Other studies, specifically, Cossa and Cronjé (2004) study on the introduction of computers into secondary schools in Mozambique highlighted a number of issues, particularly the lack of infrastructure and teachers skilled in computing. This study, however, examines the use of ICT in three selected schools using a socio-technical perspective, while highlighting the key determinants of the intention to use ICT in teaching and learning, using aspects of the UTAUT model. This chapter synthesizes the research findings detailed in Chapters Five and Six in order to answer the research questions. The discussion is presented in line with the research questions as reflected in the introductory chapter.

7.1 Research question one – Qualitative findings

The goal of the qualitative aspect of this research was to further enhance the understanding of the process of Information and Communication Technology (ICT) integration into the education system from the perspective of a socio-technical approach. A translation concept from the Actor Network Theory (ANT) was used to address the social and technical, human and non-human factors, in answering the research question:

- RQ1 − How does the '*translation process*' of integrating ICT within secondary schools in Mozambique take place?

The mapping of the moments of the translation process for the implementation of ICT into schools assisted in the identification of relevant actors required for the functioning of the actor network. The translation analysis also revealed the extent to which various actors, including technology, were enrolled in the integration of technology for learning and teaching activities. The research was initiated because the use of technology in the Mozambican secondary school context had been considered promising for the enhancement of the quality of the education system. Therefore, relevant actors in the process were highlighted, which included technology itself, the school as the implementer entity, and the Ministry of

Education as the project initiator. Tatnall (2010) noted that the introduction of an actor in a given context shapes, and is, in turn shaped by the functioning of the existing network. On the other hand, Williamson and Parolin (2013) stated that the implementation of technology is a process in which an actor network is created. These notes presuppose the existence of other surrounding entities which must be examined when technology is to be implemented. The socio-technical characteristics of the technology discussed in Chapter Three provide the impetus for the current research. The limited amount of research examining the implementation of technology in Mozambican schools, taking a socio-technical approach, motivated the thesis. Therefore, the research closely examined the school actor network which accommodates technology, and the main non-human actors in the research.

In tracing the translation moments proposed in the research framework in Chapter Three and further presented in Chapter Five, the heads of schools were interviewed. These actors described the technology trajectory in each of the research sites. The initial interviews focused on the way in which technology was introduced into the school context in order to identify the actors and the way in which their interests were enrolled in the network. The human actors, such as teachers who were involved in the initial training programme, were identified, and then approached by the researcher for further explanations. The interviewed actors pointed to other actors, highlighting students, teachers, national and international donors, as relevant to the maintenance of the created network. Other non-human actors, apart from the technology were deemed important for the satisfactory implementation of ICT initiatives. The actors included the ICT curriculum guide, the schools' basic infrastructure and the secondary school curriculum. As the translation analysis progressed, other actors were revealed, and the presence of technology in the schools was noticeable. For example, computers and the Internet connectivity needed to negotiate with the schools' basic infrastructure. Therefore, negotiations included the identification of the computer room, and provision of other entities required for the functioning of the network, including technology. Callon (1987) contends that actors in a network are identified when their presence is felt necessary to the proper functioning of the created actor network. Following this assumption, the interaction between technology, the lack of an ICT implementation plan at the school-level context, the power shortage and other physical infrastructure became apparent and relevant to the establishment of the strong actor-network. These results are in line with the findings of Herselman (2003) and Nchunge, Sakwa and Mwangi's (2012) studies as discussed in Chapter Two.

The translation framework assisted in the tracing of a technology trajectory and the identification of its association with other entities in the network. As the network developed, interactions between human and human, human and non-human, and non-human and non-human actors were established. Tatnall (2010) pointed out that the strength of the network depends on the durability of the relationship between the actors comprising the network. The associations between entities result from a process of negotiation in which actors' interests are enrolled in the network in order to achieve a particular goal. The translation analysis exposed the complexity of the process of introducing technology into secondary schools. The four moments of translation suggested that, for the technology to be successfully enrolled and translated to the teaching and learning practices in secondary schools, it should be viewed as a non-human actor that acts in collaboration with other entities – human and non-human actors. The socio-technical elements surrounding the schools' context influence the process of technology translation. Therefore, the way in which technology interacts with the non-technical and social factors, determines the success of its implementation. As proposed in the conceptual framework, a successful translation of technology influences the participants' use of technology, as too their behavioural intention to use technology. The ANT framework suggests that, in the creation of an actor network, entities should be granted the same status regardless of their internal characteristics. Callon (1999b) referred to this fact as the principle of generalized symmetry. Actor networks are created by the heterogeneity of actors comprising human and non-human entities. The assumption of heterogeneity is that in ANT analysis, all the actor associations should be considered both social and technical (Law & Callon, 1992).

Translation is an ongoing process in which actors attempt to mobilize and convince others in order to gain the required resources to sustain the project (Williamson & Parolin, 2013). The translation of technology into schoolwork practices, in which social and technical entities are granted the same status, will evolve over time, affecting teachers' and students' intention to use and their usage of technology. As the new actors join the network, certain other actors' interests change; they exit, and at the same time, actor network requirements change. The Ministry of Education initiated the project which needed assistance from other black-box actors. For example, national and international donors joined the network. Computers and the Internet were provided to the schools in which school administrators, teachers, and students needed to be enrolled and to translate their interest to the network. For the functioning of the network, human actors, as with the non-human actors, rely on the existence of other objects

and material which must be enrolled in the created actor network. This chain of associations defining the extension of the network, threatens the process of technology translation into the education system. For example, the difference in the way in which technology was implemented in each of the research sites was observed. While school B is reasonably equipped in terms of computer rooms, number of computers, interactive board, projector and printer, the scenario observed at the other two schools was different. At school C, computers were installed in the library because of the lack of an appropriate room. This fact concurs with what the interviewees said, that basic resources such as electricity and sockets in the reading rooms were lacking in school C. Therefore, the current status of technology integration in schools may be considered an initial stage of the translation process, in which social, technical, and economic actors are to be considered. In summary, the translation approach assisted in the identification of interactions involving human and non-human actors, which would not have been considered relevant in a non-socio-technical study. From the ensuing discussion, it is determined that non-human actors are just as important as the human actors in the process of diffusion of the integration of ICT in secondary schools. The non-human factors identified are the school environment, technology itself, ICT policies, ICT curriculum-guide, an implementation plan at the school level, ICT infrastructure, secondary school curriculum, time-table and mandatory infrastructure, such as electricity and water.

7.2 Research questions two – five: Quantitative data discussion

As stated in the introductory chapter, quantitative research was conducted to complement the qualitative case study. Quantitative research focused on the identification of factors affecting students' and teachers' behavioural intention to use technology for academic activities. The conceptual framework considered that four constructs (performance expectancy, effort expectancy, social influence, and facilitating conditions), based on the Unified Theory of Acceptance and Use of Technology (UTAUT) model, influence the intention to use ICT in teaching and learning. Therefore, this section discusses results presented in the previous chapter addressing performance expectancy, effort expectancy, social influence, and facilitating conditions relating to students' and teachers' behavioural intention to use technology. The discussion section is elaborated, based on the research questions of the thesis, as follows:

- RQ2 − How does performance expectancy influence behavioural intention regarding the integration of ICT into secondary schools in Mozambique?

Performance expectancy is the influential construct on users' behavioural intention to use technology. In this thesis, performance expectancy is used to measure students' and teachers' perceptions of the use of technology in school for the benefit of their performance in academic activities. Results revealed that performance expectancy is a significant and strong predictor of students' behavioural intention to use technology for learning. Results from descriptive statistics showed that students were somewhat positive towards the use of technology, from the analysis of the mean values. Similarly, it was observed that the scores for performance expectancy for the teachers' data indicated that teachers are certain of improving their performance with the use of technology. In Venkatesh et al.'s (2003) findings, the performance expectancy construct is moderated by age and gender, in which students (younger users) place more importance on technology use to increase their performance. The descriptive statistics of the research indicated that the majority of students' participants are below the age of 15, which suggests a moderating role of age on the intention to use technology in the hope of improving performance. The results are consistent with those of Oye, Noorminshah, and Ab.Rahim (2011), in which performance expectancy was the predictor factor in tertiary institutions. More recent studies, for example, Wong, Teo, et al. (2013), in which student teachers' behavioural intention to use whiteboards was strongly influenced by performance expectancy factors and Kolog, Sutinen, Vanhalakka-Ruoho, Jarkko, and Anohah (2015), study also indicated that performance expectancy was the predictor in the adoption and use of e-counselling. In this study, however, it may be necessary for teachers to develop, not only their computing skills, but also to attend pedagogical training in the use of ICT in teaching. As indicated in Table 6-15, teachers use the word processor most frequently – the most basic application software. Teacher training in the use of ICT is one of the mentioned factors influencing integration of technology in the classroom (Gilakjani et al., 2013). These researchers argued that, if appropriately trained, teachers' self-efficacy would increase, thus increasing the probability of integrating technology into teaching and learning activities. The results in Table 6-14 indicate that about 94.1 per cent of the teachers have been using technology for more than five years, and 76.5 per cent use their own technology to perform school activities. These statistics suggest that the provision of a constructive training programme that focuses on, not only their professional development, but also their effective use of technology, will contribute to the integration of ICT in schools.

The thesis research question regarding the degree of effort needed to use technology in school was stated as follows:

- RQ3 − To what extent does effort expectancy influence the behavioural intention to integrate ICT into secondary schools in Mozambique?

The construct effort expectancy captured the degree to which students and teachers found it easy to use technology in schools for learning and teaching. Effort expectancy is mentioned as having a positive influence on users' behavioural intention to use technology (Venkatesh et al., 2003). This research examines the effects of effort expectancy on teachers' and students' behavioural intention to use technology for teaching and learning. The analysis of data revealed that effort expectancy had the lowest influence on behavioural intention to use technology, however, there was a positive and significant effect on students' behavioural intention to use technology in schools. The descriptive results also indicated a weak mean score for effort expectancy for the student and teacher samples. Venkatesh et al.'s (2003) study indicates that effort expectancy on user's behavioural intention was more significant in the early stages of technology use than later when more experience is gained. Therefore, in addition to gender and age, the effort expectancy factor is also moderated by experience. The results obtained in this research may partially be explained by the characteristics of the samples. Although the greater percentage of respondents indicated some experience, in that they use their own technology to perform school activities, 24.7 per cent of participants (of the student sample) had never used technology in class, and 80.1 per cent had never used it for learning purposes. The analysis of the teacher sample also indicated that technology was seldom used for instructional purposes. These results confirm the outcome of interviews and observations, in which the unavailability of adequate resources and lack of experience explain the deficient translation of technology into schoolwork practices. The predictive capability of effort expectancy for technology use was affirmed by other studies such as those of Oye, Noorminshah, et al. (2011) and Wong, Teo, et al. (2013).

In considering the effect of students' and teachers' social influence on their behavioural intention to use technology, the research question was formulated as follows:

- RQ4 − How does social influence affect the behavioural intention to integrate ICT into secondary schools in Mozambique?

Social influence was revealed as the second predictor of students' behavioural intention to use technology. The social influence construct refers to the extent to which students and teachers are influenced by others' opinions in the use of technology. The thesis conceptualized that social influence, such as friends, colleagues, family, teachers, as well as the Ministry of Education, influence students' and teachers' behavioural intention to use technology. The results depicted in the descriptive statistics indicated positive social support for students and teachers with reference to the use of technology in schools. This implies that students and teachers with higher social support tend to have stronger intentions to use technology for teaching and learning activities. The results could be explained by the gender factor in the student sample. Venkatesh et al. (2003) found that gender, age, experience, and voluntariness of use influence user behaviour intention, in which women had stronger intention than did men. The majority of the students were female, whose intention to use technology is likely to arise from their social influence. The results are consistent with those of Kolog et al. (2015). It follows that the provision of sound ICT infrastructure and adequate training could affect these teachers' intention to use technology, and, in turn, the students' behavioural intention, leading to an effective use of technology. Students' behavioural intention to use technology is affected by their social influence, in which teachers might be the more influential actor. In a similar way, teachers also may need support from their managers. During interviews, participants from school B emphasized the support they receive from the head of school, where the school principal has a strong ICT background. This is confirmed in the observations made, as school B is reasonably equipped, and this school was used in the pilot project for the implementation of ICT. The thesis also investigated the predictive factor of facilitating conditions on students' and teachers' behavioural intention. The research question was stated as:

- RQ5 – How do the facilitating conditions influence the intention to integrate ICT into teaching and learning activities in the schools?

Facilitating conditions is an important predictive factor for behavioural usage in Venkatesh et al.'s (2003) seminal study of technology adoption. The facilitating conditions were found in Venkatesh et al.'s (2003) research not to be a predictor of intention to use if users are inexperienced. However, the present research investigated the effect that the facilitating

conditions construct has on students' and teachers' behavioural intention. The construct assessed students' and teachers' perceptions on the availability of necessary resources for the use of technology in school. The results pointed out that facilitating conditions is the third predictor of students' behavioural intention to use technology, which differs marginally from what Venkatesh et al.'s study hypothesized and is contrary to other studies, such as the research of Kolog et al. (2015), and Wong, Teo, et al. (2013). These results are consistent with that of Khechine, Lakhal, Pascot, and Bytha (2014), who tested the relationship and found a positive effect of facilitating conditions on user intention. The figures depicted in descriptive statistics indicate that respondents perceived that there is a relatively low availability of resources. The results indicate that the facilitating conditions factor is a predictor of student behavioural intention. The results suggest that there is a need to improve the required facilitating conditions so as to improve the acceptance of technology use in schools. From interviews and observations, it was clear that inadequate resources, for example, the absence of an ICT technician to help maintain and repair computers, was noticeable and repeatedly mentioned in all the research sites. This suggests that the computing equipment needed repairs and maintenance frequently, or that students were not competent enough to handle small issues which crop up.

Other factors which may affect the process of translation of technology in schools, and therefore its acceptance and use for performing academic activities, were determined. Participants were asked to indicate factors which they consider impede the use of technology in school. The identified factors included the lack of skills, interest, time, obligatory use of technology, and the unavailability of resources. The lack of skills is in keeping with the limited use of technology by teachers, specifically the basic purpose of word-processing. This result is also observed in the students' sample, in which the majority indicated that they never used technology for learning, for searching for academic information on the Internet, or for communication purposes in school. It is likely that students are not using technology effectively in schools. Another finding is related to the use of social networking applications at schools. The findings indicated that there are significant numbers of teachers (9) and students (102) who used social networking applications 'often'. It is reasonable to suggest that they may be more willing to use technology for teaching and learning if all the facilitating conditions are in place. Therefore, technology translation into schoolwork practices is still in the initial stages. The results from both students' and teachers' data indicate the unavailability of resources as the major barrier to the use of technology in

schools. This result also confirms the outcomes of interviews and fieldwork observations. Although translation of technology is considered an ongoing process which evolves over time (Williamson & Parolin, 2013), facilitating conditions should be addressed in the acceptance and use of technology. As mentioned earlier, although the initial pilot project was considered successful in that many schools were equipped with computers, this study highlights the need for sustainability. In other words, a well-resourced school would need a technician or someone responsible for maintaining the computers and overall infrastructure, notwithstanding trained educators in the use of technology for effective and continued integration of technology into the education system.

The discussion illustrates a complementary mix of both theories. The ANT and a modified UTAUT provides a comprehensive understanding of ICT integration as well as the predictive intention to use ICT in secondary schools in Mozambique. Although the two theories used for data collection, analysis and interpretations of the results are theoretically different, they may be considered complementary. The combination of findings provides some support for the conceptual framework. The proposed framework may be applied in situations in which the social and technical entities are considered relevant to the successful implementation of technology.

7.3 Chapter summary

This chapter discussed the findings of the research. The chapter provided a mapping of research questions with the findings obtained from data analysis. The results from the two perspectives suggest that, for the effective translation of technology, more factors which also influence the behavioural intention towards the use of technology should be included for the proper functioning of the network. Therefore, the socio-technical perspective using ANT addressed RQ1, while the quantitative perspective, using UTAUT, addressed RQ2 to RQ5. All research questions addressed the proposed research framework. The results explain the partially successful enrolment phase in which attempts to establish a solid network of actors were observed through the translation of other actors' interests in the actor network. The results from the UTAUT perspective indicated that less effort expectancy is needed in the use of technology for performing academic activities. The translation process was not impacted by the degree of effort required for the use of technology. The next chapter concludes the

thesis by summarizing the thesis process, conclusions, contributions and limitations of the research.

CHAPTER EIGHT

CONCLUSION

The study is concerned with the integration of technology into the education sector, in investigating the phenomenon in three secondary schools in Mozambique. This study focuses on the socio-technical aspects of ICT integration in order to understand the acceptance and use of technology in schools. To this end, the study was underpinned by two theories, which contributed to the conceptual framework to increase the understanding of technology integration in the education system, given the lack of ICT integration or use of technology in Mozambique since its first introduction in 1998. The theoretical perspective illustrated the complexity underlined in the implementation of technology, in which the extent of user acceptance and use is associated with the translation of technology into the local school context.

Driven from assumptions underlining the use of ICT for promoting innovation in the education sector as pointed out by Tolica et al. (2015) or for the promotion of socio-economic development as indicated by Heeks and Stanforth (2015), ICT integration is gaining space in the delivering of academic activities. Therefore, this research was conducted for the monitoring of the integration process and the outcomes of ICT investment in the education sector. Researchers have revealed a variety of factors constraining the effective use of ICT in education. The purpose of the thesis was to examine the socio-technical factors which could affect the acceptance and use of technology in secondary schools. The research was conducted combining qualitative and quantitative data approaches. The thesis identified the salient factors influencing students' expectations of the use of technology. From the review of literature on the implementation of technology in schools, and particularly in the Mozambican context, it was evident that there was an absence of theoretical research combining a socio-technical model approach. Therefore, the proposed conceptual framework assisted in developing a deeper understanding of technology implementation in the context of schools in Mozambique. The data analysis which was underpinned by the Actor Network Theory (ANT) and Unified Theory of Acceptance and Use of Technology (UTAUT) theories presented in Chapter Three, was elaborated on in Chapters Five and Six. The translation process from the ANT has informed the analysis of qualitative data,

while UTAUT provided the theoretical basis for quantitative data. Both theories were conceptualized in the proposed research framework that guided the study. While translation analysis provided an understanding of the socio-technical aspects surrounding the introduction of technology in school, UTAUT helped with the identification of factors and their relationship to students' and teachers' intention to use technology. The research intended to answer the following research questions:

- RQ1 − How does the '*translation process*' of integrating ICT within secondary schools in Mozambique take place?
- RQ2 − How does performance expectancy influence behavioural intention regarding the integration of ICT into secondary schools in Mozambique?
- RQ3 − To what extent does effort expectancy influence the behavioural intention to integrate ICT into secondary schools in Mozambique?
- RQ4 − How does social influence affect the behavioural intention to integrate ICT into secondary schools in Mozambique?
- RQ5 – How do the facilitating conditions influence the intention to integrate ICT into teaching and learning activities in the schools?

The summary of the research process is presented in the following sections.

8.1 Overview of the research process

The research was conducted under the umbrella of the mixed methods research approach. The suitability of the mixed methods research approach was led by the research topic questions, and by the theoretical assumptions presented in Chapter Three. Therefore, a combined use of qualitative and quantitative approaches was adopted for framing data gathering, analysis, and interpretation of the results. The qualitative part of the research enabled the contextualization of the research topic, exploring participants' experiences and their interactions with technology by employing interview-based case studies, analysis of documentation, and observations. The quantitative aspect of the research was intended to explore the views of students and teachers through questionnaire-based surveys. The use of various techniques of data collection allowed comparison and identification of similarities and differences across research sites, which helped to triangulate and validate data collected from different sources. Therefore, qualitative and quantitative findings were combined to inform the study as data were simultaneously used with

the purpose of complementing each other. The research adopted a multiple-case study strategy, in which the study sites and individuals were selected purposefully according to Creswell's (2014) recommendations. The research sites were composed of public secondary schools implementing technology at three localities in the Maputo province. The fieldwork was conducted in two phases. In the first phase qualitative data were collected, and a questionnaire survey was piloted between March and May 2015. The second phase of data gathering was completed between September and October 2015. The qualitative data analysis was performed following theoretical propositions of the Actor Network Theory (ANT), and the Unified Theory of Acceptance and Use of Technology (UTAUT) framed the quantitative data analysis. The use of theories for the analysis of data allowed the researcher to capture salient actors in the integration of technology, both human and non-human, relevant to user acceptance and use of technology. The study proposed a research framework that combined the perspectives of ANT and UTAUT to guide the process of data-gathering and analysis, and to inform the findings. The adopted research framework assisted in the identification of interactions involving human and non-human actors, which had an impact on the teachers' and students' acceptance of the integration of technology into schools. The results showed that the disregarding of social context entities during the initial stage of the project had an effect on the teachers' and student's behavioural intention to use technology. This substantiated the findings of Govender and Chitanana's (2016) study, which indicated that teachers' perceptions of e-learning technology are influenced by the way in which relationships between human and non-human entities are created. In the same vein, Meyer, Marais, Ford and Dlamini (2017) proposed a framework that can be used to assist in introducing ICT in education projects in order to assess the readiness of the community before the implementation of technology.

8.2 Summary of the research findings

Mozambique is politically committed to the adoption and use of ICT to improve the quality of education. Therefore, the benefits of using technology were spontaneously mentioned as indirectly contributing to the enhancement of the quality of teaching and learning in the research sites. Teachers and students recognized the potential of technology to improve the quality of teaching and learning activities. However, the tracing of the non-human actor of technology

suggested that ICT had not been translated completely into the schools' context. The results from both students' and teachers' data indicate the unavailability of basic resources as the major barrier to the use of technology in schools. The summary of the translation analysis is presented in the following section.

8.2.1 Qualitative findings

The use of technology in the education system has been considered for the improvement of teaching and learning, particularly in developing countries (Tolica et al., 2015). The thesis assessed the integration of technology into Mozambican schools using a theoretical-framework-informed approach. The socio-technical use of an ANT approach informed the complexity surrounding technology integration into schools, thereby giving a richer understanding of ICT integration into schools. The translation framework revealed that integration of technology into schools is not a linear process, as it comprises a series of negotiations in which human and non-human actors are linked. The ANT approach suggested that negotiations which establish a set of definitions and meanings are relevant to the understanding of the phenomenon under research. The extent to which actors' interests are aligned characterizes the convergence of actors in a created network (Callon, 1999b). The identification of actors, their roles and interests in building a cohesive actor network, is a process which evolves over time. This research acknowledged the relevance of ANT in the understanding of artefacts through which the technical entities operate in the integration of technology. The outcome of the analysis suggested that technology has an impact on participants' interests, which apparently changes the teaching and learning practices. On the other hand, translation revealed the complexity of the interactions required between various actors for the stability of the network. Aligning the identified actors' interests will result in a solid actor network.

The thesis does not support the assumption that integration of technology into an education system is considered either a success or a failure in most of the cases, comparing the planned goals and the implementation outcomes. According to the translation of an actor from an ANT perspective, integration of technology is an ongoing process which is dependent on a variety of factors in which local-context actors should be considered. Therefore, the process of technology

integration is a dynamic process of technology translation which leads to the performance of user acceptance and use of technology. Efforts to translate technology effectively into the education system will result in users being likely to accept technology for the teaching and learning process. This indicated that the effective acceptance and use of technology could be observed through a successful translation of technology into academic practices. The provision of identified artefacts throughout the translation analysis could enable the re-problematization, *interessement*, enrolment, and mobilization of actors.

In summary, the attempts of the Ministry of Education to introduce technology into secondary schools should be viewed as an ongoing translation process, in which actors join in while others exit the network in the process of its creation. The emerging changes in the process of integration of technology into schools must be monitored; and strategies for the re-problematization design should be based on the identified solution. The understanding obtained from the translation analysis could help to elucidate the complexity regarding the integration of technology. By following translation moments, the researcher has obtained theoretical and practical understanding of the constraints of the integration of the technology process. This came about because, from the perspective of ANT, every artefact that can act in the network has an effect on the same network, as with human actors. Therefore, the research evaluates the role of actors, both human and non-human in the integration of technology into schools. Complementary quantitative analysis was conducted under the UTAUT framework.

8.2.2 Quantitative findings

Factors affecting teachers' and students' levels of acceptance and use of technology in the Mozambican secondary schools' context were evaluated. The measured items used in the research were adapted from Venkatesh et al. (2003), with changes to suit the proposed model and the research-site context. The research found a statistically significant relationship between performance expectancy, effort expectancy, social influence, and facilitating conditions, and the students' behavioural intention to use technology in school. The results revealed a relatively low explanatory power of the model in reflecting students' behavioural intention to use technology. However, the result was acceptable in social science studies. Performance expectancy, effort

expectancy, social influence, and facilitating conditions together account for only 14.2 per cent of the variance of students' behavioural intention. This result is an indication that there are certain other factors (in addition to those investigated in the research) which should be considered in order to improve the predictive power of students' behavioural intention. Performance expectancy was the most significant predictor, followed by social influence and facilitating condition factors, in explaining students' intention. Effort expectancy representing the ease of use of technology revealed the least variance on students' behavioural intention to use technology. Notwithstanding the relatively low explanatory power of the regression model, the findings generated from quantitative analysis suggested that UTAUT is a valid framework for research on acceptance and use of technology in the schools of Mozambique. The findings may be used to assist projects in which introduction and use of technology in education take place in the country.

8.3 Reflection on the conceptual framework

The thesis examined the socio-technical context of technology integration for the identification of relevant factors which could affect the acceptance and use of technology in secondary schools. The socio-technical approach described the interdependencies existing between technology, people, and the school's contextual background. The association of the technical components and the social context in which the technology is situated, were framed according to the Actor Network Theory (ANT). Therefore, the thesis conceptualized the integration of technology into the education system as a process in which a network is created, with various entities and objects influencing one another to maintain a cohesive relationship. User acceptance and use of technology is therefore conceived as an effect of a successful network of human and non-human actors in which technology is included. Therefore, to assess the level of user acceptance and use of technology in Mozambican secondary schools, the Unified Theory of Acceptance and Use of Technology (UTAUT) model was applied. ICT in the education system has been used for a long time, however, researchers reveal that there are still uncertainties regarding the objectives and the use of ICT, particularly in developing countries (UNESCO, 2015). These result from the heterogeneity and complexity of factors impacting technology integration into the education system, leading to the unpredictability of the expected outcomes. The complexity of these

interrelated factors or variables represents the socio-technical characteristics of ICT integration into the education system. The socio-technical approach emphasizes the complexity of factors and the unpredictability of results involved in the process of integrating ICT into schools. Sawyer and Jarrahi (2014) stated that the introduction of technology in a given organization causes the interaction between social and technical aspects, which must jointly be considered. The assumption underlying a socio-technical approach is that both the social and the technical should be regarded as having the same significance in the process of technology integration.

The application of this conceptual framework led to the identification of actors, including the socio-technical factors interacting with one another, in the implementation of technology into secondary schools, and the way in which factors related to performance expectancy, effort expectancy, social influence, and facilitating conditions influence the acceptance and usage of technology in schools.

8.4 Contribution to the body of knowledge

The present thesis made contributions to the research in the domain of technology implementation into schools in developing countries, more specifically, in Mozambique. The study contributes in several ways which are explained below to the relevant body of knowledge.

Methodological contribution

The thesis has contributed to the conceptual framework research of technology integration in the education system. Much research has been conducted on the integration of technology into the education system using either ANT or UTAUT, for example, in (Al harbi, 2014; Fenwick & Edwards, 2013; Oye et al., 2012a; Wong, Teo, et al., 2013). However, these discussions miss the complexity of the implementation of technology in which the extent of user acceptance and use is associated with the translation of technology into the local context. For instance, Elgali and Kalman (2010) stated that the success of technology integration into teaching and learning activities is strongly dependent on the engagement of relevant actors, such as teachers and students, with the ICT. Few studies have used a combination of ANT and UTAUT. The researcher is aware of only one study (Williamson and Parolin (2013)) that based its findings on

a combination of ANT and UTAUT in understanding the genesis of planning support systems. To the researcher's knowledge, no study employed a combination of both ANT and UTAUT theories to understand the integration and acceptance of technology into secondary schools in Mozambique. Therefore, by combining the two theories, the study provided both a theoretical and a practical contribution. The conceptual framework used in the thesis is a useful contribution to the research of technology integration into the education system.

The second major contribution is related to the elucidated challenges regarding the socio-technical characteristics of technology when implemented in a socio-material environment such as a school. The schools comprise the heterogeneity of actor networks and the adoption; and coherent establishment of any technology within the education system is considered a complex process which depends on the compatibility of the school context and work practices. The ANT perspective, in which translation concepts were used, provided insights into the understanding of ways in which the actor networks, including technology, should be established and sustained over time. The thesis analysis highlighted the linkage between the local context in which the technology is to operate and the extent to which the user is likely to adopt and use technology in schools.

Enhanced understanding of the phenomenon of ICT integration

The study has gone some way towards enhancing our understanding of ICT integration in schools in a developing country. The use of the translation concept from ANT contributed to the tracing of a technology trajectory in the local context of the school. In the problematization moment, the principal actor established the use of technology in secondary schools as an Obligatory Passage Point (OPP). Through the establishment of two *interessement* devices, the focal actor sparked the other actors' interests and negotiated their roles in the process of creating an actor network. The apparent lack of commitment of the non-human actors and non-ICT teachers to the project, revealed the weakness of the project structure. Therefore this was taken as the cause of the limited action of the focal actor in the enrolment of entities. The strategy in which the created network was given to the need of the schools, revealed the way in which actors translated their interests, thereby defining the trajectory of the network on each research site.

The thesis also makes practical contributions by confirming the relationship between performance expectancy, effort expectancy, social influence, and the facilitating conditions factors in the explaining of students' intention to use technology in Mozambican schools. The findings may be used to assist projects in which the introduction and use of technology in education takes place in the country.

Literature on ICT in education

This thesis contributes to existing literature on ICT integration in education with particular reference to Mozambique where a gap was identified – which this thesis set out to fill, with regard to the research context and the specific focus on Maputo province.

8.5 Conclusion

The multi-case strategy in which qualitative and quantitative data informed the research findings presented the socio-technical characteristic of technology translation in the school context. Although attempts to introduce and deploy the use of technology in the schools were noticeable, the challenges posed by its associated network in the existing school context were also evident. From the review of literature on the implementation of technology in schools, and particularly in the Mozambican context, the emphasis on the non-human elements is often partially omitted in the process of translation. However, the dynamic nature of the technology itself contributed to its partial translation in the schools context. ICT revealed its potential to empower teachers and students, and also to improve the quality of work and relationships within the schools. The use of electronic communication within the schools and among the actors involved in the network was repeatedly mentioned.

As presented in Chapter Five, the network of actors in the schools is complex. From the review of the literature, corroborated by evidence from the case studies, teachers, students and the related artefacts are the key social actors or factors impacting on the translation of technology in the education system. These factors must be considered and negotiated from the beginning of technology introduction so as to promote its translation in the teaching and learning practices.

Although translation of technology is considered an ongoing process which evolves over time (Callon, 1999b), facilitating conditions should be addressed for the acceptance and use of technology. The interviewed participants spontaneously mentioned the benefits of the use of technology, simultaneously indicating constraints posed by the status of the existing school context.

In summary, the findings revealed that there is a complex and silent network of associations between key actors in the school context which contributes to promoting acceptance and use of technology in academic practices. This finding emerged as a result of the use of ANT which revealed how technology interacts with its related network entities for its translation into schoolwork practices. Therefore, there is a strong possibility that with the provision of sound ICT infrastructure and constructive training programmes, the integration of technology into the schools may be improved and sustained.

8.6 Implications

The literature has underlined the complexity that characterizes the process of integrating technology into the education system in which the overall structure and the surrounding social actors involved in the school context should be considered. Although many studies were conducted for the understanding of ICT implementation in education in many countries, based on the researcher's knowledge, currently there is no study examining the technology used in which socio-technical elements are considered in the context of secondary schools in Mozambique. The government of Mozambique is politically committed to the use of ICT in education. This point is reflected in the efforts of the government to develop a number of initiatives and policies for the adoption and deployment of technology in the country. However, the full potential of the use of technology in education is unlikely to be realized without an effective involvement of the surrounding artefacts which may influence the acceptance and use of technology. The result of this study has implications for the process of ICT integration into teaching and learning activities in the country by extending the boundaries of knowledge in the process of technology integration in secondary schools.

IT was also emphasized in the literature, that if a teacher, who is the main actor in the implementation of technology in schools, has competence in the personal use of technology, he or she will, consequently, be motivated to adopt and integrate technology into the classroom. From the descriptive analysis of teacher data provided in Chapter Six, about 94 per cent of teachers indicated that they have been using technology for more than five years. The analysis of the teachers' sample also indicated that only 17.6 per cent of the teachers use technology for instructional purposes in which the word-processing application is the most often (88.2 per cent) used technology among the teachers. These results suggested that they are possibly using technology in a very simplified way, which is not reflected in the improvement of teaching and learning in the classroom. The thesis recommends the development of projects to support teachers in the successful adoption and use of technology. This may include the provision of training programmes to promote professional development with regard to the use of software applications, such as web tools, spread-sheets, PowerPoint, learning management system, Facebook, inter alia, and also in how to integrate technology in a pedagogically sound way, generally and in subject-content knowledge, specifically. Additionally, ICT technicians should be trained or provided in schools in order to assist in the maintenance of ICT infrastructure.

Literature also underlines the potential of technology use in education to promote students' cognitive thinking, problem-solving and learning in a collaborative environment. It must be emphasized that education should make use of technology to prepare students to live in a technology-based environment characterizing a 21st century society. The study recommends the provision of more equipment and availability of computer rooms in which students can learn and practice independently.

8.7 Limitations and directions for future research

As with any research on the technology introduction, the study has encountered certain limitations. The first limitation is related to time constraints. The thesis adopted a mixed methods approach. Data collection was conducted concurrently, given the limitation of the study time frame. Had it been possible for the qualitative data analysis to have been used to inform the quantitative part of the research, this would have added further value to the thesis. This limitation could be used to frame future research on the domain of technology integration into secondary

schools. The study was conducted more or less during the period of decision-making, technology introduction into schools still being a pilot project. It must be pointed out that innovation diffusion is a function of time, which affects the accuracy of information obtained after adoption or rejection of the technology over a long period. Venkatesh et al.'s (2003) research was longitudinal, in which UTAUT was tested at three different times, that is, from the time of initial introduction to phases of greater experience of technology usage. For the introduction of a new system, UTAUT proponents recommend the examination of user behavioural intention and user behaviour at different points of time. Therefore, the thesis suggests a future longitudinal research which would provide a better understanding of the factors affecting students' and teachers' behavioural intention to use technology in the Mozambican context.

The major limitation of this study is the small number of teacher respondents. Although, the reseacher targeted 60 participants with 20 from each research site, only a small number responded. Consequently, the results from the quantitative analysis cannot be statistically generalized to the population of teachers. The thesis intended to examine factors such as performance expectancy, effort expectancy, social influence, and facilitating conditions in relation to students' and teachers' behavioural intention to use technology. During the fieldwork it was difficult to contact all the teacher participants, many of whom made themselves unavailable for the survey, despite the level of effort the researcher employed. This limitation also provides direction for future research, in which the findings may be generalized to the population, thereby involving more teachers in the study. The involvement of a larger population of teachers should be possible if a longitudinal study is conducted.

Despite the mentioned limitations, the thesis makes a solid contribution by illuminating the complexities regarding technology integration into the education system. The researcher believes that the thesis has developed awareness for the decision-makers of the challenges regarding the effective implementation and use of technology in Mozambican schools. The implementation of technology into education should be considered an innovation translation process in which user acceptance and use of technology are effects of the successful actor network.

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APPENDICES

Appendix A

UNIVERSITY OF KWAZULU-NATAL
College of Law and Management Studies
School of Management, Information Technology and Governance

Interview schedule – Head of schools

Research topic: A socio-technical understanding of Information and Communication Technology (ICT) in education - a case study of three secondary schools in Mozambique

Researcher: Lucia Ginger

The interview will focus on understanding how the technology was introduced and translated into the school context work practices, which include issues on:

- Assessing the experience of participants on integrating computers and the Internet into the school environment;
- Describing of the problems faced in the initial stage of technology integration and the strategies used to overcome the difficulties; and
- Describing of the strengths and weakness found in the early stage and how are they influencing technology integration in the teaching and learning process.

1. How long have you been in the position of Head of this school?
2. How does the process of technology integration in class was initiated?
3. Is there is any documentation providing the vision, plan or strategies to tackle technology integration in the education system? Who provided that document plan or policy?
4. To what extent did the Ministry of Education and the school administration plan the integration of technology into the education system?
5. Does your school have a policy for the integration of computers and the use of the Internet in class? (If not, how are you dealing with the integration process)
6. Who decided on the inclusion of this school to pilot technology in class? Was there any formal procedure to join the project?
7. Did you conduct an analysis before and during the initial stage of technology integration in this school? (If yes, who was involved and describe the result of the analysis done)
8. What is the main strategy that the school used to initiate the process of ICT integration in class? Is the strategy working?
9. Does the Ministry of Education provide enough support for the integration of technology into the secondary schools education system? What is the Ministry doing?
10. In your opinion, is there a connection between the Ministry of Education goals regarding to the use of ICT in class, and the school work practices?

11. Is the integration of technology in class aligned to the provision of required resources such as ICT and school infrastructure, technical staff and staff competence?
12. What about your ICT competence, do you think there is a relationship between the ICT skills of the Head of school and the school performance?
13. What about your staff ICT skills, do you think the teachers are competent to integrate ICT into the teaching and learning process?
14. Which criteria did you use to standardize the integration of ICT in different subjects?
15. How does the built network (integration of technology) differ from the previous network? What are the differences between before, during and after ICT integration in the education system?
16. What benefits do you think were brought by technology to the education system in general and to you in particular?
17. Is there any change to the curriculum? If yes, how do the changes affect teachers and students?
18. Does the school use computers and the Internet for administrative work?
19. Are there any further comments you would like to share regarding to the technology integration into the education system?

Thank you

Appendix A
(Portuguese translation of statement for interview with Head of school)

UNIVERSITY OF KWAZULU-NATAL
College of Law and Management Studies
School of Management, Information Technology and Governance

Interview schedule – Head of schools

Tema: ***A socio-technical understanding of Information and Communication Technology (ICT) in education - a case study of three secondary schools in Mozambique***

Pesquisadora: Lúcia Ginger

A presente entrevista, tem como objectivo a compreensão de como as TIC's foram implementadas e como estão sendo integradas no ensino secundário, nível de Sistema Nacional de Educação. A mesma irá focalizar os seguintes aspectos:

- Colher a experiência dos entrevistados sobre o uso de computador e da *Internet* no ambiente escolar;
- Descrição dos problemas encarrados na fase inicial do projecto de integração das TIC's no ensino e que estratégias foram usadas para superarem os mesmos; e
- Descrição dos pontos fortes e fracos do processo e como estes, influenciaram o uso das TIC's no processo de ensino e aprendizagem.

1. A quanto tempo o senhor exerce as funções de director nesta escola?
2. Como foi o processo inical da integração das TIC's no processo do ensino?
3. Existirá algum documento, legislação ou plano estratégico que aborda o processo de integração das TIC's no Sistema Nacional de Educação? Quem os providenciou?
4. Terá existido um plano de implementação do Ministério da Educação ou da escola com vista a integração das TIC's no Sistema Nacional de Educação?
5. Haverá alguma politíca da escola para a integração das TIC's no processo de ensino e aprendizagem? (Não existindo, como tem integrado as TIC's na escola)
6. Que critério ditou a escolha desta escola para o projecto piloto da integração das TIC's no ensino secundário? Houve algum procedimento formal?
7. Terá havido um estudo prévio ou durante a fase inicial de implementação do projecto? (Em caso afirmativo, quem foram os envolvidos e pode descrever os resultados obtidos)
8. Qual foi a estratégia que a escola usou para implementar as TIC's no ensino? È funcional?
9. Existirá algum apoio e acompanhamento do Ministério de Educação para manutenção do projecto? Concretamente, o que o Ministério tem feito?
10. Na sua opnião, existirá condições objectivas na escola, para a implementação das TIC's no processo de ensino conforme as directrizes do Ministério da Educação?

11. A integração das TIC’s no processo de ensino, estará acompanhado da provisão de recursos necessários tais como, computadores, infrastruturas básicas e pessoal técnico qualificado para o alcance dos objectivos do projecto?
12. Qual a motivação do senhor director para a integração das TIC’s no ensino, considerando que a mesma poderá infuenciar o sucesso ou não do projecto?
13. Até que ponto os professores estão capacitados tecnicamente para implementar o projecto?
14. Qual foi o critério usado para a padronização do uso das TIC’s no diferentes níveis e disciplinas?
15. Que avaliação faz do processo antes, durante e depois da sua implementação?
16. Na sua opnião quais são os beneficios que as TIC’s adcionaram no Sistema Nacional de Educação do ponto de vista geral e em particular na presente escola?
17. Acha que as TIC’s desempenham um papel fundamental para educação?
18. No processo de gestão administrativa, a escola usa computadores e *Internet*?
19. O senhor director terá algum comentário adicional que queira apresentar relativamente a integração das TIC’s no Sistema Nacional de Educação.

Muito obrigada

Appendix B

UNIVERSITY OF KWAZULU-NATAL
College of Law and Management Studies
School of Management, Information Technology and Governance

Interview schedule – Teachers

Research topic: A socio-technical understanding of Information and Communication Technology (ICT) in education - a case study of three secondary schools in Mozambique

Researcher: Lucia Ginger

The interview will focus on understanding how the technology was introduced and translated into the school context work practices.

1. When and from whom did you hear about ICT integration into the secondary schools education system?
2. What was your thinking concerning the use of computers and the Internet for teaching and learning?
3. What did the school do in order to integrate technology into the teaching and learning programme?
4. Was there any training to improve teachers ICT skills before ICT integration into class?
5. What did you do in the initial stage of the technology integration in order to accommodate computers and the Internet in your class? What are the challenges?
6. What about your ICT competence, do you think you have enough skills to integrate technology effectively into the teaching and learning process?
7. What changes did you make in order to integrate technology into teaching and learning?
8. Is the school providing enough support for the integration of the technology in class? If yes, describe the kind of support you are receiving.
9. Which are the obstacles you are facing in integrating technology teaching and learning process?
10. In your opinion, are the teachers and students benefiting from the use of technology in class?
11. Could you describe the impact of ICT use on teachers' and students' performance?
12. In your opinion, what can be done in order to achieve the goal of integrating ICT into the secondary schools to improve the quality of the education system?
13. Are there any further comments you would like to share regarding to the technology integration into the education system?

Thank you

Appendix B
Portuguese translation of statement for interview with teachers

UNIVERSITY OF KWAZULU-NATAL
College of Law and Management Studies
School of Management, Information Technology and Governance

Interview schedule – Teachers

Tema: ***A socio-technical understanding of Information and Communication Technology (ICT) in education - a case study of three secondary schools in Mozambique***

Researcher: Lucia Ginger

The interview will focus on understanding how the ICT was introduced and translated into the school context work practices.

1. Quando ouviu falar da integracão das TICs no ensino secundário? Qual foi a fonte?
2. Qual e a apreciação que faz sobre o uso do computador e da internet no processo de ensino e aprendizagem?
3. Na sua opinião acha fundamental o uso das TICs no processo de ensino e aprendizagem? Explica dando alguns exemplos.
4. Existe algum incentivo da direcção da escola para a materialização dos objectivos perconizados no processo? Em caso afirmativo, que tipo de incentivo?
5. Teve alguma formação na área das TICs? Teve alguma capacitação especifica para integra-las nas suas aulas?
6. Pode descrever alguns desafios da integração das TICs no processo de ensino e aprendizagem? Como foi a integração na sua disciplina?
7. Acha que tem conhecimento suficiente para integrar as TICs nas suas aulas?
8. Que mudanças efectuou com vista a integração das TICs nas suas aulas?
9. Tem havida capacitação para o desenvolvimento professional dos professores no uso das TICs?
10. Na sua opinião, quais sao os beneficios que os professores e estudantes tem obtido com o uso das TICs nas aulas?
11. Podes descrever o impacto do uso das TICs na performance dos professores e dos estudantes?
12. Na sua opinião, o que deverá ser feito para atingir os objectivos perconizados no projecto – a integração das TICs com vista a melhorar a qualidade do ensino.
13. Tem alguma cometário adcional em relação a integração no sistema nacional de educação?

Obrigada

Appendix C

REPUBLICA DE MOÇAMBIQUE

GOVERNO DA PROVINCIA DO MAPUTO DIRECÇÃO PROVINCIAL DE EDUCAÇÃO E CULTURA
DEPARTAMENTO DE DIRECÇÃO PEDAGÓGICA

CREDENCIAL

Esta devidamente credenciada srª **Lucia Joaquim Ginger,** estudante de Doutoramento em Sistema de Informação e Comunicação na Universidade de Kwazulu-Natal (UKZN) República da Africa do Sul, encontrando-se neste momento no processo de recolha de dados para o trabalho de investigação na provincia de Maputo, solicita a V. Excia, a concessão de todo apoio necessário para o alcance dos seus objectivos.

Matola 13 de Outubro 2014

Appendix D

UNIVERSITY OF KWAZULU-NATAL
College of Law and Management Studies
School of Management, Information Technology and Governance

CONSENT TO PARTICIPATE IN INTERVIEW – Head of school

Researcher: Lucia Ginger**,** Tel:+258828954730**, Email:** lucia.ginger@gmail.com / 213568981@stu.ukzn.ac.za
Supervisor: Prof. Irene Govender, **Tel**: +27312603485, **Email:** govenderi4@ukzn.ac.za
HSSREC Research Office: Ms Phumelele Ximba, **Tel**:+2731 260 3587, **Email:** ximbap@ukzn.ac.za

You are being asked to participate in an academic research project conducted by Lucia Ginger, a student in the Department of Information System and Technology, University of Kwazulu-Natal (UKZN), South Africa, and a staff member of the University of St. Thomas of Mozambique. The research topic is entitled ***A socio-technical understanding of Information and Communication Technology (ICT) in education - a case study of three secondary schools in Mozambique.*** The results of this research will be used solely for academic purposes. You were selected as a possible participant in this study because your school has been piloted with computer and the Internet use in class. Please, take time to read the information below, and ask questions about anything that is not clear or if you would like more information.

- This interview is voluntary. You have the right not to answer any question, and to stop the interview at any time or for any reason. The interview is expected to take about 45 minutes.

- The researcher would like to record this interview so that it can be accurately quoted in this study. An electronic recording will be made if you do grant permission for this.

- All data will be stored in a secure space. Confidentiality and anonymity is assured. After the research the data will be destroyed according to UKZN ethics protocols.

DECLARATION

I…… (full names of participant) hereby confirm that I understand the contents of this document and the nature of the research project, and I consent to participate in the research project.

I understand that I am at liberty to withdraw from the project at any time, should I so desire. I hereby provide consent for the audio-recording of my interview YES NO

SIGNATURE OF PARTICIPANT DATE

_____ _____

Appendix D
(Portuguese translation of the consent form for Head of school)

UNIVERSITY OF KWAZULU-NATAL
College of Law and Management Studies
School of Management, Information Technology and Governance

TERMO DE CONSENTIMENTO - Director da Escola

Pesquisadora: Lucia Ginger**,** Tel:+258828954730**, Email:** lucia.ginger@gmail.com / 213568981@stu.ukzn.ac.za
Supervisora: Prof. Irene Govender, **Tel**: +27312603485, **Email:** govenderi4@ukzn.ac.za
Departamento de Ética em Pesquisas da UKZN - HSSREC: Sra. Phumelele Ximba,
Tel:+2731 260 3587, **Email:** ximbap@ukzn.ac.za

O(a) Senhor(a) director(a) está sendo convidado(a) a participar como voluntário(a), de um estudo de carácter académico. Meu nome é Lúcia Ginger, sou estudante no departamento de Sistemas de Informação e Tecnologias da Universidade de Kwazulu-Natal, República de Africa de Sul, e funcionária na Universidade São Tomás de Moçambique. A pesquisa tem como tema ***A socio-technical understanding of Information and Communication Technology (ICT) in education - a case study of three secondary schools in Mozambique*****.** Os resultados deste estudo, serão usados apenas para fins académicos.

Após receber os esclarecimentos das informações que se seguem, no caso de aceitar fazer parte do estudo, assine ao final deste documento. Em caso de dúvida sobre o estudo, poderá entrar em contacto com a pesquisadora responsável ou com a supervisora do mesmo, nos endereços acima indicados. Em casos de dúvidas sobre os seus direitos como participante neste estudo, poderá contactar o departamento de Ética em Pesquisas da UKZN - **HSSREC**.

Use o tempo que for necessário para ler e compreender as informações que se seguem, podendo proceder a qualquer questionamento, adiccionar ou comentar sobre as mesmas.

- A sua participação é voluntária e a recusa em participar não irá acarretar qualquer penalidade;
- A sua participação é livre, isto é, poderá retirar o seu consentimento ou interromper a sua participação a qualquer momento;
- Não é obrigado(a) a responder à todas questões colocadas, podendo interromper a sua participação em qualquer fase da pesquisa sem prejuízo. A entrevista terá a duração estimada de 30 minutos;
- Para facilitar a recolha e análise da informação, a pesquisadora gostaria de proceder a gravação da entrevista. Porém, a gravação electrónica terá lugar após sua permissão;

- A informação recolhida neste estudo, será tratada e armazenada com confidencialidade e a mesma será referenciada de forma anónima. De salientar que depois do estudo, a informação será destruída de acordo com o protocolo de ética em uso na UKZN.

DECLARAÇÃO

Eu…… (nome completo do participante), fui esclarecido(a) sobre o conteúdo deste documento, natureza do estudo e das minhas condições em participar do mesmo e dou livremente o meu consentimento.

Sei que em qualquer momento poderei interromper a minha participação neste estudo se assim o desejar. A minha participação é voluntária e autorizo a gravação electrónica da entrevista
Sim ( ) Não ( )

Assinatura do Participante _____ Data _____

Appendix E

UNIVERSITY OF KWAZULU-NATAL
College of Law and Management Studies
School of Management, Information Technology and Governance

CONSENT TO PARTICIPATE IN INTERVIEW - TEACHER

Researcher: Lucia Ginger**,** Tel:+258828954730**, Email:** lucia.ginger@gmail.com / 213568981@stu.ukzn.ac.za
Supervisor: Prof. Irene Govender, **Tel**: +27312603485, **Email:** govenderi4@ukzn.ac.za
HSSREC Research Office: Ms Phumelele Ximba, **Tel**:+2731 260 3587, **Email:** ximbap@ukzn.ac.za

You are being asked to participate in an academic research project conducted by Lucia Ginger, a student in the Department of Information System and Technology, University of Kwazulu-Natal (UKZN), South Africa, and a staff member of the University of St. Thomas of Mozambique. The research topic is **A socio-technical understanding of Information and Communication Technology (ICT) in education - a case study of three secondary schools in Mozambique.** The results of this research will be used solely for academic purposes. You were selected as a possible participant in this study because your school has been piloted with computer and the Internet use in class. Please, take time to read the information below, and ask questions about anything that is not clear or if you would like more information.

- This interview is voluntary. You have the right not to answer any question, and to stop the interview at any time for any reason. The interview is expected to take about 30 minutes.

- The researcher would like to record this interview so that it can be quoted accurately in this study. An electronic recording will be made if you grant permission for this.

- All data will be stored in a secure space. Confidentiality and anonymity are assured. After the research the data will be destroyed according to UKZN ethics protocols.

DECLARATION

I…… (full names of participant) hereby confirm that I understand the contents of this document and the nature of the research project, and I consent to participate in the research project.

I understand that I am at liberty to withdraw from the project at any time, should I so desire. I hereby provide consent for the audio recording of my interview YES NO

SIGNATURE OF PARTICIPANT DATE

_____ _____

Appendix E
(Portuguese translation of the consent form teacher)

UNIVERSITY OF KWAZULU-NATAL
College of Law and Management Studies
School of Management, Information Technology and Governance

TERMO DE CONSENTIMENTO – Professor(a)

Pesquisadora: Lucia Ginger**,** Tel:+258828954730**, Email:** lucia.ginger@gmail.com / 213568981@stu.ukzn.ac.za
Supervisora: Prof. Irene Govender, **Tel**: +27312603485, **Email:** govenderi4@ukzn.ac.za
Departamento de Ética em Pesquisas da UKZN - HSSREC: Sra. Phumelele Ximba,
Tel:+2731 260 3587, **Email:** ximbap@ukzn.ac.za

O(a) Senhor(a) professor(a) está sendo convidado(a) a participar, como voluntário(a), de um estudo de carácter académico. Meu nome é Lúcia Ginger, sou estudante no departamento de Sistemas de Informação e Tecnologias da Universidade de Kwazulu-Natal, República de Africa de Sul, e funcionária na Universidade São Tomás de Moçambique. A pesquisa tem como tema ***A socio-technical understanding of Information and Communication Technology (ICT) in education - a case study of three secondary schools in Mozambique*.** Os resultados deste estudo, serão usados apenas para fins académicos.

Após receber os esclarecimentos das informações que se seguem, no caso de aceitar fazer parte do estudo, assine ao final deste documento. Em caso de dúvida sobre o estudo, poderá entrar em contacto com a pesquisadora responsável ou com a supervisora do mesmo, nos endereços acima indicados. Em casos de dúvidas sobre os seus direitos como participante neste estudo, poderá entrar em contacto com o departamento de Ética em Pesquisas da UKZN - **HSSREC**.

Use o tempo que for necessário para ler e compreender as informações que se seguem, podendo proceder a qualquer questionamento, adiccionar ou comentar sobre as mesmas.

- A sua participação é voluntária e a recusa em participar não irá acarretar qualquer penalidade;
- A sua participação é livre, isto é, poderá retirar o seu consentimento ou interromper a sua participação a qualquer momento;
- Não é obrigado(a) a responder à todas questões colocadas, podendo interromper a sua participação em qualquer fase da pesquisa sem prejuízo. A entrevista terá a duração estimada de 20 minutos;
- Para facilitar a recolha e análise da informação, a pesquisadora gostaria de proceder a gravação da entrevista. Porém, a gravação electrónica terá lugar após sua permissão;

- A informação recolhida neste estudo, será tratada e armazenada com confidencialidade e a mesma será referenciada de forma anónima. De salientar que depois do estudo, a informação será destruída de acordo com o protocolo de ética em uso na UKZN.

DECLARAÇÃO

Eu…… (nome completo do participante), fui esclarecido(a) sobre o conteúdo deste documento, natureza do estudo e das minhas condições em participar do mesmo e dou livremente o meu consentimento.

Sei que em qualquer momento poderei interromper a minha participação neste estudo se assim o desejar. A minha participação é voluntária e autorizo a gravação electrónica da entrevista.
Sim ( ) Não ( )

Assinatura do Participante _____ Data _____

Appendix F

UNIVERSITY OF KWAZULU-NATAL
College of Law and Management Studies
School of Management, Information Technology and Governance

Questionnaire survey - Teachers

Research topic: A socio-technical understanding of Information and Communication Technology (ICT) in education - a case study of three secondary schools in Mozambique. The questionnaire survey seeks to explore the experience and views of teachers about the use of computers and the Internet in class.

Demographic information

1	**Gender**		Male		
			Female		
2	**Age**				
	Under 21	21 – 25	26 - 30	31 and older	
3	**Highest Level of academic qualification**				
	Basic	Middle		higher	
4	**Professional training**		Yes		
			No		
5	**Indicate your access to a computer with the Internet connection at home**				
	I do not have a computer at home	I have a computer without Internet		I have a computer with the Internet connection	
6	**Indicate your access to a smartphone and its usage for the Internet connection**				
	I do not have a smartphone	I do have a smartphone but I do not use it to access the Internet		I have a smartphone and use it to access the Internet	
7	**Do you use your own technology to perform school activities?**		Yes		
			No		
			Not applicable		
8	**How long have you been using technology in school?**				
	Never	up to 5 years		more than 5 years	
9	**How often do you use technology?**				
	Never	Less than once a month	at least once a month	at least once a week	at least once a day

Indicate the factors that are preventing you from using technology for teaching (tick all that apply)

	Factors	**Tick**
10	I do not have skills	
11	I am not interested	
12	I do not have time	
13	There are no computers available	
14	It is not compulsory	

Indicate how often you use technology for the following purpose in school:

	Purpose	never	rarely	sometimes	often
15	Teaching				
16	Administrative work				
17	Search for academic material				
18	Communication				

Indicate how often you use the following applications for school work:

	Application	never	rarely	sometimes	often
19	Word processing				
20	Spreadsheet				
21	PowerPoint				
22	Data base				
23	Graphic programs				
24	Internet				
25	Social networking				

Please rate your level of agreement with each following statement:

	Performance expectancy	**Strongly Disagree**	**Disagree**	**Neutral**	**Agree**	**Strongly Agree**
26	The availability of ICT and school infrastructure will improve my performance as a teacher					
27	Using the technology will enable me to accomplish school activities easily					
28	The use of technology in school will save me time and effort					
29	The students' ICT skills are very limited to be able to use technology in class					
30	The use of technology will help me to keep track of students grades					
31	Technology will make my preparation of teaching material easy					
32	Compared to traditional teaching, using technology will increase my productivity					
	Effort expectancy	**Strongly Disagree**	**Disagree**	**Neutral**	**Agree**	**Strongly Agree**
33	Using technology is easy for me					
34	It is easy to use technology if one receives proper training					
35	It is easy for me to integrate technology into pedagogical activities					
	Social influence	**Strongly Disagree**	**Disagree**	**Neutral**	**Agree**	**Strongly Agree**
36	My colleagues and friends who use ICT, think that I should use technology in class					
37	My family think that I should use technology					

	in class					
38	The Head of school supports the use of technology in class					
39	The Ministry of Education supports the integration of technology into the curriculum					
Facilitating conditions		**Strongly Disagree**	**Disagree**	**Neutral**	**Agree**	**Strongly Agree**
40	I have the necessary resources to use technology in class					
41	I have adequate skills to use technology in class					
42	The school infrastructure is not adequate to integrate technology into classroom teaching					
43	The curriculum in use is not suitable for the use of technology in class					
44	An ICT technician is available to assist with the technology use in class					
45	A technician is available to help when I have difficulties using the technology					
46	A technician is available to help when the technology breaks down					
Behavioural intention		**Strongly Disagree**	**Disagree**	**Neutral**	**Agree**	**Strongly Agree**
47	I intend to use the available technology in the class in the future					
48	I want to learn how to use technology in order to improve my teaching					
49	I want to improve my ICT skills					
50	I intend making use of technology in class a priority					

Thank you

Appendix F
(Portuguese translation of the questionnaire survey - teachers)

UNIVERSITY OF KWAZULU-NATAL
College of Law and Management Studies
School of Management, Information Technology and Governance

Questionário - Professores

Tema: *A socio-technical understanding of Information and Communication Technology (ICT) in education - a case study of three secondary schools in Mozambique.* O presente questionário visa colher experiências e opiniões de estudantes sobre o uso do computador e da *Internet* nesta escola.

Dados demográficos

1	**Sexo**	Masculino ◯			
		Feminino ◯			
2	**Idade**				
	Menos de 21 ◯	De 21 a 25 anos ◯	De 26 a 30 anos ◯	Mais de 30 anos ◯	
3	**Nível académico**				
	Básico ◯	Médio ◯	superior ◯		
4	**Teve formação profissional?**	Sim ◯			
		Não ◯			
5	**Acesso a um computador com ligação a *Internet* em casa**				
	Não tenho computador em casa ◯	Tenho computador sem ligação à *Intenet* ◯	Tenho computador com ligação à *Intenet* ◯		
6	**Acesso a um *smartphone* e sua utilização para aceder a *Intenet***				
	Não tenho um *smartphone* ◯	Tenho um *smartphone* mas não o uso para aceder a *Internet* ◯	Tenho um *smartphone* e tenho usado o mesmo para aceder a *Internet* ◯		
7	**Tem usado computador e ou *smartphone* pessoal como meio auxíliar para realizar trabalhos da escola?**	Sim ◯			
		Não ◯			
		Não se aplica ◯			
8	**Há quanto tempo usa computador na escola?**				
	Nunca ◯	Menos de 5 anos ◯	Mais de 5 anos ◯		
9	**Qual é a frequência de uso de computador?**				
	Nunca ◯	Uma vez em cada dois meses ◯	Pelo menos uma vez por mês ◯	Pelo menos uma vez por semana ◯	Pelo menos vez por dia ◯

Da lista que segue, indique os factores que influenciam para a não utilização da technologia na sua actividade de ensino (indique todos os factores possíveis)

	Factores	**Tick**
10	Não tenho conhecimentos suficientes para usar TICs	
11	Não tenho interesse em usar as TICs	
12	Falta de tempo	

13	Não tenho computador disponível	
14	Falta de obrigatoriedade para o uso de computador	

Indique a frequência do uso da technologia na escola para os *items* que se seguem:

	Purpose	**nunca**	**raro**	**ocasional**	**sempre**
15	Ensino				
16	Trabalho administrativo				
17	Pesquisas na *Internet*				
18	Comunicação				

Indique a frequência do uso das apliacações abaixo indicadas na realização dos trabalhos da escola:

	Application	**Nunca**	**Raro**	**Ocasional**	**Sempre**
19	*MS office - Word*				
20	*MS office – Excel*				
21	*MS office - PowerPoint*				
22	Base de Dados				
23	Programas gráficos				
24	*Internet*				
25	Redes socias				

Indique o seu nível de concordância em relação a cada declaração seguinte:

Expectativa de desempenho		**Discordo completamente**	**Discordo**	**Neutro**	**Concordo**	**Concordo completamente**
26	O uso de TICs irá melhorar o meu desempenho profissional					
27	O uso das TICs permitirá realizar as minhas tarefas facilmente					
28	O uso das TICs permitirá realizar as minhas tarefas mais rapidamente					
29	As competências dos alunos são limitadas para a utilização das TICs no ensino					
30	O uso da tecnologia ajudará a manter melhor controle de notas dos meus alunos					
31	A preparação do material didático será mais fácil com o uso das TICs					
32	Comparado ao ensino tradicional, o uso de TICs aumentará minha produtividade					
Expectativa de Esforço		**Discordo completamente**	**Discordo**	**Neutro**	**Concordo**	**Concordo completamente**
33	Aprender a usar TICs é ou foi fácil para mim					
34	Com a capacitação que tive, foi fácil usar as TICs					
35	Usar as TICs nas actividades pedagógias é ou foi fácil para mim					
Influência Social		**Discordo**	**Discordo**	**Neutro**	**Concor**	**Concordo**

		completamente			**do**	**completamente**
36	Meus amigos e colegas que usam TICs acham que eu devo usar tecnologia					
37	Meus familiars acham que eu deveria integrar TICs nas minhas aulas					
38	O director da escola incentiva o uso das TICs no processo de ensino					
39	O Ministério da Educação apoia a intergração das TICs no processo de ensino e aprendizagem					
Condições Facilitadora		**Discordo completamente**	**Discordo**	**Neutro**	**Concordo**	**Concordo completamente**
40	Eu tenho recursos (tempo, computador, acesso à Internet, etc) necessários para integrar TICs no processo de ensino					
41	Tenho competências para integrar TICs nas minhas aulas					
42	A escola possui infraestruturas básicas para a integração das TICs no processo de ensino					
43	O currículum em uso é adequado para integração do computador como meio auxiliar de ensino					
44	Há um técnico disponível para ajudar no uso das TICs no processo de ensino					
45	Há um técnico disponível para ajudar sempre que tenho dificuldades no uso computador					
46	Há um técnico disponível para consertar sempre que um computador deixa de funcionar					
Intenção comportamental		**Discordo completamente**	**Discordo**	**Neutro**	**Concordo**	**Concordo completamente**
47	Eu pretendo usar os recursos tecnológicos disponíveis para o ensino no futuro					
48	Eu quero aprender como usar as TICs para melhor a minha actividade de leccionação					
49	Eu quero melhor as minhas compentências em TICs					
50	Eu pretendo tornar o uso de computador no ensino como prioridade					

Obrigada

Appendix G

UNIVERSITY OF KWAZULU-NATAL
College of Law and Management Studies
School of Management, Information Technology and Governance

Questionnaire survey - Students

Research topic: A socio-technical understanding of Information and Communication Technology (ICT) in education - a case study of three secondary schools in Mozambique.

The questionnaire survey seeks to explore the experience and views of students about the use of computers and the Internet in class.

Demographic information

1	**Gender**		Male	
			Female	
2	**Age**			
	Under 15	15 – 18	19 - 20	20 and older
5	**Indicate your access to a computer with the Internet connection at home**			
	I do not have a computer at home	I have a computer without Internet	I have a computer with Internet connection	
6	**Indicate your access to a smartphone and its usage for the Internet connection**			
	I do not have a smartphone	I do have a smartphone but I do not use it to access the Internet	I have a smartphone and use it to access the Internet	
7	**Do you use your own technology to perform school activities?**		Yes	
			No	
			Not applicable	
8	**How long have you been using technology in school?**			
	Never	Up to 6 months	More than 6 months	
9	**How often do you as a student use technology in class?**			
	Never	Less than once a month	At least once a month	At least once a week	At least once a day

Indicate the factors that are preventing you from using technology for school activities (tick all that apply)

	Factors	**Tick**
10	I do not have skills	
11	I am not interested	
12	I do not have time	
13	There are no computers available	
14	It is not compulsory	

Indicate how often you use technology for the following purpose in school:

	Purpose	never	rarely	sometimes	often
15	Learning				
16	Internet searching				
17	Communication				

Indicate how often you use the following application for school work:

	Application	never	rarely	sometimes	often
18	Word processing				
19	Spreadsheet				
20	PowerPoint				
21	Database				
22	Graphics programmes				
23	Internet				
24	Social networking				

Please rate your level of agreement with each following statement:

	Performance expectancy	**Strongly Disagree**	**Disagree**	**Neutral**	**Agree**	**Strongly Agree**
25	The use of technology will improve my studies					
26	The availability of ICT and school infrastructure will improve my performance as a student					
27	Using the technology will enable me to accomplish school activities easily					
28	The use of technology will enable me to get academic information easily					
29	The use of technology will help me to perform homework easily					
30	Compared to traditional learning, using technology will increase my productivity					
	Effort expectancy	**Strongly Disagree**	**Disagree**	**Neutral**	**Agree**	**Strongly Agree**
31	Using technology is easy for me					
32	My interaction with technology in class is clear and understandable					
33	It is difficult to use technology in all subjects					
	Social influence	**Strongly Disagree**	**Disagree**	**Neutral**	**Agree**	**Strongly Agree**
34	My friends who use ICT think that I should use technology					
35	My family think that I should use technology in class					
36	My teachers encourage me to use technology					
37	The school principal supports the integration of technology in the curriculum					
	Facilitating conditions	**Strongly**	**Disagree**	**Neutral**	**Agree**	**Strongly**

		Disagree				**Agree**
38	I have the necessary resources to learn how to use technology					
39	My teachers are competent to use technology in class					
40	The school infrastructure is not adequate for integrating technology into classroom learning					
41	The curriculum in use is not suitable for the use of technology in class					
42	An ICT technician is available to assist with the technology use in class					
43	An ICT technician is available to help when I have difficulties using the technology					
44	An ICT technician is available to help when the technology breaks down					
Behavioural intention		**Strongly Disagree**	**Disagree**	**Neutral**	**Agree**	**Strongly Agree**
45	I intend to use the available technology in class in the future					
46	I want to learn how to use technology in order to improve my learning					
47	I want to improve my ICT skills					

Thank you

Appendix G
(Portuguese translation of the questionnaire survey - Students)

UNIVERSITY OF KWAZULU-NATAL
College of Law and Management Studies
School of Management, Information Technology and Governance

Questionário – Estudantes

Tema: *A socio-technical understanding of Information and Communication Technology (ICT) in education − a case study of three secondary schools in Mozambique*. O presente questionário visa colher experiências e opiniões de estudantes sobre o uso do computador e da *Intern*et nesta escola.

Dados demográficos

1	**Sexo**		Masculino Feminino	
2	**Idade**			
	Menos de 15 anos	De 15 a 18 anos	De 19 a 20 anos	Mais de 20 anos
5	**Acesso a um computador com ligação à *Internet* em casa**			
	Não tenho acesso ao computador em casa	Tenho acesso ao computador sem ligação à *Intenet*	Tenho acesso ao computador com ligação a *Intenet* ◯	
6	**Acesso a um *smartphone* e sua utilização para aceder a *Intenet***			
	Não tenho um *smartphone* ◯	Tenho um *smartphone* mas não o uso para aceder a *Internet* ◯	Tenho um *smartphone* e tenho usado o mesmo para aceder a *Internet*	
7	**Tem usado computador e ou *smartphone* pessoal como meio auxíliar para realizar trabalhos da escola?**		Sim Não Não se aplica	
8	**Há quanto tempo usa computador na escola?**			
	Nunca usei	menos de 6 meses	mais de 6 meses	
9	**Qual é a frequência de uso de computador na escola?**			
	Nunca usei ◯	uma vez em cada dois meses ◯	pelo menos uma vez por mês ◯	pelo menos uma vez por semana ◯	pelo menos uma vez por dia ◯

Da lista que segue, indique os factores que influenciam para a não utilização da technologia na realização de trabalhos da escola (indique todos os factores possíveis)

	Factores	***Tick***
10	Não tenho conhecimentos suficientes para usar TICs	

11	Não tenho interesse em usar as TICs	
12	Falta de tempo	
13	Não tenho computador disponível	
14	Falta de obrigatoriedade para o uso de computador	

Indique a frequência do uso da technologia na escola para os *items* que se seguem:

	Item	**nunca**	**raro**	**ocasional**	**sempre**
15	Aprendizagem				
16	Pesquisas na *Intenet*				
17	Comunicação				

Indique a frequência do uso das aplicações abaixo indicadas na realização dos trabalhos da escola:

	Aplicação	**nunca**	**raro**	**ocasional**	**sempre**
18	*MS office - Word*				
19	*MS office – Excel*				
20	*MS office - PowerPoint*				
21	Base de Dados				
22	Programas gráficos				
23	*Internet*				
24	Redes socias				

Indique o seu nível de concordância em relação a cada declaração seguinte:

Expectativa de desempenho		**Discordo completamente**	**Discordo**	**Neutro**	**Concordo**	**Concordo completamente**
25	O uso de TICs irá melhorar o meu desempenho académico					
26	O uso de TICs permitirá realizar trabalhos da escola com mais facilidade					
27	O uso das TICs permitirá realizar as minhas tarefas mais rapidamente					
28	O uso de TICs permitirá obtenção de informação académica facilmente					
29	O uso da techologia, irá facilitar-me na realização do TPC					
30	Comparado ao ensino tradicional, o uso de TICs aumentará minha produtividade					
Expectativa de Esforço		**Discordo completamente**	**Discordo**	**Neutro**	**Concordo**	**Concordo completamente**
31	Aprender a usar TICs é ou foi fácil para mim					
32	Minha interação com as TICs é clara e de fácil compreensão					
33	È facil usar TICs como meio auxiliar as aulas					

Influência Social		Discordo completamente	Discordo	Neutro	Concordo	Concordo completamente
34	Meus amigos que usam TICs acham que eu devo usar technologia					
35	Meus familiars acham que eu devo usar TICs na escola					
36	Meus professores ncentivam o uso das TICs na realização das actividades académicas					
37	O director da escola tem dado suporte para a utilizar TICs no processo de ensino e aprendizagem					
Condições Facilitadora		**Discordo completamente**	**Discordo**	**Neutro**	**Concordo**	**Concordo completamente**
38	Eu tenho recursos (tempo, computador, acesso à Internet, etc) necessários para aprender a utilizar TICs					
39	Meus professores possuem competênciapara integrar as TICs no processo de aprendizagem					
40	A escola possui infrastruturas básicas para a integração das TICs no processo de aprendizagem					
41	O currículum em uso é adequado para integração do computador como meio auxiliar de aprendizagem					
42	Há um técnico disponível para ajudar no uso das TICs no processo de aprendizagem					
43	Há um técnico disponível para ajudar sempre que tenho dificuldades no uso computador					
44	Há um técnico disponível para consertar sempre que um computador deixa de funcionar					
Intenção comportamental		**Discordo completamente**	**Discordo**	**Neutro**	**Concordo**	**Concordo completamente**
45	Eu pretendo usar os recursos tecnológicos disponíveis para aprendizagem no futuro					
46	Eu quero aprender como usar as TICs para melhorar o processo da minha aprendizagem					
47	Eu quero melhor as minhas compentências em TICs					

Obrigada

Appendix H

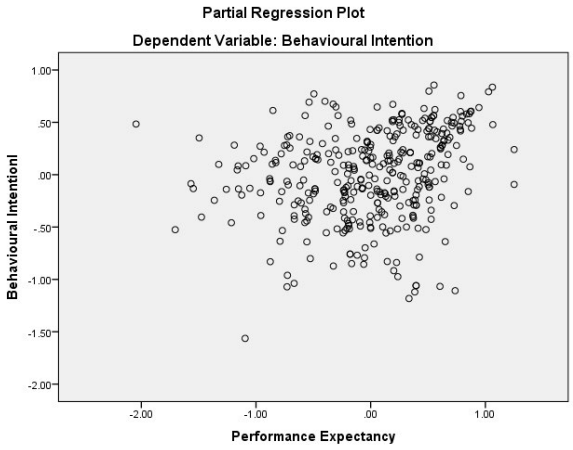
Table for Determining Sample Size from a Given Population

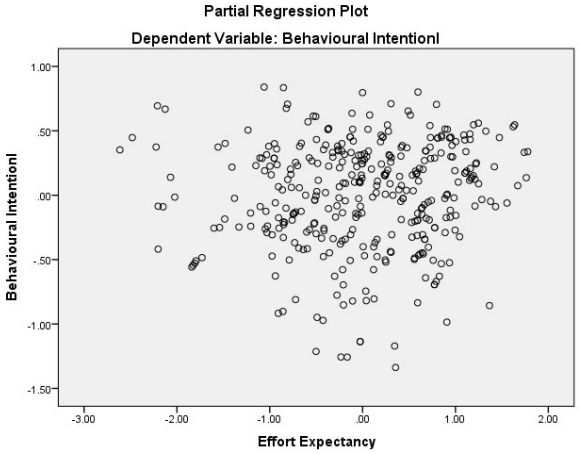
N	*S*	*N*	*S*	*N*	*S*
10	10	220	140	1200	291
15	14	230	144	1300	297
20	19	240	148	1400	302
25	24	250	152	1500	306
30	28	260	155	1600	310
35	32	270	159	1700	313
40	36	280	162	1800	317
45	40	290	165	1900	320
50	44	300	169	2000	322
55	48	320	175	2200	327
60	52	340	181	2400	331
65	56	360	186	2600	335
70	59	380	191	2800	338
75	63	400	196	3000	341
80	66	420	201	3500	346
85	70	440	205	4000	351
90	73	460	210	4500	354
95	76	480	214	5000	357
100	80	500	217	6000	361
110	86	550	226	7000	364
120	92	600	234	8000	367
130	97	650	242	9000	368
140	103	700	248	10000	370
150	108	750	254	15000	375
160	113	800	260	20000	377
170	118	850	265	30000	379
180	123	900	269	40000	380
190	127	950	274	50000	381
200	132	1000	278	75000	382
210	136	1100	285	1000000	384

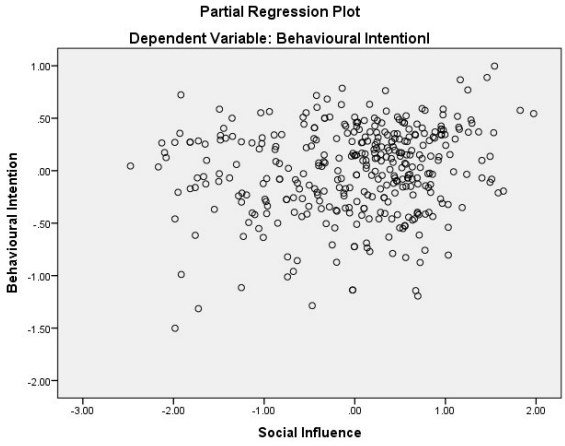
Note.—*N* is population size.
S is sample size.

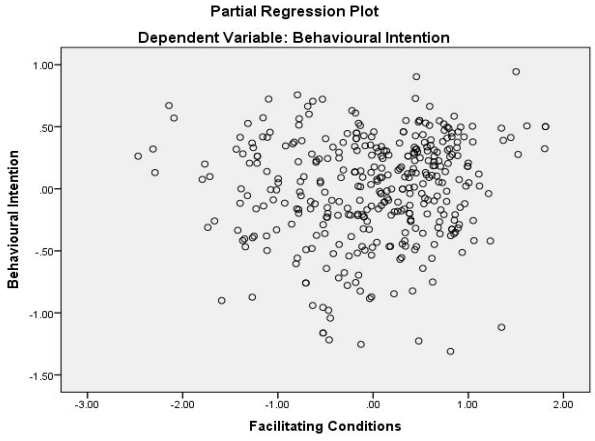
Appendix I

Scatter plots between dependent (behavioural intention) and independent variables (performance expectancy, effort expectancy, social influence, and facilitating conditions)

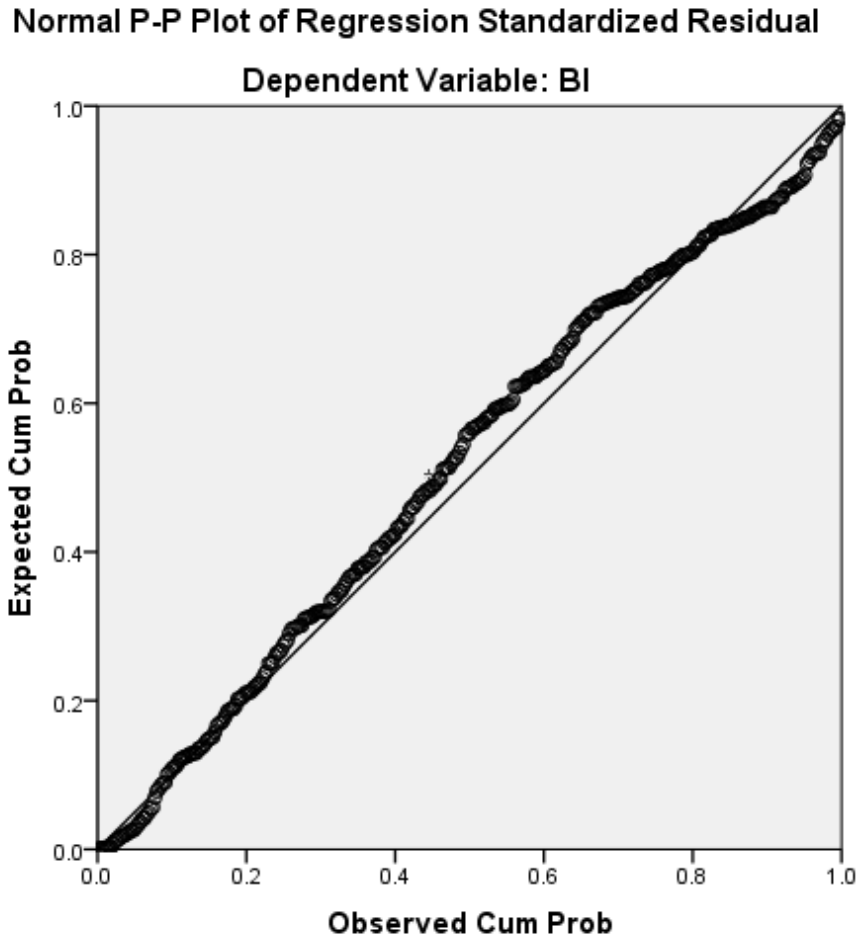








Appendix J


Normal P-P Plot of Regression Standardized Residual
Dependent Variable: BI
Expected Cum Prob
Observed Cum Prob
0.0
0.2
0.4
0.6
0.8
1.0

Appendix K

UNIVERSITY OF KWAZULU-NATAL
INYUVESI YAKWAZULU-NATALI

09 January 2015

Mrs Lucia Joaquim Ginger 213568981
School of Management, IT & Governance
Westville Campus

Protocol reference number: HSS/1478/014D
Project title: The integration of Informal and Communication Technology (ICT) in the secondary school education system: a case study of Maputo Province in Mozambique.

Dear Ms Ginger

Expedited Approval

In response to your application dated 12 November 2014, the Humanities & Social Sciences Research Ethics Committee has considered the abovementioned application and the protocol have been granted **FULL APPROVAL.**

Any alteration/s to the approved research protocol i.e. Questionnaire/Interview Schedule, Informed Consent Form, Title of the Project, Location of the Study, Research Approach and Methods must be reviewed and approved through the amendment/modification prior to its implementation. In case you have further queries, please quote the above reference number.

Please note: Research data should be securely stored in the discipline/department for a period of 5 years.

The ethical clearance certificate is only valid for a period of 3 years from the date of issue. Thereafter Recertification must be applied for on an annual basis.

I take this opportunity of wishing you everything of the best with your study.

[redacted]
/px

cc Supervisor: Dr Irene Govender
cc Academic Leader Research: Professor B McArthur
cc School Administrator: Ms Angela Pearce

Humanities & Social Sciences Research Ethics Committee
Dr Shenuka Singh (Chair)
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