

Faculty of Sciences
Department of Computer Science & Information Systems

**EXAMINING THE EFFECT OF INFORMATION QUALITY AND
GENDER ON SECONDARY SCHOOL TEACHERS' TECHNOLOGY
ACCEPTANCE - A CASE STUDY OF BOTSWANA**

by

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Table of Contents

DECLARATION REGARDING THE WORK AND COPYRIGHT	v
Abstract.....	vii
Acknowledgements	viii
Dedication.....	ix
LIST OF ABBREVIATIONS	x
LIST OF TABLES.....	xii
LIST OF FIGURES.....	xiv
Chapter 1 INTRODUCTION	1
1.1 Introduction	1
1.2 Background to the study.....	2
1.3 Problem Statement.....	5
1.4 Research Objectives.....	5
1.4.1 General Objectives.....	5
1.4.2 Specific Objectives	6
1.4 Research Questions	6
1.5 Justification of the study.....	6
Chapter 2 LITERATURE REVIEW	8
2.1 Introduction	8
2.2 Technology in Education.....	8
2.2.1 The role of Technology in Education	8
2.2.2 Barriers to Technology Acceptance in Education	11
2.2.3 Technology in Education in Africa	12
2.2.4 Technology in Education in Botswana	15
2.3 Factors Influencing teachers' technology adoption and acceptance.	17
2.3.1 Personal Characteristics.....	18
2.3.2 Institutional Characteristics	20
2.3.3 Technology-related Characteristics	22
2.4 Models and Theories that explain factors affecting teachers' technology acceptance.	23
2.4.1 Theory of Reasoned Action (TRA)	25
2.4.2 Theory of Planned Behaviour (TPB)	26

2.4.3 Technology Acceptance Model (TAM).....	27
2.4.4 Innovation Diffusion Theory (IDT)	29
2.4.5 Unified Theory of Acceptance and Use of Technology (UTAUT)	30
2.5 Research gap.....	32
2.6 Theoretical framework and model development.....	33
2.6.2 External Variables	36
2.7 Chapter Summary	41
Chapter 3 RESEARCH METHODOLOGY	42
3.1 Introduction	42
3.2 Research Design.....	42
3.3 Research Population	45
3.4 Sampling	45
3.4.1 Probability Sampling	46
3.4.2 Sample size	46
3.5 Data Collection Methods	47
3.5.1 Secondary Data Analysis	47
3.5.2 Primary Data Collection	49
3.5.3 Ethical Considerations	50
3.6 Data collection Instrumentation.....	50
3.6.1 Survey Questionnaire	50
3.7 Data Processing and Analysis.....	54
3.7.1 Reliability	55
3.7.2 Validity	55
3.8 Chapter Summary	57
Chapter 4 RESEARCH FINDINGS.....	58
4.1 Introduction	58
4.2 Findings on the existing technology acceptance theories and models and their limitations	58
4.3 Findings on the factors influencing teachers' technology acceptance.....	60
4.4 Findings on the influence of IQ and gender on teachers' technology acceptance	65
4.4.1 Demographic profile for study participants.....	66
4.4.1.1 Gender	66
4.4.1.2 Age	67

4.4.1.3 Work position	68
4.4.1.4 Teaching Subject.....	69
4.4.1.5 Number of Years using Ed-Admin System	71
4.4.2 Frequency analysis on the model variables.....	72
4.4.2 Reliability and validity analysis	82
4.4.3 Hypothesis Testing.....	90
4.4.4 Assessment of total, direct, and indirect effects	92
4.5 Chapter Summary	94
Chapter 5 DISCUSSION OF RESULTS	95
5.1 Introduction	95
5.2 Discussion of results on the existing technology acceptance models and theories.....	95
5.3 Discussion of identification of factors influencing teachers' technology acceptance.....	95
5.4 Discussion of results on the proposed extended Technology Acceptance Model addressing context of Botswana.....	98
5.5 Chapter Summary	102
Chapter 6 OVERVIEW, LIMITATIONS, RECOMMENDATIONS, FUTURE RESEARCH AND CONCLUSION	103
6.1 Overview of the study.....	103
6.2 Limitations	103
6.3 Recommendations	104
6.3.1 More research to be done in technology adoption in basic education in Botswana.	104
6.3.2 Teachers involvement in system development	104
6.3.3 Provision of school-based ICT adoption policy and Teacher trainings	105
6.4 Future research.....	105
6.4.1 Expansion of the study sample	105
6.4.2 Expansion of the study model with more factors.....	105
6.4.3 Expansion and modification of the IQ variable.....	106
6.5 Conclusion.....	106
References	108

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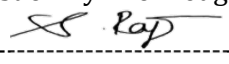
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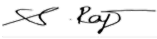
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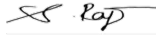
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The undersigned certifies that they have read and hereby recommends for acceptance by the College of ICT a dissertation/thesis entitled '**Examining the Effect of Information Quality and Gender on Secondary Schools' Technology Acceptance – A Case Study of Botswana**' in fulfilment of the requirements for the degree of Master of Science in Information Systems of the Botswana International University of Science and Technology.

For 

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Dr. Selvaraj Rajalakshmi (Co-Supervisor)

Date 02/08/2023

Date 2/08/2023

Abstract

Technology provides means of widening educational opportunities. However, it is also noted that teachers hardly incorporate it in their daily teaching activities. The problem remains more persistent in developing and underdeveloped countries. To date, there is limited or no research in Botswana that examined the factors that can facilitate or hinder usage of technology by secondary school teachers. To further explore this problem, the TAM has been adapted and extended by information quality (IQ) and technology self-efficacy (TSE) to assess teachers' adoption of technology in secondary schools in Botswana.

For the investigation, a quantitative methodology was used. A total of 280 secondary school teachers of different ages and gender from various regions in Botswana participated in the survey. The survey comprised of 40 items which were responded to using Likert's five scale basis. For data processing and analysis, the smart PLS3 statistics software program was used, and structural equation modeling (SEM) was utilized as the main data analysis technique.

The study's findings indicated that TSE, IQ, perceived ease of use plus usability (PEUU), and perceived usefulness (PU) have an influence on teachers' attitude towards using technology with PU contributing the strongest effect ($\beta = 0.590$). However, contrary to the existing literature, TSE did not have any direct influence on the teachers' PU and PEUU. In addition, the findings on gender moderation showed that teachers of both genders do not differ statistically on technology adoption behaviour. However, a significant difference was observed in $PU \rightarrow ATU$ gender groups relationship, with female teachers scoring a stronger effect.

Finally, an assessment on total direct and indirect effects of the model variables indicated that, altogether, the model determinants accounted for 52.2% of the variance in teachers' attitude towards technology use. Overall, the thesis findings show a demonstration of the effectiveness of TAM in predicting teachers' adoption of technology.

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Dedication

My late grandparents as well as my parents are honored in this thesis.

LIST OF ABBREVIATIONS

IT – Information Technology

ICT – Information and Communications Technology

TAM – Technology Acceptance Model

BIUST – Botswana International University of Science and Technology

BOSciCTA – Botswana Schools Information and Communication Technology Association

MCST – Ministry of Communication, Science and Technology

MoESD – Ministry of Education and Skills Development

MoBE – Ministry of Basic Education

UNESCO – United Nations Education, Science and Cultural Organisation

UIS – Institute for Statistics

PU – Perceived Usefulness

PEU – Perceived Ease of Use

PEUU – Perceived Ease of Use +Usability

TSE – Technology Self-Efficacy

IQ – Information Quality

ATU – Attitude towards Using

RNPE – Revised National Policy for Education

ETSSP – Education and Training Sector Strategic Plan

WWW – World Wide Web

ITU – International Telecommunications Union

TRA – Theory of Reasoned Action

TPB – Theory of Planned Behaviour

IDT – Innovation Diffusion Theory

UTAUT – Unified Theory of Acceptance and Use of Technology

PBC – Perceived Behavioural Control

PE – Performance Expectancy

EE – Effort Expectancy

SI – Social Influence

FC – Facilitating Conditions

SN – Subjective Norm

SEM – Structural Equation Modelling

CFA – Confirmatory Factor Analysis

AVE – Average Variance Extracted

CR – Composite Reliability

LIST OF TABLES

Table 1.1: Examples of Adopt a School Initiative Donations	4
Table 2.1: Barriers in Technology Adoption in Education	12
Table 2.2: Summary of Models and Theoretical Frameworks on End-Users' Technology Acceptance	24
Table 2.3: Definitions of Constructs in Technology Acceptance Models and Theories	32
Table 3.1: Summary of Study Main Variables and their Sources	45
Table 3.2: Likert Scale and their codes	47
Table 3.3: Perceived Ease of Use + Usability Constructs	52
Table 3.4: Perceived Usefulness Constructs	52
Table 3.5: Attitude Towards Use Constructs	52
Table 3.6: Technology Self-Efficacy Constructs	53
Table 3.7: Information Quality Constructs	54
Table 3.8: Internal consistency and significance (Source [138])	55
Table 4.1: Summary of Contributions and Limitations of Technology Acceptance Models and Theories	58
Table 4.2: Summary of Reviewed Studies on Factors Influencing Technology Adoption in Education	60
Table 4.3: Factors influencing teachers' technology acceptance from the literature review.	65
Table 4.4: Distribution of gender	66
Table 4.5: Age Distribution	67
Table 4.6: Work Position Distribution	68
Table 4.7: Grouping of teaching subjects	70
Table 4.8: Teaching subject distribution	70
Table 4.9: No. of years using Ed-Admin system distribution	71
Table 4.10: Attitude Towards Use frequency distribution	73
Table 4.11: Perceived Ease of Use + Usability	74
Table 4.12: Perceived Usefulness frequency distribution	76
Table 4.13: Technology Self-Efficacy distribution	78
Table 4.14: Information Quality frequency distribution	81
Table 4.15: Reliability analysis	83
Table 4.16: The mean and standard Deviation for ATU items	83
Table 4.17: Reliability analysis	83
Table 4.18: The mean and standard Deviation for PEUU items	84
Table 4.19: Reliability Analysis	84
Table 4.20: The mean and standard Deviation for PU items	85
Table 4.21: Reliability analysis	85
Table 4.22: The mean and standard Deviation for TSE items	85
Table 4.23: Reliability analysis	86
Table 4.24: The mean and standard Deviation for IQ items	86
Table 4.25: Convergent validity	88

Table 4.26: Fornell-Larcker matrix.....	89
Table 4.27: Heterotrait-Monotrait ratio	90
Table 4.28: Direct and Indirect Effects on Dependent Variables	92
Table 4.29: Hypotheses Testing Results	94
Table 0.1: Appendix 1 Study Constructs Items	121

LIST OF FIGURES

Figure 2.1: Theory of Reasoned Action (adapted from Fishbein & Azjen [85])	26
Figure 2.2: Theory of Planned Behavior (adapted from Ajzen [86])	27
Figure 2.3: Original Technology Acceptance Model (adapted from Davis [87])	29
Figure 2.4: Unified Theory of Acceptance and Use of Technology (adapted from Venkatesh et al [88])	31
Figure 2.5: Proposed Research Model (Adapted from [102], [71])	35
Figure 3.1: Dataset sample for the data collected from teachers.....	46
Figure 4.1: Gender Distribution	67
Figure 4.2: Age Distribution	68
Figure 4.3: Work position distribution	69
Figure 4.4: Teaching subject distribution	71
Figure 4.5: No. of years using Ed-Admin system distribution.	72
Figure 4.6: Attitude Towards Use frequency distribution	73
Figure 4.7: Perceived Ease of Use + Usability.....	75
Figure 4.8: Perceived Usefulness frequency distribution	77
Figure 4.9: Technology Self-Efficacy distribution.....	80
Figure 4.10: Information Quality frequency distribution	82
Figure 4.11: Cronbach's Alpha values.....	83
Figure 4.12: Composite Reliability test.....	87
Figure 4.13: Average Variance Extracted	87
Figure 4.14: Path coefficients for all relationships	90
Figure 4.15: Standardized path coefficients for all respondents.....	91
Figure 4.16: Standardized Path Coefficients for Gender Differences.....	93

Chapter 1 INTRODUCTION

1.1 Introduction

Information and Communication Technology (ICT)'s rapid development has brought about a change in all areas of the economy worldwide [1]. Kawari & Sain [2] defined ICT as “a combination of technological tools and resources that are used to manipulate and communicate information”. The education sector has as well been affected by this evolution. Information Technology (IT) development and advancement had led to a change in the set-up of education systems globally. Alshmrany and Wilkinson [3] argue that ICT can provide innovative alternatives to the instructional and learning barriers experienced in the conventional system by offering a platform for novel teaching approaches and effective administration instruments. According to Wong and colleagues [4], these innovations have increased the capacity of educators to handle and distribute knowledge and they further provided an opportunity for learners to improve the acquisition of new knowledge in different aspects. With the rapid changes brought about by ICT, it is vital for teachers to adjust to the changes for them to be relevant and be current with the new educational system [5].

The use of information technology in today's classroom is crucial. In recent decades, technology-infused education has been proposed and introduced by governments globally [6]. In education, Information and Communication Technologies (ICTs) include the use of computer systems, the internet, projectors, radios, and televisions [7]. According to Courville [8], the role of technology in a traditional school setup is to increase efficiency and effectiveness in the transfer and acquisition of skills and knowledge. Courville [8] defined efficiency as “the quickness by which we obtain knowledge while effectiveness is associated with the amount of imparted knowledge that is operationally mastered”. Several scholars [9], [8], [9] have articulated on the advantages of ICT usage in education. Listed below are some of the suggested benefits of utilising ICTs in teaching and learning.

1. supporting student-centred learning
2. Producing a creative and innovative learning environment.

3. Promoting collaborative learning more especially in distance environments.
4. Offering skills needed for succeeding in the digital age.

Numerous scholars [10], [11], [12] have argued that teachers are regarded as agents in regards to acceptance and use of technology in the education fraternity. Despite the benefits linked to the usage of technology in teaching and learning activities, there has been high resistance observed among public school teachers worldwide [13]. Consequently, teachers' technology adoption and acceptance has been an area of interest for researchers see [4], [11], [14], [15], [16], [12] over the past decades. This study investigates the degree to which information Quality (IQ) and gender influence teachers' technology acceptance of information systems utilizing the Technology Acceptance Model (TAM) as a theoretical foundation. In this chapter, the background or context of the research, the problem statement, the general and specific objectives, the research questions, and the justification of the study are discussed further.

1.2 Background to the study

Utilisation of ICTs in education is growing all over the world-wide, more so that the developing countries, have since joined the race of technological evolution and are investing heavily in preparing their communities for the educational evolution [9].

Botswana, just like other developing countries responded to the global reforms in education prompted by globalization few decades ago. Globalisation has been defined as "the process of world shrinkage, of distances getting shorter, and things moving closer" [17]. It has to do with how much easier it is for people on the opposite sides of the globe to interact with one another for mutual gain.

Botswana has since made several significant attempts of endorsing the usage of technologies across all economic sectors. In the last two decades, before other reforms aimed at achieving the same goal of ICT adoption, the Botswana government launched a 10 year-long vision called vision 2016: Towards Prosperity for all. The vision was one of the government's reactions to the global evolution of the information age and wished to accommodate for people of Botswana to be ready to adapt to challenges which come with the evolution. The vision

contained seven pillars of which the first one was “an informed and educated nation”. The emphasis on this pillar was to establish a lifelong learning culture with much focus on having a community that fits in the modern information age. The desire was that all education levels must be reformed to meet the knowledge-based community standards. The government has envisioned an education system that will empower a citizen to become innovative and competitive globally. As such, more programmes, as discussed below, were developed, and implemented, guided by the objectives of the vision 2016 policy.

In 2007, the government of Botswana, via the then Ministry of Communication, Science and Technology (MCST) established a National Information and Communication Technology policy called Maitlamo to accommodate technological evolution programs. The ICT policy was mandated to provide a roadmap for driving the country’s social, economic, cultural, and political transformations by using information and communication technologies to advance national development [18]. The policy defined the proposed programmes that will be implemented in the six key areas of national development, which are;

- 1) community access and development
- 2) government
- 3) learning
- 4) health
- 5) economic development and growth of the ICT sector
- 6) Infrastructure and security and legislation and policy.

For the learning category, Maitlamo national ICT policy [18] proposed a program called Thutonet also known as the school connectivity program. In 2014, the education sector through the Ministry of Education and Skills Development (MoESD) launched the Thutonet programme. The programme was mandated to address one of the primary goals of the country’s ICT policy which was to develop a lifelong learning culture which will maximize potential among citizens and swiftly construct knowledge-based systems through innovation. The programme was to cover all categories of education for all of citizenship from children to adults.

The Thutonet provided both the agenda and platform for the coordinated delivery of ICTs in the education sector, which covered among others the provision of modern ICT equipment, improvement of the student-to-computer ratio and ICT integration in all levels of education.

With the implementation of Thutonet, the Botswana government equipped computer laboratories in all junior and senior secondary schools with computer systems. The education ministry also received some donations in the form of computers and other ICTs from private sector companies through the initiative called “Adopt a School”. Adopt a school initiative was a call by the government to individuals, the business community, and non-governmental organizations to aid with the support of resources or services needed by schools to strengthen and improve the standard of education in public schools. As a result, several schools (see table 1 for examples of donations), both primary and secondary, received donations in form of IT equipment through the initiative.

Table 1.1: Examples of Adopt a School Initiative Donations

School	Donation	Donor	Reference
Motsumi Junior Secondary school	Computers	Botswana Fibre Networks	[19]
Kareng Primary Schools	Computers	Botswana Stock Exchange	[20]
Metsimantsho Primary School		Botswana Stock Exchange	[20]

The Ministry of Education also procured a browser-based software called Educational Administration System (Ed-Admin) for both junior and senior schools. The Ed-Admin system is a system that manages all school-based activities such as academic, student, staff, finance, and school infrastructure recording and management. The system was introduced to enable the schools to shift from the traditional manual method of managing work-related records such as student performance cards.

Besides IT equipment acquisition, certain higher institutions of learning assisted the government with training in-service secondary schools on basic IT skills. For example, the Botswana International University of Science and Technology (BIUST) partnering with the Botswana Schools Information and Communication Technology Association (BoSciCTA) and Ministry of Basic Education (MoBE) trained 938 secondary school in-service teachers and administrators on basic computers skills course called Comp 101 from 2016 through to 2018 as reported on WeekndPost newspaper dated 4th of June 2018.

1.3 Problem Statement

Despite the government's efforts discussed in section 1.2, integration of technology in basic education in Botswana is still lagging and teachers are not utilizing available technologies in schools [21]. According to Teo [22] the degree to which technology's incorporation into education is well implemented is dependent on a teacher's eagerness to make use of technology in learning and teaching activities. A teacher is one of the most important players in any effective incorporation of technology in learning and teaching [22]. Therefore, it is important to have a better comprehension on the factors that affect teachers' usage of technology in teaching.

The government of Botswana wishes to have improved and increased technology use in basic education schools. Regrettably, there have been limited studies or research that concentrate on the factors that affect teachers' decisions to usage of technology.

1.4 Research Objectives

1.4.1 General Objectives

The study's overall objective is to analyse factors that affect secondary school teachers' technology acceptance using an extended Technology Acceptance Model (TAM) in relation to Botswana.

1.4.2 Specific Objectives

The study's specific objectives were as follows.

- identify factors influencing teachers' technology acceptance.
- Identify the existing theories and models used to explain technology acceptance and their limitations.
- To develop an extended TAM that can be used to assess how information quality (IQ) and gender affect secondary school teachers' technology acceptance.

1.4 Research Questions

- What are the factors that influence teachers' technology acceptance?
- What are the existing theories and models used to explain technology acceptance and what are their limitations?
- To what degree do information quality and gender influence secondary school teachers' technology acceptance in Botswana?

1.5 Justification of the study

The issue of using technology in teaching and learning is one of the current concerns for many governments across the world. Governments across the world are investing in the provision of ICT infrastructures, hardware, and software in schools. Even though many assume that the availability of ICT infrastructures and related resources are meant for the success of technology adoption and effective use, it has been proven not to be the case.

Botswana, as a developing country has since made noticeable advancements regarding technology transfer and adoption in basic education. The government, through their policies like the Revised National Policy on Education of 1994, Vision 2016 policy, Maitlamo National ICT policy and Education and Training Sector Strategic Plan (ETSSP) [23], has made a traceable advancement in acquiring ICT equipment for secondary schools across the country.

Additionally, according to the comparative e-readiness report published by United Nations Education, Science and Cultural Organization (UNESCO) Institute for Statistics (UIS) in 2015,

Botswana was among the top countries in e-readiness for ICT in school assessment, in Sub-Saharan region. The statistics by UNESCO (UIS) (2015) indicated that Botswana had a very good infrastructure in terms of school laboratories and internet coverage. Regrettably, these technologies remain largely under-utilized.

With the significant number of investments made in basic education schools, it is imperative to find out whether the technology is being utilized for the purpose it was intended for. Consequently, Botswana needs to find out if teachers are adopting and effectively using technology in schools as teachers are believed to be the main drivers for any successful technology adoption. Also, by so doing, the government will be able to evaluate the impact of its policies on technology adoption in education, some of which term has elapsed. For example, the long-term vision expired in 2016 and the ETSSP term ended in 2015, however, their impact on technology adoption in schools proves to be inadequate. The government is now implementing another plan of providing all senior secondary schools with laptops on the ratio 1: 1 for both students and teachers. It is crucial to establish how teachers feel about the technologies made available to them.

This research will examine what influences secondary school teachers to utilize technology. The study's findings would be of assistance in coming up with means to reinforce ICT incorporation in learning and teaching in Botswana secondary schools. The study will contribute to recommending to both policy makers and all the concerned stakeholders on what factors to consider when making decisions. The study results will also add to the current literature on technology adoption and acceptance in Botswana, Africa, developing countries and in general, thus the relevance of this study.

Chapter 2 LITERATURE REVIEW

2.1 Introduction

The integration and interaction between businesses, governments and individuals among people, companies and governments, advancements in technology have prompted the prolific usage of ICTs in throughout the sectors of the economies, education inclusive [24]. The role that technology plays in education is to increase skills and knowledge transfer's effectiveness and efficiency, thus it is widely acknowledged that both learners and educators may benefit from technology usage. Therefore, rejection or acceptance of educational technology is a significant issue of concern.

This section gives an overview of the proposed study's empirical background. In this chapter, firstly, technology in education is reviewed on its roles in education, barriers to technology adoption and the state of adoption of technology in African and Botswana education. Secondly, the chapter will present a review of factors that influence teachers' technology adoption. Thirdly the technology acceptance models and theories will be reviewed and lastly, the study's theoretical framework will be discussed.

2.2 Technology in Education

Currently, ICT is applied in all aspects of education, such as assessment, instruction, and learning, and it is regarded as a potent tool for development and transformation of education [25]. Kler [26] argues that the entire concept of education has transformed because of the usage of ICT in teaching and learning and has proven to be beneficial to both learners and educators. Consequently, the transformations and evolution experienced in education due to ICT has been a key area of interest for scholars and governments. The next 2 sections discuss the role played by technology in education and barriers to its adoption.

2.2.1 The role of Technology in Education

Courville [27] contends that the main role of technology in a traditional setting, is to aid the transfer, effective acquisition of skills and knowledge efficiently. He defined efficiency as "the quickness by which we obtain knowledge and effectiveness as the amount of imparted

knowledge that is operationally mastered”. Fu [7] also adds that engaging students in ICT applications makes knowledge acquisition more reachable. From the literature, the following benefits have been discussed by several studies.

1) Improving the accessibility and quality of Education

Usage of the internet and other ICTs can eliminate the digital divide between rural and urban societies [28]. These technologies enable students from both divides to have access to contemporary pedagogic approaches and knowledge. Carnoy [29] postulates that the schools’ connectivity to the World Wide Web (WWW) permits students in remote zones to access information or content which was previously accessible to only populations near large cities and libraries. ICT increases the flexibility of learning as learners can have access to learning materials anytime and anywhere. Students can also access mentors, peers, professionals, and peers all over the world which in turn improves the quality of education. Scholars agree that the accessibility to ICT increases students’ learning inspiration and commitment, and facilitate the learning of fundamental abilities required for success in today’s technological world ([28], [24]). Fu [25] concluded that ICT usage may subsequently increase students’ autonomy, competence, and creativity, which can boost the quality of both learning and teaching.

2) Enhances Student-Centered learning environment.

Mikre [30] defined a student-centred learning environment as a “learning environment that pays attention to knowledge, skills, attitudes and beliefs that learners bring with them to the learning process”. The ICT tools are transformational instruments that can support the transition from a teacher-centered to a student-centered approach to education ([7], [31], [30], [26]). With the use of ICTs, students are provided with a platform that empowers them to build new knowledge and acquire new skills by accessing, analyzing, and interpreting information from different sources [7]. The students become active in their learning while the teacher becomes the advisor or the encourager [32].

3) Produces a creative learning environment.

Creativity is one of the most referenced skills in the 21st-century teaching and learning [33]. Thangarajathi [34] defined creativity as the ability to generate novel, useful ideas and innovation and the successful implementation of those ideas. Courville [27] asserts that the use of technologies that utilize multi-media such as text, pictures, audio, and videos can assist students to visualize previously unfamiliar content which assists in learning. According to Thangarajathi [34], technology supports creativity because it is a platform that requires interaction and when used correctly, it can allow students to engage in meaningful creative activities and explore their potential.

4) provides new opportunities for teaching and learning.

The usage of ICTs in schools provides educators with new opportunities of developing fresh methods and strategies of improving learners' effectiveness and interest in learning [26]. Kler adds that the learners are also provided with a platform they can use to develop their skills differently from the traditional method of education. Furthermore, Fu [25] reasons that the longer the students are exposed to an ICT environment the higher the chances that they develop higher critical thinking skills and acquire greater cognitive levels in particular learning contexts.

5) encourages collaboration in context of distant learning.

Distance learning, also known as open learning is defined as "the type of education where students work on their own at home or at the office, and communicate with faculty and other students via email, electronic forums, video conferencing, chat rooms, instant messaging and other forms of computer-based communication" [35]. Eze and colleagues [36] affirm that ICT plays a crucial role in collaborative learning, which is now taking an increasing profile in the curricula of numerous schools. The use of ICTs permits students to collaborate, communicate and share information anytime, anywhere. For this purpose, Kumar [37] states that different types of ICTs like prints, audio, computers, and the internet are very useful. Through the platforms, students from around the world can together analyze problems and share and

explore ideas on solutions [7]. The ICT tools are quoted as essential for aiding the achievement of attaining the 21st-century skills, which among others include collaboration.

Bingimlas [38] argues that it is not appropriate to simply assume that the benefits of the use of ICTs are easily available to the school environments to transform education. He [38] reasons that there are several barriers which are encountered by schools when integrating ICT in education. Barriers to technology acceptance in education are discussed in the next section.

2.2.2 Barriers to Technology Acceptance in Education

Incorporating ICT in the teaching and learning environments has been reported as slow and unsatisfactory. This led to a number of studies to investigate the obstacles to ICT integration in education ([39], [40], [41], [42]). Barriers to ICT integration refer to conditions which bring about complications to a successful process of ICT integration in an educational setting ([43], [44], [38]). Several studies have discussed barriers to ICT integration in numerous means, settings, and conditions [44]. Barriers to ICT integration have been classified as first-order, second order and third order. First order means impediments related to resources and institutions procedures, and scholars have cited an inadequate level of access to resources and ICT infrastructure such as computers and the internet, lack of time, technical assistance, and training for teachers to improve their ICT skills. In comparison, the first-order barriers have also been classified as external, extrinsic or school-level barriers by some researchers ([45], [43], [38], [46]). It is also pointed out that the first-order barriers have been lifted in almost all public schools in developed countries.

Second-order barriers, also classified as internal, intrinsic, or teacher-level barriers, refer to teachers' beliefs that hinder the integration of technology. Pedagogical beliefs, attitudes about technology, motivation and willingness to change were cited as second-order barriers by several studies ([38], [45], [46], [43]). In addition, the authors highlighted that it is more challenging to remove second-order barriers compared to first-order barriers.

In 2012, Chai and Tsai [43], proposed yet another classification named third order barrier. They argued that the teachers may have adequate access to rich digital ICT resources and training and have positive attitudes and strong beliefs towards pedagogy and technology but

still fail to put in place a successful integration because of inadequate design thinking capacity required for a dynamic classroom environment. Design thinking encompasses human creative thinking capacity which teachers can rely on to adapt to the varying teaching and learning contexts or varying groups of students [43]. Thus, they suggested that a potential third-order barrier would be teachers' lack of applying design thinking.

In addition to the above-mentioned barriers, table 1 summaries the barriers identified by other numerous other studies.

Table 2.1: Barriers in Technology Adoption in Education

Barriers	Authors
Lack of teacher training on ICT	[41], [42], [47], [39],
Insufficiency of teacher confidence	[42]
Negative attitude and resistance to change	[41], [40], [40], [48]
Insufficient teacher competence	[26]
Lack of time(teachers)	[41], [42], [47], [39], [40], [48]
Inadequate technical and administrative support	[42], [47], [48]
ICT infrastructure deficiencies and resource accessibility	[41], [42], [47], [39]
Lack of knowledge	[42], [40], [48]

The next discussion focuses on the state of technology in the continent of Africa.

2.2.3 Technology in Education in Africa

In terms of socio-economic development, Africa is the most challenged region characterized by constant conflicts and natural disasters which impede sustainable development [49]. International Telecommunications Union (ITU) [49] claims that although the said impediments' magnitude differs from one nation to another, statistics have shown that African nations have lower household internet access of 14.3 percent versus the 57.4 percent global estimate of 2019 statistics. Additionally, Africa is ranked the lowest region on basic or standard ICT skills and has largest significant gender gap in the use of ICTs [49].

Furthermore, United Nations [50] reports that the African region remains behind other continents. Although there has been significant growth observed in the aspects of ICT

development like telephony and broadband access, smartphone adoption and mobile internet and speed of internet connection in the African region, a significant gap still exists between Africa and other continent [50]. These insights give a picture of the status of ICT development in different sectors of economies of developing countries in Africa.

Murgor [51] noted that even though ICT has grown significantly around the world over the past decades, the growth seems to be rather slow in African developing countries. Although African countries have put in significant efforts in developments of ICT projects, more failures than successes were experienced. Heeks [52] perceives that most African countries' ICT projects fail either totally or partially. He describes total failure of systems or initiatives as never implementing at all or abandoning projects immediately after implementation, while in partial failure the major goals are not achieved, or only sub-set of the original objectives are attained.

Several researchers ([46], [51], [53], [54]) in the literature have examined the causes of the unsuccessful adoption of ICT in Africa. Several reasons or barriers have been addressed at national level as opposed to personal or institutional level. African and Sub-Sahara African literature has mostly categorized barriers into social-cultural, economic, and political barriers. This study adopted the said categories as discussed below.

Socio-cultural barriers

The social barriers consist of issues of access, commonly known as the “digital divide”, inadequate IT education and skills, language barriers to IT content and African culture in relation to IT. Oroma et al [53] suggest that the level of poverty experienced by people in developing countries limits them to essential needs such as food and medication, leaving technologies as luxuries afforded by the privileged hence the digital divide gap. Additionally, Oroma et al [53] claim that human aspects such as attitude and resistance to change are some of the obstacles to using ICT. Culturally, the traditional educational environment that most Africans are familiar with does not include the use of technologies, hence resistance to the use technology in education [53].

Salam et al. [46] suggest language as one of the obstacles to adoption of ICT in underdeveloped nations. Salam et al. [46] cited that research has since shown that English is used in more than 80% of web material and software which becomes a problem to most developing countries as English is not their first language.

Economic Barriers

The instability that characterizes the African region disturbs national plans and policies hence stagnation in national development [51]. The lack of development consequently affects all sectors of the economy. As a result, the tremendous growth of ICT had been observed for the years particularly in developed countries, while the growth experienced in developing countries is relatively slow [51]. The economic status of most developing African countries hinders access to IT infrastructure which is costly, which in turn frustrates efforts of information technology adoption. IT infrastructure refers to “a set of shared tangible and intangible resources composed of computers, network and telecommunication technologies, data and core software applications needed to transfer and manage information” [55]. Most of the African countries depend on substantial foreign aid from developed countries for development of information technology, the aid which mostly is not customized to suit the local problems in the African countries [55]. Consequently, because of the high costs IT infrastructures and their maintenance, Africa is failing to accelerate IT adoption.

In their study in which they explored and evaluated factors that lead to ICT in education being under-utilized, Oroma and colleagues [53], highlighted the inability to afford to purchase ICT equipment and the failure to pay for training services as major socio-economic impediment to IT adoption. The study targeted teachers from seven different universities in Kenya, Uganda, and Tanzania. Similarly, several studies ([56], [57], [54], [55]) are of the same view that the economic status of African countries contributes largely to economic impediments to usage of ICT which mainly deals with the ability to procure ICT equipment and all related services to such equipment.

Political Barriers

Studies have associated political barriers with issues like lack of comprehensive national ICT policies, failure to implement policies and political supremacy. National ICT policies are guiding documents on how the planning and development of ICT should be executed. Ejiaku [55] noted that most governments of developing countries have ineffective national ICT policies which in turn hinders the growth of the information technology. Ineffective policies lack comprehensiveness relating to content and coverage. Most African nations have the challenge of not monitoring and evaluating policies and ICT projects ([58], [59], [60]). Okereke [61] observed that one of the projects which failed due to lack of monitoring and evaluation was Microsoft's digital villages in South Africa. For example, the project in which the community of Soweto received a donation of with computer package collapsed immediately after the donor stopped funding the activities of the project.

Makwinja [62] also argues that a lack of extensive evaluation and monitoring of development goals, strategies and policies is a common major setback in developing countries. In the case of Botswana, there has been an evolution of educational policies and strategies to improve the education landscape in the country, most of which have not been evaluated post their end dates [62].

Botswana has also made significant growth in IT infrastructures and formulation of national ICT policies and other documents guiding the implementation of IT adoption. As such, IT adoption in Botswana cannot be likened or generalized with that of other African countries. Specific studies must be done to specifically address Botswana situation.

2.2.4 Technology in Education in Botswana

Botswana has been pin-pointed as one of the nations of Sub-Saharan Africa that has made noteworthy progress in ICT acquisition. The Africa Infrastructure Development Index Statistics department [63] ranked Botswana position 10 for 2016, and positions 9 and 8 for years 2017 and 2018 respectively on ICT infrastructure development. In the same report, the ICT infrastructure development was measured by the number of phone subscriptions, users of the internet, fixed (wired) broadband and international Internet bandwidth subscribers [63]. A

similar performance was reported by the International Telecommunication Union [64] where Botswana was ranked among the top 10 African nations on the same ICT infrastructure development. The progress is the indication that the country is committed to develop the ICT sector.

Implementation of information and communication technologies in Botswana education has been guided by various policies and strategies. These includes vision 2016, Maitlamo national ICT policy, ETTSP 2015-2020, Vision 2036 and the recent presidential reset agenda. Over the past two decades, there has been several successes regarding integration of ICT in education such as the acquisition of IT equipment for secondary schools. On the other hand, these available technologies were said to be underutilized ([21], [65]). The level of adoption of technology by teachers remains questionable and largely unknown in Botswana.

The insufficient literature concerning technology adoption in Botswana, frequently focus on describing the situation of ICT development and barriers hindering its adoption by teachers in schools. In their study, Mogwe and Batlotlegi [58] investigated the state of ICT use in Botswana primary schools and analysed the present ICT adoption challenges in these primary schools. Their results showed that a low level of ICT usage, basic ICT knowledge deficit and insufficient ICT infrastructure are among the most significant obstacles to ICT adoption and use in the primary schools. Similarly, Leteane and Moakofhi [65] reported on primary school teachers' perceptions on barriers impeding the adoption of ICT in primary school education.

In another related research, Matyokurehwa [66] also investigated and analysed the difficulties encountered in implementing ICT in tertiary institutions and observed that the major challenges are lack of capital, late introduction of ICT to students and institutional curriculum design.

On a different subject apart from barriers obstructing technology adoption, Tsayang, Batane and Majuta [59] investigated the learning effects of smart boards for learners in the selected 4 secondary schools and 1 college of education in Botswana. Their findings suggested that the use of smart board technologies could enhance and improve pedagogical methods in

Botswana and improve the students learning and performance. Makwinja [62] concluded that the government need to overhaul, rethink, reform and transform the country's education. Makwinja [62] emphasised that the government lacks planning and implementing evaluation strategies on their main ICT policies, strategies, and plans, which lead to the development of redundancy in some plans and lack of progress milestones. The literature in Botswana still confirms that there is a lack of investigation into the factors influencing teachers' decisions on accepting or rejecting technologies available to them. For that reason, it is essential to investigate the motivation behind behaviour to use the technology available for them. This research project explores the factors influencing adoption of technology by secondary school teachers as a way of filling the gap.

2.3 Factors Influencing teachers' technology adoption and acceptance.

Several researchers have written on factors affecting teachers' adoption and incorporation of ICT in learning environments. For example, Fu [7] categorized the factors as internal and external. The external factors relate to school and include among others, technology accessibility, instructional planning time, administration and technical assistance, the educational curriculum, school environment and culture, teacher load and daily management. Internal factors are related to individual teachers and examples are knowledge of ICT use; opinions and attitudes on technology use, self-confidence and knowledge and technology self-efficacy [7].

Afshari et al. [10] grouped teacher and school factors into non-manipulative and manipulative. They [10] defined non-manipulative factors as "factors that cannot be directly influenced by the school such as age, teaching experience, government policy and availability of external support", while manipulative influences are factors that the school can influence such as teachers' attitudes toward using technology, skills and knowledge and availability of ICT support in the school.

Buabeng - Andoh [1] and Kler [26] put factors affecting teachers to adopt and use technology in three categories which are personal, institutional, and technological characteristics. This same approach by Buabeng - Andoh [1] and Kler [26] has been adopted for the purpose of this research to discuss the factors affecting teachers' decisions to utilize or reject technology.

2.3.1 Personal Characteristics

According to Buabeng - Andoh [1] and Kler [26], teachers' individual traits, like their age, gender, educational background and perspective regarding the use of technology can have effect on the adoption and incorporation of technology in teaching and learning. It is vital to comprehend the teachers' characteristics that have effect on their decisions on whether to approve or deny technology.

Teachers' attitudes toward technology use

Attitude towards behaviour has been characterized as an emotion, either pleasant or negative, associated with engaging in a target behaviour. Researchers have presented strong evidence on the element that teachers' perspective on using technology is among the most important factors that cannot be overlooked. Andoh [1] claims that if educators view the usage of educational technologies favourably, then they can be responsible for suitable perceptions about the acceptance and incorporation of ICT in teaching and learning methods. In their investigation into pre-service teachers' technology acceptance, Aypay et al. [12] found that teachers' attitudes toward computers affected their behavioural intention to use positively. The survey gathered information from 754 pre-service teachers across different in Turkey universities through a questionnaire. In a related study, Teo [16], established that teachers' attitude towards usage of technology was a key factor of teachers' behavioural desire to technology use. The study targeted teachers and a population of 592 teachers participated by responding to self-report questionnaire items. Teo [16] concluded that when teachers adopt a positive attitude towards technology use, then the same feelings will reinforce their desire towards use of technology. Similarly, in an investigation conducted on pre-service educators in Singapore by Teo [67], similar results of the positive effect of attitude towards use on behavioral desire to use technology was observed.

Computer self-efficacy

Self-efficacy is one the key determinants of teachers' willingness to adopt technology. Self-efficacy has been defined as "people's beliefs about their competences to yield designated levels of performance that exercise impact over events that affect their lives" [68]. Bandura

[68] claims how individuals think feel, motivate themselves, and act is determined by their self-efficacy beliefs. He further indicates that people with high confidence in their abilities stand higher chances of succeeding in their tasks, set themselves challenging goals and should they encounter failure, they quickly recover their sense of efficacy and challenge themselves to put more effort to overcome the failures. Additionally, Bandura [68] asserts that people who doubt their capabilities stand low chance of being successful in executing their tasks and they also shy away from challenging tasks as they usually view them as threats. The same people give up easily when experiencing challenges or failures.

Buabeng-Andoh [1] simplified self-efficacy to be the belief that a person has in their capacity to carry out the activities they set out to perform. From the perspective of teachers, Peralta, and Costa [69] view the same confidence to be how likely teachers believe they are to be successful in utilizing ICT for educational objectives, as well as how much control they believe they have over that accomplishment.

Wong et al [4] defined computer teaching efficacy as “teachers’ evaluation of their capability to teach with computers and their personal beliefs in using computers as an effective teaching method to improve students’ performance in learning.” In their study in which 302 student teachers participated, Wong, Teo and Russo [4], revealed that computer teaching efficacy influences the utilization of ICT in education. Similarly, in their study in which 258 university lecturers from both public and private universities in Taiwan participated, Chang and colleagues [6] discovered that technology acceptance is significantly influenced by one’s level of computer self-efficacy. Also, Player-Koro’s study [70] in which 210 teachers were the questionnaire respondents, self-efficacy was found to be beneficial to teachers’ acceptance of technology.

On another modification of self-efficacy, Holden, and Rada [71] compared computer self-efficacy to technology self-efficacy, and the results of their study in which 378 K-12 teachers participated indicated that technology self-efficacy was more influential in teachers’ technology acceptance than computer self-efficacy. They [71] described technology self-

efficacy as “the user’s personal confidence toward successfully and purposefully using a specific technology”.

Gender

There are conflicting findings on the matter of the effect of gender differences on the adoption of technology. Some scholars claim that gender difference has an effect of technology acceptance while others have proven otherwise on the matter. Researchers have investigated the gender differences in relation to teachers’ self-efficacy, teachers’ attitudes towards computer use and teachers’ beliefs.

Other personal characteristics that have been considered as having an influence on teachers’ decisions to accept or reject technology are age, personal innovativeness, trust, teaching experience and teacher workload. These characteristics have not been explored broadly; hence their influence remains inconclusive and inconsistent. For example, Sanchez-Prieto and co-writers [72] did not find the influence of teachers’ age on technology while Sumak & Sorgo [73] found age to have an effect on teachers’ decisions on accepting or rejecting technology.

2.3.2 Institutional Characteristics

Institutional factors are provisions by the institution to improve the existing teachers’ traits [1]. Such factors are professional development, ICT accessibility and technical and leadership support [26].

Professional Development

According to Mitchell [74] professional development is “the process whereby an individual acquires or enhances the skills, knowledge and/or attitudes for improved practice”. Afshari et al. [10] claim that the any program involving technology adoption in education must center on teachers’ professional development. Professional development may be formal through organized events by the organization such as workshops, seminars, and college courses or informal where self-directed professional development, peer discussions and collaborations are utilized [75]. Lai, Wang, and Huang [75] argue that the participation of teachers in professional development is a key predictor of technology adoption. Moreover, teachers’ skills

and knowledge gained through professional development may also influence technology use indirectly [75].

In their study investigating factors that support teachers' ability, teachers' motivation, and perceptions of learning by students in classrooms using technology, Ritchie, and Baylor [76] claim that how ICT is used in classroom is significantly impacted by professional development. Afshari et al. [10] added that teachers need professional development to properly employ technology to enhance learning for students. Due to the constantly evolving technologies, teachers need to undergo continuous training to keep up with latest innovations [10].

ICT accessibility

Teachers need access to ICT resources in order use them [1]. Buabeng-Andoh [1] asserts that the accessibility and availability of ICT resources such as software and hardware, has a major impact on how well ICT is adopted and integrated in teaching and learning in schools. Gulbahar [77] adds that for any successful technology infusion, contemporary technology should be made available in school. Also, several studies ([41], [42], [39]) have reported that one of the main obstacles to successfully integrating technology in educational settings is a lack infrastructure for information and communication technologies. Afshari et al. [10] concluded that the accessibility of software and hardware, as well as the equity of staff and students' access to resources have an impact on how effectively technology is used in schools.

Technical and Leadership Support

Technical support means ``offering support and consultancy services to teachers and administrative staff to overcome possible obstacle during the use of technologies`` [77]. Afshari, Bakar, Luan, Samah and Fooi [10] suggested that if teachers were unsure about how to get assistance if something went wrong with their use of computers, they would not want to use them. The absence of technical support in a school may result in lack of preventative technical maintenance being carried out, which in turn may lead to higher risks of experiencing more technical breakdowns [78]. Buabeng-Andoh [1] note that the effect of such lack of support during technology failures may lead to teachers not willing to utilize it.

Moreover, leadership support is also significant as it influences the school culture of reflecting on new ways of teaching and learning [76]. Baylor and Ritchie explain that leaders in technology-enhanced environments have the duty of recognizing teachers who strive to integrate technology into learning and teaching, preparing, and establishing a vision and serving as role models. Transformational leadership may contribute to the improved ICT integration in developments for teaching and learning [1]. Dinc [42] and Salehi [39] have also concluded that one of the challenges to for teachers integrating technology in teaching and learning is a lack of leadership and technical support.

2.3.3 Technology-related Characteristics

Technology-related characteristics also affect the dissemination and adoption of innovation [1]. Rogers [79] argued that characteristics of technology as perceived by individuals have an impact on the degree of adoption of technology. He further listed five innovative features (relative advantage, compatibility, complexity, observability and trialability) that may contribute to the acceptance or adoption of an innovation. Several studies have provided evidence that technological traits have influence on teachers' attitudes and behavioural intent to utilize technology. There has been extensive research on teachers' perceptions on system usability and usefulness ([80], [81], [82], [83], [84], [85]) and the research findings indicated that they have direct significant impact on their attitude and behavioural intentions to utilize technologies.

Lai & Chen [86] investigated the factors affecting the adoption of teaching blogs by secondary school teachers and found out that teachers' perceived enjoyment, comparability, perceived usefulness, and perceived ease of use had influence on teachers' decisions to use technology. Other authors have also examined technological features such as technological complexity [12] and codification effort [86] and found that they affect teachers' decisions to utilize or reject technology.

2.4 Models and Theories that explain factors affecting teachers' technology acceptance.

According to Alomary and Woollard [87] the difficulties in forecasting human behavior has led to generation of technology acceptance models and theories to clarify the users' adoption and use patterns for new technologies. A theory "provides a set of descriptive variables which can be used to predict a particular phenomenon" while a model "is any abstract representation of some portion of the real world, constructed for the purpose of understanding, explaining, predicting or controlling a phenomenon being investigated" [88].

These models and theories, originating from several academic fields like psychology and sociology, intend to elucidate the idea regarding how end users might comprehend, approve, or reject technology [67]. The adoption and use of new technology is referred to as technology acceptance [88]. Technology adoption has been defined as the "implementation of the software and hardware technology in an organization to increase productivity, competitive advantage, improve processing speed and make information readily available" [89].

Models and theories with the most dominance in explaining technology acceptance are the Unified Theory of Acceptance and Use of Technology (UTAUT), Theory of Reasoned Action (TRA), Innovation Diffusion Theory (IDT), Technology Acceptance Model (TAM) and Theory of Planned Behavior (TPB). These theories and models (see summary in table 3) are discussed further below.

Table 2.2: Summary of Models and Theoretical Frameworks on End-Users' Technology Acceptance

Model or Theory	Factors Affecting Technology Acceptance
Theory of Reasoned Action (TRA) [90]	• Attitude Towards Behavior • Subjective Norm
Theory of Planned Behavior (TPB) [91]	• Attitude towards Behavior • Subjective Norm • Perceived Behavioral Control
Technology Acceptance Model (TAM) [92]	• Perceived Usefulness (PU) • Perceived Ease of Use (PEU)
Innovation Diffusion Theory (IDT) [79]	• Relative Advantage • Compatibility • Complexity • Trialability • Observability
Unified Theory of Acceptance and Use of Technology (UTAUT) [93]	• Performance Expectancy • Effort Expectancy • Social Influence • Facilitating Conditions The relationships between the above constructs, intention and actual behavioral usage are moderated by; • Age • Experience • Gender • Voluntariness of Use

2.4.1 Theory of Reasoned Action (TRA)

One of the oldest theories of technology acceptance is the theory of Reasoned Action (TRA), which was first developed in the field of psychology in 1975 by Fishbein and Azjen [90]. The TRA is a generic and was not intended to focus on any technology or behaviour however, it was later found useful in investigating individuals' Information Technology (IT) acceptance behaviour. According to Fishbein and Azjen [90], there are two factors that influence behavioral intention; Subjective norm and attitude toward behaviour (for definitions, see table 4). Behavioral intention in turn influences actual behavior as shown on diagrammatic presentation in figure 1. The theory suggests that a person's feelings (negative or positive) regarding engaging in a desired behavior and their perceptions on how other important people or people close to them may have opinions on whether they ought to or ought not to engage in the behaviour (subjective norm) determine their behavioral intention. The intention then predicts the actual behavior.

According to the existing literature the TRA has been used widely in different settings more especially in the academia and business environments successfully [88]. However, the theory has been criticized for absence of discussion of the impact of habit, cognitive reflection, and moral factors [94]. Additionally, Momani and Jamous [95] also indicated that the theory is limited as it does not provide for other behavioral intention like fear, mood, and previous experiences.

Samaradiwakara and Gunawardera [88] shared the same view that contrary to the TRA's assumption that when someone creates an intention to act, they are free to do so, in practice, the freedom to act will be limited by restrictions such as inadequate capacity, time,

environment or organizational restraints, and unconscious tendencies.

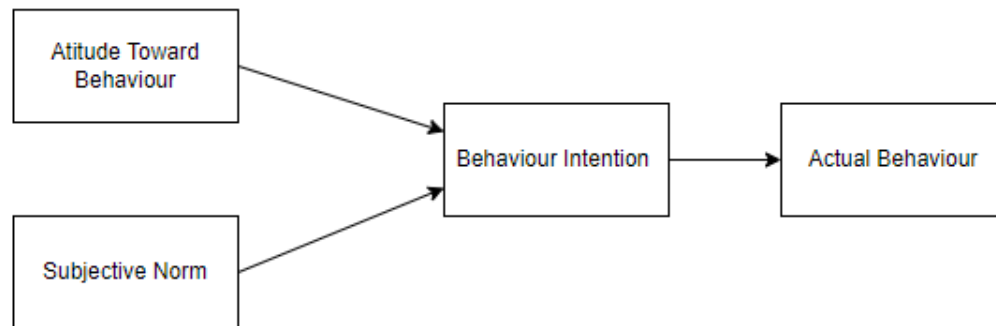


Figure 2.1: Theory of Reasoned Action (adapted from Fishbein & Ajzen [85])

2.4.2 Theory of Planned Behaviour (TPB)

Ajzen's Theory of Reasoned Action is expanded upon in the Theory of Planned Behaviour (TPB) [91]. The intention of the extension was to improve upon some drawbacks observed in the TRA to consider mandatory situations. According to figure 2 below, the Theory of Planned Behaviour has similarities with the Theory of Reasoned Action except that Ajzen [91] has introduced a new concept called Perceived Behavioural Control (PBC). Jen and colleagues [96] characterized perceived behavioral control as the impression of ease with which the behaviour is carried out. The wide-spread use of the TPB has led to advances over the TRA in the field of technological adoption.

According to Taherdoost [94] the availability of resources, abilities, and opportunities, and as well as how significant they are viewed to be, determines PBC. As such, Taherdoost [94] argues that if a computer system is not accessible, one's attitude toward information technology will not be mostly relevant according to TPB, and the theory will be considered as a theory that is greatly influenced by the degree of a person's voluntariness to use the technology. Momani and Jamous [95] add that, as a limitation, the theory disregards potential influences on people's decision to engage in certain behaviour from the environment or economy.

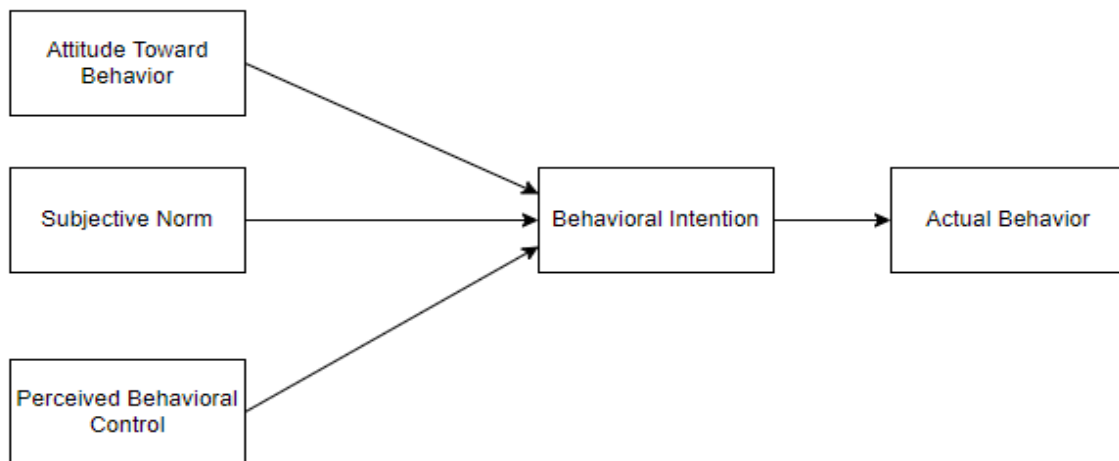


Figure 2.2: Theory of Planned Behavior (adapted from Ajzen [86])

2.4.3 Technology Acceptance Model (TAM)

In 1989, Davis [92] developed the Technology Acceptance Model (TAM) to define technology use behaviour. It originated in the field of information technology. The paradigm is based on the TRA, in which two core ideas being Perceived Ease of Use (PEU) and Perceived Usefulness (PU) replaced attitude toward behaviour (see figure 3). Perceived Usefulness is defined as “the degree to which a person believes that using a particular system would enhance his or her job performance” [96] while Perceived Ease of Use refers to “the degree to which a person believes that using a particular system would be free of effort” [96]. TAM, however, does not comprise the TRA’s subjective norm construct. The model (TAM) is applied to establish the approval, adoption, and utilization of information technology [97]. Three stages, adoption, validation, and extension are covered by TAM when it comes to technological acceptance.

A TAM was designed to predict determinants of user’s acceptance behavior over a variety of computer technologies and user groups. The TAM contends that a user’s attitude toward utilizing a particular technology directly affects their intention to use it, which in turn influences their actual usage. Attitude toward technology usage refers to “the evaluative effect of positive or negative feelings of individuals in performing a certain behavior” [94]. Davis [92] predicts that users will be willing to work with a type of technology if they believe it to be beneficial and simple to use, hence he proposed two main determinants, perceived

usefulness, and perceived ease of use to directly determine one's attitude toward using technology. As shown in figure 3, perceived usability is also believed to have a significant impact on perceived usefulness. He also contends that the best indicator of a person's perceived usefulness is the strongest predictor of an individual's intention to use technology.

As the TAM evolved, Davis added that "the belief of a person towards a system may be influenced by other factors referred to as external variables in TAM". User training, system characteristics and user involvement in design were among the external variables [98]. The model offered provision for more external variables to be added for exploration. Compared to its competing models and theories, TAM is believed to have advantage of richness and parsimony, being predictive, and robust ([99], [96]). Furthermore, TAM has been commended for being easy to use and apply across different research settings [88].

Despite the advantages of TAM over other theories and models, the existing literature on TAM applications and validation were mostly targeting students as study population and lacked business and work-related environments [89]. Chuttur [98] supplements that the students targeted as participants are usually under controlled environments and may have different motivations like obtaining grades or awards, therefore the results cannot be generalized to the users in working environments. In their review on the contribution and limitation of the TAM in technology adoption in education, Zaineldeen and colleagues [97] found out that most of the studies they reviewed which applied TAM targeted students as study participants, and e-learning platforms. They [97] therefore recommended more studies to be done on in-service teachers and lecturers as technology acceptance has been described to vary based on user types.

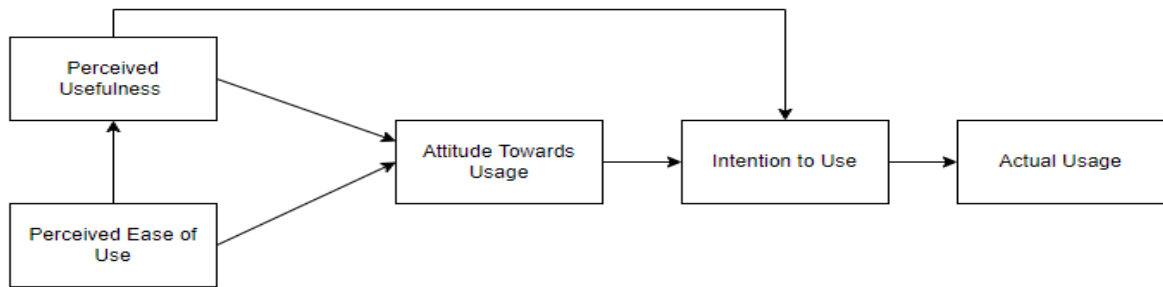


Figure 2.3: Original Technology Acceptance Model (adapted from Davis [87])

2.4.4 Innovation Diffusion Theory (IDT)

Innovation Diffusion Theory (IDT) was developed in 1995 by Rogers [79]. Rogers put forward four major determinants for determining behaviour: innovation, communication channels, time, and social systems. He then defines the terms diffusion, communication and innovation as follows:

Diffusion: “it is the process in which an innovation is communicated through certain channels over time among members of a social system.”

Communication: “is a process that leads to create and share understanding.”

Innovation: “an idea, process, object, or practice that can be considered to be new.”

The concept explains how an innovation spreads over time among members of a social system by using specific channels [100]. While its main goal is to give an account for how any technological innovation proceeds from the stage of creation to general use (or not), it has been used to both individual and organizational level analysis [88]. The IDT proposes five innovation characteristics that influences individual’s behaviors as relative advantage, compatibility, complexity, Trialability and observability (see table 4 for definitions). The IDT model has been used outside of IT in a variety of sectors, including mental health, and has been hailed as an accurate indicator of social and technological development [89].

In his analysis of theories and models relating to technological acceptance, Taherdoost [94] argues that “IDT focuses more on the system characteristics, organizational attributes and

environmental aspects but has less power in explanatory and less practical for prediction of outcomes compared to other adoption models.” Khan and Woosley [89] add that IDT is based on the innovation features and the social system surrounding it, therefore the constructs and any other variations are limited to the variables in the model, which indicate the limitation and inadequacy of the model.

2.4.5 Unified Theory of Acceptance and Use of Technology (UTAUT)

Venkatesh and co-authors [93] compared similarities and differences between eight technology acceptance models and theories which are; Theory of Reasoned Action, Theory of Planned Behaviour, Technology Acceptance Model, the model of PC utilization, innovation diffusion theory, the motivational model, combined Technology Acceptance Model-Theory of Planned Behaviour and social cognitive theory and later combined them to form the UTAUT.

According to figure 4’s representation of the Unified Theory of Acceptance and Use of Technology (UTAUT), there are four significant constructs; performance expectancy (equivalent to perceived usefulness), effort expectancy (equivalent to perceived ease of use), social influence and facilitating conditions (see table 4 for definitions) that predicts user’s behavioral and usage behaviour. Additionally, four variables were identified (age, gender, experience, and voluntariness of use) to moderate the relationships.

Compared to other technological acceptance models and theories, UTAUT has been regarded as being more reliable. However, the theory has drawn criticism for having numerous distinct variables that can be used to predict intents and actions [87] . Moreover, Jen, Lu and Liu [96] argue that additional research is required to verify and validate its appropriateness.

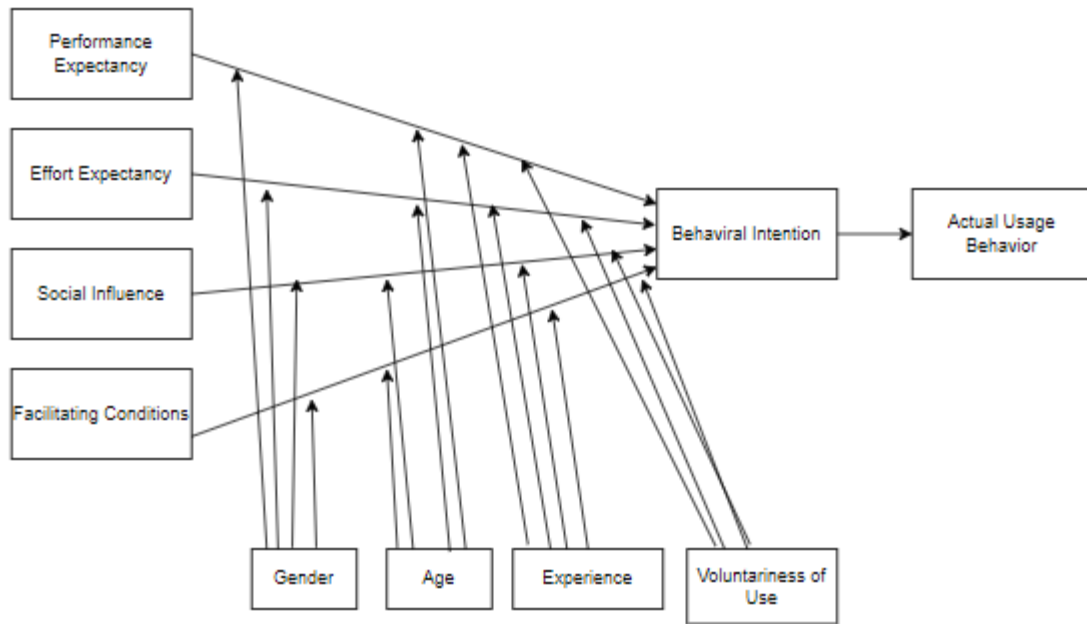


Figure 2.4: Unified Theory of Acceptance and Use of Technology (adapted from Venkatesh et al [88])

Table 2.3: Definitions of Constructs in Technology Acceptance Models and Theories

Construct	Definition
Attitude towards Use Behavior (ATU)	"An individual's positive or negative feelings about performing target behavior" [94].
Subjective Norm (SN)	"The person's perceptions that most people who are important to him think he should or should not perform the behavior in question" [96].
Perceived Behavioral Control (PBC)	"Reflects perceptions of internal and external constraint on behaviour" [96].
Perceived Usefulness (PU)	"The degree to which a person believes that using a particular system would enhance his or her job performance" [96].
Perceived Ease of Use (PEU)	"The degree to which a person believes that using a particular system would be free of effort" [96].
Relative Advantage (RA)	"The degree to which an individual perceives the innovation as a good idea and advantageous" [79].
Compatibility	"The degree to which an individual perceives the innovation or technology as being compatible with current values, needs and previous experiences" [79].
Complexity	"The degree to which an innovation is perceived to be easy to understand and use" [79].
Trialability	"The ease of experimenting with a technology or innovation" [79].
Observability	The degree to which the results and benefits of the innovation are evident and visible to individuals [79].
Performance Expectancy (PE)	The belief that using the system will increase job performance [101].
Effort Expectancy (EE)	Describes how easy a system is to use [101].
Social Influence (SI)	It defines how much is a user influenced by other people's belief in using a system [101].
Facilitating Conditions (FC)	It depicts the conviction of a user in the existing organizational infrastructure and support [101].
Experience	"The degree of knowledge or skill that individual has in using technologies or particular technology in addition to the period of time with this skill" [93].
Voluntariness of Use	"The degree to which use of the innovation is perceived as being voluntary, or of free will" [93].

2.5 Research gap

There has not been extensive research done on technology acceptance and use in secondary education in Botswana. The literature available is mainly limited to government documents

such as policies, programs, long term visions and what is planned to take place (Maitlamo national ICT policy, long term vision 2016 and 2036, ETSSP). The government plans are commonly focused on acquisition and provision of ICTs in various areas of the economy. The secondary schools are one of the areas which has since received some considerable different technologies. However, there has been no or limited evaluation on the intended user of these technologies, on how they received the technologies and how well are they using them. This study will examine the factors influencing secondary schools' teachers' decisions on adopting or rejecting technology.

Certainly, there have been several studies conducted on teachers' technology in other parts of the world including countries in the sub-Sahara region. However, such research conclusions cannot be applied to Botswana as whole, as each country is unique politically, economically, and socially. Botswana has been reported to be among the most stable countries politically in the region and it has made significant growth economically than some of its counterparts in the region. Through the ICT policies and development plans Botswana has also made noteworthy steps in acquisition of ICTs for secondary schools. As such, there is need for research that will target population of secondary schools in Botswana. Therefore, the study will help to explain the technology adoption from individual perspective of secondary school teachers in Botswana.

Technology Acceptance Model was chosen as a theoretical framework for this research after analyzing technology acceptance theories and models.

2.6 Theoretical framework and model development

The section discusses the adapted Technology Acceptance Model variables and the proposed model hypotheses. The TAM as discussed in section 2.4.3 of this chapter was initially cited by Davis [92] in 1989, and it has been used since, validated, and extended by several authors in different settings and technologies since its inception. According to the published research, the initial TAM is a helpful theoretical model to examine why users accept information technology. The model is commonly utilized in the field of education. However, fewer studies have been done on secondary school teachers. Several studies have been done on pre-service

teachers. As such, their opinions may be different from that of working teachers. Additionally, student teachers are borne to have more exposure to more technologies and technological training compared to practicing teachers.

Moreover, TAM researchers have suggested that the model's suitability needs to be tested in different settings and populations. From the reviewed literature, fewer studies have been done in developing countries of Africa in particular. Therefore, the proposed study intends to apply and extend the model in the setting of Botswana population.

Even though TAM is widely used in education, there have been fewer studies evaluating the effect of system characteristics on adoption of technology by teachers. The proposed study aims to evaluate information quality, a system characteristic, on acceptance of technology by secondary school teachers. The study adapted the TAM modified and extended by Holden and Rada [71]. On the same adapted model, the study proposes to add the information quality variable as an external variable and assess how gender affects the model relationships as a moderator shown in figure 5. The hypotheses of the research model and external variables of the proposed model are reviewed in the section that follows.

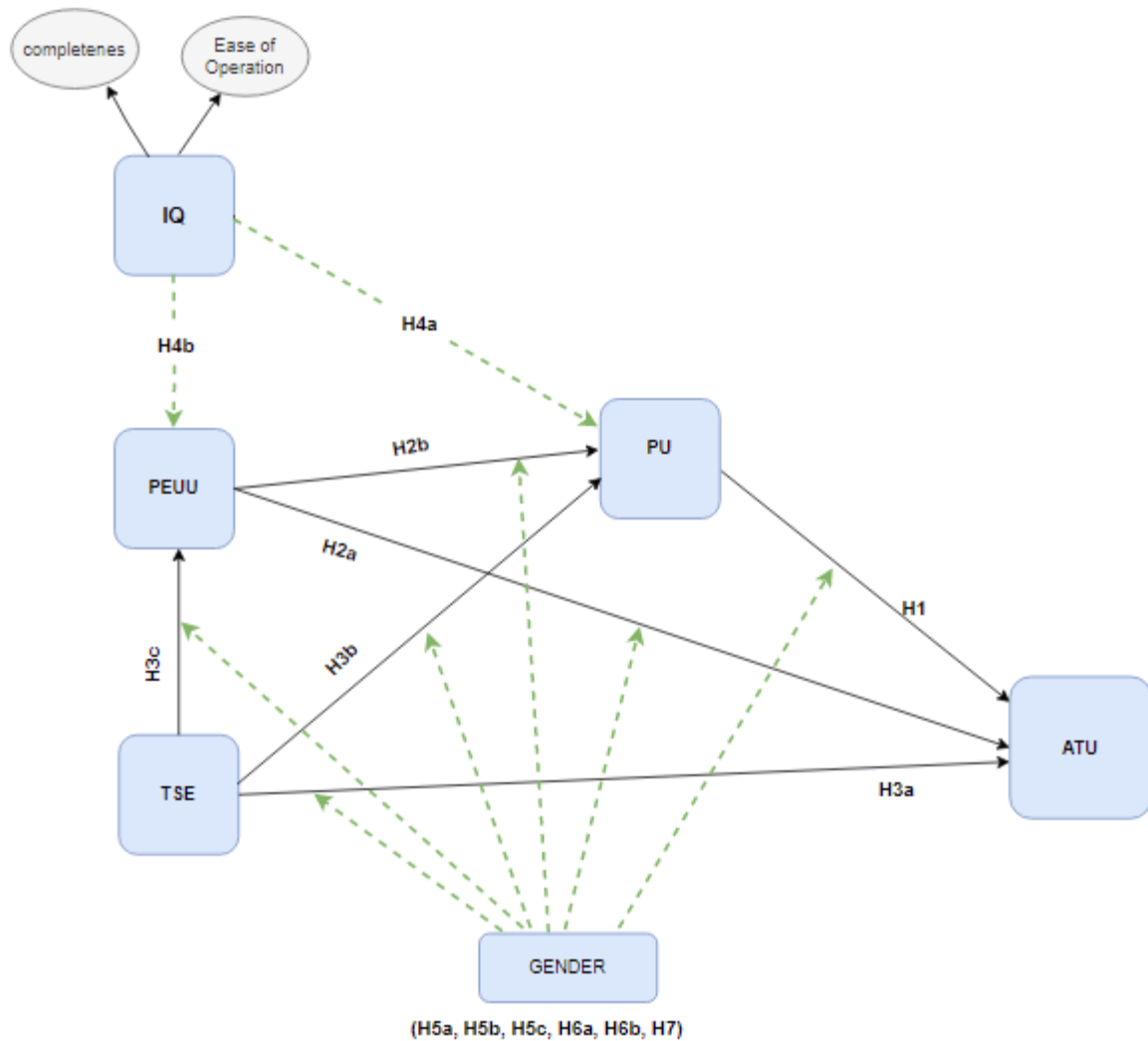


Figure 2.5: Proposed Research Model (Adapted from [102], [71])

Based on the findings from the literature on the key determinants of the TAM, the study proposed the following hypothesis.

H1. Perceived Usefulness will positively influence teachers' Attitude towards Use significantly.

H2a. Perceived Ease of Use + Usability will positively influence teachers' Attitude towards Use significantly.

H2b. Perceived Ease of Use + Usability will positively influence teachers' Perceived Usefulness significantly.

2.6.2 External Variables

Davis ([92]) left provision for the addition of external variables which could have an influence on the key determinants of the TAM. External variables refer to other personal, technological, or organizational characteristics that may influence technology acceptance decisions. Several authors that have added external variables to the TAM framework and have found significant relationships between the variables and the TAM key determinants (perceived ease of use and perceived usefulness). For instance, Teo and co-authors ([11]) proposed a model in which it was discovered that subjective norm has a significant impact on pre-service teachers' attitude toward using computers. The same study indicated that facilitating conditions as an external variable showed a strong favorable influence on the perceived ease of use. On a different research work by Teo and Noyes [14], perceived ease of use, perceived usefulness, and intention to use technology were found to be positively affected by perceived enjoyment.

In the proposed research, two external variables, Technology Self-efficacy, and Information Quality (IQ) are going to be assessed to find out how they influence the key determinants of the TAM. The IQ variable will consist of two constructs: completeness and ease of operation (adopted from an information quality assessment methodology developed by Lee and colleagues [103]) which are believed to be essential for the teachers. Teachers are believed to require systems that contains all the necessary values (information) for their job and a system that allow them with ease to manipulate the information to meet their needs.

Technology Self-Efficacy

Self-efficacy is well-defined as “a belief in one’s own abilities to perform an action or activity necessary to achieve a goal or task” [68]. Bandura [68] claims that an individual has confidence in their ability to carry out a task well and believes that the outcome of the task will bear a positive outcome, they will be motivated to do so. Researchers tested variations of self-efficacy in their studies. In their study to determine how computer teaching-efficacy and gender affect acceptance of technology among student teachers in Malaysia, Wong, and colleagues [4], found that teacher’s perceived ease of use, perceived usefulness and attitude toward using technology are positively affected by computer teaching-efficacy. They [4]

defined computer teaching efficacy as “the student teacher’s evaluation of their capability to teach with computers (self-efficacy), and their personal beliefs in using computers as an effective method to improve students’ performance in learning (expectation outcome)”.

Another self-efficacy variation, computer self-efficacy, was tested by Hu and colleagues [13]. Computer self-efficacy refers to a person’s assessment on their capacity to operate a computer [13]. In their long-term investigation into technology adoption by teachers, the teachers’ perceived ease of use was positively impacted by computer self-efficacy. Similarly, Salloum and co-authors [104], in their study of exploring university students’ acceptance of E-Learning, claims that computer self-efficacy has a positive influence on the student’s perceived ease of use. On a different study, Holden, and Rada [71], compared the significance of computer self-efficacy and technology self-efficacy influence on teachers toward their perceived ease of use and perceived usefulness. They noted that technology self-efficacy and computer self-efficacy are similar except that technology self-efficacy focuses on any identified technology rather than computers in general. The study results showed that computer self-efficacy did not influence the perceived ease of use, contrary to results by Venkatesh [93] study. However, technology self-efficacy was found to have direct influence on teachers’ perceived ease of use + usability. According to Holden and Rada, technology self-efficacy refers to “the user’s personal confidence toward successfully and purposefully using specific technology.”

Based on the empirical support above, the study proposes the following hypothesis: H3a, H3b and h3c

H3a. Technology self-efficacy will positively influence the teachers’ attitude towards use significantly.

H3b. Technology self-efficacy will positively influence the teachers’ Perceived Usefulness significantly.

H3c. Technology self-efficacy will positively influence the teachers’ Perceived Ease of Use + Usability significantly.

Information Quality

Information and communication technology usage to create, receive and transfer information with reference to internet technologies is on the rise in almost all aspects of the modern life [105]. DeLone and McLean [106] defines information as “an output of an information system or a message in a communication system and it can be measured at technical, semantic and effectiveness levels”. Information quality is a metric used to assess the output quality of an information systems [107]. Gable, Sedera and Chan [107] add that organizations make significant expenditures in information systems in anticipation of the organization’s success. The evaluation of the information system characteristics has varied and provided little consensus over the decades [107]. Lee and co-authors [103] added that over the decades, IQ has lacked comprehensive methodologies for its assessment and improvement.

One of the essential qualities of information system is information quality (IQ) by several Information System (IS) researchers. Reviewing the literature, very limited studies ([108], [109], [110], [111], [112]) were discovered to have assessed the relationship between information quality and the user’s adoption of technology. Even though the investigation of the influence of IQ is still inadequate, the concentration of authors is largely on users in business entities and institutions of higher learning. Teachers in secondary schools are also using information systems hence the importance for examining the influence of IQ of such systems on teachers’ decisions to accept or reject them. The proposed study intends to fill this gap.

Saaed & Helm [110] examined, using a web-based student information system (SIS), the impact of information system attributes and perceived usefulness on post-adoption utilization of information system for university students. The theoretical framework of the study was created by combining TAM with the Information System (IS) success model. The study findings suggested that IQ, as one of the system attributes had a noteworthy impact on the students’ perceived usefulness.

Pai & Huang [108] applied the TAM to examine the effect of information, service and system quality as adopted from DeLone and McLean [106]’s information system success model to the

introduction of healthcare information systems. A total of 366 health practitioners in Taiwan participated in the research and the study findings showed that the practitioners' perceived usefulness was affected by IQ positively.

Also, in their investigation on the relationship between online and offline features of Internet shopping malls and customers' acceptance behavior, Ahn, Ryu & Han [112] found that the perceived ease of use and perceived usefulness of the user were directly affected by information quality. Similarly, Salloum [111] found that IQ has a favorable direct impact on university students' perceived usefulness and perceived ease of use in relation to e-Learning. Consequently, based on the conclusions, the study put forward Hypothesis H4a & H4b as follows.

H4a. Information Quality will favorably impact teachers' Perceived Usefulness significantly.

H4b. Information Quality will favorably impact teachers' Perceived Ease of Use + Usability significantly.

Gender

Gender remains the subject of concern in the technology acceptance research area. The matter is concerned with understanding and reflecting how males and females react to and use computers and other technologies [113]. According to Ikolo and Okto [114], because of the gender roles imposed by various cultures, women are raised to believe that technology and its application are just for their male counterparts. In addition, many factors inside and outside classroom such as the media's portrayal of males as technological gurus, cultural norms that place differing expectations on boys and girls, the design of learning exercises, the style of feedback in performance scenarios, and the arrangement of classroom seating have led to the existing gender digital divide [114].

Teo [113] established gender structural invariance of TAM and concluded that both males and females in their sample treated the items in the scale the same way. Hence there were no significant statistical gender differences on $ATU \rightarrow BI$, $PEU \rightarrow ATU$ and $PEU \rightarrow PU$ paths. However, the findings revealed that the impact of perceived usefulness was more for females

than for males. In a related study, Yuen, and Ma [115] examined the impact of gender differences on 186 student teachers and found that gender differences moderated the TAM relationships. Their study findings indicated that females' behavioral intentions to use technology are more significantly influenced by their perceived usefulness and perceived ease of use than their male counterparts. Furthermore, perceived ease of use will influence perceived usefulness strongly for males than females. Teo, Fan and Du [83] found no statistically significant difference between the effects of gender on attitudes toward technology, behavioural intention to use technology, and perceptions of usefulness and ease of use.

Teo, Russo and Wong [4] investigated the impact of computer teaching-efficacy (CTE) and gender on Malaysian student teachers' acceptance of technology and observed significant gender difference on the CTE → PEU, CTE → PU and CTE → ATU paths only. Other model relationships PU → BI, ATU → BI and PU → ATU did not indicate any significant gender differences.

Other several studies ([116], [117], [118], [119]) reported that gender differences do not have moderating effects on technology acceptance factors.

The evidence provided by the literature proves that gender issue in education remains largely inconclusive, hence more research needs to be carried out to verify the impact of gender on teachers' adoption of technology acceptance in diverse environments. The research proposes to investigate the gender influence and predict the following hypotheses.

H5a. TSE will significantly impact PU to a greater extent for men than for women.

H5b. TSE will significantly impact PEUU to a greater extent for men than for women.

H5c. TSE will significantly impact ATU to a greater extent for men than for women.

H6a. PEUU will significantly impact ATU to a greater extent for men than for women.

H6b. PEUU will significantly impact ATU to a greater extent for men than for women.

H7. PU will significantly impact ATU to a greater extent for men than for women.

2.7 Chapter Summary

In conclusion, the chapter have discussed the documented literature in technology adoption in education. Firstly, the part played by technology in education was investigated to appreciate its necessity in education. Secondly, the barriers hindering technology adoption in education were also appreciated to recognize the possible eliminated barriers in the target area of the study. Thirdly, the literature on the state of ICT adoption in Africa and Botswana was discussed to appreciate the differences that may influence the necessity for conducting more studies or not in the targeted population. Fourthly, the literature on factors influencing teachers' technology acceptance and the existing technology acceptance models and theories were also reviewed. Lastly, the framework from the adapted TAM was presented and study hypotheses were established.

Chapter 3 RESEARCH METHODOLOGY

3.1 Introduction

This chapter's goal is to provide overview about the research approaches and procedures used during the study to address research specific objectives and questions. Specific objective 1 and 2 were achieved through secondary data analysis while specific objective 3 was achieved through primary data collection and analysis.

The research design, research population, sampling strategy, data collection strategies, data processing and analysis are all covered in further detail in this chapter.

3.2 Research Design

Asenahabi [120] defined research design as “a plan adopted by the researcher before data collection begins in order to achieve research objective in a valid way”. Research design determines and articulates the kind of data gathering and analysis approaches that are to be utilized as a way of obtaining answers for research questions and get desired findings [120]. One of the most crucial phases of research is data collection. Therefore, understanding the kind of data to be collected for purposes of achieving desired and relevant results for the study is important for the researcher as well. Data can be collected as qualitative or quantitative. Qualitative research is “a process of naturalistic inquiry that seeks an in-depth understanding of social phenomena within their natural setting” [121]. The main goal of qualitative research is to use the thoughts and experiences of participants to create meaning, purpose, and reality. [120]. According to Ahmad and co-writers [121] qualitative researchers use multiple systems of enquiry like “biography, case study, historical analysis, discourse analysis, ethnography, grounded theory, and phenomenology to study human phenomena as opposed to logical and statistical procedures.”

On the other hand, quantitative research has been defined as “a set of strategies, techniques and assumptions used to study psychological, social and economic processes through the exploration of numeric patterns” [121]. The method focuses on collection of fresh data from the population in accordance with the problem and work on the objective by measuring it through the actions and opinions which helps to describe the data [122]. The relationships

among variables in the objectives permit the researcher to generate data or test hypothesis through different data collection methods [120].

The quantitative research method was employed for the primary goal of this study, where data was gathered on factors that affect acceptance of technology by teachers consistent with the TAM proposed by Davis [92]. The data gathered was then analyzed to assess the implication and applicability of the factors in context of Botswana secondary school teachers. The factors that affect the acceptance of technology by teachers were obtained from analysis of the secondary data from the literature review.

The current study has extended the original TAM by including Technology Self Efficacy (TSE) and Information Quality (IQ) as independent variables, which is consistent with the literature. Additionally, the current study moderated the TSE, PEUU and PU relationships by gender. The survey was conducted in English language.

Variables of the Study

To investigate the study respondents' acceptance of technology, the study adapted the factors based on the extended TAM, as shown in table 5. The study's variables are defined below.

Perceived Ease of Use + Usability

Davis [92] defined Perceived Ease of Use as "the degree to which a person believes that using a particular system would be free of effort". Usability is characterized as how well a product or a system enables users to achieve specified goals, which simply translates to the system's effectiveness and efficiency in meeting users' needs and specifications [123]. If secondary school teachers believe that computers are easier to use or do not need extensive effort to use and they perform their duties efficiently and effectively, the likelihood of teachers using them is high.

Perceived Usefulness

According to Davis [92], "perceived usefulness is defined as the degree to which a person believes that using a particular system would enhance his or her job performance." If

secondary school teachers believe that using computers improves their performance on their daily work, they are probability going to adopt or accept them, otherwise they would not.

Technology Self-Efficacy

Self-efficacy is defined as “people’s beliefs about their capabilities to produce designated levels of performance that exercise influence over the events that affect their lives” [68]. Bandura [68] further emphasizes that people’s feelings, thoughts, motivation, and behaviour are all influenced by their self-efficacy beliefs. If secondary school teachers demonstrate high technology self-efficacy, means they believe they can successfully use any given technology. If they (teachers) have low technology self-efficacy means they may believe that they might encounter difficulties using given technology.

Information Quality

To define information quality, Howard, and co-writers [124], first define information as processed facts and data, subsequently information quality as a major criterion for measuring the success of an information system. They [124] further argue that information is regarded as of high quality if it is fit for purpose according to the judgment of the consumer or user of information. As such the secondary school teachers are best suited to decide whether the information from the information systems they are using is of high or low quality. If the information is best suited to the purpose, teachers are likely to approve and utilize the information system. From the information quality methodology by Lee and colleagues [103] this study focuses on two components which are completeness and ease of operation to form IQ variable.

Attitude towards Using

Attitude toward using behavior has been defined as “an individual’ positive or negative feelings about performing behavior” [34]. It has been argued teachers are more likely to accept and utilize technology in their teaching and learning activities if they feel positive about using it.

Table 3.1: Summary of Study Main Variables and their Sources

Construct	Number of items	Source
Attitude toward use	4	[102] [71]
Perceived Ease of Use + Usability	9	[71] [102]
Perceived Usefulness	6	[102] [71]
Information Quality	11	[103]
Technology Self-Efficacy	10	[71]

3.3 Research Population

Rahi [122] defined study population as “all people or items one wishes to understand”. It is a group of people or items that the study’s findings can be applicable to or generalized to [125]. The research population for this study consisted of teachers from secondary schools in Botswana, both junior and senior levels.

3.4 Sampling

“Sampling is the process of selecting a segment of the population for investigation” [122]. Mathers and co-writers [126] explain that some study instances will allow for all target population to be part of the study participants while in some instances it would not be practical to include all the population for participation. As such, sampling is required in instances where the potential participants are more common and cannot be covered as an entire population in the study. Sampling has been reported to be beneficial in reducing workload and being cost effective ([126], [122]). Authors ([125], [122]), have categorized main sampling techniques as probability and non-probability. Probability sampling means “a sampling approach in which each unit has an equal chance of probability to be selected” [122]. On the other hand, Rahi [122] defines non-probability sampling as “the sampling approach in which the chance or probability of each unit to be selected is not known or confirmed” and is further categorised into judgement, quota, snowball, and convenience sampling. Probability sampling was considered to have been the most appropriate sampling technique for data collection from the targeted population for the objectives of this study.

3.4.1 Probability Sampling

According to Casteel and Bridier [125], probability sampling technique is used primarily for quantitative studies and gives each item or individual in a concerned population the same possibility of selection. Probability sampling is categorized into multi-stage sampling, cluster sampling, random sampling, stratified sampling, systematic random sampling, and simple random sampling [122]. Given the size of the number of secondary school teachers that make up the study's target population, simple random sampling was best suitable probability technique. Moreover, the population studied is dispensed around the country, which made simple random sampling more suitable for the study to be feasible. Simple random sampling means "a sampling approach in which each unit of the population has an equal probability of inclusion in the sample" [122].

3.4.2 Sample size

A questionnaire was designed and distributed among 340 secondary school teachers who were selected randomly. Altogether, 280 completed questionnaires were received back for use in research analysis. The data collection was captured in the spreadsheet application and converted into dataset. A sample of the dataset is shown in figure 6.

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Figure 3.1: Dataset sample for the data collected from teachers.

The gender was coded using values 1 and 2 for male and female respectively while the responses for variable statements which consisted of strongly agree, agree, neutral, disagree and strongly disagree were coded as shown in table 6.

Table 3.2: Likert Scale and their codes

Likert Scale	code
Strongly Agree	5
Agree	4
Neutral	3
Disagree	2
Strongly Disagree	1

3.5 Data Collection Methods

Two different research methodologies, primary data collecting and secondary data analysis, were used for the primary goals of this study. The use of secondary data analysis was to address specific objectives 1 and 2 while primary data was collected to achieve specific objective 3.

3.5.1 Secondary Data Analysis

The difference between primary and secondary data can be defined by the relationship between the person(s) who collected a data set and the person(s) who is analyzing it [127]. A data set collected by a researcher or a team of researchers for a specific purpose or analysis is primary data but if it was collected by someone for some other purpose is secondary data [127]. Johnston [128] defines secondary data analysis as “the process of analyzing the data that was collected by someone else for another primary purpose”. Several authors ([127], [128], [129], [130]) have put much emphasis on the importance of secondary data analysis as a technique of collecting data on basis that it provides the following benefits;

- It offers economic advantage of collecting data and saves time.
- it provides wide breath of data available for researchers.
- It provides opportunity for utilizing similar research methodologies/ principles.

With the goal to address specific objectives 1 and 2, and to answer research questions 1 and 2 in this study, secondary data analysis was applied to identify factors influencing teachers' technology acceptance and identify existing acceptance theories and models for technology their limitations.

The process of secondary data analysis followed the steps suggested by Johnston [128] which are 1) developing the research questions; 2) identifying relevant data set/ literature; 3) evaluating data set and 5) conclude and present findings. The following section present how the stages were applied to this study.

Developing research questions

Research questions 1 and 2 were adopted from chapter 2 of the study.

Identifying relevant data set/literature

The existing literature sources such as books, journal articles and articles published on websites were used to identify factors influencing teachers' technology acceptance and existing technology acceptance models and theories applied in education.

Research databases such as Google scholar, IEEE Xplore Digital Library, EBSCO, JSTOR, Academia and SpringerLink were used to retrieve relevant publications.

For factors influencing teachers' technology acceptance, selection of the articles into the review was based on the following criteria: i) target population being teachers or educators (this included both student teachers or pre-service and practicing teachers in secondary or high schools); ii) articles in English; iii) the articles published 12 years ago or earlier (that is between 2010 and 2022) and iv) the research design or method reported.

Evaluating data set

All the articles that met the selection criteria had to go through evaluation. The primary goal of evaluating the articles is to make sure that the data set is appropriate for the intended research study before the data is being used [128]. Porritt and colleagues [131] define the same process as data appraisal, which they argue it helps the researcher to exclude articles of low quality and identify strength and limitations of the included articles. The selected articles on factors influencing teachers' technology acceptance were all evaluated using some criteria suggested by Johnston [128] that examined: 1) the study's main objective; 2) adequacy of

research sample size and sampling strategies; 3) the link between study hypothesis and theoretical frameworks; 4) the methodology applied; 5) the suitability of data analysis used and 6) the study findings.

As such, the final list of articles to be reviewed was established and the following set of data was extracted from articles; author(s), year of publication, country of study, method of study, participants, sample size, theoretical model, technology studied and the identified factors influencing teachers' technology acceptance.

3.5.2 Primary Data Collection

The term "primary data" refers to information that has been gathered from first-hand-experience [132]. Since the information has not yet been made public, it is regarded trustworthy, impartial, and authentic [132]. Kabir [132] further explained that primary data can be collected using a variety of data collection techniques including observations, surveys, experiments, and interviews. In this research, primary data were gathered in addition to the secondary that were evaluated. The primary data was necessary to validate the applicability and reliability of the secondary data results as no record of related study that targeted the same participant type in Botswana was found.

In the process of preparing for the data collection exercise, the Ministry of Tertiary Education, Research, Science and Technology (MTERST)'s approval in form of a research permit was acquired. Further permissions were requested from the management (school heads or their deputies) of individual schools. The data collection schedule was made such that it did not overlap with the busiest days of the school calendar where activities such as examinations and sports were taking place.

A data collection representative from each chosen school was sought prior to the gathering of data. A computer studies or computer awareness representative from each selected senior or junior school respectively were briefed on the questions on the questionnaire and procedures of administering the questionnaire. The representatives distributed the questionnaires to the participants and gave them a time frame of 5 days to respond and return them. They kept

reminding those who missed the set timeframe and only collected back from the participants who were willing to submit back.

3.5.3 Ethical Considerations

Research ethics consists of standards conduct that apply to all people in the society which include duties such as not to harm others, help others, not stealing from others and keeping one's promises [133]. When conducting research, it is the responsibility of the researcher to consider the study participants' privacy and confidentiality. The concept of confidentiality is established on the principle of respect for autonomy and is closely connected with anonymity.

To safeguard confidentiality, the participants were not asked any personal information (like names and identity numbers) that can identify them. Furthermore, the participants were promised that data collected from them will be protected from view or use by third parties. Furthermore, prior to the participants taking part in the study, the researcher obtained their consent. The participation was on voluntary basis and respondents were made aware that they might opt out of the data collection process at any time.

Lastly, there were no incentives offered to participants and that was also explained to them before they engaged in the data collection exercise.

3.6 Data collection Instrumentation

Considering the mathematical character of the investigation, a survey method was deemed appropriate and was selected for it. A total of eight weeks was taken for data collection process.

3.6.1 Survey Questionnaire

After closely studying different types of data collection instruments, the most effective approach for collecting the quantitative data needed for this study was determined to be a questionnaire. Moreover, it was best suited than other data collection methods like observation and interview due to the number of participants which were targeted. A questionnaire is "a data collection instrument that consists of a series of questions and other prompts for the purpose of gathering data from the respondents" [134]. Etikan and Bala [135]

point out that the questionnaires can be used for both qualitative and quantitative research. But it is mostly used for quantitative data.

A closed ended questions questionnaire was designed and distributed among secondary school teachers. A closed ended questionnaire is one in which all potential responses are predetermined, and as such, the participant is only permitted to provide the pre-coded response [126]. The questionnaire used a five-point Likert scale with possible responses being strongly agree, agree, neutral, disagree and strongly disagree.

Demographic and Professional Characteristics

To evaluate the demographics of teachers, standard questions were used. The gender and age of the participants were two demographic details that were collected. On their professional standing, data collected included their current work position, Teaching Subject and number of years using Ed-Admin System.

Main Research Variables

The study's main factors were technology self-efficacy, perceived usefulness, information quality, attitude towards using and perceived ease of use + usability. Additionally, gender was used to moderate hypothesized relationships between technology self-efficacy, attitude towards using, perceived ease of use + usability and perceived usefulness. The following alterations were made in the study constructs.

- The information quality items started with the words “The Ed-Admin System”.
- Under TSE, the words “computer/internet application” were replaced by the word “technology”.
- Other variable (ATU, PU, and PEUU) items were adopted as they are from the Holden & Rada [71] study.

Below are the constructs of the variables to be assessed (see tables 7 – 11)

Table 3.3: Percieved Ease of Use + Usability Constructs

Code	Statement
PEUU 1	My interaction with technology is clear and understandable
PEUU 2	Interacting with technology does not require a lot of my mental effort.
PEUU 3	I find technology to be easy to use
PEUU 4	I find it easy to get technology to do what I want it to do.
PEUU 5	I find technology to be flexible to interact with
PEUU 6	Learning how to perform tasks using technology was easy.
PEUU 7	Technology has good functionality (features).
PEUU 8	I feel I have an intuitive sense of how to operate technology
PEUU 9	I find it easy to remember how to perform tasks using technology

Table 3.4: Perceived Usefulness Constructs

Code	Statement
PU 1	Using technology improves my performance in my job
PU 2	Using technology in my job increases my productivity
PU 3	Using technology enhances my effectiveness in my job
PU 4	I find technology to be useful in my job
PU 5	In my job, usage of technology is relevant
PU 6	I have no problem with the quality of technology's output

Table 3.5: Attitude Towards Use Constructs

Code	Statement
ATU 1	Computers make work more interesting
ATU 2	Working with computers is fun
ATU 3	like using computers
ATU 4	I look forward to those aspects of my job that require me to use of computer

Table 3.6: Technology Self-Efficacy Constructs

Code	Statement
TSE 1	In general, I could complete any desired task using any technology if there was no one around to tell me what to do as I go.
TSE 2	In general, I could complete any desired task using any technology if I had never used a technology like it before
TSE 3	In general, I could complete any desired task using any technology if I had only the manuals for reference
TSE 4	In general, I could complete any desired task using any technology if I had seen someone using it before trying it myself
TSE 5	In general, I could complete any desired task using any technology if I could call someone for help if I got stuck
TSE 6	In general, I could complete any desired task using any technology if someone else had helped me get started.
TSE 7	In general, I could complete any desired task using any technology if I had a lot of time to complete the task for which the technology was provided.
TSE 8	In general, I could complete any desired task using any technology if I had just the built-in help facility for assistance.
TSE 9	In general, I could complete any desired task using any technology if someone showed me how to do it
TSE 10	In general, I could complete any desired task using any technology if I had used similar technologies before this one to do the same task

Table 3.7: Information Quality Constructs

Code	Statement
IQ 1	The Ed-Admin system information includes all necessary values
IQ 2	The Ed-Admin system information is incomplete (R)
IQ 3	The Ed-Admin system information is complete
IQ 4	The Ed-Admin system information is sufficiently complete for our needs
IQ 5	The Ed-Admin system information covers the needs of our tasks
IQ 6	The Ed-Admin system information has sufficient breadth and depth for our task
IQ 7	The Ed-Admin system information is easy to manipulate to meet our needs
IQ 8	The Ed-Admin system information is easy to aggregate
IQ 9	The Ed-Admin system information is difficult to manipulate to meet our needs (R)
IQ 10	The Ed-Admin system information is difficult to aggregate (R)
IQ 11	The Ed-Admin system information is easy to combine with other information.

3.7 Data Processing and Analysis

Data analysis was conducted using the SmartPLS 3 statistics software program. Two phases of data analysis were carried out in this study which are descriptive statistic and assessment of significance which evaluated constructs about attitude towards using technology among secondary school teachers. Descriptive statistics were used to determine the study's instrument's stability and accuracy by evaluating the constructs' validity and reliability. The standard deviation and mean for ATU, PUU, PU, TSE, and IQ were calculated. To evaluate the measurement model, a Confirmatory Factor Analysis (CFA) was performed. The Average Variance Extracted (AVE), composite reliability (CR), and factor loadings of individual items for variables made up the CFA.

3.7.1 Reliability

According to Haradhan [136], reliability means “the consistency, stability and repeatability of results, that is, the result of a researcher is considered reliable if consistent results have been obtained in identical situations but different circumstances”. The reliability of this study was examined by using a Cronbach’s alpha coefficient to check for internal uniformity within the study constructs’ item set. Internal consistency is used to assess how well different items measure the same characteristics [137]. The most common test for internal consistency is the Cronbach’s alpha coefficient, which has a range of 0 to 1. Table 12 shows the Cronbach’s alpha coefficients and their significance as adapted from Strainer [138].

Table 3.8: Internal consistency and significance (Source [138])

Cronbach’s alpha	Internal consistency
$\alpha \geq 0.9$	Excellent
$0.7 \leq \alpha < 0.9$	Good
$0.6 \leq \alpha < 0.7$	Acceptable
$0.5 \leq \alpha < 0.6$	Poor
$\alpha < 0.5$	Unacceptable

Greater internal consistency of the item within the scale is indicated by a coefficient value nearer to 1. The commonly acceptable coefficient is 0.7 or higher. The Cronbach’s alpha formula is given in Eq. (1).

$$\alpha = \frac{k}{k-1} \left(1 - \frac{\sum s_{i^2}}{s_{t^2}} \right) \text{-----Eq. (1)}$$

Where α is the computed Cronbach’s alpha, k is the quantity of items, s_{i^2} is the variance for each item and s_{t^2} is the variance of the total scale.

3.7.2 Validity

In a quantitative study, validity means “the degree to which a concept is accurately measured” [139]. Therefore, it is crucial to verify the accuracy of the data collection instrument to obtain accurate and useful results. Research that has high validity produces results that correspond

to real properties and variations in the real world. There are two construct validity approaches used in this study, convergent and discriminant, which were applied to evaluate the accuracy of the constructs of the suggested model. Heale and Twycross [139] defined construct validity as “the extent to which a research instrument measures the intended construct”.

The average variance extracted, and the composite reliability were both used to test the convergent validity. The formulae for computing the average variance extracted and composite reliability are shown in Eq. (2) and Eq. (3) respectively.

$$VE = \frac{\sum_{i=1}^n \lambda_i^2}{n} \text{----- Eq. (2)}$$

Where VE is the average variance extracted, n is the total number of variables observed and λ represents the standardised factor loading.

$$CR = \frac{(\sum_{i=1}^n \lambda_i)^2}{(\sum_{i=1}^n \lambda_i)^2 + (\sum_{i=1}^n \delta_i)^2} \text{----- Eq. (3)}$$

Where CR is the composite reliability, n is the number of variables, λ is the standardised factor loading and δ represents error variance terms.

Convergent validity checks if the same idea measured in various manners produces similar findings. Discriminant validity is proof that an idea is different from other strongly related ideas. To check for discriminant validity, the Heterotrait-Monotrait and Fornell-Lacker ratios were used.

The second phase of analysis was concerned with the contributions and significance of independent variables on dependent ones. In this phase, study hypothesis was also tested through path analysis tests. All the suggested correlations between the variables had their coefficient (beta and p-values) determined. The beta coefficient allows direct comparisons between independent variables to establish which has the highest effect on the dependent variables while the p-value is the likelihood of obtaining results at least as extreme as the observed results of the observed statistical hypothesis test. The p-values are in the range of 0 to 1. Statistical significance is defined as a p-value of 0.05 or less. Statistically, a p-value is used

to validate a hypothesis against collected data. Additionally, all the proposed model relationships were moderated by gender.

A bootstrapping test was conducted to test and estimate direct, indirect, and total impacts linked to each of endogenous and exogenous variable on attitude towards technology usage. Furthermore, the coefficient of determination (R^2) was determined to summarize the total variance accounted for regarding dependent variables by independent variables. The R^2 is calculated as shown in Eq. (4).

$$R^2 = 1 - \frac{SSR}{SST} \text{-----Eq. (4)}$$

Where R^2 is the coefficient of determination,

$$SSR = \sum (y - \hat{y})^2$$

$$SST = \sum (y - \bar{y})^2$$

SSR stands for Sum of Squared Regression (model-explained variation), SST stands for Sum of Squared Total (overall data variation), y represents the exact value, $\hat{y}$ is the predicated value of y and $\bar{y}$ is the mean of y values.

The outcomes of the discussed tests are further deliberated in detail in chapter 4.

3.8 Chapter Summary

In conclusion, the chapter defined the research design for the study. Primary and secondary data analysis design was explained. The criteria for selecting the relevant studies were set. The quantitative research method was selected for primary data collection. Research population, sample size, sampling method, ethical considerations and the structure of the data collection instrument were explained further. Moreover, the data analysis approaches for primary data collected were also discussed. Several statistics tests such as validity and reliability were explained.

Chapter 4 RESEARCH FINDINGS

4.1 Introduction

This section provides the study's data analysis and results. The chapter is presented in 3 sub-sections which each addresses the findings on the study research questions.

4.2 Findings on the existing technology acceptance theories and models and their limitations

The study's findings for specific objective 2, which also addresses the research question 2 were attained through the review of the existing literature. There are several models and theories of technology adoption that have been identified in the literature but five, TRA, TPB, IDT, TAM and UTAUT were found to be the most popularly used in adoption of technology. Their contributions and limitations were studied and summarized according to table 13 below.

Table 4.1: Summary of Contributions and Limitations of Technology Acceptance Models and Theories

Theory/Model	Author(s)	Concept	Contribution	Limitation
TRA	Fishbein & Ajzen [90]	Two belief-based constructs: attitudes and subjective norms are used to conceptualize behavioural intention. Actual behavior is influenced in behavioral intention [91]	1) One of the earliest technology acceptance models. 2) Widely used in different settings successfully	1) Fails to address other factors like role of habit, cognitive deliberation and moral factors
TPB	Ajzen [91]	Extension of TRA. Adds a new construct: perceived behavioral control	1. Improves upon some drawbacks observed in TRA.	1) Too dependent on availability of resource and skills 2) Lacks consideration for environmental and economic factors
IDT	Rogers [79]	Technological characteristics	1) The model has been	1) Has less explanatory

		influence innovation adoption. Relative advantage, comparability, complexity, trialability and observability are traits that influence innovation adoption		implemented in various fields besides IT successfully.	power and more practical for outcome prediction than other models. 2) The factors are limited to the variables in the model.	
TAM	Davis [92]	Replaces the TRA attitude toward behavior with 2 determinants: PEU and PU, which influence attitude and behavioral intention. Eliminate TRA's subjective norm. Provides for external variables.	1) 2) 3)	Compared to other models, it said to be predictive and robust Eliminates some limitations experienced in TRA and TPB Has been tested and applied successfully in different environments and technologies.	1) 2)	Its application has mostly targeted students in controlled environments It has been criticized for being a simple model
ATAUT	Venkatesh et al [93]	Made up of combined constructs from 8 technology acceptance model and theories (IDT, CTAMTPB, SCT, TRA, TPB and TAM) Further moderates the relationship by voluntariness of use, experience, gender, and age	1) 2)	Considered to be more robust than other theories and models. It has been used successfully in recent research.	1) 2)	Critiqued for having numerous independent factors when attempting to predict intentions and behavior. Still needs further application to verify and confirm its appropriateness

4.3 Findings on the factors influencing teachers' technology acceptance.

The findings of the specific objectives 1 was achieved through secondary data analysis. The selection process from the literature search to quality appraisal generated 19 articles (as shown on table 6) which were subjected. The studies were published between 2010 and 2021. All the selected studies applied the quantitative research methods.

Most of research projects were carried out in China (n = 4), then in Singapore (n =3), two were conducted in Taiwan and one in each of Botswana, Turkey, Slovenia, Virginia, Malaysia, Netherlands, Korea, and India. Therefore, this indicate that majority of studies were conducted in Asia and America against a few which were conducted in Africa as shown in table 14.

Most studies (n = 8) targeted pre-service or student teachers as participants, four targeted high or secondary school teachers and either primary, college or university teachers and school principals were participants in the rest of the studies.

Table 4.2: Summary of Reviewed Studies on Factors Influencing Technolgy Adoption in Education

Author(s)	Country	Study Method	Participants	Sample Size	Type of Technology	Theoretical Model
Timothy Teo [16]	Singapore	Quantitative	Primary and Secondary School teachers	592	General	TAM
Weng et al [80]	Taiwan	Quantitative	Elementary School Teachers	90	Multimedia teaching materials	TAM
Wong et al [4]	Malaysia	Quantitative	Student Teachers	302	General	TAM
Holden & Rada [71]	Virginia	Quantitative	Secondary teachers	99	General	TAM
Joo et al [81]	Korea	Quantitative	College teachers	296	TPACK	TAM
Yeun & Ma [84]	China	Quantitative	In-service teachers	152	General	TAM

Farjon et al [140]	Netherlands	Quantitative	Pre-service teachers	398	General	Will Skill Tool (WST)
Lai & Chen [86]	Taiwan	Quantitative	Secondary School Teachers	325	Teaching Blogs	Innovation Diffusion Theory (IDT)
Sumak & Sorgo [73]	Slovenia	Quantitative	Primary to University teachers	898	Interactive White Boards	ATAUT
Prieto et al [72]		Quantitative	Primary pre-service teachers	678	Mobile devices	TAM
Aypay et al [12]	Turkey	Quantitative	Pre-service teachers	754	General	TAM
Teo [67]	Singapore	Quantitative	Pre-service Teachers	157	General	TAM/ Theory of Planned Behaviour
Teo & Noyes [14]	Singapore	Quantitative	Pre-service Teachers	153	General	TAM
Wang & Han [82]	China	Quantitative	Secondary Vocational Schools teachers	1294	General	TAM
Teo, Fan & Du [83]	China	Quantitative	Pre-service teachers	339	General	TAM
Nair & Das [141]	India	Quantitative	High school teachers	195	General	TAM
Wong [142]	China	Quantitative	Pre-service teachers	234	General	TAM
Totolo [15]	Botswana	Quantitative	Secondary school Principals	111	General	TAM
Chang et al [85]	Taiwan	Quantitative	University teachers	258	General	TAM

As shown in table 6, every study that was reviewed was predicated on a theoretical framework. The UTAUT, Innovation Diffusion Theory (IDT), Theory of Planned Behaviour (TPB) and Will Skill Tool (WST) theory which were each used in one study however the TAM was used most (n=15).

The theoretical frameworks that guided the investigations helped identify a variety of factors impacting teachers' behavioural intention to accept, adopt and utilize technology in teaching and learning. The factors which were mostly recorded were perceived ease of use, which is comparable to effort expectancy, perceived usefulness which is comparable to performance expectancy and attitude towards use as shown in table 7.

The sample sizes of the studies ranged from 99 to 1294 teachers. Majority of the studies did not target any specific technology except for 5 studies which focused on multimedia teaching materials [80], TPACK [81], teaching blogs [86], interactive white boards [73] and mobile devices [72].

Factors influencing teachers' technology acceptance.

Demographic characteristics

Out of all the studies reviewed, only three studies ([72], [4], [73]) explored the moderating effects of teachers' personal characteristics. All the three studies investigated the moderating effect of gender relationships of determinants of teachers' technology acceptance. The findings by Wong, Teo & Russo [4] and Sanchez-Prieto, Olmos-Miguelanez and Garcia-Penalvo [72] failed to support the hypothesis that gender differences would moderate the relationships between the behavioural factors of intentions to use technology. However, the results by Wong and co-authors [4] indicated women's attitudes towards technology usage and perceived usefulness were significantly impacted by their computer teaching-efficacy compared to their male counterparts. Also, computer teaching efficacy affected perceived ease of use more strongly for women rather than for men. On another study by Sumak & Sorgo [73] noted significant difference on gender moderation. According to their findings, female teachers had more favourable societal influences and facilitating conditions that affected their intention to use relationships. On another hand, the performance expectancy to behavioural intention influence was stronger for male teachers.

Sumak & Sorgo [73] further moderated their model relationships with age, user-type (being pre-adopters and post-adopters) and teaching experience. Their results indicated that all the moderators had effects among the same or different relationships.

On a different study by Sanchez-Prieto and colleagues [72], the findings did not support the predictions that differences between age and academic year would moderate the relationships between behavioural determinants of intention of using technology.

Teachers' characteristics

Several studies ([12], [80], [11], [72]) reported that teachers' individual attributes do influence their intention to accept, embrace and utilize technology in their line of duty. The characteristics of teachers reported to be influential from the reviewed literature are attitude towards use, self-efficacy, experience, competency, personal innovativeness, anxiety, and subjective norm. A total of 14 studies ([11], [80], [4], [84], [140], [12], [67], [82], [83], [81], [71], [14], [141], [142]) have argued that teachers' attitudes on technology use have a significant statistical impact on how they intend to use technology. The finding suggests that teachers who feel positively about using technology are more likely to use it.

The other teachers' trait that was discussed by several authors is self-efficacy. A total of 8 studies ([12], [72], [84], [81], [71], [143], [142] [85]) reported a statistically significant relationship between self-efficacy and other factors influencing teachers' adoption of new technologies. The findings indicate that the teachers' intentions to use technology are influenced by how confident they are in their ability to do a certain task.

Subjective norm was another teachers' characteristic that was considered to influence the intention of teachers to use technology. Several studies ([67], [16], [84], [85], [142]) implied that teachers are more inclined to use technology if they believe that key individuals in their lives believe that they should. Other teachers' traits, which were discussed by one author each were competency [140], experience [140], mobile anxiety [72] and enjoyment in helping others [86].

Technological Characteristics

The following technological characteristics were reported from the reviewed studies, job relevance, perceived usefulness, compatibility, perceived ease of use, codification effort, effort expectancy, technological complexity, and performance expectancy. Majority of studies ([16], [80], [143], [71], [81], [84], [12], [67], [82], [83], [14], [141], [142], [15], [85]) (n= 16,

84%), observed that teachers' attitudes and intentions toward using technology were significantly influenced by their perceptions of perceived usefulness and perceived ease of use. Additionally, another study by Sumak and Sorgo [73] reported the same influences by effort expectancy and performance expectancy on teachers' attitudes and intentions to use technology. The results imply that teachers are likely to adopt and use computers or various technologies if they believe they are easier to use and they enhance their job performance.

Two studies ([86] & [85]) cited comparability as one of the factors influencing of teachers' adoption and usage of technology. The finding that assumes that teachers would accept and use technology if they are observing consistency with the technology from their past experiences. The following characteristics were also reported by one author each; technological complexity [12], job relevance [85] and codification effort [86] as factors influencing teachers' technology acceptance and use.

Organizational characteristics

Regarding organizational characteristics, it has been suggested that teacher's intentions to adopt and use technology are influenced by facilitating conditions, access, social influence, and school support. A total of 5 ([16], [73], [12], [67], [142]) studies conversed that facilitating conditions significantly affect teachers' intentions to use technology. The result indicates that teachers will be more willing to use technology if they feel that the organizational and technical infrastructures and support required to use such technology are available. Other organizational factors that affect adoption and usage of technology by teachers were school support [86], access [140] and social influence [86], and were each discussed by a single study.

Table 4.3: Factors influencing teachers' technology acceptance from the literature review.

Study	Factors
Timothy Teo [16]	PEU, PU, FC, ATU, SN
Fumei Weng et al [80]	PEU, PU, ATU
Wong et al [4]	PEU, PU, ATU, CSE
Holden & Rada [71]	PEUU, PU, ATU, TSE
Joo et al [81]	PEU, PU, ATU, TPACK, Teacher Self Efficacy
Yeun & Ma [84]	PEU, PU, ATU, SN, CSE
Farjon et al [140]	Experience, access, attitude, competency
Lai & Chen [86]	School Support, Perceived Enjoyment, Codification Effort, Compatibility, Enjoyment in helping others, PEU, PU, Personal Innovativeness
Sumak & Sorgo [73]	PE, EF, FC, SI
Prieto et al [72]	Self-Efficacy, Mobile Anxiety, PEU, PU, BI
Aypay et al [12]	PU, PEU, CSE, Technological Complexity, FC, ATU
Teo [67]	FC, SN, PEU, PU, ATU
Wang & Han [82]	PEU, PU, ATU, BI
Teo, Fan & Du [83]	PEU, PU, ATU, BI
Teo & Noyes [14]	Perceived enjoyment, ATU, PU, PEU, Intention to Use
Nair & Das [141]	PU, PEU, ATU
Wong [142]	CSE, SN, FC, PU, PEU, ATU, BI
Totolo [15]	PU, PEU, BI
Chang et al [85]	PU, PEU, BI, CSE, SN, Job Relevance, Compatibility

4.4 Findings on the influence of IQ and gender on teachers' technology acceptance

The findings on the quantitative data collected from secondary school teachers are discussed below. A total of 280 secondary school teachers participated in the research. The primary method used for data analysis was Structural Equation Modelling (SEM). The SmartPLS 3 statistics software program was employed in this work, yielding descriptive statistics based on the percentages and frequencies scores of the selected variables of the study. Validity and reliability analysis were conducted on the evaluation of the measurement model. The significance of the path coefficients was established, and the structural model fit was also

examined. This section presents the findings on the frequency analysis on demographic characteristics and model factors in sections 4.4.1 and 4.4.2 respectively, as well as reliability and validity analysis, hypothesis testing and assessment of model variables' overall, direct, and indirect effects in sections 4.4.3, 4.4.4 and 4.4.5 respectively.

4.4.1 Demographic profile for study participants

Demographic characteristics refer to features that describe the status of people or person [144]. This section presents the study participants' demographic characteristics relating to gender, age, current work position, teaching subject and experience in using the Ed-Admin systems.

4.4.1.1 Gender

According to the findings, of the 280 teachers who took part in the research, 54.2% of them were female while 45.7% were males (see table 16).

Table 4.4: Distribution of gender

Description	Category	Frequency	Percent	Valid Percent	Cumulative Percent
Gender	Male	128	45.7	45.7	45.7
	Female	152	54.2	54.2	100
Total		280	100	100	

The gender distribution of the study participants is further shown in figure 7 below.

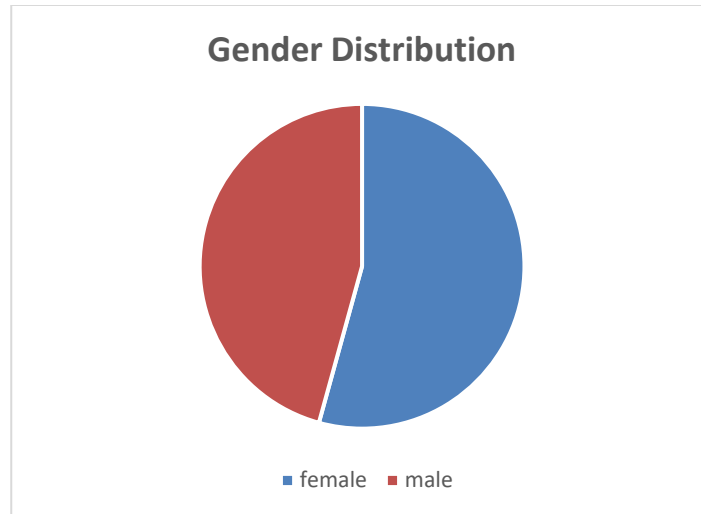


Figure 4.1: Gender Distribution

The results suggest that both males and females were given an equal opportunity during data collection.

4.4.1.2 Age

In the survey, the respondents were required to provide their age. Table 17 and figure 8 shows the distribution of age ranges of the participants.

Table 4.5: Age Distribution

Description	Category	Frequency	Percent	Valid Percent	Cumulative Percent
Age	<30 years	33	11.8	11.8	11.8
	31-40 years	131	46.8	46.8	58.6
	41-50 years	112	40.0	40.0	98.6
	>50 years	4	1.4	1.4	100
Total		280	100	100	

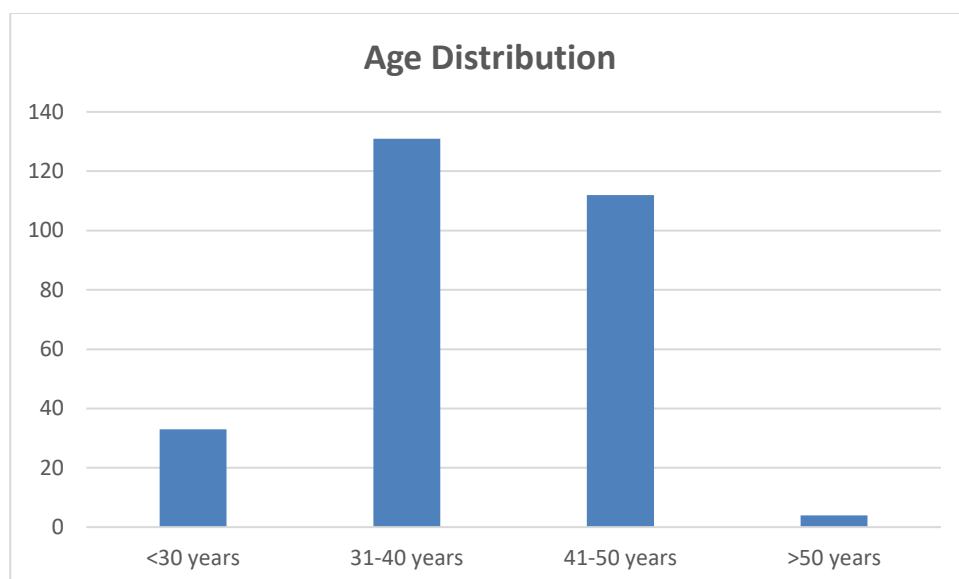


Figure 4.2: Age Distribution

The findings indicate that majority of participants (58.6%) were aged between 30 years and 50 years, the ones below 30 years accounted for 11.8% and the least was those ones aged above 50 years who constituted only 1.4%. This could mean that secondary school teachers in Botswana tend to be between the ages 30 and 50.

4.4.1.3 Work position

The respondents were also requested to provide their current job title as one of the demographic characteristics in the data collection tool. Table 18 below shows the distribution of the participants' current positions.

Table 4.6: Work Position Distribution

Description	Category	Frequency	Percent	Valid Percent	Cumulative Percent
Work position	Assistant teacher	27	9.6	9.6	9.6
	Teacher	75	26.8	26.8	36.4
	Senior Teacher 2	147	52.5	52.5	88.9
	Senior Teacher 1	31	11.1	11.1	100
Total		280	100	100	

The results indicate that teachers from all teaching positions participated. The teaching positions range from the assistant teacher (which is the teaching entry point) to senior teacher grade 1 which is the last position just before the head of department position.

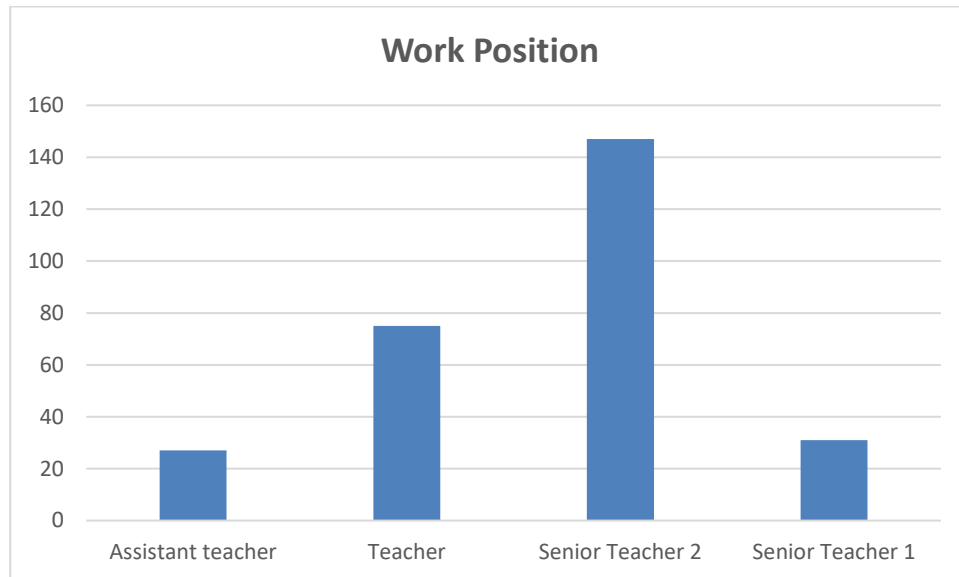


Figure 4.3: Work position distribution

From 280 teachers who participated in the study, 52.5% which is majority hold the post of senior teacher grade 2 as shown in figure 9. The second largest number of participants were teachers holding the position of teacher. Assistant teachers and senior teachers grade 1 scored the low participation percentages of 9.6 and 11.1 respectively.

4.4.1.4 Teaching Subject

Teaching subject of the participant was one of the details that was requested in the data collection tool. As is indicated in table 19 below, the subjects were divided into groups.

Table 4.7: Grouping of teaching subjects.

Group	Subjects
Humanities	Moral Education, Religious Education, History, Geography, Development Studies, Social Studies, Guidance and Counselling
Sciences	Biology, Physics, Chemistry, Integrated Science
Languages	Setswana, English
Practical Subjects	Computer Studies, Agriculture, Physical Education, Home Economics, Art and Design, Design and Technology
Mathematics	Mathematics, Statistics, Additional Mathematics
Business Subjects	Accounting, Commerce, Business Studies

Majority of participants (25%) as shown in figure 10 and table 20 was teaching practical subjects followed by humanities and sciences teachers. However, the distribution frequency of the results suggests that teachers from all different subjects were offered a fair chance to take part in the study.

Table 4.8: Teaching subject distribution

Description	Category	Frequency	Percent	Valid Percent	Cumulative Percent
Teaching subject	Humanities	61	21.8	21.8	21.8
	Sciences	58	20.7	20.7	42.5
	Languages	43	15.4	15.4	57.9
	Practical Subjects	70	25	25	82.9
	Mathematics	27	9.6	9.6	92.5
	Business Subjects	21	7.5	7.5	100
Total		280	100	100	

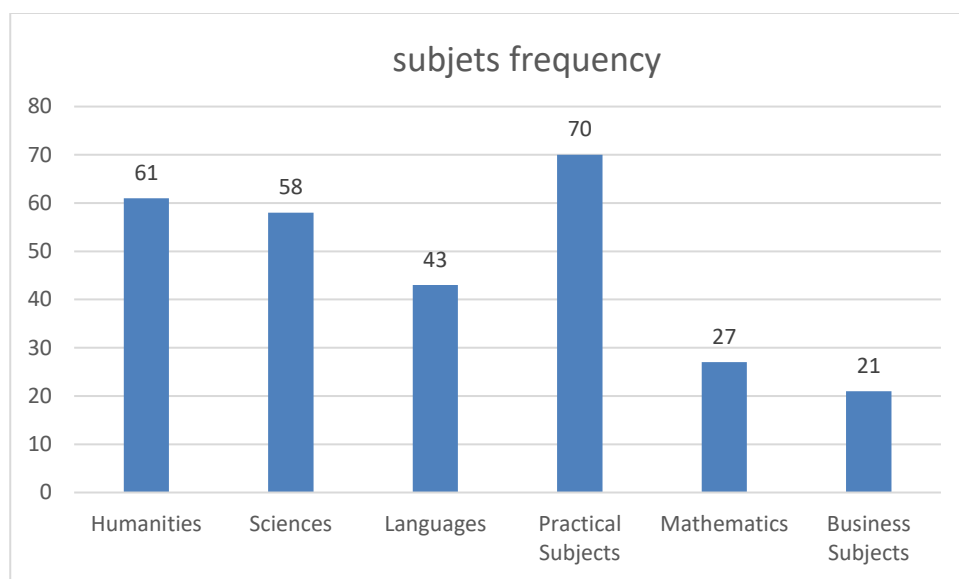


Figure 4.4: Teaching subject distribution

4.4.1.5 Number of Years using Ed-Admin System

The participants in the study were requested to state how long they had been using the Ed-Admin system. The maximum number of using the system recorded was 13 years while the minimum was 1. During analysis the years were categorized into two; 0 – 5 and more than 5. The outcomes show that majority of teachers (53.2 %) who took part in the research have used the Ed-Admin system for more than 5 years. However, the difference noted between the two categories of number of years was insignificant as the 46.8 % was recorded for those who have been using the system for 5 or less years as shown in table 21.

Table 4.9: No. of years using Ed-Admin system distribution

Description	Category	Frequency	Percent	Valid Percent	Cumulative Percent
No. of years using Ed-Admin System	≤5 years	131	46.8	46.8	46.8
	>5 years	149	53.2	53.2	100
Total		280	100	100	

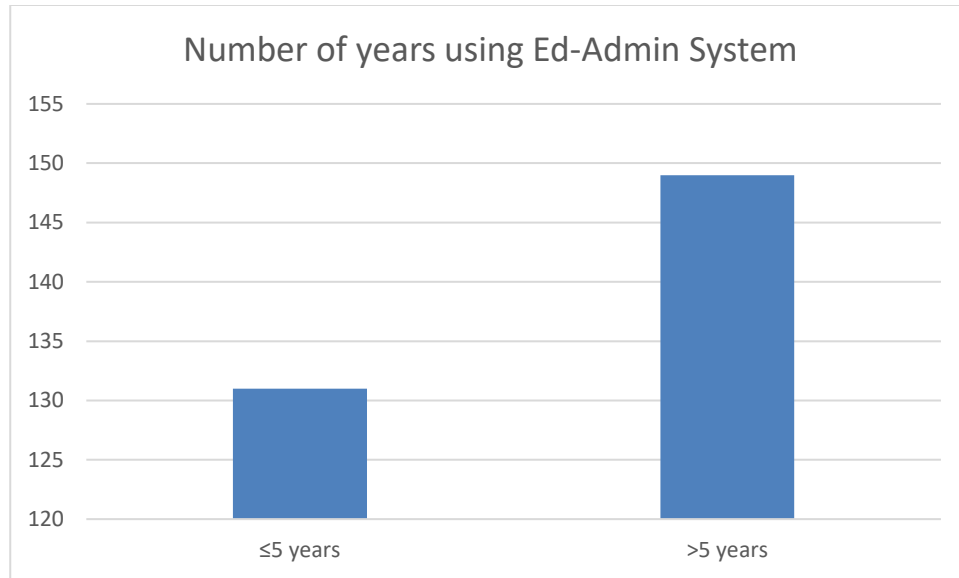


Figure 4.5: No. of years using Ed-Admin system distribution.

4.4.2 Frequency analysis on the model variables

The assessment of the 5 variables (ATU, PEUU, PU, TSE, and IQ) of the proposed model were included the questionnaire's second section after demographic data about the participants. The participants were requested to tick on the appropriate box to indicate how much they agreed or disagreed with the provided statements. There were five possible responses: strongly disagree, disagree, neutral, agree and strongly agree. The results of the participants' responses to the research variables' statements are covered in this section.

Attitude towards Use

To assess the attitude towards use variable, the participants were given 4 statements to respond to and their response distribution on the statements are as shown in table 22 and fig 12. The statements are code ATU1, ATU2, ATU3 and ATU 4.

Table 4.10: Attitude Towards Use frequency distribution

Item	Statement	Strongly Agree		Agree		Neutral		Disagree		Strongly Disagree	
		N	%	N	%	N	%	N	%	N	%
ATU 1	Computers make work more interesting	117	41.8	141	50.4	14	5	8	2.9	0	0
ATU 2	Working with computers is fun	108	38.6	149	53.2	17	6.1	6	2.1	0	0
ATU 3	I like using computers	104	37.1	134	47.9	34	12.1	7	2.5	1	0.4
ATU 4	I look forward to those aspects of my job that require me to use computer	93	33.2	155	55.4	22	7.9	9	3.2	1	0.4

From the results, more than 80% of teachers indicated that computers increase the interest of their work, find using computers enjoyable, like working with computers and are anticipating the parts of their career that will demand them to make use of computers. Few individuals disagreed while some felt unsure about the statements given in this variable. The findings show that teachers appreciate the usage of technology in their work and are willing and ready to utilize it in daily learning and teaching activities.

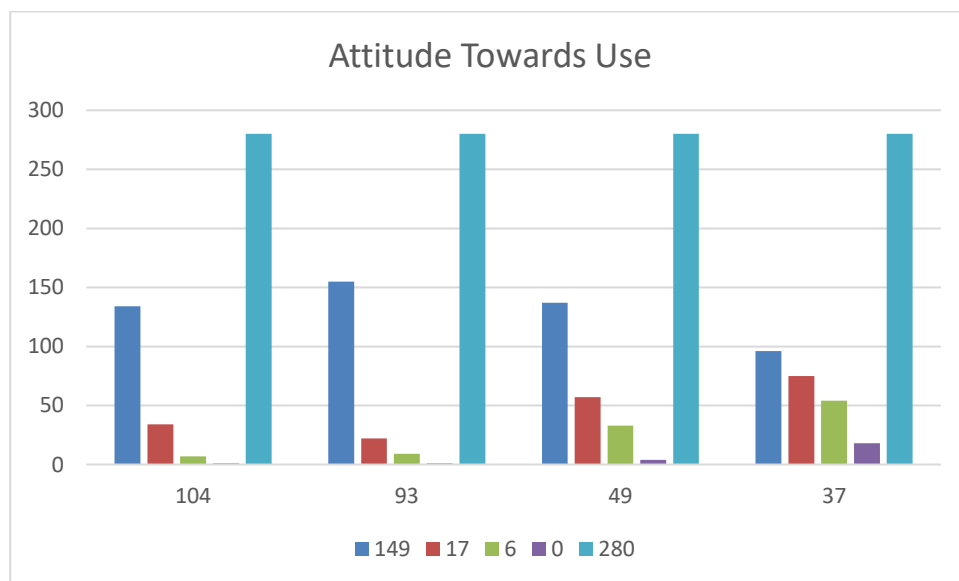


Figure 4.6: Attitude Towards Use frequency distribution

Perceived Ease of Use + Usability

Respondents were given 9 statements to assess the PEUU variable. Table 23 and figure 13 show how the participants reacted to the statements. The statements are coded PEUU1 to PEUU number 10.

Table 4.11: Perceived Ease of Use + Usability

Item	Statement	Strongly Agree		Agree		Neutral		Disagree		Strongly Disagree	
		N	%	N	%	N	%	N	%	N	%
PEUU 1	My interaction with technology is clear and understandable	72	25.7	143	51.1	52	18.6	13	4.6	0	0
PEUU 2	Interacting with technology does not require a lot of my mental effort.	56	20	131	46.8	48	17.1	39	13.9	6	2.1
PEUU 3	I find technology to be easy to use	65	23.2	123	43.9	58	20.7	33	11.8	1	0.4
PEUU 4	I find it easy to get technology to do what I want it to do.	51	18.2	129	46.1	44	15.7	51	18.2	5	1.8
PEUU 5	I find technology to be flexible to interact with	66	23.6	136	48.6	45	16.1	32	11.4	1	0.4
PEUU 6	Learning how to perform tasks using technology was easy.	41	14.6	128	45.7	72	25.7	37	13.2	2	0.7
PEUU 7	Technology has good functionality (features).	81	28.9	157	56.1	37	13.2	5	1.8	0	0
PEUU 8	I feel I have an intuitive sense of how to operate technology	29	10.4	165	58.9	62	22.1	24	8.6	0	0
PEUU 9	I find it easy to remember how to perform tasks using technology	38	13.4	152	54.3	53	18.9	36	12.9	1	0.4

In assessing PEUU, majority of teachers (more than 50%) agreed with all the statements which were given. Even though most teachers agreed with all the statements, a less number was accounted for under the strongly agree response. This could indicate a lack of confidence in their ability to use technology. Most teachers (more than 75%) demonstrated that their use

of technology is clear and understandable. However, 52 teachers were neutral while 13 disagreed.

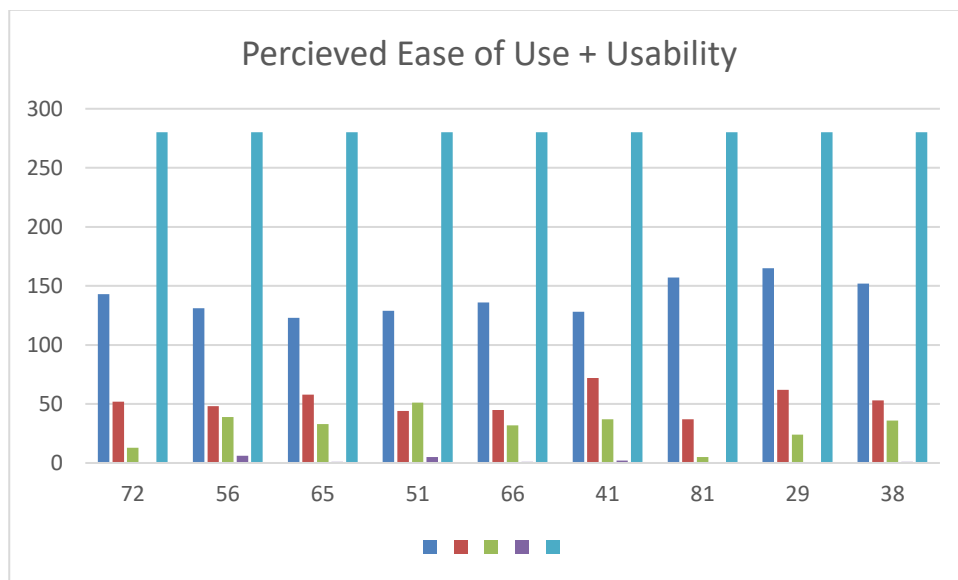


Figure 4.7: Perceived Ease of Use + Usability

Despite having a high percentage of teachers agreeing in all statements in this variable, a noticeable and significant percentage of 30% or more in neutral and disagree response was noted in some statements. More than 30% of teachers are unsure and disagree with technology requiring less of their mental effort during interaction with it. The same percentage was observed for statements PEUU 3, PEUU 4, PEUU 6, PEUU 8 and PEUU 9. The results suggest that there is an opportunity for improvement in how teachers perceive and utilize technology within their environment of learning and teaching.

Perceived Usefulness

Six statements (code PU 1, PU 2, PU 3, PU 4, PU 5, and PU 6) were given to the participants to assess their views on their perceived usefulness of technology. Table 24 and figure 14 present the findings.

Table 4.12: Perceived Usefulness frequency distribution

Item	Statement	Strongly Agree		Agree		Neutral		Disagree		Strongly Disagree	
		N	%	N	%	N	%	N	%	N	%
PU 1	Using technology improves my performance in my job	106	37.9	139	49.6	31	11.1	4	1.4	0	0
PU 2	Using technology in my job increases my productivity	91	35.2	147	52.5	28	10	13	4.6	1	0.4
PU 3	Using technology enhances my effectiveness in my job	90	32.1	152	54.3	23	8.2	13	4.6	2	0.8
PU 4	I find technology to be useful in my job	119	42.5	135	48.2	16	5.7	10	3.6	0	0
PU 5	In my job, usage of technology is relevant	113	40.4	140	50	16	5.7	9	3.2	2	0.8
PU 6	I have no problem with the quality of technology's output	50	17.9	138	49.3	69	24.6	13	4.6	10	3.6

The findings indicate that most teachers (more than 50%) consider technology to be a beneficial tool for their teaching and learning processes. Teachers agree that technology improves their job performance, increases their productivity, and enhances effectiveness in their jobs. They also believe that technology is useful and relevant in their jobs. Even though more than 50% of participants agreed that they are not bothered by the output of quality of the technology, more than 30% of other teachers disagreed or were unsure. Overall, the findings show that most teachers appreciate the role technology plays in their work, which might be the strong starting point were policies makers can utilize in enhancing technology adoption and use in education.

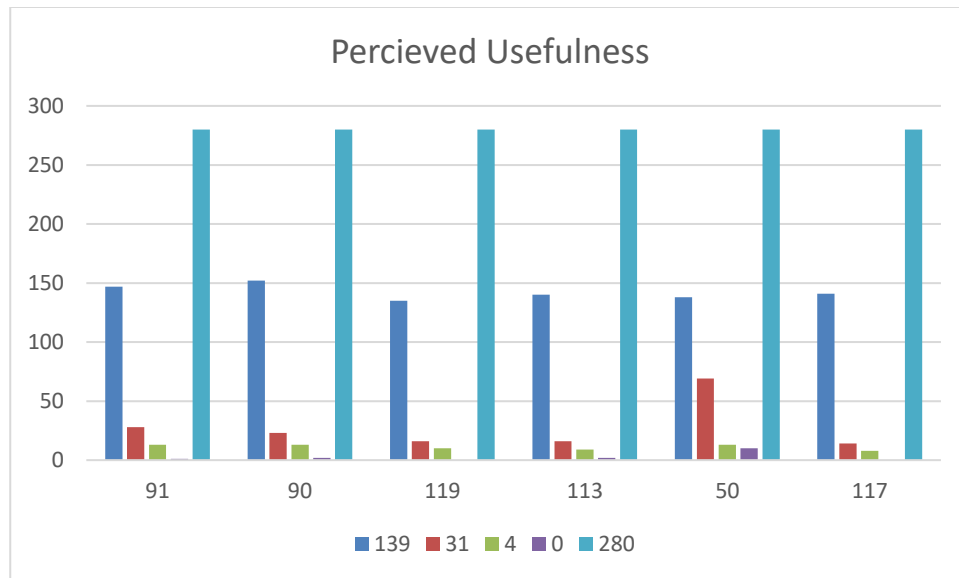


Figure 4.8:Perceived Usefulness frequency distribution

Technology Self-Efficacy

In the questionnaire, participants were given 10 statements (coded TSE 1 to TSE 10) to express their view on their technology self-efficacy by selecting responses ranging from strongly disagree to strongly agree. The response frequency for all TSE statements is shown in table 25 below. According to the results, generally, the teachers will need some form of assistance to complete their desired tasks while using technology.

Table 4.13: Technology Self-Efficacy distribution

Item	Statement	Strongly Agree		Agree		Neutral		Disagree		Strongly Disagree	
		N	%	N	%	N	%	N	%	N	%
TSE 1	In general, I could complete any desired task using any technology if there was no one around to tell me what to do as I go.	49	17.5	137	48.9	57	20.4	33	11.8	4	1.4
TSE 2	In general, I could complete any desired task using any technology if I had never used a technology like it before	37	13.2	96	34.3	75	26.8	54	19.3	18	6.4
TSE 3	In general, I could complete any desired task using any technology if I had only the manuals for reference	49	17.5	121	43.2	50	17.9	51	18.2	9	3.2
TSE 4	In general, I could complete any desired task using any technology if I had seen someone using it before trying it myself	46	16.4	151	53.9	47	16.8	31	11.1	5	1.8
TSE 5	In general, I could complete any desired task using any technology if I could call someone for help if I got stuck	59	21.1	171	61.1	28	10	16	5.7	6	2.1
TSE 6	In general, I could complete any desired task using any technology if someone else had helped me get started.	76	27.1	151	53.9	31	11.1	20	7.1	2	0.8
TSE 7	In general, I could complete any desired task using any technology if I had a lot of time to complete the task for which the technology was provided.	66	23.6	146	52.1	46	16.4	22	7.9	0	0
TSE 8	In general, I could complete any desired task using any technology if I had just the built-in help facility for assistance.	67	23.9	124	44.3	61	21.8	25	8.9	3	1.1

TSE 9	In general, I could complete any desired task using any technology if someone showed me how to do it	93	33.2	146	52.1	25	8.9	8	2.9	8	2.9
TSE 10	In general, I could complete any desired task using any technology if I had used similar technologies before this one to do the same task	80	28.6	149	53.2	29	10.4	22	7.9	0	0

The results for TSE 2 indicate that about 50% of teachers are unsure and disagree with having the ability to carry out and intended activity with any technology, even if they never utilized one comparable to it. This suggest that teachers will be comfortable with trying out technologies like technologies they have used before. In TSE 3, most teachers indicated that they could finish their desired task using any technology if they had only manuals for reference.

More than 50% of participants also agree that if they had observed someone using a technology before attempting it, they could execute any desired task with it. Moreover, most teachers indicated that they could be able to complete any task with any technology if there is someone, they could call in case they get stuck or if someone else had helped them get started. The results suggest that teachers will need technical support to be always available for them when using technology.

For statement TSE 7, most teachers agree that they will be able to complete desired task using technology if they are given more time. This suggest that training teachers on various technologies is necessary to reduce time taken on completing their tasks. On statements TSE 8, TSE 9, and TSE 10 more than 50% of teachers who participated in the study further confirmed that they will need help of in-built help facility or from another person for them to perform tasks using technology.

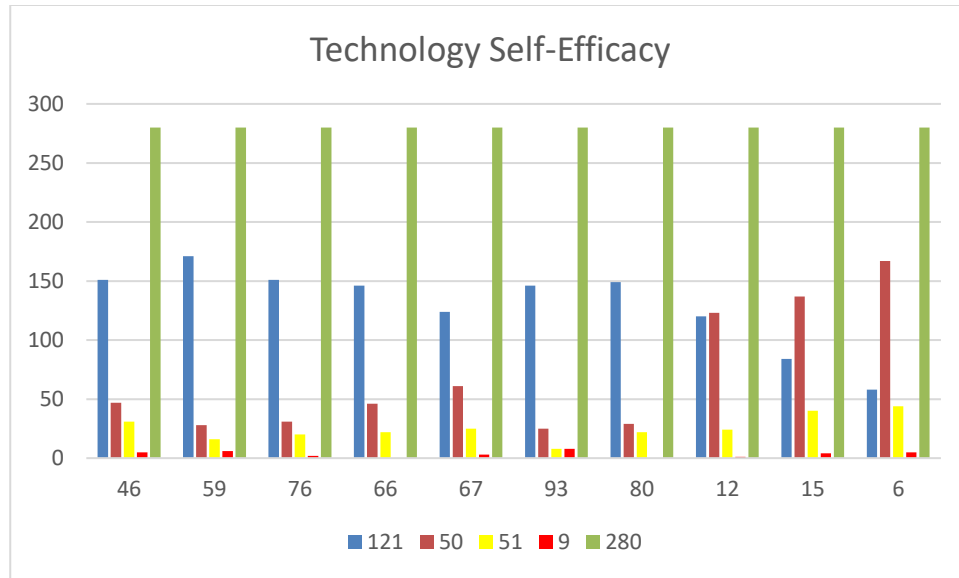


Figure 4.9: Technology Self-Efficacy distribution

Information Quality

Eleven statements (coded IQ 1 to IQ 11) were given to participants to express they feel about the system they are using's information quality. The frequency analysis of the results is given in table 26 and figure 16. According to the findings a larger number of respondents were unsure of whether the system information was complete or not and whether it contained all necessary values for their job or not. However, most of teachers concurred that the system's information is enough for their needs, meets their requirements of their tasks, and is simple to adjust to suit their objectives. This could suggest that the teachers are utilizing a little part of the system and living other parts of the system.

In other statements, IQ 8 to IQ 11, most participants disagreed or remained neutral on whether the system information is easier to aggregate, manipulate to meet their needs or combine with other information or not. This suggest that the input of teachers during development of information systems or data management systems might be necessary.

Table 4.14: Information Quality frequency distribution

Item	Statement	Strongly Agree		Agree		Neutral		Disagree		Strongly Disagree	
		N	%	N	%	N	%	N	%	N	%
IQ 1	The Ed-Admin system information includes all necessary values	12	4.3	120	42.9	123	43.9	24	8.8	1	0.4
IQ 2	The Ed-Admin system information is incomplete (R)	15	5.4	84	30	137	48.9	40	14.3	4	1.4
IQ 3	The Ed-Admin system information is complete	6	2.1	58	20.7	167	59.6	44	15.7	5	1.7
IQ 4	The Ed-Admin system information is sufficiently complete for our needs	10	3.6	162	57.9	72	25.7	30	10.7	6	2.1
IQ 5	The Ed-Admin system information covers the needs of our tasks	13	4.6	176	62.9	57	20.4	23	8.2	11	3.9
IQ 6	The Ed-Admin system information has sufficient breadth and depth for our task	12	4.3	134	47.9	102	36.4	26	9.3	6	2.1
IQ 7	The Ed-Admin system information is easy to manipulate to meet our needs	18	6.4	130	46.4	87	31.1	44	15.7	1	0.4
IQ 8	The Ed-Admin system information is easy to aggregate	8	2.9	120	42.9	115	41.1	28	10	9	3.2
IQ 9	The Ed-Admin system information is difficult to manipulate to meet our needs (R)	12	4.3	78	27.9	130	46.4	54	19.2	6	2.1
IQ 10	The Ed-Admin system information is difficult to aggregate (R)	8	2.9	70	58.3	149	53.2	49	17.5	4	1.4
IQ 11	The Ed-Admin system information is easy to combine with other information.	10	3.6	71	59.2	162	57.9	33	11.8	4	1.4

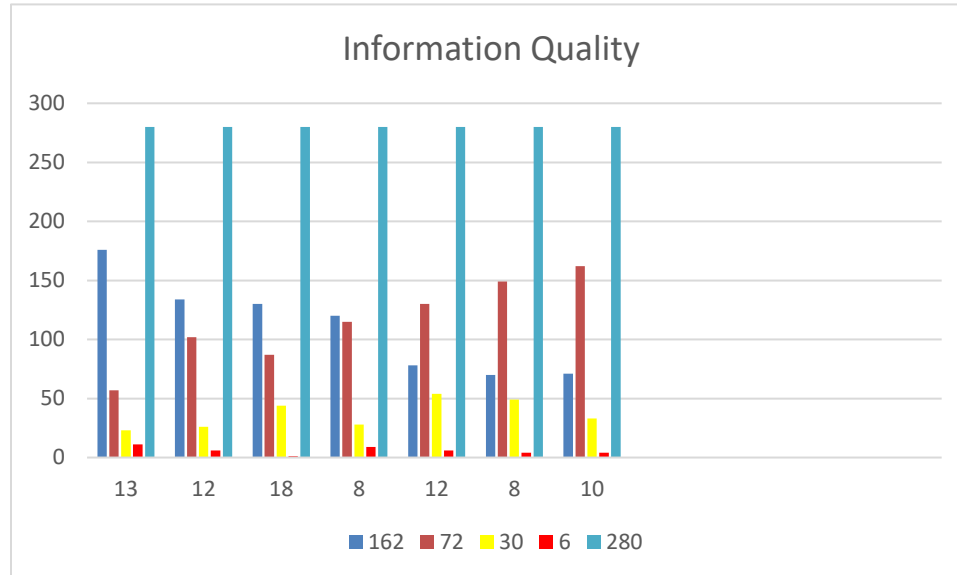


Figure 4.10: Information Quality frequency distribution

4.4.2 Reliability and validity analysis

The validity and reliability of tests results are presented in this section.

Reliability

The consistency of a unit of measurement is related to reliability [139]. The internal consistency of the data tool was evaluated using the Cronbach alpha method. From the results shown in figure 17, there was internal consistency, as evidenced 5 items have a Cronbach Alpha closer to or exceeding the widely used alpha score of 0.7.

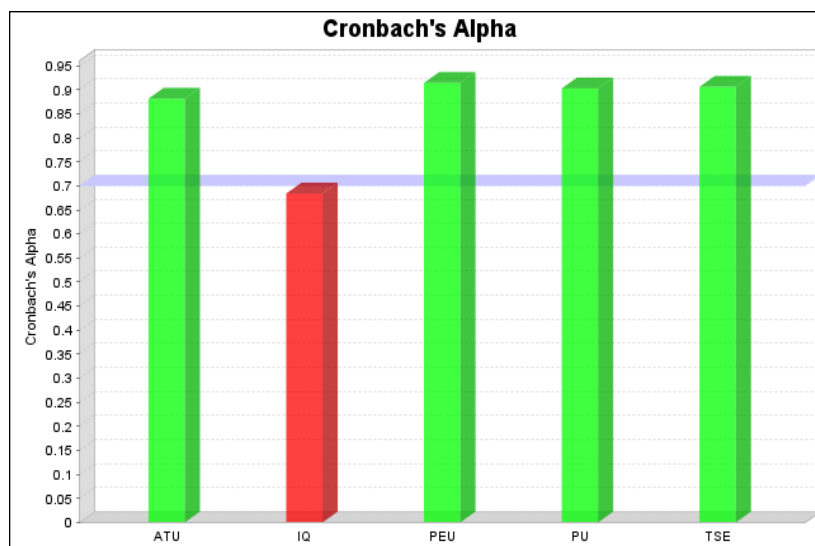


Figure 4.11: Cronbach's Alpha values

Attitude Towards Use

The results show that ATU scored the Cronbach' Alpha of 0.882 (see table 27) which indicates internal consistency was observed in the variable.

Table 4.15: Reliability analysis

variable	No of Items	Cronbach's Alpha
Attitudes towards use	4	0.882

The computed means and standard deviations for the four items used to measure the ATU are displayed in Table 28 below.

Table 4.16: The mean and standard Deviation for ATU items

Item	Mean	Standard Deviation	Number Observed
Atu1	4.311	0.697	280
Atu2	4.282	0.673	280
Atu3	4.189	0.768	280
Atu 4	4.179	0.735	280

According to the findings, most respondents chose "Agree" or "Strongly Agree" for the ATU items, as the mean values ranges between 4.179 and 4.311.

Perceived Ease of Use + Usability

The nine items used to measure the PEUU scored the Cronbach's Alpha of 0.914 (see table 29) hence reliability was observed in the variable.

Table 4.17: Reliability analysis

variable	No of Items	Cronbach's Alpha
Perceived ease of use + usability	9	0.914

Table 30 below shows the outcomes for the items measuring PEUU's computed mean and standard deviation.

Table 4.18: The mean and standard Deviation for PEUU items

Item	Mean	Standard Deviation	Number Observed
Peuu1	3.979	0.793	280
Peuu2	3.686	1.011	280
Peuu3	3.779	0.945	280
Peuu4	3.607	1.036	280
Peuu5	3.836	0.927	280
Peuu6	3.604	0.916	280
Peuu7	4.121	0.691	280
Peuu8	3.711	0.764	280
Peuu9	3.679	0.876	280

The findings indicated that, on average, the mean values varied between 3.604 and 4.121. This indicate that most of the responses were observed as "Agree" and "Strongly Agree".

Perceived Usefulness

For PU, a value of 0.903 was found for Cronbach's alpha as shown in table 31. The results give evidence that internal consistency was detected in the variable.

Table 4.19:Reliability Analysis

variable	No of Items	Cronbach's Alpha
Perceived usefulness	6	0.903

Additionally, the mean and standard deviation were calculated, and the findings are displayed in Table 3. The average values range between 3.732 and 4.296 hence the results show that on average the respondents ticked "Agree" or "Strongly Agree" as their responses on the statements that addressed the variable.

Table 4.20: The mean and standard Deviation for PU items

Item	Mean	Standard Deviation	Number Observed
Pu1	4.239	0.699	280
Pu2	4.121	0.793	280
Pu3	4.125	0.799	280
Pu4	4.296	0.733	280
Pu5	4.261	0.765	280
Pu6	3.732	0.928	280

Technology Self-Efficacy

The variable TSE scored 0.906 (see table 33) for the Cronbach's Alpha value, that proves that there is internal consistency in the variable.

Table 4.21: Reliability analysis

variable	No of Items	Cronbach's Alpha
Technology self-efficacy	10	0.906

Table 34 below shows the results of the mean, and the standard deviation of the items use to measure technology self-efficacy. According to the findings, participants generally chose "Agree" as their response on the statements they were given on the variable.

Table 4.22: The mean and standard Deviation for TSE items

Item	Mean	Standard Deviation	Number Observed
Tse1	3.693	0.940	280
Tse2	3.286	1.113	280
Tse3	3.536	1.075	280
Tse4	3.721	0.926	280
Tse5	3.932	0.853	280
Tse6	3.996	0.856	280
Tse7	3.914	0.841	280
Tse8	3.811	0.935	280
Tse9	4.100	0.885	280
Tse10	4.025	0.838	280

Information Quality

Likewise, the internal consistency of the information quality variables was examined, and a Cronbach's alpha value of 0.684 was noted as shown in Table 35.

Table 4.23:Reliability analysis

variable	No of Items	Cronbach's Alpha
Information Quality	11	0.684

Information quality scored the lowest value of 0.684 and was also accepted even though was less than 0.7. The decision was supported by the literature demonstrating that Cronbach alpha scores ranging between 0.6 and 0.7 are considered moderate but also acceptable ([145], [146], [147]).

Table 4.24:The mean and standard Deviation for IQ items

Item	Mean	Standard Deviation	Number Observed
IQ1	3.421	0.723	280
IQ2	3.236	0.812	280
IQ3	3.057	0.720	280
IQ4	3.500	0.815	280
IQ5	3.561	0.860	280
IQ6	3.429	0.803	280
IQ7	3.429	0.842	280
IQ8	3.321	0.817	280
IQ9	3.129	0.844	280
IQ10	3.104	0.765	280
IQ11	3.179	0.735	280

Validity

The degree to which a test assesses a theoretical construct that is intended to be measured is known as a construct validity [146]. Discriminant and convergent validity tests were used to determine the construct validity for this study. According to Hajjar [146], convergent validity

assesses the extent to which a pair of constructs that should be connected theoretically are in fact linked. Both the average variance extracted (AVE) and the composite reliability (CR), as indicated in table 10, were used to test the convergent validity. The results suggest that convergent validity was established. Figure 19 illustrates that for all research constructs, the composite reliability more 0.7.

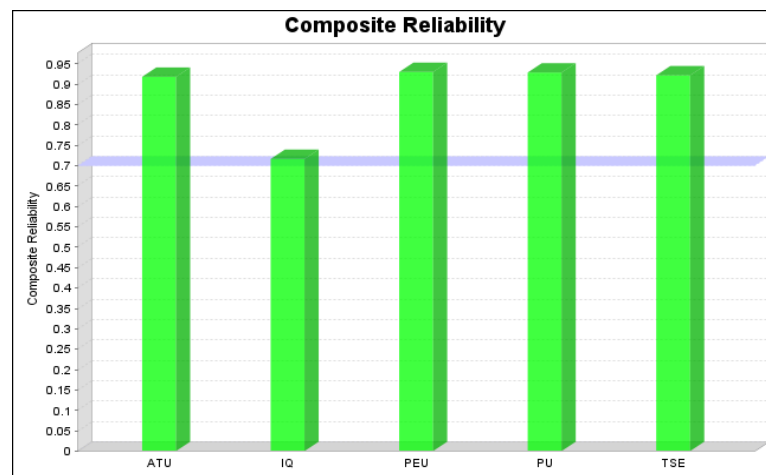


Figure 4.12: Composite Reliability test

Moreover, except for information quality, all variables had average variance extracted was greater than 0.5 (see figure 20), further validating convergent validity.

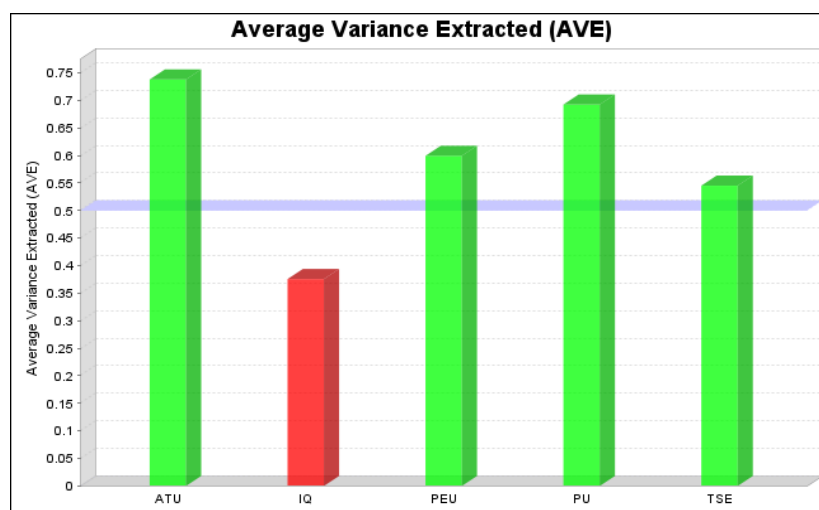


Figure 4.13: Average Variance Extracted

Even though the average variance extracted for information quality was below the suggested score of 0.5, the value was accepted as valid, supported by the literature by Fornell & Larcker [148] that suggest that if the AVE of a construct is less than 0.5 but its composite reliability exceeds 0.7 can be accepted.

Table 4.25: Convergent validity

Constructs	Items	FL	CR	AVE
Perceived ease of use + usability	PEUU 1	0.765	0.930	0.599
	PEUU 2	0.711		
	PEUU 3	0.859		
	PEUU 4	0.768		
	PEUU 5	0.852		
	PEUU 6	0.797		
	PEUU 7	0.583		
	PEUU 8	0.779		
	PEUU 9	0.818		
Perceived usefulness	PU1	0.879	0.929	0.693
	PU2	0.930		
	PU3	0.909		
	PU4	0.868		
	PU5	0.837		
	PU6	0.489		
Attitude towards use	ATU1	0.851	0.918	0.738
	ATU2	0.904		
	ATU3	0.867		
	ATU4	0.812		
Technology self-efficacy	TSE1	0.601	0.922	0.545
	TSE2	0.569		
	TSE3	0.864		
	TSE4	0.734		
	TSE5	0.720		
	TSE6	0.736		
	TSE7	0.763		
	TSE8	0.806		
	TSE9	0.736		
	TSE10	0.805		
Information Quality	IQ1	0.668	0.717	0.376
	IQ2	-0.290		
	IQ3	0.517		
	IQ4	0.728		
	IQ5	0.761		
	IQ6	0.727		

	IQ7	0.756
	IQ8	0.728
	IQ9	-0.430
	IQ10	-0.451
	IQ11	0.456

To evaluate discriminant validity, two techniques; the Fornell-Lacker and the Heterotrait-Monotrait ratio were used. When two measurements are used to compare similar but conceptually unrelated constructs, discriminant validity assesses how closely they are connected. The result as shown table 38 suggest that the discriminant validity has been established because all constructs' average variance extracted square root have greater values than their correlations with all other constructs in the study.

Table 4.26: Fornell-Larcker matrix

	TSE	IQ	PEUU	PU	ATU
TSE	(0.738)				
IQ	0.148	(0.613)			
PEUU	0.598	0.242	(0.774)		
PU	0.356	0.239	0.521	(0.932)	
ATU	0.351	0.111	0.517	0.700	(0.859)

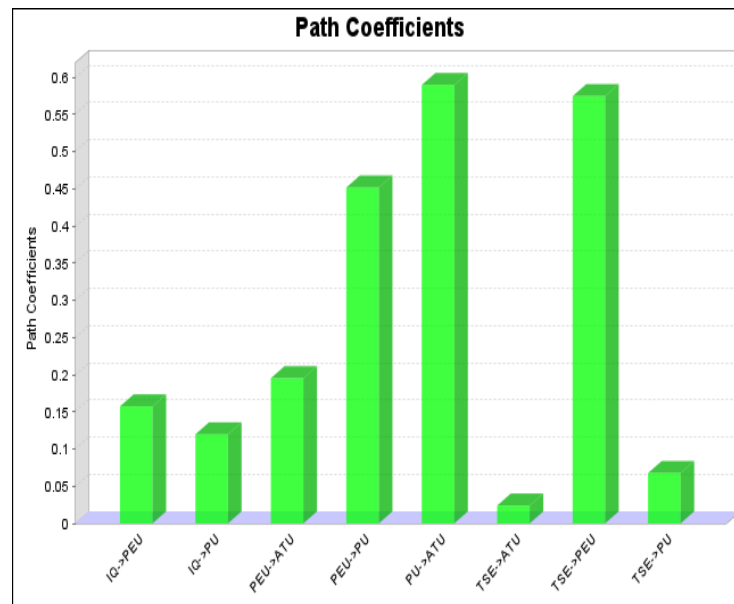
The Heterotrait-Monotrait ratio shown in table 39 further validates the discriminant validity. The results shown in table n indicates that all the correlations for all indicators are less than 0.85 which demonstrate discriminant validity.

Table 4.27: Heterotrait-Monotrait ratio

	TSE	IQ	PEUU	PU	ATU
<i>TSE</i>	1				
<i>IQ</i>	0.208	1			
<i>PEUU</i>	0.618	0.259	1		
<i>PU</i>	0.386	0.277	0.578	1	
<i>ATU</i>	0.376	0.135	0.572	0.771	1

4.4.3 Hypothesis Testing

The results shown in Figure 21 are the estimates of parameter for the hypothesized model. As already specified in the model, there were three endogenous variables, that is, perceived ease of use plus usability, attitude towards use, and perceived usefulness. Figure 21 below displays all the relationships' path coefficients.

**Figure 4.14: Path coefficients for all relationships**

Results show that IQ positively influences both PEUU ($\beta = 0.157$, $P\text{-value} = 0.01$) and PU ($\beta = 0.191$, $P\text{-value} < 0.05$) and the findings were statistically significant at 5% level of significance (see figure 22). This supports H4b and H4a respectively. The findings also indicate that TSE positively influences PEUU ($\beta = 0.575$, $P\text{-value} < 0.01$), which supports H3c. However, the results

indicate that TSE does not influence PU ($\beta = 0.327$, $P\text{-value} > 0.05$) and ATU ($\beta = 0.329$, $P\text{-value} > 0.05$). Hence H3b and H3a are not supported. Furthermore, the results show that PEUU influence positively both PU ($\beta = 0.452$, $P\text{-value} < 0.01$) and ATU ($\beta = 0.462$, $P\text{-value} = 0.01$), hence supporting h2b and h2a respectively. From the results PU positively influence ATU ($\beta = 0.590$ ($P\text{-value} < 0.01$), hence supporting H1. This result was statistically significant at 5% level of significance. This result provides enough evidence to support.

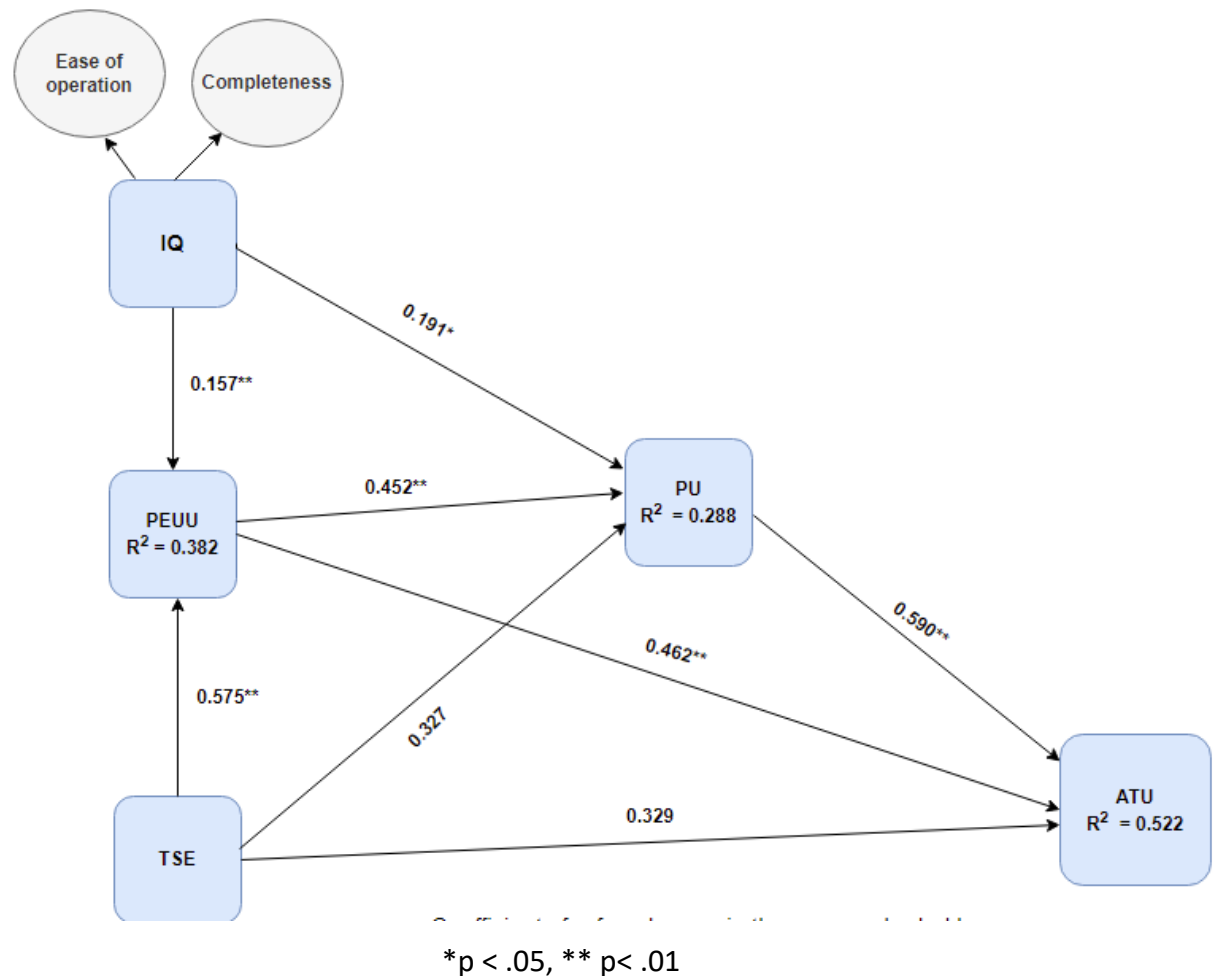


Figure 4.15: Standardized path coefficients for all respondents

Information quality, perceived ease of use and usability, as well as technology self-efficacy, were significant determinants of perceived usefulness, resulting in an R^2 of 0.288. Thus, technology self-efficacy, information quality and perceived ease of use + usability has explained 28.8% of variance in perceived usefulness. Perceived ease of use + usability was

significantly determined by technology self-efficacy and information quality and the corresponding variance explained 38.2%. In total the model accounts for 52.2% of the variance in attitude toward computer use. This suggest that most of the variation in the endogenous latent variables could be attributed to the models hence a better fit.

4.4.4 Assessment of total, direct, and indirect effects

A bootstrapping test was performed to evaluate the indirect effect and estimate confidence intervals for it. The direct, indirect, and total effects linked with each of the exogenous and endogenous variables factors are shown in table 40. The most predictor of attitude toward computer use is perceived usefulness with a total effect of 0.590. This is followed by perceived ease of use + usability, technology self-efficacy and information quality with a total effect of 0.462, 0.329, and 0.143 respectively. Altogether, the four factors listed above make up 52.2% of the variance in attitudes about using a computer.

Table 4.28: Direct and Indirect Effects on Dependent Variables

Dependent	Predictor	Standardised Estimates			
		R ²	Direct	Indirect	Total(a)
PEU	IQ	0.382	0.157	-	0.157
	TSE		0.575	-	0.575
PU	IQ	0.288	0.120	0.071	0.191
	TSE		0.068	0.260	0.328
	PEU		0.452	-	0.452
ATU	IQ	0.522	-	0.143	0.143
	TSE		0.024	0.305	0.329
	PEU		0.195	0.266	0.462
	PU		0.590	-	0.590

To explore the gender differences, moderation analysis was performed to determine if there were significant differences between females and males in the strength of path coefficients. Figure 7 displays the findings of investigations of gender differences. It was found that the two groups are not statistically significant for any of the relationships (because no p-value meets the condition). This implies that gender has no impact on the relationships TSE → PU, TSE → PEUU, TSE → ATU, PU → ATU and PEUU → ATU. Unexpectedly, only PU → ATU was

significantly different for gender groups and other path coefficients for TSE→PU, TSE→PEUU, TSE→ATU and PEUU→ATU did not differ between the groups.

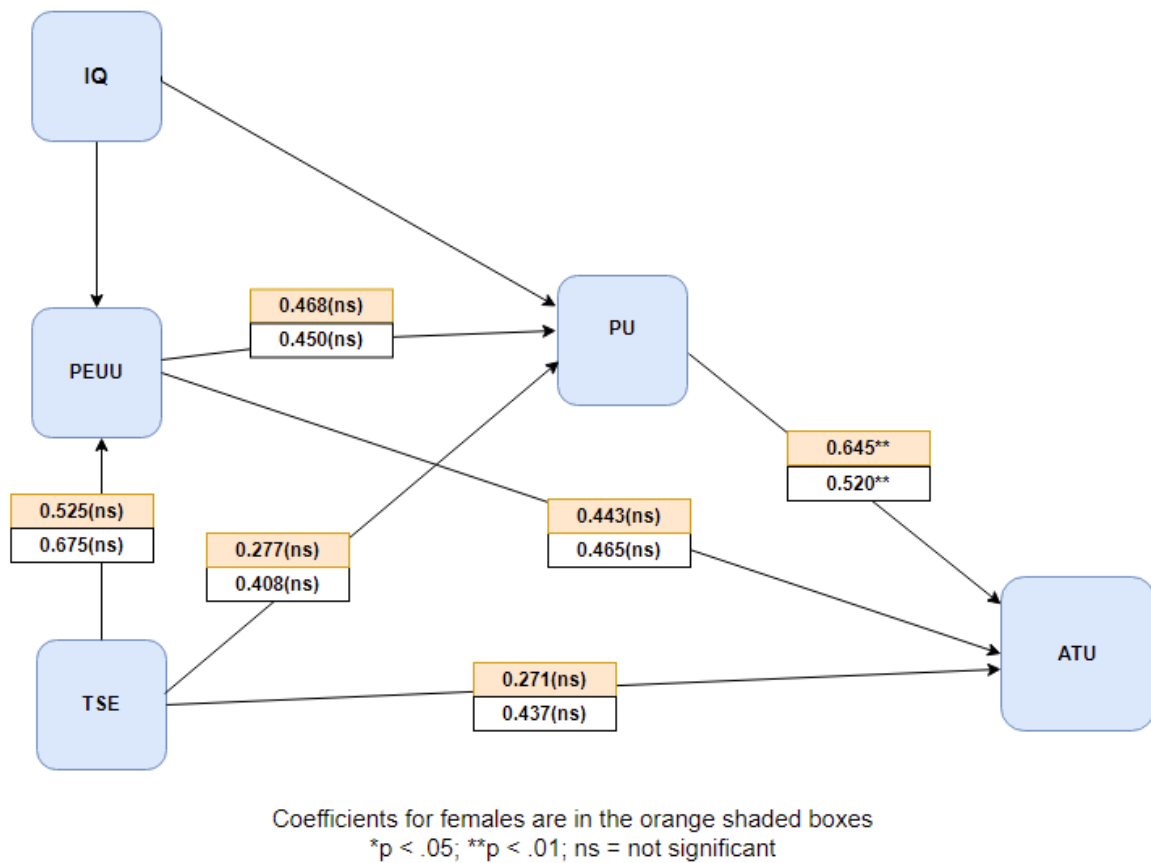


Figure 4.16: Standardized Path Coefficients for Gender Differences

Therefore, this investigation did not provide evidence for hypotheses H5a through H7. The findings of the hypotheses testing are presented in Table 41.

Table 4.29: Hypotheses Testing Results

Hypotheses	Path	Hypothesis	p-value	Results
Main effect				
H1	PU → ATU	Positive	0.000	Supported
H2a	PEUU → ATU	Positive	0.001	Supported
H2b	PEUU → PU	Positive	0.000	Supported
H3a	TSE → ATU	Positive	0.647	Not supported
H3b	TSE → PU	Positive	0.368	Not supported
H3c	TSE → PEUU	Positive	0.000	Supported
H4a	IQ→PU	Positive	0.037	Supported
H4b	IQ → PEUU	Positive	0.006	Supported
Gender Difference				
H5a	TSE → PU	Men > Women	0.682	Not supported (not different)
H5b	TSE → PEUU	Men > Women	0.092	Not supported (not different)
H5c	TSE → ATU	Men > Women	0.642	Not supported (not different)
H6a	PEUU → ATU	Men > Women	0.431	Not supported (not different)
H6b	PEUU→ PU	Men > Women	0.902	Not supported (not different)
H7	PU → ATU	Men > Women	0.235	Not supported (Women > Men)

4.5 Chapter Summary

In conclusion, the findings on the factors influencing teachers' technology acceptance from the reviewed studies were presented. The studies satisfying the criteria indicated in section 3.5.1 of chapter 3 were selected and the summary of their characteristics were presented. The findings of existing technology acceptance models and theories and their limitations from the literature review were also presented and summarized. The results on the analysis from the data collected from secondary school teachers were discussed. The data gathered was analyzed using the SmartPLS 3 software and the structural equation modelling method was applied. The results made provision for the specific objectives to be achieved and research questions to be answered.

Chapter 5 DISCUSSION OF RESULTS

5.1 Introduction

The findings are discussed in this chapter regarding the study's specific aims and research questions. The chapter discusses the results in relation to research question 1, 2 and 3 in sections 5.2, 5.3 and 5.4 respectively. Furthermore, the same chapter deliberates on the implications of the findings in practice. The summary of the results is addressed in section 5.5.

5.2 Discussion of results on the existing technology acceptance models and theories

To select the most appropriate model for the investigation, the study sought to identify the existing technological acceptance models and theories. The findings as deliberated in section 4.2 of chapter 4, five models and theories (TRA, TPB, IDT, TAM and ATUAT) were found to be dominant in the technology acceptance literature. Upon reviewing contribution and limitations of these models and theories, TAM was selected as the most suitable for the purpose of the research.

The TAM was chosen and adapted as it is believed to be one of the predictive and robust models, more especially in the field of education. The model has been applied, validated, and extended by several scholars in the education settings and technologies. However, it has been noted by several authors that the applications and validation of the TAM has mainly targeted students in controlled environments, which makes their findings not conclusive to other user-types. The argument is that students or student teachers and in-service teachers are different type of user with different responsibilities and motivation to be generalized under the same findings. In-service teachers were the study's intended population, hence the requirement for the application of the TAM for verified results.

5.3 Discussion of identification of factors influencing teachers' technology acceptance

Three categories (teachers' characteristics, technological and organizational characteristics) were used to group the variables that affect teachers' intention to adopt and utilize technology. Specific to demographics, inconsistent and inconclusive outcomes were reported

concerning the impact of teachers' gender and age. Also, it is also worth noting that there were only three studies that assessed the modifying impacts of age and gender. As a result, there is a lack of assurance regarding the relationships between teachers' intention to utilize technology in the teaching and learning environment and their gender and age. However, the results may imply that regardless of gender and age, teachers have been provided with similar opportunities and mandate in terms of having access to and utilizing technology. Other authors presented moderating effects of teaching experience and course year in their studies. However, there was no conclusion made on the findings about the moderations because each were examined by one study. Further research is necessary to verify the findings on moderating effects on the technology use by teachers.

The more frequently investigated characteristics when reporting on teachers' personal traits were attitudes towards use and self-efficacy. Teachers' attitude toward using technology has been found to have a direct, positive, and significant influence on their behavioral intention on using technology. This implies that individual teachers who have positive feelings about performing target tasks using technology are likely to accept and utilize it in their work-related obligations than their colleagues who exhibit negative feelings. It was discovered that self-efficacy had a favorable direct impact on teachers' perceptions of technology usability, usefulness, and behavioural intention, implying that teachers who believe that they can use technology successfully, may have higher intentions of using it in their job.

Five studies in total investigated the impact of subjective norm in teachers' technology adoption. Inconsistent and inconclusive results were observed. In one study, subjective norm was found to have a direct positive effect on teachers' perceived usefulness and perceived ease of use and the opposite findings were reported in another study. As such, further investigation on the matter is recommended. Two studies explored the impact of perceived enjoyment on teachers' technology adoption. The results of the studies found out that perceived enjoyment has a direct positive influence on teachers' perceived ease of use, perceived usefulness, and behavioral intention to use technology. The findings suggest that teachers who find using technology enjoyable on its own right, are likely to deem technology

beneficial and easy to use and consequently use it. However, more research is essential to verify the findings.

Moreover, other authors discussed competency, personal innovativeness, experience, mobile anxiety, and enjoyment in helping others as teachers' traits that affect their intent to use technology. Nonetheless, the findings regarding traits were not considered conclusive as they were each investigated in one study only.

According to the evidence from the literature on the characteristics of technology, teachers' attitudes, and intentions to use technology in teaching and learning are directly, favorably, and significantly influenced by perceived usefulness (equivalent to performance expectancy) and perceived ease of use (equivalent to effort expectancy). This finding denotes that educators who observe that technology is easier to use and enhances their work productivity and performance have higher ambitions for using technology and a better attitude toward using it.

A total of two studies investigated the influence of compatibility and they found out that it has a positive direct influence on teachers' perceived usefulness and intention to use technology. The findings suggest that teachers are likely to utilize technology if they believe the technology to be conforming with their current needs, values, and prior experiences. However, the comparability feature needs to be investigated further for verification. Only one study each explored technological complexity, job relevance and codification effort and found that all had significant impact on teachers' intent to utilize technology. However, it is crucial to indicate that further investigation and exploration is needed as conclusion cannot be made from one study only. Likewise, the situation calls for further investigations on the same characteristics.

With respect to organizational characteristics, facilitating conditions was the commonly investigated trait, and was discovered to have a considerable favorable impact on teachers' perceptions of usability. However, a conflicting finding were observed on the impact of facilitating conditions on behavioral intent to use, in which some authors reported a positive direct influence while others reported the opposite. Further investigations on the matter is

required to clarify the results. Other organizational characteristics noted from the literature were school, support, access, and social influence. It is important to communicate that no conclusion could have been made for the characteristics as they were each investigated by one study.

Implications

The review's conclusions might instruct and guide all the concerned stakeholders responsible for technology adoption in basic education, such as policy makers, system developers, education, and school leadership in creating efficient and practical approaches that encourage and inspire teachers' use of technology in their teaching and learning activities. Extensive training of teachers would address the noted personal and environmental characteristics noted in the review. The other strategy could include developing and influencing organizational cultures that support the use of technologies in schools by school leadership.

5.4 Discussion of results on the proposed extended Technology Acceptance Model addressing context of Botswana

The findings of this investigation offered fractional support for the hypothetical relationships of the modified extended TAM. The study validated the TAM in educational context of Botswana as a nation that is developing. The research further explored the influence of the following: information quality of the information systems used, technology self-efficacy and gender on technology adoption of teachers. The study's overall model explained 52.2% of the variance towards attitude towards use of technology among secondary school teachers.

As expected, perceived ease of use + usability and perceived usefulness were discovered to have a significant favorable impact on teachers' attitude towards technology use. These results are consistent with other research that found strong positive connections between perceived usefulness and perceived usability ([111], [4], [71], [67], [12]). Among the two (PU and PEUU), the most important determining factor of attitude towards use is perceived usefulness ($\beta = 0.590$). This finding indicates that teachers' attitudes toward using technology would improve and become more favorable if they thought it was beneficial and is easy to

use. Additionally, it has been discovered that teachers' perceptions on technology usability had an immense positive impact on how useful they were. These results supports the original term TAM hypothesis ([92]) and prior studies ([111], [4], [81], [71], [67], [12]). The findings suggest that, as widely establish in the literature, when teachers believe that technology is less demanding mentally and is simpler to use will consequently find it useful in improving performance and productivity in their job.

With respect to efficacy, as predicted, it was established that technology self-efficacy had a direct favorable impact on teachers' perceived ease of use + usability. The finding is consistent with previous research that found out that computer self-efficacy influences perceived ease of use positively ([4], [71], [149], [150]). The secondary school teachers perceived that they could use technology and consequently that led to them believing that technology was easier to use and required less mental effort from them.

Surprisingly, an unexpected finding from the study is that technology self-efficacy had no considerable impact on both teachers' perceived usefulness and attitude towards use. This result disagrees with other research that discovered a strong positive relationship between perceived usefulness and self-efficacy ([4] [12], [150]) and on attitude towards use ([4]). However, the outcomes are consistent with research by Al-Haderi [149] and Said and co-writers [111] who found an insignificant relationship between computer self-efficacy and perceived usefulness. The findings indicate that secondary school perceive technology not useful regardless of their ability of use it. This may be because different technologies are available for teachers, and they do not know how to use them efficiently. The other contributing factor may be that teachers in Botswana are still practicing the traditional method of teaching which does not involve the use of technology. This request for the curriculum changes to fit in technology use teaching and learning objectives and training on efficient uses of different technologies.

Teachers who participated in the research reported that system information quality (completeness and ease of operation) influence their perceived usefulness and perceived ease use + usability positively. These findings suggest that when teachers perceive that the

information from the systems, they are using is complete in the sense that it includes all the necessary values for their needs and tasks and, the same information is perceived to be easier to manipulate, aggregate or combine with other information from other sources to meet their needs, they would have higher intentions of using the system. These results agree with those of earlier research which noted that perceived ease of use and perceived usefulness were significantly and positively influenced by information quality ([111], [112]).

Even though a significant effect of information quality towards PU and PEUU was established, the influence was found to be the weakest ($\beta = 0.191$ and $\beta = 0.157$ towards PU and PEUU respectively) among all relationships in the model. This indicates that more research should be done with more or other information quality constructs as suggested by [103] in the methodology of information quality. This could help with establishing the best combination of constructs in information quality suitable for teachers in their teaching and learning systems.

Additionally, the research examined if gender difference influences determinants of teachers' attitude towards using technology. The study examined gender as the moderator for the model relationships and further investigated how gender groups influence the relationships. On the issue of gender being a moderator, the study findings failed to validate statistically the projections that gender moderate relationships; $PU \rightarrow ATU$, $PEUU \rightarrow ATU$, $PEUU \rightarrow PU$, $TSE \rightarrow PU$, $TSE \rightarrow ATU$ and $TSE \rightarrow PEUU$. These results put forward that irrespective of gender, secondary school teachers who demonstrate higher perceived usefulness, perceived ease of use and technology self-efficacy will reveal better and positive attitude toward technology usage. These findings are contradictory to the previous literature which found gender to be a significant moderator on the relationships ([151], [93]). However, this study findings agree with several literature ([4], [83]) that did not find gender as a moderator for the relationships.

On the issue of the influence of gender groups on the relationships; $PEUU \rightarrow ATU$, $PEUU \rightarrow PU$, $TSE \rightarrow PU$, $TSE \rightarrow ATU$ and $TSE \rightarrow PEUU$, no significant influence was observed for both men and women, although the beta values for males were higher than that of females. However, the effect of perceived usefulness towards attitude towards use was significant for both men and women. Furthermore, interestingly, perceived usefulness affected attitude

towards use more strongly for women ($\beta = 0.645$) than for men ($\beta = 0.520$). The finding indicates that compared to male teachers, female teachers' attitude towards the use of technology will be more strongly impacted by their belief in technology being useful and effective in their work.

Implications

The results of this study have repercussions for theory, application, and future research. For theory, about 50% of variance in secondary school teachers' intention to accept and use technology has not been accounted for in the adapted TAM model. The factors influencing teachers' intention to use technology in this study were limited to the adapted model, which means some of crucial factors may have not been captured due to the limitation posed by the model. For that reason, this drawback emphasizes the need for further research to establish the most suitable models accounting for teachers in intended end actual use of various technologies in the teaching and learning contexts.

According to research on how information quality effects teachers' intention to use it in the teaching environment suggest the significance of assessment of information quality of information systems developed for teachers on a broader scale to understand their preferences. This could appeal to system developers to determine ways in which teachers could be involved or have an input during the development and testing stages of systems which are intended for them.

Regarding findings on the influence technology self-efficacy on teachers' perceived ease of use and usability, this could highlight for policy makers and curriculum developers to work on strategies that will strengthen teachers' technology self-efficacy. The strategies should focus on sources of self-efficacy such as experience, which will suggest that teachers will need trainings on various technologies at their disposal, to cultivate their confidence and skills in using them. The leadership in schools and technical staff ought to be able to model the use of technology to their supervisees and colleagues as that could inspire them to believe that they too possess same capabilities as their co-workers. Again, social persuasion on teachers and

appraisal on their technology capabilities may most likely put more effort in technology use and continuing using it.

Concerning the gender moderation, the findings indicated that both men and women would ordinarily adopt technology in the same way. However, female teachers' perceived usefulness would strongly influence their attitude towards more than their male colleagues. The finding suggests that special dispensation for female teachers such as extra or special training should be put in place to improve on how they view the usefulness of technologies.

For research, more studies are required to investigate teachers' intention using a bigger sample, covering all other parts of the country regions which were not covered. Also, further additional factors that influence teachers' technology acceptance can be explored. Moreover, more construct on information quality can be added to establish the most suitable information quality variable for explaining teachers' preference.

5.5 Chapter Summary

In summary, the findings from chapter 4 were discussed. Specific objectives 1 and 2 were achieved through the review of the literature and identified factors influencing teachers' technology acceptance and existing technology acceptance models and theories respectively. The TAM was selected as the suitable model for the scope of the study. The influence of IQ and gender through the adaptation of the TAM was discussed answering research question 3 in the process. The study designed a TAM framework which consisted of information quality, technology self-efficacy, perceived ease of use plus usability, perceived usefulness and attitude towards technology usage as factors influencing teachers' technology acceptance. Moreover, the model relationships were moderated by teachers' gender.

Chapter 6 OVERVIEW, LIMITATIONS, RECOMMENDATIONS, FUTURE RESEARCH AND CONCLUSION

6.1 Overview of the study

The research set out to accomplish three objectives; 1) identify factors influencing teachers' technology acceptance, 2) identify the existing technology adoption theories and models and find their limitations and 3) examine the impact of information quality and gender on acceptance of technology by secondary schools' teachers in Botswana. As indicated in chapter 1, the developments brought using ICT globally has changed the education scenery altogether. However, the journey to shift to the technology-enhanced education environments has been and is still a difficult journey for various governments as the adoption of technology has been reported to be still lagging.

Botswana is experiencing the same problem despite heavy investments of ICT infrastructures channeled to the basic education sector. The evident problem is absence of extensive investigation in understanding how the intended technology users feel about the technologies made available for them. The research intended to close such a gap. Chapter 2, the literature review covering barriers obstructing technology adoption and factors influencing teachers' technology acceptance were discussed. In the same chapter, the literature on technology in education was reviewed targeting technology's role in education and the state of technology in African and Botswana schools. Additionally, the existing technology acceptance models and theories were investigated. Their limitations and contributions were reviewed as well.

The methodology discussing how the objectives were tackled was discussed in chapter 3. Chapter 4 presented the results of the study objectives and research questions. The research findings were discussed in chapter 5. The study's limitations are discussed in the following section.

6.2 Limitations

Addressing the review on factors influencing technology acceptance of teachers, one drawback of the review was that the chosen studies were only published in English, therefore, this may have led to exclusion of other relevant papers published in other languages. The

other limitation was that data collection did not cover all the country's regions of education. The study sample could be extended by covering all other regions. Furthermore, the factors proposed by the study were limited to the adapted model. There are numerous factors that have been discussed in the literature that could possibly be incorporated in the study model in research to come. When evaluating the information quality variable, only two constructs from the IQ methodology by Lee and co-authors [103] were examined, there are several remaining constructs which could be added to model IQ best suited for teachers.

Another limitation was observed about validation of the IQ variable. The average variance extracted (AVE) for IQ did not meet the recommended value of 0.5 or higher. Other research practices such as removing construct items that have negative factor loading could be applied to improve the validity of IQ.

6.3 Recommendations

The study put forward the following recommendations.

6.3.1 More research to be done in technology adoption in basic education in Botswana.

It has been evident that there is generally lack of widespread research on technology adoption in Botswana. However, the literature available on the matter is commonly about the situation of the ICT in Botswana, barriers to implementing ICT and the government plans and policies. The assessment of ICT in Botswana schools has indicated that there have been noticeable developments regarding acquisition of ICTs in secondary schools and the government continues to acquire more. However, the adoption rate of these ICTs in schools remains largely unknown, hence the recommendation on carrying more research on both teachers and students' technology adoption.

6.3.2 Teachers involvement in system development

Various information systems (IS) are deployed to school for teachers to use to enhance their daily work activities. In most cases, these IS being developed without the involvement of the intended users which are teachers. As a result, such systems end up not being used or fully utilized if the teachers feel they do not meet their needs or they do not provide a workable solution to their problems. The software developer should focus on system functionalities and

features to improve the acceptance of the systems. Hence the recommendation for system developers to involve teachers during the process of developing the systems. The teacher involvement could range from providing system requirements, testing the systems before their implementation, and providing constant feedback to the developers during their system use times.

6.3.3 Provision of school-based ICT adoption policy and Teacher trainings

The study recommends for the government and policy makers to develop and implement school-based ICT adoption policies. This policy could provide a roadmap on how the concerned plans and activities will be carried out. The policy could stipulate the evaluation methods which could be put in place to measure progress of the programs. Furthermore, the policy could give guidance on the intensity of training required by different teachers after assessments as teachers' skills will always vary. Teachers need to be trained frequently on different technology to improve their ICT skills and confidence in using technologies. The study results indicated that teachers have glitches concerning technology self-efficacy, which can be improved by trainings.

6.4 Future research

The following are suggested for future research.

6.4.1 Expansion of the study sample

There were 280 teachers who participated in the study, mostly in the central education region. It is recommended for the study to be spread throughout the country's all education regions as that will provide an opportunity to access remote areas which may bring forth different insights regarding the findings.

6.4.2 Expansion of the study model with more factors

The research's findings were restricted to the factors given by the adapted model. It is therefore recommended for more factors to be added to the model to expand the explaining aspect of the model. There are several factors discussed in the literature that could be tested in the model. In addition, the results on the moderating effects of gender indicated that the

matter remains inconclusive hence more studies need to be carried out to address the gender issue.

6.4.3 Expansion and modification of the IQ variable

The study examined IQ constituting of 2 constructs as provided by the IQ methodology developed by Lee, Strong, Kahn and Wang [103]. There is other several remaining constructs such as timeliness, security, consistency, reliability, validity, and currency that could be added to the IQ variable and model a robust IQ variable appropriate for teachers.

6.5 Conclusion

The objective of the study was to develop a technology acceptance framework for factors influencing secondary teachers' technology acceptance in context of Botswana. General and specific objectives and research questions were established in chapter 1. The specific objective 1 was to identify the factors influencing teachers' technology acceptance and it was achieved through reviewing the existing literature. As such the research question 1 was answered. The specific objective was to identify the existing technology acceptance models and theories and compare them regarding their contributions and limitations. The objective was accomplished through the literature review, hence answering research question 2. The objective aided with choosing the model suitable for the study and the TAM was selected as the suitable model for the study. The last objective was to investigate the influence the IQ and gender on teachers' technology acceptance in the context of Botswana. To answer question 3, TAM was adapted, and the IQ variable was added, and the model relationships were moderated by gender. In the process of answering the question data was collected from 280 secondary school teachers and the data was analyzed using the sequential equation modelling method to confirm the model reliability and validity.

The findings presented in chapter 4 on the data confirmed that the model fits proposed, and the findings were further discussed in chapter 5. Furthermore, the study implications were discussed in chapter 5. Chapter 6 present the overview, the limitations, and recommendations of the study.

In conclusion, the rapidly evolving landscape of education calls for integration of technology in teaching and learning activities. Research has proven that the resistance among teachers on technology acceptance reflects on broader personal, institutional, cultural, and policy-driven factors. Therefore, addressing teachers' technology acceptance demands a comprehensive reevaluation and restructuring of educational policies, institutional cultures, and personal development frameworks. The process challenges policy makers, educational leaders, and researchers to surpass traditional paradigms, challenge deep-rooted cultures and collaboratively forge a new path towards fostering a culture of technological acceptance and innovation in education.

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Table 0.1: Appendix 1 Study Constructs Items

Item		statement	Sources
PEUU	PEUU 1	My interaction with technology is clear and understandable	[71]
	PEUU 2	Interacting with technology does not require a lot of my mental effort.	
	PEUU 3	I find technology to be easy to use	
	PEUU 4	I find it easy to get technology to do what I want it to do.	
	PEUU 5	I find technology to be flexible to interact with	
	PEUU 6	Learning how to perform tasks using technology was easy.	
	PEUU 7	Technology has good functionality (features).	
	PEUU 8	I feel I have an intuitive sense of how to operate technology	
	PEUU 9	I find it easy to remember how to perform tasks using technology	
PU	PU 1	Using technology improves my performance in my job	[71]
	PU 2	Using technology in my job increases my productivity	
	PU 3	Using technology enhances my effectiveness in my job	
	PU 4	I find technology to be useful in my job	
	PU 5	In my job, usage of technology is relevant	
	PU 6	I have no problem with the quality of technology's output	
ATU	ATU 1	Computers make work more interesting	[71]
	ATU 2	Working with computers is fun	
	ATU 3	like using computers	
	ATU 4	I look forward to those aspects of my job that require me to use of computer	
TSE	TSE 1	In general, I could complete any desired task using any technology if there was no one around to tell me what to do as I go.	[71]
	TSE 2	In general, I could complete any desired task using any technology if I had never used a technology like it before	
	TSE 3	In general, I could complete any desired task using any technology if I had only the manuals for reference	
	TSE 4	In general, I could complete any desired task using any technology if I had seen someone using it before trying it myself	
	TSE 5	In general, I could complete any desired task using any technology if I could call someone for help if I got stuck	
	TSE 6	In general, I could complete any desired task using any technology if someone else had helped me get started.	

	TSE 7	In general, I could complete any desired task using any technology if I had a lot of time to complete the task for which the technology was provided.	
	TSE 8	In general, I could complete any desired task using any technology if I had just the built-in help facility for assistance.	
	TSE 9	In general, I could complete any desired task using any technology if someone showed me how to do it	
	TSE 10	In general, I could complete any desired task using any technology if I had used similar technologies before this one to do the same task	
IQ	IQ 1	The Ed-Admin system information includes all necessary values	[71]
	IQ 2	The Ed-Admin system information is incomplete (R)	
	IQ 3	The Ed-Admin system information is complete	
	IQ 4	The Ed-Admin system information is sufficiently complete for our needs	
	IQ 5	The Ed-Admin system information covers the needs of our tasks	
	IQ 6	The Ed-Admin system information has sufficient breadth and depth for our task	
	IQ 7	The Ed-Admin system information is easy to manipulate to meet our needs	
	IQ 8	The Ed-Admin system information is easy to aggregate	
	IQ 9	The Ed-Admin system information is difficult to manipulate to meet our needs (R)	
	IQ 10	The Ed-Admin system information is difficult to aggregate (R)	
	IQ 11	The Ed-Admin system information is easy to combine with other information.	