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Factors influencing the usage of agile methodologies amongst Information Technology personnel within the banking sector

A research report submitted to the Faculty of Commerce, Law and Management of the University of the Witwatersrand in partial fulfilment of the requirements for the Degree of

Master of Commerce (Coursework) in the field of Information Systems

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Date Submitted: 13 June 2018

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Plagiarism Declaration

I declare that this is my own unaided work. I have read and understood the Senate policy on plagiarism. I am aware that plagiarism is “failure to acknowledge the ideas and writing of another” or “presentation of the ideas or writing of another’s as one’s own”.

This research report has not been submitted before for any degree or examination in any other University.

_____

Grace Mudarikwa

Date: 13/06/2018

Abstract

The aim of the study was to investigate the factors that influence the usage of agile methodologies amongst Information Technology (IT) personnel within the banking sector. Agile methodologies have been acclaimed to have many benefits. Despite this, challenges have been found in the usage of agile methodologies. The study was conducted with 143 participants from two major banks in South Africa and with a professional institution of IT personnel. The research was positivist in nature and took a deductive form by testing the Unified Theory of Acceptance and Use of Technology (UTAUT).

A cross-sectional survey was used to collect the data. The study had 5 research questions and 5 hypotheses. The effect of 5 moderating variables was tested on the 5 hypotheses. The hypotheses were tested using multiple regression analysis. The Simple slope test was used to explore the moderating effects on the main hypotheses. The results of the study confirm that Performance Expectancy and Social Influence have a significant effect on Behavioural Intention. The study also confirmed that Facilitating Conditions were a significant predictor of Usage. Only the moderating effect of agile experience on Facilitating Conditions and Usage was found to be significant.

The implication of the study is that usage of agile methodologies within the banking sector needs to cater for Performance Expectancy, Social Influence and Facilitating Conditions. Facilitating conditions however need to be varied depending on the level of agile experience. The study contributes from a theoretical perspective by testing the factors that influence usage of agile methodologies. The study also contributes from a methodological perspective by using a cross-sectional survey to collect data. There are limited survey studies done by academics on the usage of agile methodologies. The study will also assist in determining the factors that influence usage of agile methodologies. Understanding these factors will assist in ensuring successful introduction of agile methodologies in the banking sector.

Keywords: Agile Methodologies, Usage, Banking, UTAUT, Information Technology Personnel

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List of Abbreviations

Abbreviation	Description
AM	Agile Modelling
ASD	Agile Software Development
BI	Behavioural intention
COBIT	Control Objectives for Information and Related Technology
DSDM	Dynamic Software Development Method
EE	Effort expectancy
FC	Facilitating conditions
FDD	Feature Driven Development
IDT	Innovation Diffusion Theory
IT	Information Technology
KMO	Kaiser-Meyer-Olkin
LD	Lean Development
PCA	Principal Component Analysis
PE	Performance Expectancy
SAFe	Scaled Agile Framework
SCT	Social Cognitive Theory
SDLC	Systems Development Life Cycle
SI	Social Influence
SLR	Systematic Literature Review
SPSS	Statistical Package for the Social Science
TAM	Technology Acceptance Model
TPB	Theory of Planned Behavioural
TRA	Theory of Reasoned Action
TSD	Traditional Software Development
UTAUT	Unified Theory of Acceptance and Use of Technology
VIF	Variance Inflation Factor
XP	Extreme Programming

1 CHAPTER 1: INTRODUCTION

1.1 Background

Software development methodologies can be broadly classified as Traditional Methodologies and Agile Methodologies (Aitken and Ilango, 2013). Traditional software development methodologies are plan driven, and require that the software development project begins by eliciting and documenting a complete set of requirements before any development can start (Pikkarainen, 2008). Traditional methodologies advocate that systems can be built without revisiting requirements and that there is always a perfect knowledge of the client's needs upfront (Paul, 2008). Development models such as the Spiral and the Waterfall model can be classified as traditional methodologies (Stoica *et al.,* 2013).

The principles underlying traditional software development methodologies pose a challenge since organizations are now operating in dynamic environments (Stavru, 2014). In these dynamic environments the speed, quality and cost for systems development are crucial for the organizations existence (Stavru, 2014). It is difficult to establish and stabilise requirements in these dynamic environments (Pikkarainen, 2008). Traditional methodologies have been criticised for being inflexible and failing to respond to changes quickly (Papadopoulosa, 2015). To address these challenges, the agile approach to software development was introduced (Noruwana and Tanner, 2012).

Agile methodologies focus on managing changing and volatile user requirements through a variety of practices (Lee and Xia, 2010). Responding and managing changing user requirements is at the core of agile development (Lee and Xia, 2010). Agile methodologies have been credited as being able to handle rapid changes in user requirements (Barlow *et al.,* 2011; Stoica *et al.,* 2013). In agile methodologies, the interaction with the client is frequent and agile methodologies have been found to have higher customer satisfaction levels (Inayat *et al.,* 2015).

Agile methodologies also produce working software that satisfies customer requirements with minimal documentation (William, 2010). Team members using agile methodologies have reported an increase in productivity (Inayat *et al.,* 2015). The methodology has been found to reduce rework and is more suited to handle defects (Inayat *et al.,* 2015).

Despite the benefits of agile methodologies, the usage of these methodologies has been found to be a challenge (Noruwana and Tanner, 2012). IT personnel in particular have been found not to fully utilise new approaches to Software development (Noruwana and Tanner, 2012). In particular Chan and Thong (2009) found that non-usage of agile methodologies is common amongst IT personnel. Non-usage can be as a result of individuals who now have to change their daily routine to adapt to agile (Gandomani and Nafchi, 2016). Understanding usage behaviour is therefore a major issue in information systems (Othman *et al.,* 2016).

Agile methodologies have gained popularity in South Africa (Noruwana and Tanner, 2012). There has been research on agile methodologies in South Africa (Dingsøyr *et al.,* 2012). The majority however of agile software development research has been in the United States of America and Canada, with a relatively fewer number of articles from South Africa (Dingsøyr *et al.,* 2012). There is therefore need to further understand agile methodology usage in the South African context. The UTAUT model by Venkatesh *et al.* (2003) was used to determine which factors influence agile usage.

1.2 Problem statement

Agile methodologies are increasingly becoming popular (Salo and Abrahamsson, 2008; Cardozo, 2010; Barlow *et al.,* 2011). In South Africa, usage of agile methodologies is also on the rise (Noruwana and Tanner, 2012). Few organisations however have been able to successfully embed agile development methodologies within their teams (Qumer and Henderson-Sellers, 2008; Noruwana and Tanner, 2012; Gregory *et al.,* 2015). Although agile methodologies are believed to have the benefit of improving the software development process, the methodologies have not always been accepted and fully utilised (Noruwana and Tanner, 2012). Not fully utilising agile methodologies poses a

challenge since significant investments are being made to introduce agile methodologies (Pathak and Saha, 2013).

There have been significant challenges with the usage of agile methodologies (Barlow *et al.,* 2011; Pathak and Saha, 2013). IT personnel have been found not to fully utilise agile methodologies and the associated benefits (Chan and Thong, 2009; Noruwana and Tanner, 2012). Other studies on agile methodology usage have found that Software Developers in particular do not always use agile methodologies (Conboy and Coyle, 2011; Leau *et al.,* 2012).

Banks have invested significant amount of resources to implement agile methodologies (Johnstone and Gill, 2017). Process improvement initiatives have also been done to ensure successful implementation of agile methodologies (Johnstone and Gill, 2017). Yet implementation of agile methodologies within the banking sector has been found to be problematic (De Gregorio, 2017). The organisational culture of banks is also antagonistic to agile principles (De Gregorio, 2017). There is also a misalignment of agile roles and structures within the banking environment (Ozkan *et al.,* 2017). Successful implementation of agile methodologies requires radical transformation of the banks culture (De Gregorio, 2017).

1.3 Purpose of the study

The study sought to determine the factors that influence usage of agile methodologies amongst IT personnel within the Banking sector. The research seeks to provide answers to the following research questions:

1.3.1 *Main Research Question*

RQ1. What are the factors that influence individual IT personnel to use agile methodologies?

1.3.2 *Sub-Questions*

RQ1a. To what extent does behavioural intention to use affect usage of agile methodologies?

RQ1b. To what extent does performance expectancy affect behavioural intention to use agile methodologies?

RQ1c. To what extent does effort expectancy affect behavioural intention to use agile methodologies?

RQ1d. To what extent does social influence affect behavioural intention to use agile methodologies?

RQ1e. To what extent do facilitating conditions affect usage of agile methodologies?

1.4 Contribution of the study

This section discusses the contributions of the study in terms of the theoretical contribution, methodological contribution and practical contribution. The section starts of by discussing the theoretical contribution. The methodological contribution is discussed next and the section ends by discussing the practical contribution.

1.4.1 *Theoretical contribution*

The study contributes from a theoretical perspective by testing the factors that influence usage of agile methodologies by IT personnel within the banking sector. The study tests the applicability of UTAUT in explaining usage behaviour on a methodology such as Agile. UTAUT has been traditionally used on tangible, physical systems and artefacts and not on a methodology. The agile methodology is not a tangible artefact but consists of intangible behavioural practises and roles (Chow and Cao, 2008). The study therefore tested the explanatory power of the UTAUT on usage of intangible behavioural practises and roles of a methodology.

1.4.2 *Methodological contribution*

The study also contributes from a methodological perspective. A cross-sectional survey was used to collect the data. There are limited survey studies done by academics on the usage of agile methodologies (Lee and Xia, 2010; Stavru, 2014). Surveys not done by academics are prone to validity and reliability issues as the scientific process might not be followed rigorously (Stavru, 2014). The study adds to the number of surveys conducted with research rigour.

The study also adds additional insight to the number of empirical studies in the agile body of knowledge. A need for more empirical studies has been found within the agile body of knowledge (Dybå and Dingsøyr, 2008; Chan and Thong, 2009). A need also for sound academic research has also been noted in the context of large scale agile implementation which is the context of this study (Gregory *et al.,* 2015; Dikert *et al.,* 2016; Vallon *et al.,* 2017).

1.4.3 *Practical contribution*

The study will determine the factors that influence usage of agile methodologies. Understanding these factors will assist in ensuring that these factors are taken into consideration when introducing agile methodologies. Knowing the factors that influence agile methodologies will assist in the successful introduction of agile methodologies to IT personnel within the banking sector.

1.5 Delimitations of the study

The original scope of the study was the banking sector; however permission was only obtained at only two major banks. Conducting the research at only two banks limits the generalizability of the study. This study was limited to IT personnel who had some exposure to agile methodologies. This was done so that the IT personnel could respond to the survey based on practical agile usage experience. The survey assessed the general use of agile methodologies and not a specific methodology.

1.6 Structure of the Research report

The report was structured into seven chapters as follows:

Chapter 2: Literature review

The purpose of this chapter was to conduct a literature review on agile methodologies. The chapter begins by giving an overview of traditional software development methodologies and agile software development methodologies. The Agile family is discussed next with a focus on Extreme Programming and Scrum. Prior research done in the field of agile methodology usage is reviewed. The chapter ends by discussing the shortcomings of this literature.

Chapter 3 – Theoretical Background and Research Model

Chapter 3 presents the theoretical underpinnings of the study. The chapter begins by discussing the origins of UTAUT. The chapter also gives a motivation of why UTAUT was selected for this study. The hypotheses are formulated based on the literature that was reviewed. The chapter ends off by presenting the research model of the study.

Chapter 4 – Research methods

The chapter starts by presenting the research paradigm that informed the study. The research design is presented next. The research instrument and data collection method are presented. This chapter also describes the population of the study and the sampling technique used. The research was conducted at two major banks and with an institution of IT professionals. The two banks will be referred to as Bank X and Bank Y throughout the remainder of the study.

The chapter gives the steps that were used to analyse the data. The limitations of the study are also addressed. The chapter also discusses the validity and the reliability of the study. The chapter ends off by discussing the ethical considerations of the study.

Chapter 5 - Data analysis

This chapter presents the results of the data analysis done on the data collected. The chapter begins by describing the steps that were taken to screen the data, handle missing values and handle outliers. The reliability and validity tests that were performed on the data are presented. The data was tested using the multiple regression analysis technique. The chapter presents the tests that were done to confirm the suitability of using multiple regression analysis. The chapter ends by discussing how the moderating variables were tested.

Chapter 6 –Discussion

The findings of the data analysed in the previous chapter are discussed in this chapter. The discussion reviews the research questions and the hypotheses. The discussion of the findings is guided by prior research. Were a hypothesis was not supported, possible reasons are proposed. The implication of each finding per research question is also discussed.

Chapter 7 – Conclusion

This chapter concludes the study. The chapter gives the implications of the study on research and practice. Recommendations and suggestions for further studies are provided in this chapter. The chapter also discusses the limitations of the study.

2 CHAPTER 2: LITERATURE REVIEW

2.1 Introduction

This chapter provides a literature review of agile methodologies to identify gaps in terms of research. The chapter starts by giving an overview of Traditional Software development methodologies. A discussion of Agile Software development methodologies then follows. The agile family with a focus on Extreme Programming and Scrum are discussed next. The literature review also discusses the state of the agile methodology field. Selected existing studies done on the usage of agile methodologies are also discussed. The literature review ends by identifying shortcomings of existing literature and how this study addresses them.

2.2 An overview of Traditional Software Development methodologies

The Software Development Life Cycle (SDLC) describes processes and activities performed in each stage to develop software (Stoica *et al.,* 2013). The SDLC is necessary to depict the phases required in software development (Leau *et al.,* 2012). Software development methodologies can be broadly classified as traditional methodologies and agile methodologies (Pikkarainen, 2008). This section discusses some of the traditional methodologies. The discussion limits itself to the Spiral and Waterfall model as these are the most popular amongst the traditional software development methodologies (Leau *et al.,* 2012).

Traditional software development (TSD) methodologies are based on a series of sequential steps from requirements definition to deployment (Awad, 2005; Leau *et al.,* 2012). TSD methodologies have a key discipline where all requirements are documented at the beginning of the project before any development commences (Leau *et al.,* 2012; Stoica *et al.,* 2013). TSD methodologies are characterised by low client interaction

(Papadopoulos, 2015). The interaction with the client is at the beginning of the project to specify requirements (Stoica *et al.,* 2013).

2.2.1 *The Waterfall Model*

One of the earliest TSD methodologies was the Waterfall model (Griffin and Brandyberry, 2008). The Waterfall model was defined by Winston Royce in 1970 as a method of teaching software development (Stoica *et al.,* 2013). The Waterfall model was developed on the premise that each phase builds from the previous phase (Griffin and Brandyberry, 2008). Each phase had to be completed before the next phase could start (Stoica *et al.,* 2013). A classic Waterfall model consisted of the following phases: requirements gathering, design, implementation, verification and maintenance (Mahalakshmi and Sundararajan, 2013).

Figure 1 below shows the Waterfall Model:

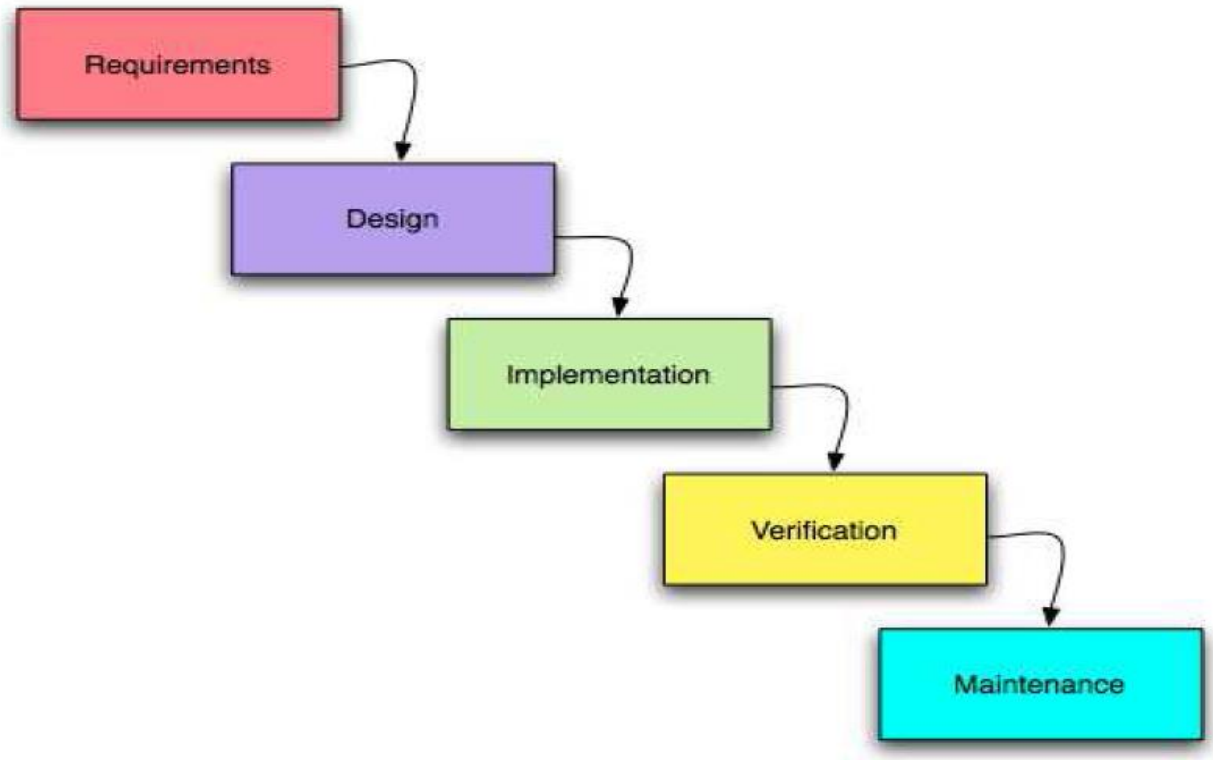


Figure 1: Waterfall Model from Mahalakshmi and Sundararajan (2013)

In the **Requirements Phase**, an understanding of the problem being solved is obtained (van Vliet, 2003). In this phase all the requirements were gathered from the Customer and analysed (Paul, 2008). The requirements were first specified at a high level and then refined to become input into the design and implementation phase (Petersen *et al.,* 2009). In the **Design Phase**, a design specification of the system was written (Paul, 2008). The architecture of the system was also specified (Petersen *et al.,* 2009). The design specification was used to implement the system (Paul, 2008).

In the **Implementation Phase**, the actual development of the system was done (Petersen *et al.,* 2009). The phase also included unit testing by the Developers of the Software (Paul, 2008). After this phase a fully functional system would be available (Paul, 2008). In the **Verification Phase**, the Testers created test cases based on the requirements specified in the Requirements Phase (Paul, 2008). The test cases were used to determine if the system met all the original requirements specified in the Requirements Phase (Paul, 2008). Besides checking the functional requirements of the system, the Verification phase was also used to test the quality of the system (Petersen *et al.,* 2009). Any defects found were corrected in the Maintenance Phase (Petersen *et al.,* 2009).

The strength of the Waterfall model was the emphasis on documentation (Paul, 2008; Stoica *et al.,* 2013). Documentation enabled new team members to understand the project fully (Stoica *et al.,* 2013). The Waterfall model has been found to work well for short term projects where requirements are fully understood and are not ambiguous (Paul, 2008; Stoica *et al.,* 2013). The Waterfall model works when requirements are most likely not going to change (Paul, 2008). The Waterfall model is simple and easy to adopt (Mahalakshmi and Sundararajan, 2013).

Since the model was sequential the Waterfall model had the challenge were it could not adequately handle changes in user requirements (Griffin and Brandyberry, 2008). It is also not always possible to have fully elaborated requirements and documents upfront (Boehm, 1988). The perfect knowledge of the customer requirements is not always possible (Paul, 2008). With the Waterfall model, new requirements negatively affected

the product development and lead to additional costs to cater for these new requirements (Stoica *et al.,* 2013). When defects were detected in testing and there was need for redesign, it was difficult to return to the design stage (Stoica *et al.,* 2013).

Another challenge with the Waterfall model was that system development is not always sequential and streamlined; steps can overlap (Mahalakshmi and Sundararajan, 2013). A subsequent phase can reveal gaps of the previous phase (Mahalakshmi and Sundararajan, 2013). The Waterfall model has been viewed as underutilising the team members (Paul, 2008). This is because each phase of the Life Cycle was done by a specific role and the other roles were not involved (Paul, 2008).

2.2.2 *The Spiral Model*

The Spiral Model was developed to try and resolve the challenges with the Waterfall model (Griffin and Brandyberry, 2008). The Spiral model represented the software development life cycle as a spiral rather than as a sequence as with the Waterfall model (Khan *et al.,* 2011). Figure 2 shows the Spiral Model:

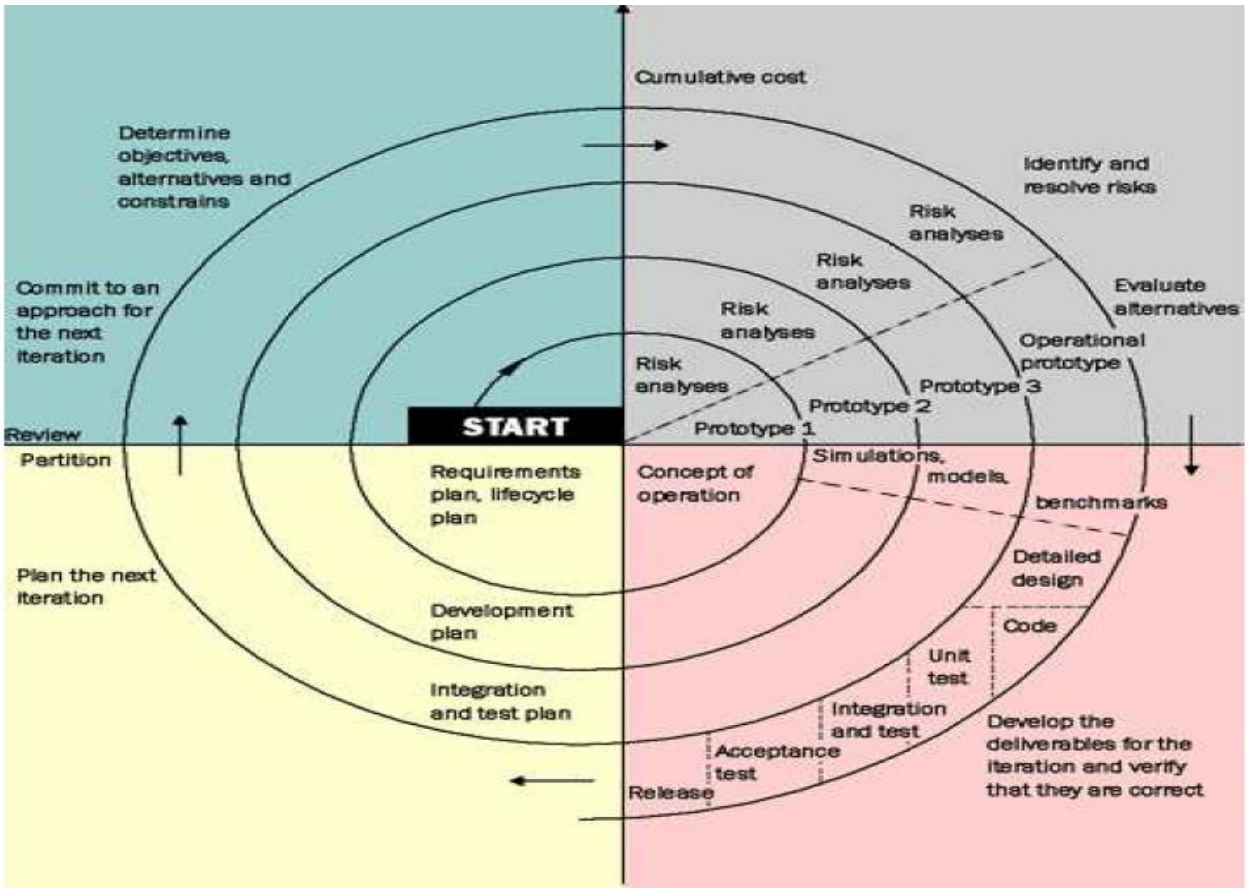


Figure 2: The Spiral Model from (Boehm, 1988).

In the Spiral Model each phase began with requirements definition and ended with a prototype (Boehm, 1988). A phase had a duration of between 6 months to 2 years (Paul, 2008). The Spiral Model used prototypes to validate the user's requirements (Boehm, 1988). This was an improvement over the Waterfall model, as clients did not have to wait until the life cycle was complete to see a model of the software (Griffin and Brandyberry, 2008). In each subsequent spiral the requirements were refined and the prototype was improved based on the subsequent prototype (Boehm, 1988).

After reviewing each subsequent prototype the customer could terminate the project if the project was not delivering the expected value (Paul, 2008). The cycle to refine requirements and build prototypes continued until the customer was satisfied with the prototype (Griffin and Brandyberry, 2008). The strength of the Spiral Model was the use of prototypes (Paul, 2008). The use of prototypes enabled the customer to review the

progress of the project sooner and to determine if the requirements were being met (Paul, 2008). Unlike with the Waterfall model, the customer only saw the first working software at the end of the final phase (Griffin and Brandyberry, 2008)

Although the Spiral model improved the software development process, it did not fully address all the challenges associated with TSD methodologies (Griffin and Brandyberry, 2008). The Spiral model had long iterations to produce the prototypes (Paul, 2008). In the case that the prototype was discontinued, resources would have been wasted during the long iterations (Paul, 2008).

2.2.3 *Challenges with Traditional Software Development Methods*

Despite the improvements introduced by the Spiral Model, TSD methodologies were still viewed as inflexible and unable to respond to change (Papadopoulos, 2015). A strict change control process also had to be followed with TSD methodologies when making changes (Stoica *et al.,* 2013). Changes were also costly to implement (Petersen *et al.,* 2009).

TSD methodologies have also been criticized for not being able to manage change in requirements (Petersen *et al.,* 2009). With TSD methodologies by the time the system is complete, it does not reflect the current requirements (Petersen *et al.,* 2009). Other issues levelled against TSD methodologies were lengthy completion times, high development and maintenance costs and quality issues (Griffin and Brandyberry, 2008). Agile methods were developed in response to these challenges (Stoica *et al.,* 2013). The next section discusses Agile Software Development methodologies.

2.3 An overview of Agile Software Development methodologies

The Agile movement was formulated during the mid 1990's in response to the limitations of TSD methodologies (Lee and Xia, 2010). In 2001 the principles of the agile movement were published in the Agile Manifesto (Lee and Xia, 2010). The Agile Manifesto specified four core values, which are: "Individuals and interactions over processes and tools; Working software over comprehensive documentation; customer collaboration over

contract negotiation; and responding to change over following a plan" (Agile Alliance, 2001). The manifesto also specified 12 principles (Agile Alliance, 2001). Beck *et al.* 2001 specify the following 12 principles:

1. "Our highest priority is to satisfy the customer through early and continuous delivery of valuable software.
2. Welcome changing requirements, even late in development. Agile processes harness change for the customer's competitive advantage.
3. Deliver working software frequently, from a couple of weeks to a couple of months, with a preference to the shorter timescale.
4. Business people and developers must work together daily throughout the project.
5. Build projects around motivated individuals. Give them the environment and support they need, and trust them to get the job done.
6. The most efficient and effective method of conveying information to and within a development team is face-to-face conversation.
7. Working software is the primary measure of progress.
8. Agile processes promote sustainable development. The sponsors, developers, and users should be able to maintain a constant pace indefinitely.
9. Continuous attention to technical excellence and good design enhances agility.
10. Simplicity the art of maximizing the amount of work not done is essential.
11. The best architectures, requirements, and designs emerge from self-organizing teams.
12. At regular intervals, the team reflects on how to become more effective, then tunes and adjusts its behaviour accordingly."

Agile Software Development (ASD) methodologies are a group of methods that work iteratively and incrementally using self-managed teams (Agrawal *et al.,* 2016). Unlike TSD methodologies that take long to deliver software, ASD methodologies place emphasis on early delivery of working software (Griffin and Brandyberry, 2008). In ASD methodology high level requirements are defined and reviewed in each subsequent iteration (Inayat *et al.,* 2015). In each iteration only Just In Time documentation is produced which specifies the minimum that is required (Dingsøyr *et al.,* 2012). Just In

Time requirements are a key distinguishing feature of ASD methodologies from TSD where requirements were specified upfront and in detail (Griffin and Brandyberry, 2008).

Unlike TSD methodologies that were unable to handle changes in requirements, ASD methodologies can adapt to rapid changes in requirements (Stoica *et al.,* 2013). The ability to respond to change has been considered to be a determinant of the success or failure of a software project (Awad, 2005). ASD methodologies have frequent interaction with the client (Stoica *et al.,* 2013). The frequent interaction helps the client and the team to define and validate the requirements in each iteration (Inayat *et al.,* 2015). In TSD methodologies the interaction with the client was relatively lower (Griffin and Brandyberry, 2008). The next section discusses the agile family.

2.4 The Agile Family

As a result of the Agile principles, different agile methodologies were formulated which are referred to at the Agile family (Verma, 2015). The Agile Family consists of the following methodologies: Scrum, Extreme programming, Agile Modelling, Feature Driven Development, Adaptive Software Development, Dynamic System Development Methodology, Crystal and Lean Software Development (Stavru, 2014). Although the Agile Family has many methodologies, most studies have been on Extreme Programming and Scrum (Dyba˚ and Dingsøyr, 2008; Hummel, 2014).

In terms of industry usage, Scrum and Extreme Programming have been found to be the most popular methodologies being used in industry (Dyba˚ and Dingsøyr 2008; Hummel 2014). Table 1 below summarizes the remaining Agile Methodology members. Thereafter Extreme Programming and Scrum are discussed in detail respectively. The research trends and usage of Extreme Programming and Scrum will be discussed in Section 2.5.3 and Section 2.5.4.

Agile Methodology	Description
Adaptive Software Development	The methodology was derived to assist with dealing with turbulent changes in the business environment (Highsmith, 2002). The method focuses on enabling the team and organization to adapt to changes (Highsmith, 2002). The method views organizations as adaptive systems that use adaptive frameworks to adapt to change (Highsmith, 2002). Adaptive Software Development recognizes the need to have a software development methodology that is tolerant to change (Paetsch *et al.,* 2003). The method is also iterative and uses constant prototyping (Paetsch *et al.,* 2003).
Agile Modelling (AM)	The methodology emphasizes the importance of modelling software. The aim of AM is to produce the minimum required models that are able to sufficiently document the system requirements with an underlying robust design (Ambler, 2002). The technique also focuses on the importance of communication (Ambler, 2002).
Crystal Methodologies	The Crystal Methodologies consists of different methodologies which can be selected depending on the project requirements (Paetsch *et al.,* 2003). The Crystal methodology focuses on the people aspects of the software development process (Highsmith, 2002). The Crystal family also focuses on collaboration, good citizenship and cooperation (Highsmith, 2002). Crystal advocates that the success of a project is based on empowering the people to make the correct decisions (Cockburn, 2004). The methods within the Crystal family are characterized by minimal documentation (Highsmith, 2002). Similar to other Agile Methodologies, the focus

Agile Methodology	Description
	is “stretch–to–fit”, where the project starts small and incrementally stretches to increase and meet the customer requirements (Cockburn, 2004).
Dynamic Software Development Method (DSDM)	DSDM is based on the rapid application development method (Paetsch *et al.,* 2003). In DSDM the initial requirements are elicited (Paetsch *et al.,* 2003). Further requirements are elicited during the development process (Paetsch *et al.,* 2003). The method focuses on active user involvement, frequent delivery and addressing current business needs (Stapleton, 2003).
Feature-Driven Development (FDD)	FDD aims to first build an overall object model of the software (Highsmith, 2002). The object model represents the simplest graphically representation of the project (Palmer and Felsing, 2002). In the subsequent iterations, FDD specifies a list of features that will need to be designed and built per iteration (Highsmith, 2002).
Lean Development (LD)	The methodology has origins from the Japanese manufacturing industry (Poppendieck and Poppendieck, 2003). The methodology is based on principles from Lean manufacturing (Highsmith, 2002). LD is able to adapt quickly to customer needs yet building a stable solution (Highsmith, 2002). The goal of LD is to manage changes in software development in 1/3 of the time, using 1/3 the budget and having at most 1/3 of the defect rate (Highsmith, 2002).

Table 1: Agile Methodology Summary

2.4.1 *Extreme Programming (XP)*

XP was one of the first agile methodologies to be put forward (Pathak and Saha, 2013). XP was developed at Chrysler by Kent Beck (Livermore, 2008). The core principles of Extreme Programming are: “Incremental planning, Small Releases, Simple Design, Refactoring, Pair Programming, Sustainable pace and On-site Customer” (Munassar and Govardhan, 2010; Pathak and Saha, 2013). In Incremental planning the customer indicates the features they want for each release (Pathak and Saha, 2013). The business requirements of these features are called stories (Munassar and Govardhan, 2010; Pathak and Saha, 2013). Based on those stories development timeline estimates are given (Munassar and Govardhan, 2010).

With the principle of Small Releases, XP aims to deliver first the minimum set of useful functionality that provides the highest business value (Munassar and Govardhan, 2010; Pathak and Saha, 2013). The functionality is reviewed by the Customer in each release (Pathak and Saha, 2013). Releases of the system functionality are frequent and incrementally add to the existing functionality of the previous release (Munassar and Govardhan, 2010). With continued increments there is need to check if the previous functionality is still working (Munassar and Govardhan, 2010).

XP implores the principle of Continuous Integration (Munassar and Govardhan, 2010; Pathak and Saha, 2013). With the principle of Continuous Integration when a story is completed it is integrated into the whole system and unit testing is done (Munassar and Govardhan, 2010).

XP also emphasizes on the principle of a Simple Design (Munassar and Govardhan, 2010; Pathak and Saha, 2013). The principle of a Simple Design ensures that adequate designing is done to meet the requirements of a release (Munassar and Govardhan, 2010). To achieve Simple Design, XP also uses refactoring techniques (Pathak and Saha, 2013). In XP, all software developers are expected to refactor their code continuously (Munassar and Govardhan, 2010; Pathak and Saha, 2013). Refactoring techniques such as removing duplicated code are utilised in XP to continuously improve the existing design (Pathak and Saha, 2013). Refactoring keeps the code simple and

maintainable (Munassar and Govardhan, 2010). After a refactoring exercise software developers must verify that the system is still working (Munassar and Govardhan, 2010).

In the XP process all software development must be done in pairs, utilizing the concept of pair programming (Munassar and Govardhan, 2010; Pathak and Saha, 2013). In Pair Programming, software developers work in pairs, on a single machine (Pathak and Saha, 2013). Utilizing pair programming enables peer review of the code (Pathak and Saha, 2013). Pair programming results in better design, reduces debugging time and facilitates knowledge sharing (Pathak and Saha, 2013). Since the code is developed in pairs, the code is owned by the team and not by any individual (Pathak and Saha, 2013). The team also works on constant pace which is sustained throughout the releases (Pathak and Saha, 2013). The sustainable pace ensures that the team does not work overtime (Munassar and Govardhan, 2010). Working overtime reduces code quality and team productivity (Munassar and Govardhan, 2010). XP encourages a 40 hour week with minimal overtime (Pathak and Saha, 2013).

In XP the customer or a representative of the customer is part of the team and is involved throughout the release (Munassar and Govardhan, 2010). The customer is on site as often as possible and available for the team (Munassar and Govardhan, 2010). Having the customer on site changes the customer's role of being a remote unapproachable entity as was with the TSD methodologies (Livermore, 2008).

The life cycle of XP consists of five phases: Exploration, Planning, Iterations to Release, Productionizing, Maintenance and Death (Anwer *et al.,* 2017). Figure 3 below shows the XP Life Cycle:

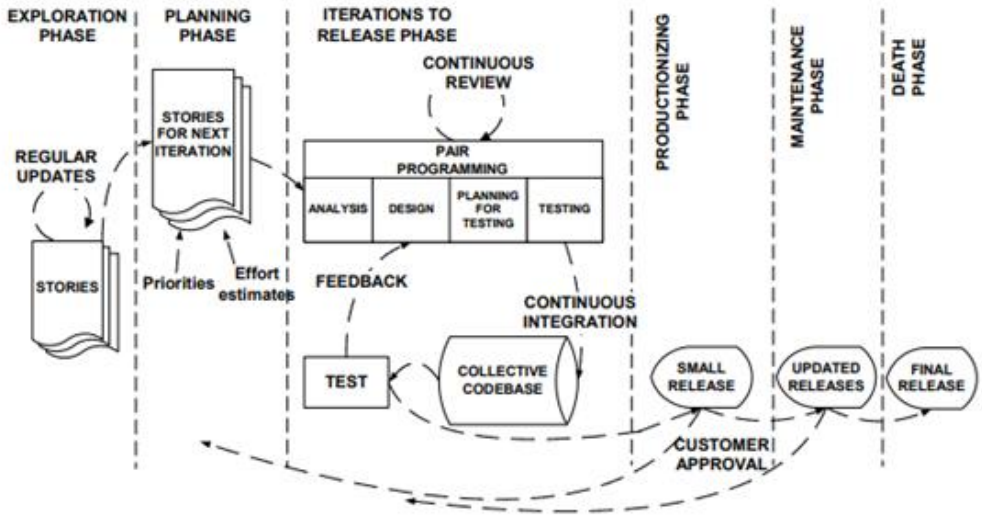


Figure 3: XP Life Cycle

The **Exploration Phase** deals with the requirement and architecture modelling of the system (Anwer *et al.,* 2017). In this phase the tools and technology that will be used to build the new system are defined (Abrahamsson *et al.,* 2017; Anwer *et al.,* 2017). A meeting is arranged to plan a release (Abrahamsson *et al.,* 2017; Anwer *et al.,* 2017). The customer writes out the story card that they wish to be included in the first release (Abrahamsson *et al.,* 2017). The story cards contain the requirement descriptions of the features to be added into the program (Abrahamsson *et al.,* 2017). In the Exploration phase the architectural possibilities of the system are also explored (Abrahamsson *et al.,* 2017). An architecture metaphor is developed in this phase (Anwer *et al.,* 2017). The architecture metaphor shows the basic objects and interfaces of the proposed system (Anwer *et al.,* 2017). The exploration phase ranges from a few weeks to a few months (Anwer *et al.,* 2017). At the end of the exploration phase there should be enough stories to start a release (Anwer *et al.,* 2017).

In the **Planning Phase**, priorities of the stories are decided to ensure that the highest business value is derived first (Anwer *et al.,* 2017). The entire XP team is involved in the planning phase (Abrahamsson *et al.,* 2017). The Developers first break down the stories into tasks (Anwer *et al.,* 2017). Based on the tasks the Developers estimate the effort

required for each story and also determine how many stories can be completed within the release (Abrahamsson *et al.,* 2017). The planning phase takes a few days (Abrahamsson *et al.,* 2017).

The **Iterations to release Phase** includes several iterations of the system before the first release (Abrahamsson *et al.,* 2017). The customer decides the stories to be included in each iteration (Abrahamsson *et al.,* 2017). The schedule set in the Planning phase is broken down into a number of iterations that between one to four weeks to implement (Abrahamsson *et al.,* 2017). The Iterations to release phase incorporates basic software development activities like analysis, design and testing (Pathak and Saha, 2013). Stories in the first iteration make the overall architecture (Abrahamsson *et al.,* 2017; Anwer *et al.,* 2017). Selected tasks are implemented using pair programming (Anwer *et al.,* 2017). Principles of code refactoring and simple design are used in this phase. At the end of the final iteration the system is ready for use in production (Abrahamsson *et al.,* 2017; Anwer *et al.,* 2017).

The **Productionizing Phase** is about deploying software in small releases (Anwer *et al.,* 2017). Additional testing and system performance checks are done before the system can be released to the customer (Abrahamsson *et al.,* 2017). New changes are evaluated for possible inclusion in the current release (Abrahamsson *et al.,* 2017).

In the **Maintenance Phase** after the first release, the XP team continues building new functionality whilst maintaining the existing functionality (Abrahamsson *et al.,* 2017; Anwer *et al.,* 2017). The maintenance phase may require incorporating new people into the team and changing the team structure (Anwer *et al.,* 2017). The team changes are required to cater for the new functionality that is being developed and the maintenance of the existing functionality (Abrahamsson *et al.,* 2017).

The **Death Phase** is the last phase of XP (Anwer *et al.,* 2017). This phase is reached if all the required functionality has been implemented and the customer does not have any additional stories to be implemented (Abrahamsson *et al.,* 2017; Anwer *et al.,* 2017). The Death phase may be reached when the system is not achieving the desired results in terms of performance (Abrahamsson *et al.,* 2017). In this phase documentation about the

system is created as there will be no more changes happening on the system and the architecture is stable (Abrahamsson *et al.,* 2017; Anwer *et al.,* 2017).

2.4.2 *Scrum*

Scrum is the most widely used agile methodology in the agile family (Anwer *et al.,* 2017). The methodology was developed by Jeff Sutherland, Ken Schwaber and Mike Beedle (Anwer *et al.,* 2017). The aim of Scrum was to resolve issues in TSD methodologies (Lee and Xia, 2010; Anwer *et al.,* 2017). Scrum was also designed to handle rapidly changing and volatile business requirements (Livermore, 2008). Scrum is an iterative, incremental process for developing software (Mahalakshmi and Sundararajan, 2013; Anwer *et al.,* 2017). Scrum can be used effectively on both small and large projects (Livermore, 2008).

Scrum uses short software delivery cycles, called Sprints which last between two to four weeks (Livermore, 2008; Anwer *et al.,* 2017). Scrum consists of 3 roles which are Product Owner, the team and the Scrum Master (Mahalakshmi and Sundararajan, 2013). In each Sprint, Scrum ceremonies are conducted. The ceremonies are Sprint planning, Daily Stand up, Sprint Development and Sprint Retrospective (Mahalakshmi and Sundararajan, 2013).

The Sprint planning meeting is conducted by the Product Owner with the team members and the Scrum Master (Mahalakshmi and Sundararajan, 2013). In the Sprint Planning the Product Owner selects tasks that are of priority (Mahalakshmi and Sundararajan, 2013). The team reviews the task and determines how much effort is required to complete the task (Mahalakshmi and Sundararajan, 2013). At the end of the Sprint Planning the team commits to a certain number of tasks for the specific Sprint (Mahalakshmi and Sundararajan, 2013). Progress on these tasks is tracked in the Daily Stand up (Anwer *et al.,* 2017). The Daily Stand up is a 10 to 15 minute check point progress meeting (Anwer *et al.,* 2017).

In Sprint development the actual work is done, to design, develop and test the software. Sprint Development is done based on the priorities identified in the Sprint Planning (Anwer *et al.,* 2017). At the end of the Sprint, the developed product is reviewed by the

Product Owner. Also at the end of the Sprint, the Sprint Retrospective is conducted Mahalakshmi and Sundararajan, 2013). The Sprint Retrospective is attended by the entire Scrum team including the Customers (Mahalakshmi and Sundararajan, 2013). The Sprint Retrospective reviews the Sprint to identify what worked and what did not work (Mahalakshmi and Sundararajan, 2013). The Sprint Retrospective also discusses ways that can be used to improve the Scrum process (Mahalakshmi and Sundararajan, 2013).

2.5 State of the field of agile methodology usage

This section discusses the Systematic Literature Review (SLR) that was conducted to understand in detail the field of agile methodologies. The section starts the discussion with the search terms that were used for the SLR, the search results are present. The section ends off by discussing the findings of the SLR.

2.5.1 *Systematic Literature Review Search Terms*

To understand the current state of knowledge in terms of agile methodologies, a SLR review was conducted. A SLR is “a systematic, explicit, and reproducible method for identifying, evaluating, and synthesizing the existing body of completed and recorded work produced by researchers, scholars, and practitioners” (Fink 2005:3). A SLR can be used to understand the breadth of research on a topic of interest. In this study a SLR was used to understand agile methodologies.

The steps used to conduct the SLR were based on the steps recommended by Okoli and Schabram (2010). After establishing the purpose of the SLR, search strings were constructed. Two search strings were created. The first search string (String 1) was for the agile methodology and members within the agile family. The search string was (“Agile” OR “Scrum” OR “Extreme Programming” OR “Agile Modelling” OR “Feature Driven Development” OR “Adaptive Software Development” OR “Dynamic System Development Methodology” OR “Crystal” OR “Lean Software Development”). The second search string was for words that are used in the context of usage studies. Search string two was (“acceptance” OR “use” OR “adoption” OR “literature review”).

The following databases were selected for the searches: Science Direct, EBSCOHost, Proquest Central, IEEE Xplore, JSTOR and Web of Science. These databases were selected as they were anticipated to have content on agile methodology research which is usually done in the disciplines of Science, Engineering and Computing.

2.5.2 *Systematic Literature Review Search Results*

The two search terms were applied to each database for the period between 2008 and 2017. For each database search filters were first applied. For the remaining articles the article tittle, abstract, and keywords were read for relevance of the article to the review. The inclusion and exclusion criterion was applied. The inclusion criteria were studies that focused on acceptance and usage within the agile family. The exclusion criteria were studies whose context was not agile software development and agile methodology usage. Appendix M shows the process flow of the SLR. In the end 13 articles were selected. The next section discusses the results of the SLR.

2.5.3 *Discussion of the state of the field of agile methodology usage*

This section discusses the state of the field of agile methodologies. The section discusses worldwide trends and reflects on the state of the trend in South Africa. The section starts by discussing trends of methods being used. A discussion of practises that have been found to be useful is given. The sections ends by discussing the benefits and challenges found with the implementation of agile methodologies.

Agile as a disciple is now being regarded as a maturing field (Gregory *et al.,* 2015). Agile methodologies are now being widely used at an increasing speed (Salo and Abrahamsson, 2008; Diebold and Dahlem, 2014). Agile methodologies were originally used by small organizations, but now there is a shift towards the methodologies being used by large organizations (Salo and Abrahamsson, 2008; Dingsøyr and Moe, 2013; VersionOne Inc, 2016). This trend has also been seen in South Africa where large corporates are now also starting to use agile methodologies (De Gregorio, 2017).

In terms of sector usage, agile methodologies were synonymous with high tech product companies (Salo and Abrahamsson, 2008). Now there is a shift where agile methodologies are being used in other sectors namely Telecommunications, Finance and Insurance (Salo and Abrahamsson, 2008; Diebold and Dahlem, 2014). The use of agile methodologies in South Africa is also diversified. Agile methodologies are being used in the financial sector (Johnstone and Gill, 2017). They are also being used in the insurance, media, retail and health sector (De Gregorio, 2017).

The commonly used agile methodologies are Scrum and XP (Diebold and Dahlem, 2014). Initially the trend was that XP was more predominantly used than Scrum (Salo and Abrahamsson, 2008; Jalali and Wohlin, 2012; Hummel, 2014). However there is a shift where Scrum is being more predominantly used than XP (Cardozo *et al.,* 2010; VersionOne Inc, 2016; Vallon *et al.,* 2017). There is also evidence of companies adapting and customizing the agile methodologies (Cardozo *et al.,* 2010; Akbar *et al.,* 2011; Diebold and Dahlem, 2014). The adaptation and customization has resulted in the formation of use hybrids methodologies (Diebold and Dahlem, 2014). The hybrid of Scrum and XP is the most popular hybrid (Diebold and Dahlem, 2014; Vallon *et al.,* 2017). In South Africa the trend has also been to use process driven methodologies such as Scrum (De Gregorio, 2017). The use of engineering driven methodologies and practises such as Extreme Programming is also low in South Africa (De Gregorio, 2017).

With the adaptation of the agile methodologies, companies select which practises are useful to them (Diebold and Dahlem, 2014). The most used and useful practise has been found to be the use of the concept of a Daily Stand up from the Scrum methodology (Dyba˚ and Dingsøyr, 2008; Vallon *et al.,* 2017). Daily stand ups are a 10 to 15 minute update meeting (Anwer *et al.,* 2017). The usefulness of the Daily stand ups has been found even from a customer perspective (Dyba˚ and Dingsøyr, 2008). From a customer perspective, daily stand ups have been found to keep the customer properly informed about the progress of the team (Dyba˚ and Dingsøyr, 2008). Daily stand ups have also been found to improve communication and expectation management between the team and the customer (Ahmad *et al.,* 2013). In South Africa the Daily Stand up has also been

cited as useful. Additionally the use of Product backlogs and Retrospectives has been cited as useful practises (De Gregorio, 2017).

In terms of benefits, the main benefit of using agile methodologies has been the increase in productivity of the team (Dyba˚ and Dingsøyr, 2008; Cardozo *et al.,* 2010; Ahmad *et al.,* 2013). In a Systematic Literature Review conducted by Cardozo *et al.* (2010) they found that productivity was the most cited outcome of using agile methodologies. When productivity is increased then operational costs and time to market are reduced (Ahmad *et al.,* 2013). The increase in productivity also positively affects the team member's job satisfaction levels and morale (Dyba˚ and Dingsøyr, 2008). Another main benefit of agile methodologies has been the fast detection and resolution of bugs which has resulted in the improvement of the quality of software (Cardozo *et al.,* 2010; Ahmad *et al.,* 2013). The cited benefits have also been experienced in South Africa (De Gregorio, 2017). However in South Africa the ability to adapt to changes faster has been cited as a top benefit (De Gregorio, 2017).

Within the agile family, the methods need the support of other methods (Ahmad *et al.,* 2013). The increased use of hybrid methods is evidence of limitations within the agile family methodologies (Cardozo *et al.,* 2010; Akbar *et al.,* 2011; Diebold and Dahlem, 2014). Another limitation has been in the effectiveness of the agile practises (Dyba˚ and Dingsøyr, 2008). The practise of pair programming has been found to be inefficient (Dyba˚ and Dingsøyr, 2008). Inefficiencies in pair programming arise when the conversation of one pair spreads to the next pair, resulting in intense and stressful debates (Dyba˚ and Dingsøyr, 2008). The decline in use of pair programming has also been experienced in South Africa (De Gregorio, 2017). Engineering related practises such as pair programming and refactoring are not being used as much as process driven practises (De Gregorio, 2017).

2.5.4 *Usage of Agile in prior studies*

The usage of agile methodologies has been attributed to the hype and buzz around agile more than the actual benefits (Gregory *et al.,* 2015). Cardozo *et al.* (2010) noted that usage is due to a belief that agile methodologies are powerful than any other

development methodology. This section discusses and reviews selected studies that have been done on the usage of agile methodologies. The section discusses the studies by Salo and Abrahamsson (2008), Chan and Thong (2009) and Gandomani *et al.,* (2014).

Salo and Abrahamsson (2008) conducted a survey to determine the levels of usage and acceptance associated with each methodology within the agile family. XP and Scrum were found to have the highest rate of usage and acceptance (Salo and Abrahamsson, 2008). The high rates of usage were attributed to the perception that these methodologies were useful (Salo and Abrahamsson, 2008). Extreme Programming was found to be useful because of the following practices: collective code ownership in the team, the use of coding standards and the use of a simple design (Salo and Abrahamsson, 2008). Scrum was found to be useful because of the use of a Product Backlog (Salo and Abrahamsson, 2008). The Product Backlog lists all the functionality of the intended system in small packages (Salo and Abrahamsson, 2008).

Chan and Thong (2009) conducted a literature review of the factors that have been found to influence agile usage. Chan and Thong (2009) found that a comprehensive set of factors that consist of individual, organizational and technology characteristics are required to understand the usage of agile methodologies. Chan and Thong (2009) emphasize the importance of individual characteristics of the personnel using the agile methodology. The emphasis is on the individual because agile methodologies are people oriented and therefore the characteristics of the people using the agile methodology are important (Chan and Thong, 2009).

Gandomani *et al.* (2014) focused on the influence of facilitating conditions in the transition and usage of agile methodologies. Gandomani *et al.* (2014) proposed the "Emergence of Agile transition facilitators theory" which consists of the following constructs: "Training, Good Coaching and Mentoring, Management Buy-in, Team Members Buy-in, Right People Selection, Empowering the Team, Continuous Meetings and Negotiations, Agile Champions and Incentive Factors". Of these factors Gandomani *et al*. (2014) found training to be the most significant facilitating condition in the usage of

agile methodologies. Agile methodologies have also not been used due to the lack of training to ensure understanding of the core agile principles. For example due to the lack of training, the emphasis of a self-organizing team has been misunderstood (Gregory *et al.,* 2015). The self-organizing team has been viewed as unstructured and informal (Gregory *et al.,* 2015).

Gandomani *et al.* (2014) also found that good coaching and mentoring assisted in embedding Agile practices (Gandomani *et al.* 2014). Lack of skills and training to implement agile methodologies has been cited as a factor resulting in non-usage of agile methodologies (Asnawi *et al.,* 2011; Ahmad *et al.,* 2013). Gandomani *et al.* (2014) found that management and team buy in was crucial in the usage process. Cockburn and Highsmith (2001) found management and leadership as influencing usage of agile methodologies.

2.5.5 *Case Studies of agile usage in Banks*

Ozkan *et al.,* (2017) conducted a case study on Türkiye Finans bank in Turkey. The bank has close to 300 branches and serves a customer base of over 3 million. The work force is around 4 5000 employees. The bank decided to use Scrum to try and deal with the issues of the Waterfall methodology. The bank needed to deliver services on time with quality and produce return of investment on IT projects. The bank chose to use the Scrum method. The peculiarity of this implementation was that the Scrum activities were being done in an environment governed by COBIT.

In the case study at Türkiye Finans bank by Ozkan *et al.,* (2017), Scrum yielded positive results of improved collaboration, communication and employee morale. There issues however arose as a result of the conflicting practises between Scrum and COBIT. When it came to meeting the reporting requirements the use of Scrum was not ideal. The internal audit also needed comprehensive documentation which was antagonistic with the minimal documentation produced in Scrum. There were issues also with the practise of segregation of duty mandated by COBIT whereas Agile advocates a cross functional team blurring the lines of segregation of duty.

In another study by Johnston and Gill (2017), they discuss the agile transformation journey of Standard Bank. The Standard Bank Group has serves over 15 million customers in more than 20 countries. The company has headquarters in South Africa. The Bank employs approximately 49 000 employees. Similar to Türkiye Finans bank, Standard Bank took the decision to introduce Agile Methodologies because of issues with the Waterfall methodology. The bank was experiencing challenges with IT budget overruns, long turnaround times and low employee satisfaction.

Standard Bank decided to implement the Scaled Agile Framework. This was decided based on the large size of the organization and the numerous IT applications. Process improvement initiatives were also conducted. For Standard bank the results were positive. There was an increase in team productivity and an overall positive Organizational Health Index.

2.5.6 *Challenges of agile usage in Banks*

The usage of agile methodologies has been problematic in banks (De Gregorio, 2017). Agile principles and practises are antagonistic to the corporate culture of banks (De Gregorio, 2017). Agile team members are cross functional (Mahalakshmi and Sundararajan, 2013). This is contrary to the structure of banks where roles are specialised and segregated (Ozkan *et al.,* 2017). Banks are also layered and decisions are made by progressing through these layers (Ozkan *et al.,* 2017). In an agile team, the Customer is part of the team and there is effective collaboration which enables quicker decision making (Mahalakshmi and Sundararajan, 2013). The agile team structure does not support decision making through layers of various roles. Significant changes are therefore required in the structure and roles of banks to enable implementation of agile roles (Ozkan *et al.,* 2017).

Banks are also known for having Legacy IT systems (Lipton *et al.,* 2016). Applying agile principles to the source code of the Legacy systems has been found to be a challenge (Boehm and Turner, 2005). The source code of these Legacy systems is usually long, complex and sometimes cannot be time boxed into increments which is an agile principle (Boehm and Turner, 2005). Legacy systems also pose a cultural paradox. Legacy

systems were predominantly built using traditional software development methodologies (Boehm and Turner, 2005). The implementation of agile methodologies means that Legacy systems need to be maintained using agile principles. Traditional software development methodologies were characterised by multiple hand offs to the next phase of the cycle (Mahalakshmi and Sundararajan, 2013). Specialised roles were also needed to fulfil each phase. Agile methodologies on the other hand are characterised by intense collaboration (Beck *et al.* 2001). The prevalent culture when Legacy systems were built is therefore different from the culture encouraged by agile methodologies.

Agile principles such as refactoring are not easily applicable to Legacy systems (Boehm and Turner, 2005). Principles of agile methodologies also advocate for minimal documentation (William, 2010). The minimal documentation has been found to be insufficient for compliance and other regulatory purposes (Ozkan *et al.,* 2017). Besides compliance issues, the systems and products in the banks are usually developed by multiple vendors located in distributed teams. Managing large projects with multiple vendors has been found to be a significant challenge in agile implementations (Dikert *et al.,* 2016).

2.6 Shortcomings of prior literature

This section discusses the shortcomings that have been identified from prior literature. The shortcomings have been in terms of the methodologies that have been studied, how they have been studied and the unit of analysis of the studies.

Stavru (2014) conducted a secondary analysis of surveys done on agile methodology usage. Using a list that consisted of 21 assessment criteria, Stavru (2014) found out that most studies on agile usage were not thorough. The studies were found to be lacking in reporting the survey method, the sampling frame and in following the scientific process (Stavru, 2014). There is also a dominance of experience reports (Gregory *et al.,* 2015; Vallon *et al.,* 2017). Experience reports are prevalent in large scale agile implementations (Dikert *et al.,* 2016). Experience reports present a contextualised report about an organization's usage of agile methodologies (Gregory *et al.,* 2015). Experience

reports can be biased to give the positive and successful points of an agile implementation and not the challenges and difficulties (Hummel 2014; Gregory *et al.,* 2015; Vallon *et al.,* 2017). This study follows the scientific process to add to the number of empirical studies on agile methodology usage.

A systematic literature review of 482 studies was conducted by Hummel (2014). Hummel (2014) found that only 6% of studies used the individual as a unit of analysis. The other studies focused on the methods, the tools, the project team and the organization as the unit of analysis. The Agile Manifesto advocates individual interaction over processes and tools, individuals are therefore at the core of the agile methodology (Gandomani and Nafchi, 2016). The introduction of a new methodology directly impacts individuals, who now have to change their daily behaviours. The first empirical findings using the individual as a unit of analysis were done by Hong *et al.* (2011), in their study of individual user acceptance of agile information systems (Hummel, 2014). The study addresses this gap by utilizing the individual as the unit of analysis.

Software Developers have been used as the main population in agile studies (Abrahamsson *et al.,* 2009; Iivari and Iivari 2011). The Agile team does not only consist of individuals fulfilling Software Developer roles. There is need to study the other individuals in the agile team other than Software Developers. This study will survey all I.T. personnel involved in the agile process.

In the South African context, agile methodologies are also gaining popularity. The studies by Ramnath in 2011 and Noruwana and Tanner in 2012 investigated the factors that influence agile usage. At the time of writing there was limited research done to determine the factors influencing the usage of agile methodologies in the Banking sector in South Africa. This study adds to the number of studies done in the Banking sector in South Africa.

2.7 Conclusion

The chapter provided a literature review of software development methodologies. The review discussed traditional software development methodologies and agile software development methodologies. The review also summarised the state of agile methodologies. The chapter ended off by discussing limitations of prior studies in agile. After identifying the shortcomings the document will now discuss the theoretical background and the research model that will be used to address these shortcomings.

3 CHAPTER 3: THEORETICAL BACKGROUND AND RESEARCH MODEL

3.1 Theoretical Background

This chapter discusses the theoretical lens that was used for the study. The theoretical lens is discussed in terms of origin, usage by country, context and usage in agile studies. The chapter also discusses how the research hypotheses were derived.

3.1.1 *Unified theory of acceptance and use of technology (UTAUT)*

The study drew on UTAUT as the theoretical framework. UTAUT facilitates the examination of user's intentions to use an information system (Williams *et al.,* 2015). UTAUT has been widely used as theoretical lens to understand user intention and behaviour (Dwivedi *et al.,* 2011; Williams *et al.,* 2014). At the time of writing, the article that proposed the UTAUT by Venkatesh *et al.* (2003) had been cited just above 19 700 times on Google Scholar. UTAUT was derived by synthesizing various models based on eight theories and models which are: "the Theory of Reasoned Action (TRA), the Technology Acceptance Model (TAM), the Motivational Model, the Theory of Planned Behaviour (TPB), a combined TBP/TAM, the Model of PC Utilization, Innovation Diffusion Theory (IDT), and Social Cognitive Theory (SCT)" (Williams *et al.,* 2014). Oliveira *et al.* (2014) note UTAUT is regarded as the most well-known improvement of the popular TAM

Research has been conducted using UTAUT in the following countries: Australia, Belgium, China, India, Malaysia, Saudi Arabia, South Africa, Taiwan and USA among others (Williams *et al.,* 2014). UTAUT has been used to study user intention for a range of technologies and varying contexts which include Government Systems, Web sites and Mobile Technology among others (Venkatesh *et al.,* 2014).

In terms of agile usage, studies have selected constructs from UTAUT and used them. Hong *et al.* (2011) combined UTAUT with the IS continuance model to determine drivers

of user acceptance of agile IS. The study used the performance expectancy, effort expectancy, social influences, and facilitating conditions constructs from UTUAT. Vijayasarathy and Turk (2011) used the constructs of social influence, experience and facilitating conditions in particular training to study the use of agile processes and methods by software developers. The studies by Schatz and Abdelshafi (2005), Ceschi *et al.* (2005) and Nerur *et al.* (2005) also used the construct of facilitating conditions in particular training in their studies. The study by Chan and Thong, (2009) used Perceived usefulness (PU) and Perceived ease of use (PEOU) to derive an acceptance model. PU maps onto the UTAUT construct of Performance Expectancy and PEOU maps onto the UTAUT construct of Effort Expectancy (Dwivedi et *al.,* 2011). Senapathi *et al.* (2013) also proposed an agile usage model and used experience as one of the constructs of the model. Figure 4 shows the UTAUT model:

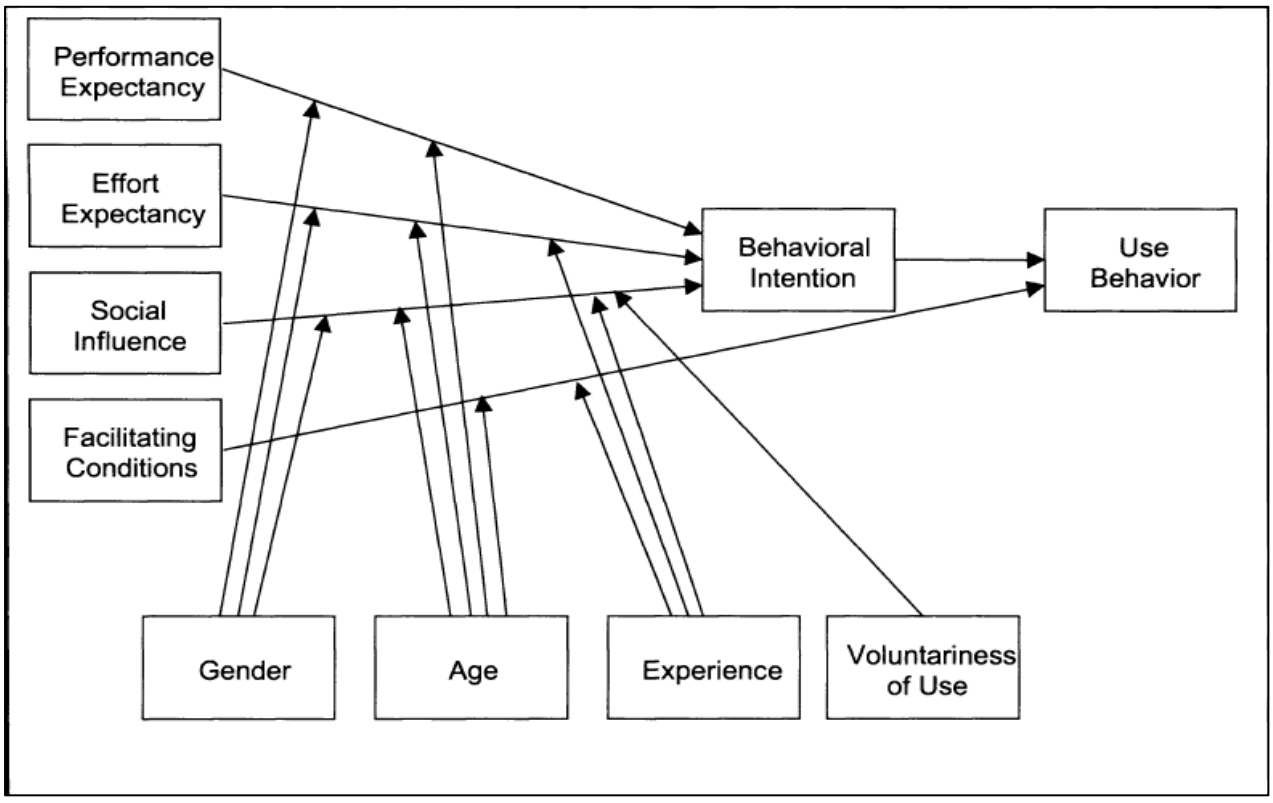


Figure 4: UTAUT by Venkatesh *et al.* (2003)

UTAUT identifies the following constructs: “performance expectancy, effort expectancy, social influence, facilitating conditions and behavioural intention” (Venkatesh *et al.,*

2016). UTAUT also has 4 moderators that are age, gender, experience, and voluntariness of use (Venkatesh *et al.,* 2016). UTAUT postulates that social influence, performance expectancy and effort expectancy are the three antecedents to behavioural intention to use a technology (Venkatesh *et al.,* 2016). The positive effect of these three antecedents on behavioural intention is moderated by age, gender, experience and voluntariness of use (Venkatesh *et al.,* 2003). Behavioural intention and facilitating conditions in turn determine technology use (Venkatesh *et al.,* 2003).

3.1.2 *The relevance of UTAUT to this study*

Since the study was on usage, UTAUT was selected because the model has been accurately used to explain the phenomena of usage (Venkatesh *et al.,* 2016). UTAUT has been found to provide a lens through which the factors that will affect usage can be tested (Williams *et al.,* 2014). UTAUT assists to understand factors that influence use of a new technology so that relevant features can be designed to enable acceptance and use of the new technology by the users (Dasgupta and Gupta, 2010). UTAUT is a useful tool to assess the probability of use of a new technology (Dasgupta and Gupta, 2010).

The context of the study is employees within the banking sector. UTAUT was selected because it was developed in the context of employee acceptance and use of technology in an organization (Venkatesh *et al.,* 2011). It was anticipated that usage of agile methodologies in some settings may be mandatory. UTAUT has explanatory power in contexts where usage is either voluntary or mandatory (Venkatesh *et al.,* 2003). The setting of the study was work related, UTAUT was found to be a fit because UTAUT is oriented for work related contexts (Im *et al.,* 2011). The study was conducted in the South African context, UTAUT has been found to explain usage behaviour across cultures and in different countries (Im *et al.,* 2011; Williams *et al.,* 2014).

3.1.3 *Comparison to TAM to UTAUT*

This section compares TAM to UTAUT and explains further why UTAUT was selected for this study.

There is a plethora of theories/models that can be used to explain user acceptance of technology (Dwivedi *et al.,* 2011). These models include TRA, TPB and TAM among others (Dwivedi *et al.,* 2011). Each of those models has been credited as having the ability to explain user acceptance of technology (Samaradiwakara and Gunawardena, 2014). However TAM and UTAUT stand out and have been widely used in Information Systems literature (Samaradiwakara and Gunawardena, 2014).

TAM was proposed by Davis in 1989. The model is made up of the following constructs, Perceived Usefulness, Perceived Ease of Use, Behavioural Intention to Use and Usage (Davis 1989). Perceived Usefulness (PU) is defined as “the degree to which a person believes that using a particular system would enhance his or her job performance” (Davis 1989:320). A system can be perceived as useful if it gives the user greater control over their work and improves their job performance (Davis, 1989). Perceived Ease of Use (PEOU) is defined as "the degree to which a person believes that using a particular system would be free of effort” (Davis 1989:320). A system can be perceived as easy to use if it does not confuse or frustrate the user (Davis, 1989). PU and PEOU determine Behavioural Intention to Use. Behavioural Intention to Use in turn determines Usage. Figure 5 below shows TAM.

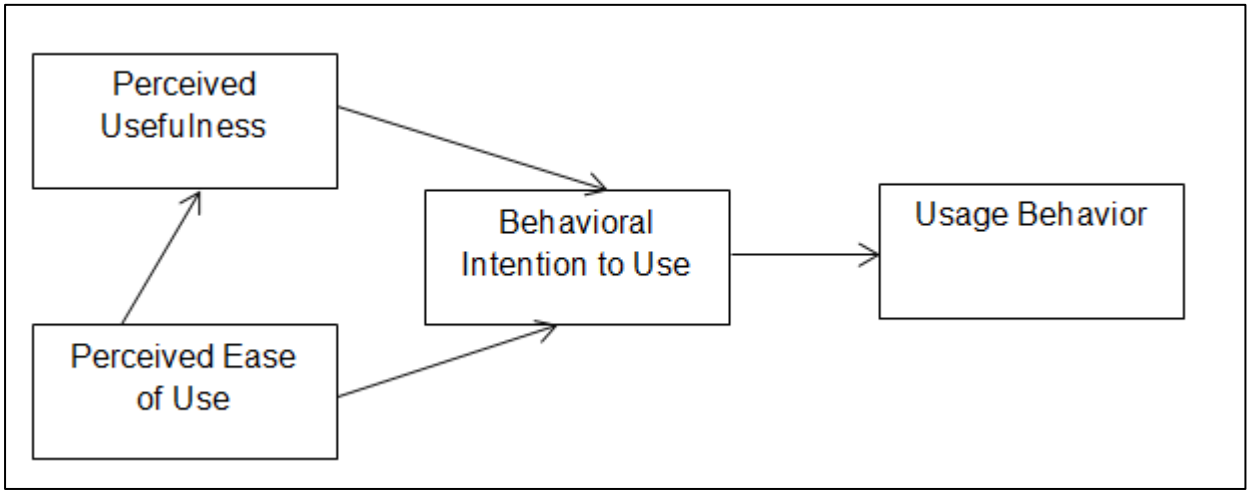


Figure 5: Technology Acceptance Model by Davis 1989

The construct of PU in TAM was extended and maps onto the construct of Performance Expectancy in UTAUT (Dwivedi *et al.,* 2011). The construct of PEOU was also was

extended and maps onto the construct of Effort Expectancy in UTAUT (Dwivedi *et al.,* 2011). Figure 4 in the previous section shows the remaining constructs from UTAUT.

TAM has been credited as a valid and robust model (King and He, 2006). TAM only has 3 constructs and is parsimonious (King and He, 2006). TAM however has been criticized for not taking into account the contextual factors (King and He, 2006). UTAUT was selected because it combines TAM and other adoption theories (Williams *et al.,* 2014). Combining TAM and other theories has given UTAUT higher explanatory power than any of its predecessors (Samaradiwakara and Gunawardena, 2014). Although UTAUT has more constructs, it has still been found to be parsimonious (Lai, 2017). UTAUT was also selected because it incorporates moderator variables (Samaradiwakara and Gunawardena, 2014). Moderator variables enhance the explanatory power of a model/theory and assist in explaining contextual variations (Samaradiwakara and Gunawardena, 2014).

3.2 Research Hypotheses

This section starts by discussing the hypotheses of the dependent variables in the study. The hypotheses of the independent variables are discussed next. The independent variables in the study are “performance expectancy, effort expectancy, social influence and facilitating conditions”.

3.2.1 *Use behaviour (U)*

UTAUT proposes two dependent variables, behavioural intention to use and use behaviour (Venkatesh *et al.,* 2003). The phenomenon of usage is important in assessing the success of the implementation of a systems development methodology (Iivari and Iivari, 2011). Usage is a behaviour (DeLone and McLean, 2003). In this study usage behaviour will be measured by the actual use of agile methodologies in one’s role on a regular basis, and also by the usage of agile methodologies more than any other software development methodology. Delone and McLean (2003) cite empirical studies where use continues to be used as a dependent variable in IS research. Understanding usage behaviour is therefore an area of concern in IS research (Chan and Thong, 2009).

It has been argued that where an intention to use a system exists, acceptance also exists (Holden & Karsh, 2009). Behavioural intention to use has been used to measure acceptance in other studies (Holden & Karsh, 2009). The goal of this study is to understand usage for the purposes of this study use behaviour will be the main dependent variable. Actual use behaviour follows behavioural intention (Venkatesh *et al.,* 2003). Behavioural intention leads to actual use behaviour (Ajzen, 1991). Behavioural intention is discussed next.

3.2.2 *Behavioural intention (BI)*

Behavioural intention is defined as "the degree to which a person has formulated conscious plans to perform or not to perform some specified future behaviour" (Warshaw and Davis, 1985:214). In the context of this study, behavioural intention will be defined as a conscious plan or decision to use agile methodologies in one's role.

Intention encapsulates how hard an individual tries to perform a behaviour or how much effort an individual exerts in order to perform a behaviour (Ajzen, 1991). The motivational drive to perform a behaviour for example system usage comes from an individual's internal evaluation of the behaviour (Ajzen, 1991). The internal evaluation results in the formation of a behavioural intention (Ajzen, 1991). If the evaluation is positive then the individual will perform the behaviour being evaluated. Ajzen (1991) also notes that the stronger an intention is to engage in a particular behaviour then the more likely to perform the behaviour. Behavioural intention precedes actual use (Ajzen, 1991). Behavioural intention has been empirically demonstrated to be an important causal predictor of system use (Venkatesh *et al.*, 2003; Venkatesh, 2012). Therefore the study proposes that:

H1: Behavioural intention to use agile methodologies will have a positive effect on use behaviour.

3.2.3 *Performance Expectancy (PE)*

Performance Expectancy is "the degree to which an individual believes that using the system will help him or her to attain gains in job performance" (Venkatesh *et al.,* 2003:447). The performance expectancy construct extends the perceived usefulness construct from TAM (Dwivedi *et al.,* 2011). In this study Performance expectancy will be specifically concerned with the extent to which an individual believes that using agile methodologies will be useful in their role and will aid job performance. If there is a possibility of realising gains from using agile methodologies then IT personnel are most likely going to use agile methodologies.

Perceived usefulness has been found to determine the usage of agile methodologies (Salo and Abrahamsson, 2008). Salo and Abrahamsson (2008) found that agile practises contributed to the perceptions of usefulness. As an example, the practise of a Daily Stand from the Scrum methodology has been found to be useful (Dyba˚ and Dingsøyr, 2008; Vallon *et al.,* 2017). Prior UTAUT methodological studies have found that Performance expectancy is the strongest and significant predictor of intention to use technology (Venkatesh *et al.,* 2003). The study by Oliveira *et al.* (2014) in the context of mobile banking usage also found that the most important factor in acceptance of mobile banking is performance expectancy. The findings have been consistent in both voluntary and mandatory settings (Venkatesh *et al.,* 2003). The study therefore proposes that:

H2: Performance expectancy will positively influence behavioural intention to use agile methodologies.

3.2.4 *Effort expectancy (EE)*

Effort Expectancy is defined as "the degree of ease associated with the use of the system" (Venkatesh *et al.,* 2003:450). The Effort expectancy construct extends the perceived ease of use construct from TAM (Dwivedi *et al.,* 2011). In the context of this study effort expectancy is also defined as the ease associated with understanding and using agile methodologies in developing and maintaining information systems. If agile methods have lower effort expectancy then the intention to use them will increase.

When users have limited experience with an information system, if the system is easy to use then there will be greater intention to use the system since learning to use the system will require less effort (Hong *et al.,* 2011). Prior studies have found that effort expectancy affect a user's behavioural intention (Venkatesh *et al.,* 2003; Gupta *et al.,* 2008; Schaupp *et al.,* 2010; Hong *et al.,* 2011). Venkatesh *et al.* (2003) further note that in both voluntary and mandatory usage settings effort expectancy significantly affects behavioural intention (Venkatesh *et al.,* 2003). The study therefore proposes that:

H3: Effort expectancy will positively influence behavioural intention to use agile methodologies.

3.2.5 *Social Influence (SI)*

Social Influence is defined as "the degree to which an individual perceives that important others believe he or she should use the new system" (Venkatesh *et al.,* 2003:451). In the current context Social Influence will be defined as "the extent to which an individual perceives that important others believe they should use agile methodologies". Hong *et al.* (2011) note that other people's opinion can play a significant role in affecting one's intention to perform a certain behaviour.

Individual behaviour is influenced by the way peers and significant others value the use of a technology (Oliveira *et al.,* 2014). When users first decide to use an Information System, they take other people's opinions into consideration (Hong *et al.,* 2011). If using an information system is considered a social norm then the user will use the information system. Social norms have been found to influence usage of agile methodologies (Vijayasarathy and Turk, 2012). Prior studies have also found that Social Influence affects user's behavioural intention (Gupta *et al.,* 2008; Lian and Yen, 2014). Hence this study proposes that:

H4: Social Influence will have a positive effect on behavioural intention to use agile methodologies.

3.2.6 *Facilitating conditions (FC)*

Facilitating conditions are “the degree to which an individual believes that organizational and technical infrastructure exists to support use of the system” (Venkatesh *et al.,* 2003:453). Facilitating conditions are not only localised or contextual but include all conditions that an individual needs to use the new technology (Workman, 2014). Similar to the definition by Venkatesh *et al.* (2003) in the context of this study, facilitating conditions will refer to “the degree to which an individual believes that organizational and technical infrastructure exists to support the use of agile methodologies”. With organizational and technical support, users may expect fewer obstacles in using agile methodologies and will therefore be willing to use agile methodologies (Hong *et al.,* 2011). Support also reduces the effort on users making them more willing to use the information system (Hong *et al.,* 2011). The studies by Vijayasarathy and Turk (2012) and Asnawi *et al.* 2011 found that organizational support such as training plays a significant role in usage of agile methodologies.

In another study, Gandomani *et al.* (2014) found that organizational support such as coaching and mentoring assisted in embedding Agile practices. Management buy in and leadership support were also found to influence usage of agile methodologies (Cockburn and Highsmith, 2001). The usage of agile Information systems by Hong *et al.* (2011) confirms the significant effect of facilitating conditions on use. Gupta *et al.* (2008) and Schaupp *et al.* (2010) also confirm the effect of facilitating conditions on use. Therefore the study proposes that:

H5: Facilitating conditions will have a positive effect on use behaviour.

3.3 Moderators

The section discusses the moderators of UTAUT. Moderating variables affect the relationship between the independent and dependent variables (Venkatesh *et al.,* 2003). UTAUT proposes moderating variables of gender, age, experience and voluntariness of use (Venkatesh *et al.,* 2003). In this study no separate hypotheses were created for the moderators. At the time of writing, there was limited literature found for moderation in the

context of agile methodologies. There was however literature found from behavioural studies that was enough to explore the moderating factors. The study therefore explored the effect of the moderators on the existing hypotheses. The sections that follow discuss each moderator variable.

3.3.1 *Gender*

The moderating effect of gender will be explored on performance expectancy, effort expectancy and social influence with their relationship to behavioural intention (Venkatesh *et al.,* 2003). The principles of agile methodologies have been found to match how women work (Martin, 2011). Russo (2015) compared the agile principles to female work characteristics from various behavioural studies. The comparison shows that agile methodologies fit the work characteristics required to make an environment where women feel that they can make a greater contribution (Russo, 2015). In other words it is expected that women will have higher performance expectancy of agile methods compared to men.

The agile methodologies and principles have also been found also to fit in with women's management style (Weilemann and Brune, 2015). Women's management style is based on communication, collaboration and building relationships, which are also core principles of Agile (Weilemann and Brune, 2015). The female management style also perfectly matches the role of a Scrum master by promoting team spirit, communication and a constructive working atmosphere (Weilemann and Brune, 2015). The implication of women's management style is that when women use agile methodologies they will require less effort expectancy.

In other studies Venkatesh *et al.* (2012) found that men rely less on facilitating conditions than women when deciding to use a new technology. Women were found to rely on external supporting factors (Venkatesh *et al.,* 2012). Men were found to be more willing to overcome constraints to using a new technology compared to women who focused on the effort required and use a new system (Venkatesh *et al.,* 2012). Venkatesh *et al.* (2012) also found that older women rely more on facilitating conditions compared to older men.

In the IT industry there are fewer women than men (Rosenbloom *et al.,* 2008; Devlin and Hern, 2017). The few women that are employed face additional barriers compared to men in conducting their work daily (Devlin and Hern, 2017). Women are sometimes subjected to stereotypes (Rosenbloom *et al.,* 2008). Eventually women have been found to exit the IT industry more than men (Devlin and Hern, 2017). Due to these disparities it is expected that there will be moderation by gender.

3.3.2 *Age*

Venkatesh *et al. (*2003) propose that age moderates performance expectancy, effort expectancy, social influence and facilitating conditions in their relationship with behavioural intention to use a technology (Venkatesh *et al.,* 2003). At the time of writing there was limited literature of age as a moderator in the context of agile methodologies. The study drew insight from cognition studies and explored this relationship.

Cognition studies have shown that older people tend to face challenges in processing new or complex information (Morris *et al.,* 2005). The challenge is attributed to the aging process which results in a decline of cognitive abilities (Morris *et al.,* 2005). It is expected that older people have increased effort expectancy when given a new methodology. To overcome these difficulties older people place emphasis on facilitating conditions (Venkatesh *et al.,* 2012).

3.3.3 *Experience*

As per UTAUT, the moderating effect of experience on facilitating conditions, social influence and effort expectancy was explored (Venkatesh *et al.,* 2012). At the time of writing there was limited literature about the effect of experience as moderator on agile methodologies. The discussion however was informed by behavioural studies.

In behavioural studies, Bandura (1977) as cited by Workman (2014) notes that previous experiences affect how people perceive and assess a future experience given a similar situation. If a person had a negative experience with a computer technology in the past, a new technology could be viewed with negativity (Workman, 2014). Experience has

been found to be a consistent and strong moderator of intentions and behaviours (Bandura, 1977 as cited by Workman, 2014).

Continued experience can lead to better understanding of the new technology thereby reducing user dependence on external support (Venkatesh *et al.,* 2012). Users with less experience will depend more on facilitating conditions (Venkatesh *et al.,* 2012). In this regards experience moderates the relationship between facilitating conditions and behavioural intention (Venkatesh *et al.,* 2012). Increasing experience with a target system reduces uncertainty associated with the system and increases an individual's sense of control over the system (Venkatesh *et al.,* 2003).

Moderation by age is also expected in the IT industry. The young and less experienced IT personnel will most likely have more exposure to agile methodologies than to traditional software methodologies. The older and more experienced IT personnel will most likely have more exposure to traditional software methodologies, especially if they have built and supported Legacy systems. Exposing these two different groups of IT personnel to agile methodologies should yield moderation based on experience and age.

3.3.4 *Voluntariness of use*

Voluntariness of use is defined as "the degree to which use of an innovation is perceived as being voluntary or of free will" (Moore and Benbasat, 1991:195). Voluntariness of use has been found to be a moderator of social influence and behavioural intention (Venkatesh *et al.,* 2003).

Voluntariness of use affects an individual's opinion on an innovation (Moore and Benbasat, 1991). In this study it is anticipated that the usage of agile will be mandatory. This is because agile methodology initiatives are being introduced organization wide and from top management. However there could be instances where depending on the department, users may have the option not to use agile. To cover both instances, voluntariness of use will be assessed in the survey, to determine whether it is mandatory or optional to use agile methodologies.

3.4 Conclusion

The chapter presented the theoretical lens of the study. The chapter discussed the origins and usage of UTAUT. A motivation of the use of UTAUT was presented. The hypotheses were formulated. The chapter ends by discussing moderators that will be explored. Figure 6 shows a summary of the research hypotheses of the study. The moderating effects that will be explored are shown by the dotted lines:

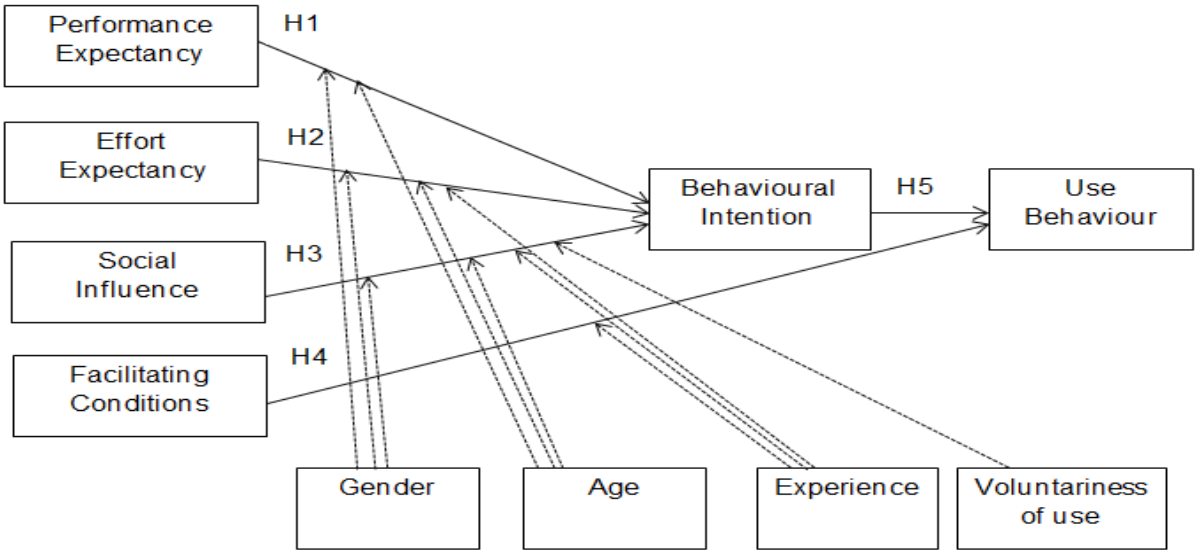


Figure 6: Summary of research hypotheses

Table 2 below states the hypotheses:

Number	Hypothesis Statement
H1	Behavioral intention to use agile methodologies will have a positive effect on use behaviour.
H2	Performance expectancy will positively influence behavioural intention to use agile methodologies.
H3	Effort expectancy will positively influence behavioural intention to use agile methodologies.
H4	Social influence will have a positive effect on behavioural intention to use agile methodologies.
H5	Facilitating conditions will have a positive effect on use behaviour.

Table 2 : Summary of Hypotheses

4 CHAPTER 4: RESEARCH METHODOLOGY

This chapter describes the research method that was used to meet the objectives of the study. The chapter also presents the research paradigm that informed the study and the research design that was adopted for the study. The chapter also describes the procedures used for data collection, how the research instrument was developed, how the research instrument was administered and the selection of the research sample. The chapter ends by discussing the limitations and some ethical considerations for the data collection procedure.

4.1 Research Paradigm

A research paradigm consists of fundamental assumptions and beliefs of how a researcher views the world and is expressed in the research process (Jonker and Pennink, 2010). Two main paradigms can be identified in existing information systems research, these are the interpretivist paradigm and the positivist paradigms (Orlikowski and Baroudi, 1991). The purpose of interpretivist paradigm is to create new and deeper understanding of social contexts (Saunders *et al.,* 2016). In the interpretivist paradigm, the researcher uses data to try and build a theory (Bhattacherjee, 2012). Interpretivist studies explore phenomena of interest directly in its natural setting (Saunders *et al.,* 2016).

The positivist paradigm is used for theory or hypotheses testing rather than theory building (Trauth and Jessup, 2000). The study lends itself to the positivist paradigm because the study tests UTAUT in explaining the factors that influence usage of agile methodologies. The hypotheses discussed in Section 3.2 were tested for their relevance in explaining usage of agile methodologies. Positivist studies posit that facts can be verified through empirical observations using structured instrumentation (Orlikowski and Baroudi, 1991). The study is also positivist as it used an adaptation of the instrumentation that was used in the formulation of UTAUT.

Positivist studies use highly structured methodologies that can be replicated (Saunders *et al.,* 2016). The replication of a study's methodology results in the positivist paradigm producing law-like generalisations (Saunders *et al.,* 2016). Taylor and Medina (2013) note that the positivist paradigm is used to investigate and predict law-like patterns of behaviour of a phenomenon. In the current study the positivist paradigm was used to investigate, confirm and predict usage behaviour of IT personnel.

The study is informed by the positivist paradigm because of the selected model, UTAUT. UTAUT is a theory from the positivist domain, and is used in positivist studies (Mandal and McQueen, 2012). The relationships presented Section 3.2 were tested with data collected from IT personnel within the Banking sector. Testing known concepts from theory using new data is deductive research (Bhattacherjee, 2012). The research took a deductive approach. The study used quantitative data. Quantitative data is used to measure statistically significant relationships between the independent variables and the predictor variables. The positivist paradigm uses quantitative data (Taylor and Medina, 2013).

The Positivist paradigm has been used in agile methodology studies. A study by Vijayasarathy and Turk (2012) utilised principles from the Positivist paradigm. In their study, Vijayasarathy and Turk (2012) conducted an online survey with 98 participants to determine drivers of agile methodology use. Vijayasarathy and Turk (2012) used the Partial list Squares technique to analyse the hypotheses and determine statistically significant relationships.

Hong *et al.,* 2011 conducted an empirical study on UTAUT and agile methodologies. In their study, Hong *et al.,* 2011 conducted an online survey with 494 participants to test UTAUT in user acceptance of agile methodologies. Hong *et al.,* 2011 used quantitative techniques to test statistically significant relationships proposed in their hypotheses. Their findings confirmed the effect of facilitating conditions on usage of agile methodologies.

Cross-sectional surveys have also been used to study agile methodologies and UTAUT. Lambert (2011) conducted an empirical study to test the relationship between using agile

methodologies and improved project delivery. A survey was sent to 278 participants. The data was statistically analysed and confirmed the relationships proposed in UTAUT, and that there was a relationship between agile usage and improved delivery time.

4.2 Research Design

This section presents the research design used of the study. The research design is a strategy and plan of how the research will be executed (Vogt *et al.,* 2012). The research design should specify the process used to develop the instrument and the sampling procedure (Bhattacherjee, 2012). The research design also specifies the plan for the collection and analysis of the data to answer the research questions and to meet the objectives of the research (Saunders *et al.,* 2016).

The research design is designed based on objective of the study (Babbie and Mouton, 2001). A research can have the objective to explore a phenomenon (exploratory research), explain a phenomenon (explanatory research) or describe a phenomenon (descriptive research) (Neuman, 2013). Exploratory research is conducted when a phenomenon is new and there is need to understand the basic facts about the phenomenon (Neuman, 2013). Explanatory research is used when a phenomenon is understood and tries to identify the reason a phenomena occurs (Saunders *et al.,* 2016). Explanatory research looks for causes and reasons of the occurrence of a phenomenon (Saunders *et al.,* 2016).

When the basic facts of the phenomenon are understood and there is need to describe the phenomenon in detail and in its social setting, descriptive research is implored (Neuman, 2013). Relational research takes the descriptive research a step further, by identifying and describing the relationship of variables found in a descriptive research (Monacelli and Bendazzoli, 2016). A relational study also known as a correlational study was used to answer the research questions in this study.

The study is relational because it sought to identify and describe the relationship of the variables that influence usage of agile methodologies. The study as expressed in the

hypothesis also sought to observe the direction and strength of relationships among variables (Shadish *et al.,* 2002). Relational studies use correlational statistics to determine whether the value of one variable increases or decreases when that of the other increases or decreases (Monacelli and Bendazzoli, 2016). The correlational statistics that were used in the study will be discussed in Section 4.6.

The study made use of a survey to measure the variables influencing usage of agile methodologies. The survey was presented online; a copy of the survey can be viewed in Appendix B, along with a cover letter explaining the purpose of the survey. Surveys have been found to be useful when the unit of analysis is the individual (Bhattacherjee, 2012). A survey was also selected because surveys are excellent when measuring unobservable data such as attitudes and behaviours (Bhattacherjee, 2012).

A survey was also used because it produces quantitative descriptions of the population under study which can be used to test theory (Gail and Benichou, 2000). A survey can be administered as longitudinal or cross-sectional (Saunders *et al.,* 2016). In a longitudinal study, the survey is administered at several points studying the change in the behaviour of the phenomenon under study (Saunders *et al.,* 2016). A cross-sectional survey is administered at a specific particular time (Bhattacherjee, 2012). A cross-sectional survey allows for the measurement of the dependent and independent variables at the same time (Bhattacherjee, 2012).

A cross-sectional survey is used to generate data for testing relationships among several constructs (Fuchs and Diamantopoulos, 2009). A cross-sectional survey was used because it allows for the determination of the association between the dependent variable and some independent variables (Gail and Benichou, 2000). The cross-sectional survey enables measurement of the dependent and independent variables at the same time (Bhattacherjee, 2012). In this study the main dependent variable was usage behaviour. The independent variables were: performance expectancy, effort expectancy, social influence and facilitating conditions. A cross-sectional survey was also used because of the limited time that was allocated to completing the data collection exercise.

4.3 Research Instrument

This section discusses how the research instrument was constructed and operationalized. The section also discusses how the pre-testing of the instrument was done. The pre-testing discussion also explains how the research instrument catered for content validity, construct validity and face validity. The section ends by discussing how the pilot test was conducted.

4.3.1 Operationalization and Instrument Construction

The constructs in the study were operationalized using multi-item scales. A seven-point Likert scale was used for every item, ranging from strongly disagree (1) to strongly agree (7). Likert scales measure how closely respondents agree or disagree with a statement (Fink, 2015). A seven-point Likert scale was used because it allows for the collection of detailed granular responses since the constructs being measured were intangible (Azzara, 2010).

The items for each construct were adapted from research instruments that have been used to measure these constructs in prior research found in the Literature review (Bhattacherjee, 2012). Adapting research items ensures Content validity, since the items would have been previously tested and assessed to ensure that the items accurately represent the attitudes they are intend to measure (Fink, 2015). Construct validity examines “how well a given measurement scale is in measuring the theoretical construct that it is expected to measure” (Bhattacherjee, 2012:37). Construct validity is improved when using adapted research items (Fink, 2015). In this study the research instrument was designed from items tested in existing literature by Venkatesh *et al.* (2003), Venkatesh and Bala (2008), Venkatesh *et al.* (2012) and Gerhart *et al.* (2015).

Table 3 shows the operationalisation of the items:

Construct	Operationalization	Measurement items
Performance Expectancy (PE)	3 items adapted from Venkatesh *et al.* (2003) 1 item adapted from Venkatesh and Bala (2008)	(PE1) Using agile methodologies is useful in my role. (PE2) Using agile methodologies enables me to accomplish tasks more quickly. (PE3) Using agile methodologies increases my productivity. (PE4) Using agile Methodologies enhances my effectiveness on the job.
Effort Expectancy (EE)	3 items adapted from Venkatesh *et al.* (2003) 1 item adapted from Venkatesh *et al.* (2012)	(EE1) I find it easy to use agile methodologies. (EE2) I clearly understand agile methodologies. (EE3) It would be easy for me to become an expert in using agile methodologies. (EE4) Learning to use agile methodologies is easy for me.
Social Influence (SI)	4 items adapted from Venkatesh *et al.* (2003)	(SI1) The Leadership and Management of my firm have been helpful in the use of agile methodologies. (SI2) People who influence me think that I should use agile methodologies. (SI3) My colleagues think that I should use agile methodologies. (SI4) In general, the organization has

Construct	Operationalization	Measurement items
		supported the use of agile methodologies.
Facilitating Conditions (FC)	3 items adapted from Venkatesh *et al.* (2003)	(FC1) I have all the resources I need to use agile methodologies. (FC2) I have the knowledge necessary to use agile methodologies. (FC3) A specific person (or group of people) is available to assist me with agile methodology related queries.
Behavioural Intention to use (BI)	3 items adapted from Venkatesh *et al.* (2003)	(BI1) I use agile methodologies given the opportunity. (BI2) I predict I would use agile methodologies, given the opportunity. (BI3) I plan to use agile methodologies given the opportunity.
Actual Use (U)	1 item Venkatesh *et al.* (2003) 2 items adapted from Gerhart *et al.* (2015)	(U1) I predict I will use agile methodologies on a regular basis in the future. (U2) I prefer to use agile methodologies than other methodology. (U3) I currently use agile methodologies more than any other methodology.

Table 3: Operationalization of constructs

4.3.2 Demographic Items

In addition to the constructs described in the previous section, items to measure the demographic characteristics were also included in the survey. Demographic characteristics pertain to the respondent's marital status, education, income, age, gender, occupation among other characteristics (Moser and Kalton, 2017). In this study the following demographic data was collected: gender, age, voluntariness of agile use experience, role and sector. The demographic data was used to check for differences in usage behaviour through moderation on the hypothesis presented in Chapter 3. Appendix A shows the list of all the demographic items that were collected.

Gender was collected with the options "Male", "Female", "Prefer not to say". Age was presented with a continuous variable using the following intervals 18 - 23 , 24 - 29, 30 - 35, 36 - 41, 42 - 47, 48 - 53, 54 years and older, Prefer not to say. Work experience using agile methodologies and general work experience in the IT sector was differentiated from each other. However both types of experiences were collected as continuous values using the following intervals: "None, 1 to 3 years, 4 to 6 years, 7 to 9 years, 10 to 12 years, 13 to 15 years and More than 15 years". The IT personnel role was collected using the following values: "Business Analysis", "Software Development", "Testing and Quality Assurance", "Programme and Project Management", "Architecture", "IT Support" and "IT Executive Leadership and Management".

The agile methodologies used by the respondents were also collected using the following values: "Scrum", "Kanban", "Extreme Programming", "Crystal", "Feature Driven Development", "Lean Software Development" and "Other" to specify any other agile methodologies. The sector was measured using the following values: "Automotive and Transportation", "Banking, Finance and Insurance", "Mining, Energy, Oil and Gas", "Food, Beverage and Manufacturing", "Public Services, Government, Healthcare and Education", "Real Estate, Retail and E commerce", "Telecommunications", "Research and Development, Products" and "Other" to specify any other industries. Voluntariness of agile usage was collected using the values "Voluntary", "Compulsory" and Not sure.

4.3.3 Pre-testing

Pretesting is the review of the survey questionnaire instrument by evaluators who are experts in the research topic or by members of the target audience (Wildemuth, 2009). For this study three academics were approached for the pre-test. The academics were selected because of their experience in the research domain. The academics were asked to review the survey and to ensure that the questions were not ambiguous, unclear and biased in wording (Wildemuth, 2009).

Suggested changes were to rephrase and adapt the statements for Behavioural intention to Use so that they were clearer. Rephrasing the statements ensured that there was face validity in the study. Face validity is concerned with whether the survey items are meaningful to the respondents and relevant in their context (Holden, 2010). A new demographic item was added to differentiate general work experience in the IT sector from work experience using agile methodologies. There was also a change to increase the categories used to collect work experience for agile methodologies as the methodology has now been around for more than 15 years. The initial categories were not broad enough.

The academics also suggested addition of a measurement item to each of the following constructs: Performance Expectancy, Effort Expectancy and Actual Use. The additional items were suggested to enhance the coverage of each construct. All items including the additional items were adapted from existing literature. The adding of additional measurement items ensured that the study has content validity. Content validity examines if a collection of items adequately represents the construct that it is trying to measure (Bhattacherjee, 2012).

4.3.4 Pilot testing

The pilot survey is a small scale test of the survey including all activities that will go into the final survey (Smith and Albaum, 2005). Pilot testing helps detect potential problems in the research design (Bhattacherjee, 2012). In this study the pilot test was done after the pre-testing. The pilot test was done using a sample of five respondents from Bank X

identified using convenience sampling. The respondents were selected because they mirror the composition of the main survey and are currently using agile methodologies. From the pilot there were no suggestions to change the content. The only suggested change was on the consent screen, where the participants suggested reducing the estimated time to complete the survey. Initially the survey was estimated to take 15 to 20 minutes, however all five respondents completed the survey in an average time of 10 minutes.

4.4 Sampling, Respondents and Sample Size

Sampling is a process of choosing representative subjects out of a population (Bhattacherjee, 2012). The full set of subjects from which a sample is taken is called a population (Saunders *et al.,* 2016). Sampling is used when it is unrealistic to measure all the subjects within the population due to budget and time constraints (Saunders *et al.,* 2016). The population consisted of IT personnel within the Banking sector using agile methodologies. The population also consisted of IT personnel within the banking sector affiliated with a particular institution of IT professionals using agile methodologies. IT personnel with roles with the following functions were also surveyed: Business Analysis, Software Development, IT Executive Leadership and Management; Testing and Quality Assurance, Programme and Project and Management, Architecture and IT Support.

For this study only a sample of IT personnel in the banking sector were surveyed due to time constraints. Although a sample was used, a sample can be used to make generalizations about the entire population (Bhattacherjee, 2012). Using a sample can have a higher accuracy than using the entire population because detailed information can be obtained from the sample than from the population (Saunders *et al.,* 2016).

Sampling techniques can be divided into probability and non-probability sampling. For non-probability sampling the chances of a case being selected from the population are unknown (Saunders *et al.,* 2016). Non-probability sampling relies on the subjective judgement of the researcher to select a suitable sample (Saunders *et al.,* 2016). In

probability sampling the chances of a case being selected or excluded from the population are equal (Rubin and Babbie, 2016).

For this study probability sampling was used. Examples of Probability sampling are simple random sampling, cluster sampling, systematic sampling, multi-stage sampling (Bhattacherjee, 2012). For this study cluster sampling and simple random sampling were used. The sample was obtained from IT personnel from Bank X and Bank Y and from an institution of IT personnel.

At Bank X organizational wide initiatives had been implemented to introduce agile methodologies. However the department that fulfils the core of the banks activities and has representation of all IT personnel is the Payments IT department. Not all departments that use agile methodologies have IT personnel in their teams. The department had 317 members who belonged to 10 teams. The sampling frame for the study therefore consisted of 317 individuals who were listed on team's mailing list. Cluster sampling was selected because the Payments IT team is disbursed and located in Johannesburg Central, Randburg and Capetown. Each team per region consisted of a cluster of the various roles of IT personnel. The teams were number from 0 to 9, and every second team was selected. Members within the selected team were part of the sample.

Similar to Bank X, at Bank Y initiatives had also been done to introduce agile methodologies. At Bank Y the population consisted of the DevOps team that is responsible for developing and supporting applications within each group cluster across that bank. The Gatekeeper granted access to the entire DevOps team. The entire DevOps was part of the sample.

The simple random sampling technique was used to select respondents from the professional institution of IT personnel. The institute had 583 LinkedIn members. The sampling frame therefore consisted of 583 members. The Microsoft Excel random function was used to generate 554 random numbers between 1 and 583. 554 random numbers were selected as they represent 95% certainty that the sample can be

generalised to the population. Members represented by the random numbers were included in the sample.

4.5 Data Collection - Questionnaire administration

The main modes of survey administration are face to face, mailed, telephone and web surveys (Cowles and Nelson, 2015). For this study the survey was administered on the web using SurveyMonkey. An email with the link to the survey was sent to the respondents. The web mode was selected because this is the method used in the banks under study to communicate and conduct surveys. There was therefore no learning required to complete the survey. The population under study was also geographically disbursed which is suited for web administered surveys (Cowles and Nelson, 2015).

The web survey was self-administered and completed at a pace and time suitable to the respondents. Self-administered surveys are relatively cheaper and less time consuming in comparison to other modes as face to face administered surveys (Vogt *et al.,* 2012). The mode was also selected because it enables access to a larger sample of respondents. Self-administered surveys are however not ideal if the respondents require clarity on the questions (Vogt *et al.,* 2012). In this study the pre-test and pilot were done to ensure that the questions were clear and not ambiguous.

The first page of the link on SurveyMonkey contained the Participant Consent screen. The Participant Consent screen contained a letter that gave details about the study and the nature of the survey. The participants were also informed that participation was voluntary. A copy of the Participant Consent screen can be found in Appendix B.

4.6 Data Analysis

The data collected from SurveyMonkey was extracted into Microsoft Excel in preparation for analysis. The data was then imported into the Statistical Package for the Social Science (SPSS) for analysis. In SPSS the data was cleaned. Missing values were replaced to ensure that complete data was analysed. Outliers were detected and where

necessary they were removed. Thereafter descriptive statistics of the respondent's demographic data was produced.

The data was then tested for validity and reliability to ensure adequate and accurate measurement of the constructs. Reliability was measured using the Cronbach Alpha for internal consistency. The Principal Component Analysis was used to measure convergent validity, discriminant validity and unidimensionality. The remaining items after the Principal Component Analysis was done were reduced to single composite scores for the purpose of hypotheses testing. Skewness and kurtosis were checked on the composite scores.

Before the hypothesis could be tested, the assumptions of multiple regression analysis were tested. The following assumptions were tested: multicollinearity, normality and linearity and homoscedasticity. After the tests were completed, the hypothesis was then tested using multiple regression analysis. A combination of multiple regression analysis and the Simple Slope analysis were used to explore the moderating effects of gender, age, IT experience, agile experience and voluntariness of use.

The following steps were followed to test the moderating variables:

Step 1: Creation of centred variables

Centred variables were created by standardising values for each variable. The centred variables that were created were for all Composite variables and Moderating variables.

Step 2: Compute Interaction terms

Interaction terms were computed by multiplying each Independent variable in Step 1 with a Moderator variable from Step 1 based on the hypothesis. Appendix I defines how each Interaction term variable was created.

Step 3: Multiple regression analysis

Multiple regression analysis was done on each dependent variable, centred independent variable (created in Step 1), centred moderator variable (created in Step 1) and the

interaction term (created in Step 2). A discussion based on the multiple regression analysis results was also done.

Step 4: Creation of Interaction Diagram in Microsoft Excel

Using the unstandardized coefficients from the multiple regression analysis, interaction plots were plotted for each test. The Interaction plots showed low and high values of the Independent variables, low and high values of the moderator variable or categories of the moderator variable and the dependent variable. A discussion was done based on the gradient and pattern of the lines in the Interaction diagram.

Step 5: Creating of Interaction Plots using varying Standard Deviations

This additional step was added, where an additional interaction plot was created for each test. This interaction plot, plotted the effect of moderator variable on 1 Standard Deviation, the mean and -1 Standard Deviation. The effect of varying the Standard Deviation was discussed for each plot.

4.7 Limitations of the study

The aim of the study was to survey IT personnel in the banking sector. Permission was not granted by all the banking institutions with IT personnel. The study was therefore limited to only two banks and IT personnel in the banking sector affiliated with a particular IT professional institution. Accessing more respondents from other banks would have improved the generalisability of the results.

The survey notification was sent using email, which results in sample bias where only IT personnel who frequently check their email would be part of the respondents. To mitigate sample bias, the respondents were informed about the study in advance and informed to expect the survey email. Gatekeepers also sent email reminders to the participants. Linked to sample biases the survey was prone to coverage errors. Coverage error occurs when the sample does not include the relevant characteristics of the population (King and He, 2005). In this study to ensure the correct sample of IT personnel within the

banking sector, the respondents had to complete demographic questions about their role, number of years spent in the IT sector and number of years spent using agile. It was still possible that respondents could complete incorrect information.

The survey was also prone to social desirability bias. Social desirability bias is as a result of respondents not telling the whole truth but responding with responses that are expected of the norm and are socially desirable (Bhattacherjee, 2012). It is anticipated that since the survey was anonymous the respondents would have responded truthfully. Also linked to social desirability, the survey was also subject to prestige bias. Prestige bias results from wording in the questionnaire that connects a particular response with a prestigious person or when a response is attached to the name of a prestigious person (De Vaus, 2013). The responses will be influenced by the association to the prestigious person (De Vaus, 2013). To mitigate against prestige bias especially in the Social Influence Construct items, generic labels for people were used. The pre testing and pilot of the survey also reviewed the Social Influence Construct items.

The study was also prone to non-response bias. Non-response bias is as a result of the respondents refusing to participate in the study, or for respondents to answer questions differently from those who do not respond to the survey (De Vaus, 2013). Non-response bias results in the results not being generalizable to the population (Bhattacherjee, 2012). To mitigate non-response bias, the respondents were informed about the study prior to the survey being sent out. The confidentiality and anonymity of the survey was reiterated also to mitigate non-response bias. Non-response bias can also be as a result of the survey using unfamiliar terms that are not used within the context of the respondents (Moser and Kalton, 2017). To mitigate against this source of non-response bias a pre-test and a pilot test of the survey was conducted.

In a cross-sectional survey, the dependent and independent variable are measured once and at the same time (Bhattacherjee, 2012). This makes it difficult to clearly observe and separate the cause from the effect (Saunders *et al.,* 2016). Causation can therefore not be established with cross-sectional surveys (Saunders *et al.,* 2016). The usage patterns can also not be established with a cross-sectional survey as the data is collected once.

The structured questionnaire used from the positivist domain limits the study. The study does not allow the participants to elaborate on their perceptions, which enables a deeper understanding of the phenomenon under study.

4.8 Validity and Reliability

The section discusses the validity and the reliability of the study. The section starts by discussing internal validity, followed by external validity. The section ends by discussing reliability. Content validity, construct validity and face validity were discussed with pre-testing in Section 4.3.3.

4.8.1 Internal Validity

Internal validity is established when a study demonstrates a causal relationship between the independent and dependent variables (Saunders *et al.,* 2016). The change in the dependent variable will be caused by the change in the independent variable and not other external factors (Bhattacherjee, 2012). In this study the internal validity were low because the dependent variables and independent variables were measured at the same time. The study did not show temporal precedence, where the cause should have preceded the effect.

The internal validity of the study was affected by past events (Saunders *et al.,* 2016). In this study the respondents had been exposed to agile methodologies and had different experiences using them. The observed effect of the dependent variable usage, may have been caused by some historical events and experiences that may have not been measured by the current independent variables.

4.8.2 External Validity

External validity is concerned with whether the results can be generalized to the population (Salkind, 2010). External validity is important in determining the usefulness of survey results (King and He, 2005). Non response biases influence external validity (King

and He, 2005). Survey research often has low response rates which results in non-response bias (Bhattacherjee, 2012). As discussed in Section 4.7 mitigation steps were taken to reduce non response bias by informing the respondents about the study prior to sending out the survey, ensuring confidentiality and anonymity and using familiar terms used in the context of the respondents. The findings of this study can therefore be generalised to other IT personnel within the banking sector.

4.8.3 Reliability

Reliability is the extent to which a measure will yield consistent findings at different times and under different conditions (Saunders *et al.,* 2016). Reliability in the study was measured using internal consistency. Internal consistency was selected because it is the most accurate and widely used approach for determining reliability (Frank-Stromborg and Olsen, 2004). Internal consistency in the study will be measured by Cronbach's alpha. The study also utilised a questionnaire constructed from previous literature where the reliability of the items had been tested

4.9 Ethical Considerations

Ethics refer to standards of behaviours that govern a researcher's conduct in relation to research participants (Saunders *et al.,* 2016). Ethics are required to ensure adherence to behavioural norms, social norms and to avoid conflict and harm to the research participants (Saunders *et al.,* 2016). The ethical considerations taken into account and adhered to in this study were informed consent, confidentiality and anonymity. Informed consent entails that all the participants are informed that their participation is voluntary and they are allowed to withdraw at any time (Bhattacherjee, 2012). In the study the informed consent letter was the first screen before the survey. The screen explained to the participants, the nature of the study, that participation was voluntary, and that there was no loss of benefits for participation or non-participation. The participants were also informed that they could withdraw from the survey at any stage.

In terms of confidentiality the data collected was kept confidential and kept safe from unauthorised access (Bhattacherjee, 2012). The participants were also informed that the data will only be used for the purposes of the study only (Bhattacherjee, 2012). The demographic information collected, was collected in ranges and could not be linked back to a particular participant. This was done to protect the participant's identity through anonymity (Bhattacherjee, 2012). The analysis was done and presented at the group level and none of the responses can be tied back to an individual participant.

Permission to conduct the study was sought and obtained from the following: Executives from the major banks, the Secretary of the professional institution of IT personnel and the Head of the School of Information Systems. The study was also submitted to the Ethics Committee at the University of the Witwatersrand for ethical clearance. The ethical clearance was granted by the committee with protocol number: CINFO/1164. The clearance certificate can be found in Appendix C.

4.10 Conclusion

The chapter discussed the research methodology followed in the study. The research paradigm and research design of the study were discussed. The chapter also discussed the research instrument development. The sampling method and data collection procedures were discussed. The next chapter discusses in detail how the data was analysed.

5 CHAPTER 5: DATA PRESENTATION AND ANALYSIS

5.1 Introduction

This chapter describes the process that was followed to analyse the data. The chapter begins by explaining how the data was screened. The profile of the respondents is presented next. A discussion of the validity and reliability of the data is given. The hypothesis testing of the dependent variables is presented next. The chapter ends of with the testing of the moderating variables on the hypothesis.

5.2 Survey response

The survey was sent to 900 participants. 154 participants responded to the survey. This is a 17% response rate. Although the response rate was low in terms of percentage, it was deemed acceptable. Web surveys have been found to have a response rate of 11% lower than any other survey method (Yan & Fan, 2010). Cross-sectional surveys have also had a decline in response rates (Groves, 2012). The lower response rate in web surveys has been attributed to the fact that the majority of people use the web for entertainment purposes and pay little attention to research surveys (Silva and Durante, 2014).

The low response rate was also accepted because the participants that took part in the study were representative of the population of interest. A survey by Statistics South Africa in 2016 found that 32.9% of people employed in the formal sector were aged between 25 and 34 years. And that 31.4% of the people were aged between 35 and 44. The majority of people employed in South Africa are therefore aged between 25 and 44. In this study where the majority of the participants fell into the 24 – 41 age range. It must also be noted that it is difficult to access participants from banks as the environments are highly regulated and deal with sensitive and confidential information. Banks are also brand conscious it was difficult to get permission to survey the participants.

5.3 Data Screening

The 154 responses from the participants were exported from SurveyMonkey into Microsoft Excel. The exported data in Microsoft Excel was compared with the individual responses on SurveyMonkey to ensure that the data had exported correctly. Of the 154 responses, 5 responses were removed because the respondents indicated that they did not have experience in agile methodologies although it was being used in their business units. Another 3 responses were removed because less than 10% of the survey was completed and the completed values were all the same for different constructs.

5.4 Missing Values

The remaining 146 responses were imported from Microsoft Excel into SPSS. There were 8 responses with missing values. Bhattacherjee (2012) suggests that missing values are handled by either dropping the entire observation or imputation. In this study imputation was used where the missing values were replaced with the average of the remaining responses from the participants.

5.5 Outliers

Stem-and-leaf Plot diagrams were plotted to identify outliers. Stem-and-leaf Plot diagrams were selected because they show a graphical display of the frequency distribution of data, the data values, the median values and extreme outlier values (Thode, 2002). 3 observations were identified to be extreme outliers on the Stem-and-leaf Plot diagram. The Z score of all the variables was also calculated. The Z score was calculated to confirm the outliers identified by the Stem-and-leaf Plot diagram. All 3 observations had Z scores that were outside of the range -3 to +3. The Z score of the observations were negative and greater than -3.

Of the 3 observations, 1 observation was found not to belong to the Banking sector but belonging to the Insurance sector. This response most probably came from the professional institution of IT personnel, which has a diverse set of membership, who are

not only from the Banking sector. The other 2 outliers had invalid responses where the respondents had given the same response for most of the questions for different constructs. The responses for usage of agile methodologies were also neutral which could have been indicative of the fact that the respondents had minimal exposure to agile methodologies. The 3 observations were therefore removed as outliers.

5.6 Sample Profile

This section provides descriptive statistics of the profile of the respondents. The survey required the respondents to complete their gender. The gender distribution of the sample was made up of 65.7% males, 33.6% females and 1 respondent preferred to not disclose their gender. Table 4 shows the gender distribution of the respondents.

Gender	**Frequency**	**Percent (%)**
Female	48	33.6
Male	94	65.7
Prefer not to say	1	0.7
Total	143	100

Table 4: Gender Distribution

In terms of age distribution, the majority of the respondents were aged between 30 and 35 years, which was 39.8% of the sample. The rest of the age distribution in descending order was as follows: 21.7% were aged between 24 and 29, 21% were aged between 36 and 41, 7.7% were aged 42 and 47, 6.3% were aged between 48 and 53, 2.1% were aged more than 54 years. One respondent was aged between 18 and 23, and 1 respondent preferred not to say their age. Table 5 shows the age distribution of the respondents.

Age	Frequency	Percent (%)
18 – 23	1	0.7
24 – 29	31	21.7
30 – 35	57	39.8
36 – 41	30	21.0
42 – 47	11	7.7
48 – 53	9	6.3
54 years and older	3	2.1
Prefer not to say	1	0.7
Total	143	100

Table 5: Age Distribution

The respondents were also asked to report on the number of years they have spent using agile methodologies. Most of the respondents were new to agile methodologies and had spent between 1 to 3 years using the methodologies. 24 of the respondents had 4 to 6 years usage of agile methodologies. Figure 7 below shows the usage profile for all the respondents:

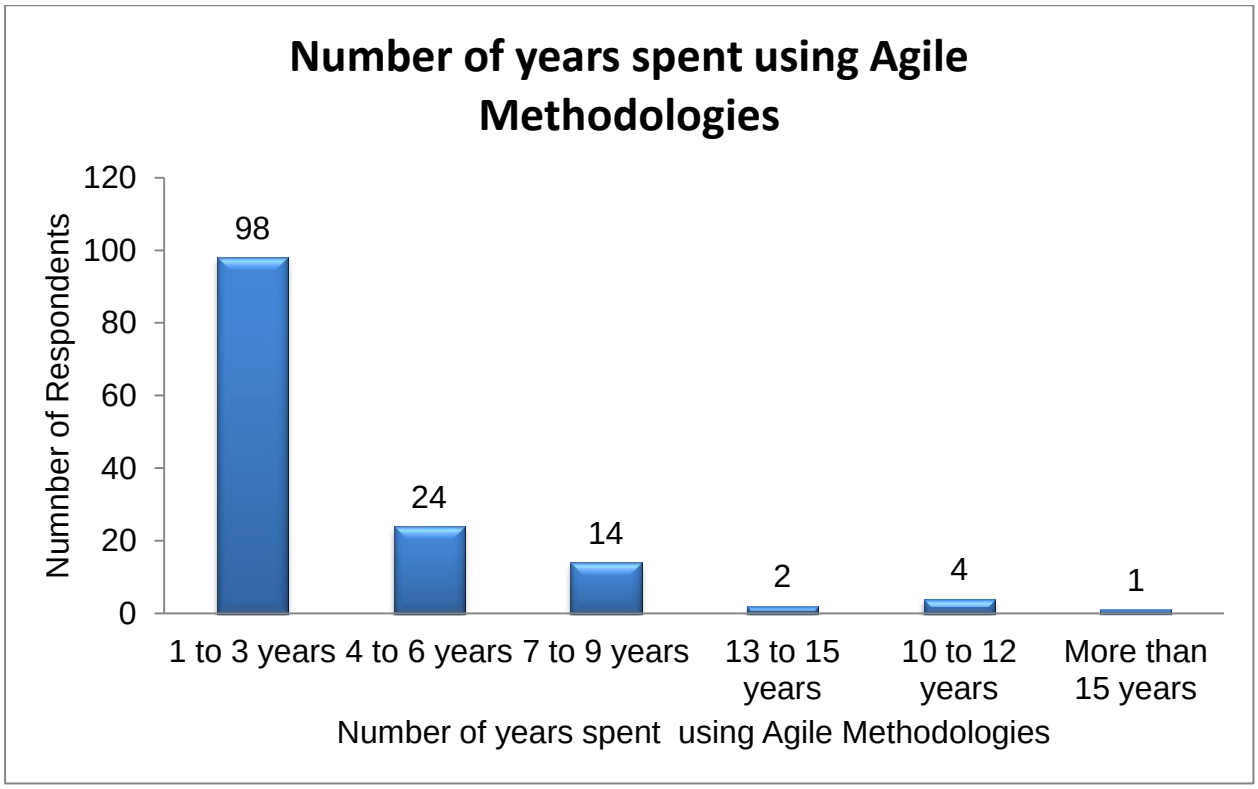


Figure 7: Number of years spent using agile methodologies

There are different methodologies that fall under the Agile umbrella (Verma, 2015). The respondents were asked to indicate the agile methodology that they are most familiar with. Scrum was the most popular agile methodology with 122 of the respondents indicating that that they were most familiar with it. The least popular agile methodologies were the Disciplined agile methodology, Agile Lean Six Sigma and the Scaled Agile Framework (SAFe). In terms of distribution, 1 respondent indicated that they were most familiar with the Disciplined agile methodology, another 1 respondent also indicated that they were most familiar with Agile Lean Six Sigma and also 1 other respondent indicated that they most familiar with the Scaled Agile Framework (SAFe). Table 6 shows the agile methodologies that the respondents were most familiar with:

Agile Methodology	Frequency	Percent (%)
Scrum	122	85.3
Feature Driven Development	10	7
Agile Lean Software Development	6	4.2
Extreme Programming	2	1.4
Disciplined agile methodology	1	0.7
Lean Six Sigma	1	0.7
Scaled Agile Framework (SAFe)	1	0.7
Total	143	100

Table 6: Agile methodologies that the respondents were most familiar with

The respondents were asked to complete what their role mainly consists of and the total number of years that they have spent in the IT sector. A cross tabulation of the number of years in IT and the role are shown in Table 7. The cross tabulation did not reveal any new findings or trend in the study.

Role Composition	Number of Years in I.T. Sector						Total
	1 – 3 years	4 – 6 years	7 – 9 years	10 –12 years	13 –15 years	'> 15 years	
Architecture	0	0	1	0	0	4	5
Business Analysis	8	5	7	5	2	4	31
IT Executive Leadership and Management	0	0	0	0	0	3	3
IT Support	1	2	2	3	1	1	10
Programme and Project Management	3	2	5	3	4	4	21
Software Development	1	8	8	7	6	9	39
Testing and Quality Assurance	12	10	6	2	3	1	34
Total	25	27	29	20	16	26	143

Table 7: Cross tabulation of Number of years of experience in the IT sector and Role

The respondents were also asked to indicate if the use of agile methodologies was voluntary or mandatory in their setting. Table 8 shows a cross tabulation of the site and voluntariness of use. The cross-tabulation revealed that for the same site there were varying levels of voluntariness of use. Across all the research sites the use agile methodologies is predominantly mandatory.

Site	Mandatory	Not Sure	Voluntary	Total
Bank X	64	9	32	105
Bank Y	7	3	9	19
Professional institution of IT personnel	12	1	6	19
Total	83	13	47	143

Table 8: Voluntariness of use per research site

5.7 Validity and Reliability Tests

Frank-Stromborg and Olsen (2004) define validity as being able to measure what is supposed to be measured. Rubin and Babbie (2016) define reliability as being able to repeatedly measure the same construct and get the same result each time. Before further data analysis could be done, validity and reliability was tested. The next section discusses the validity and reliability tests that were conducted.

5.7.1 Convergent validity, Discriminant validity and Unidimensionality

Convergent validity is concerned with "the closeness with which a measure relates to or converges on the construct that it is purported to measure" (Bhattacherjee, 2012:59). For Convergent validity, items under the same construct should correlate. Discriminant validity is concerned with whether an item measures one construct (Bhattacherjee, 2012). Unidimensionality is concerned with whether each item on an instrument reflects one latent variable (Gefen and Straub, 2005). Both convergent validity and discriminant validity are associated with unidimensionality. The study used Principal Component Analysis (PCA) to test unidimensionality.

Before PCA could be done, the Kaiser-Meyer-Olkin (KMO) Test and the Bartlett's Test of Sphericity were run to determine if the data was suited for factor analysis. The sampling was found to be adequate since the overall KMO measure was 0.853. The individual KMO values for each variable are shown on the diagonal of the anti-image correlation

matrix found in Appendix D. The Bartlett's Test of Sphericity had a significance of 0.000 indicating that there was correlation between the variables. Table 9 below shows the results of the KMO test and the Bartlett's Test of Sphericity.

Kaiser-Meyer-Olkin Measure of Sampling Adequacy		.853
Bartlett's Test of Sphericity	Approx. Chi-Square	2282.366
	Difference	210
	Significance	.000

Table 9: KMO Test and the Bartlett's Test

The PCA was run since the sampling was adequate. The display was done for significant coefficients with an absolute value above .4. The results of the PCA showed that all Communalities were above 0.6. The minimum Communality was 0.77. This indicates that for each variable more than 77% of the variance could be explained by the underlying factors. Refer to Appendix E for all the Communalities per variable. An Orthogonal Varimax rotation was used to show the results of the factor loadings. The Orthogonal Varimax rotation was selected because it has been used in most UTAUT studies and is easier to interpret than other rotations (Attuquayefio and Addo, 2014). A solution with 6 components was extracted with a total variance of 84.8%. The 6 components were enforced through SPSS. Refer to Appendix F for the Total Variance Explained table. Table 9 below shows the 6 component solution:

Principal Component Analysis						
	Component					
	1	2	3	4	5	6
PE3	.885					
PE2	.875					
PE4	.841					
PE1	.808					
EE3		.862				
EE2		.862				
EE4		.841				
EE1		.811				
BI3			.912			
BI1			.902			
BI2			.870			
U1				.888		
U3				.874		
SI1					.886	
SI3					.796	
FC3						.845
FC1						.790
Extraction Method: Principal Component Analysis. Rotation Method: Varimax with Kaiser Normalization. Rotation converged in 6 iterations.						

Table 10: Principal Component Analysis Results

Four items that cross loaded were dropped to derive a stable solution. The items were FC2, S12, SI4 and U2. The remaining items had a significant loading of more than .79. Thereafter the rotation converged after 6 iterations. FC2 could have cross loaded because it was assessing if there was adequate knowledge to use agile methodologies. FC1 had assessed if there was adequate resources to use agile methodologies. Knowledge can be viewed and classified as a resource. "SI2 - People who influence me think that I should use agile methodologies" could have not been answered properly because it may have brought some internal antagonism where the respondents may view themselves as strategic thinkers influencing their environment and not being influenced. "SI4 – In general, the organization has supported the use of agile methodologies" could have not been difficult for the participants to answer as the research setting were huge corporates and assessing the organizational support would be difficult due to the size of the organization. "U4: I prefer to use agile methodologies than other methodology" would have been difficult to answer as the use of agile is mainly mandatory and has little to do with preference. The items for PE all loaded onto the same component indicating unidimensionality and convergent validity. Similarly the items for EE and BI also loaded onto the same component indicating unidimensionality and convergent validity.

5.7.2 Reliability

Internal consistency is the most widely used approach for determining reliability (Frank-Stromborg and Olsen, 2004). Internal consistency is concerned with the degree to which a set of items designed to measure the same concept are inter-correlated (Frank-Stromborg and Olsen, 2004). A strong correlation which can be measured by the Cronbach's alpha means there is internal consistency (Salkind, 2010). In this study reliability was measured using the Cronbach's Alpha. Table 11 below shows the Cronbach alpha's for each variable.

Variable	**PE**	**EE**	**BI**	**U**	**SI**	**FC**
Cronbach's Alpha	.926	.916	.933	.838	.633	.762

Table 11: Cronbach alpha's

The Cronbach's alphas were all high and had values above 0.5 indicating that the underlying items were reliable and measuring the same construct. In comparison to the other variables Social Influence (SI) and Facilitating conditions (FC) had relatively lower values of .633 and .762. The lowers values were attributed to the fact that the variables were left with 2 items after the other items were dropped in the PCA.

5.7.3 Composite Scores

The composite scores were then calculated as the average of the scale items weighted equally. From this section all reference to variables refers to the composite variables. Descriptive statistics for each composite variable were extracted. Table 12 shows the results:

	Range	Min	Max	Mean	Std Deviation	Skewness		Kurtosis	
						Statistic	Std Error	Statistic	Std Error
CompPE	4.00	3.00	7.00	5.9638	.85519	-.825	.206	.531	.410
CompEE	4.00	3.00	7.00	5.8659	.80212	-.818	.206	.916	.410
CompU	6.00	1.00	7.00	5.8333	1.12913	-1.564	.206	3.208	.410
CompSI	5.00	2.00	7.00	5.5145	1.15724	-.799	.206	.118	.410
CompFC	5.00	2.00	7.00	5.2428	1.34441	-.768	.206	-.304	.410
CompBI	3.00	4.00	7.00	6.2717	.72020	-1.122	.206	1.591	.410

Table 12: Measures of Central Tendency and Normality for the Composite variables

For normal distribution, the skewness must lie between -1 and 1, and the kurtosis must lie between -3 and 3 (O'Rourke *et al.,* 2005). To identify possible outliers in the composite variables, Stem-and-Leaf Plot diagrams were created and also the Z Scores for the composite variables were calculated. From the dataset, another 5 entries were removed which were common extreme outliers on all the composite variables. The remaining dataset had 138 observations.

The skewness was normal and within the acceptable range for all the composite variables except for the Usage (CompU) and Behavioural Intention (CompBI). Appendix G shows the histograms with the distribution of each composite variable. Usage was negatively skewed (-1.564) and had a positive kurtosis of (3.208). Behavioural Intention was negatively skewed (-1.122) and had a positive kurtosis of 1.591. These variables were left as is as they were both not extremely deviated from the normal range of skewness and kurtosis. A Spearman Correlation was done to verify the impact of the skewness on the independent variables. The Spearman correlation is discussed in the next section.

5.7.4 Spearman Correlation for Dependent Variables

The Spearman Correlation was done to confirm if the skewness and kurtosis of Usage and Behavioural Intention would significantly affect further analysis. The Spearman correlation technique was used because it is suited for ordinal ordered scales. Ordinal ordered scales were used for both Usage and Behavioural Intention. The technique was also selected because the composite score for Usage and Behavioural Intention were not normally distributed. Appendix K shows the plots for Normality for Behavioural Intention and Usage. There were points that deviated from the diagonal indicating that the variables were not normally distributed. The skewness and kurtosis for usage were predominantly outside of the normal range of -1 and 1 for skewness and -3 and 3 for kurtosis (O'Rourke *et al.,* 2005). The skewness of usage was -1.564 and the kurtosis was 3.208. The skewness of Behavioral Intension was -1.122 and the kurtosis was 1.591.

The Spearman correlation was run for Behavioural Intention and its Predictor variables. All relationships between Behavioural Intention and its Predictor variables were statistically significant. The correlation coefficients were very low for Effort Expectancy with a value of .320 and Social Influence with a value of .351. The strongest correlation was with Performance Expectancy with a value of .547. Table 13 shows the results of the Spearman Correlation for Behavioural Intention:

Spearman Correlations		CompBI	CompPE	CompEE	CompSI
CompBI	Correlation Coefficient	1.000	.547**	.320**	.351**
	Sig. (2-tailed)	.	.000	.000	.000
	N	138	138	138	138
CompPE	Correlation Coefficient	.547**	1.000	.344**	.443**
	Sig. (2-tailed)	.000	.	.000	.000
	N	138	138	138	138
CompEE	Correlation Coefficient	.320**	.344**	1.000	.340**
	Sig. (2-tailed)	.000	.000	.	.000
	N	138	138	138	138
CompSI	Correlation Coefficient	.351**	.443**	.340**	1.000
	Sig. (2-tailed)	.000	.000	.000	.
	N	138	138	138	138
**. Correlation is significant at the 0.01 level (2-tailed).					

Table 13: Spearman Correlation of Behavioural Intention and its Predictor variables

The Spearman correlation was run also for Usage and its Predictor variables. The relationship between Usage and Behavioural Intention was statistically significant

however the correlation coefficient was low with a value of .309. The relationship between Usage and Facilitating Conditions was also statistically significant with a relatively higher correlation coefficient of .454. Table 14 shows the results of the Spearman Correlation for Usage and its Predictor variables:

Spearman Correlations		**CompBI**	**CompU**	**CompFC**
CompU	Correlation Coefficient	.309**	1.000	.454**
	Sig. (2-tailed)	.000	.	.000
	N	138	138	138
CompBI	Correlation Coefficient	1.000	.309**	.241**
	Sig. (2-tailed)	.	.000	.004
	N	138	138	138
CompFC	Correlation Coefficient	.241**	.454**	1.000
	Sig. (2-tailed)	.004	.000	.
	N	138	138	138
**. Correlation is significant at the 0.01 level (2-tailed).				

Table 14: Spearman Correlation of Usage and its Predictor variables

Both Spearman correlations indicated that relationships existed between all the variables. In the case of Behavioural Intention there was a positive relationship with the independent variables: “Performance Expectancy, Effort Expectancy and Social Influence. In the case of Usage, there was a positive relationship with the independent variables: Facilitating Conditions, and Behavioural Intention”. Further analysis was conducted with the parametric test of multiple regression analysis since the Spearman Correlation had confirmed that relationships existed among the variables.

5.8 Multiple Regression Analysis

This section discusses the multiple regression analysis done on the hypotheses. Hypothesis 1 to 5 was tested using multiple regression analysis. The assumptions of multiple regression analysis were tested before running the multiple regression analysis (Pallant, 2013). The assumptions are discussed below:

5.8.1 Multicollinearity

Multicollinearity occurs when more than two independent variables are highly correlated (Pallant, 2013). The presence of multicollinearity implies that the same data is being collected by different variables (Henseler *et al.,* 2009). The most common way of determining multicollinearity is using the Variance Inflation Factor (VIF) and Tolerance (Henseler *et al.,* 2009). Tolerance refers to the variance of one independent variable from another (Pallant, 2013). A Tolerance value of less than .1 indicates multiple correlations with other variables and therefore collinearity (Pallant, 2013). VIF is derived by dividing 1 by the Tolerance (Pallant, 2013). A VIF greater than 10 indicates collinearity (Henseler *et al.,* 2009). Tests were run for VIF and Tolerance for Behavioural Intention and for Usage. All tolerance values were greater than .1 indicating that there was no collinearity. All VIF values were all significantly less than 10 indicating further that there was no collinearity. Table 15 and Table 16 shows the results of the VIF values and Tolerance values for the Dependent variables.

	Collinearity Statistics of BI	
	Tolerance	**VIF**
CompEE	.813	1.230
CompPE	.847	1.180
CompSI	.830	1.204

Table 15: VIF and Tolerance for Behavioural Intention and its Predictor Variables

	Collinearity Statistics of Usage	
	Tolerance	**VIF**
CompBI	.973	1.028
CompU	.973	1.028

Table 16: VIF and Tolerance for Usage and its Predictor Variables

5.8.2 Normality

Normality exists when for any combination of the independent variables, the dependent variable is normally distributed (Kleinbaum *et al.,* 2013). Normality was tested using the Normal Probability Plot (Pallant, 2013). Normal Probability Plots were plotted for Behavioural Intention and Usage. Since Behavioural Intention and Usage had skewness and kurtosis that were slightly out of range, it was expected that the normality would have small deviations from the norm but acceptable. The Normal Probability Plot for Behavioural Intention had most of the points on the diagonal indicating that there were no extreme deviations from the norm. The Normal Probability Plot for Usage also had most points on the diagonal with some small deviations but acceptable. Appendix K shows the Normal Probability Plot for Behavioural Intention and Usage.

The small deviations were deemed acceptable because when the sample size is greater than 100 then the normality assumption for multiple regression analysis becomes less critical (Allison, 1999; Elliott and Woodward, 2007). Elliot and Woodward (2007) note that even with a sample of greater than 30 or 40 the normality assumption is less critical. When the normality assumption becomes less critical then parametric procedures can be used even if the data are not normally distributed (Elliott and Woodward, 2007). The normality assumption becomes less critical because of the Central Limit Theorem that has proved that confidence intervals and the *p* values will still be accurate despite non normal distribution (Allison, 1999; Elliott and Woodward, 2007).

5.8.3 Linearity and Homoscedasticity

Linearity and Homoscedasticity pertain to the variance of the independent variables being constant (Kleinbaum *et al.,* 2013). Linearity and Homoscedasticity can be assessed using Scatter Plots (Pallant, 2013). To ensure Linearity and Homoscedasticity the Scatter plots must have a random pattern (Pallant, 2013). Scatter plots for both Dependent variables were plotted. The plots had a random pattern. The Scatter plots can be found in Appendix L.

5.9 Hypothesis Testing

The hypotheses were tested using multiple regression analysis because it is more appropriate for hypotheses testing and analysing how multiple independent variables can be used to predict a dependent variable (Rubin, 2012). The multiple correlation coefficient, R was calculated. R is used to indicate the strength of the relationship between the dependent variable and the independent variables (O'Rourke *et al.,* 2005). R values can range from 0.00 to 1.00 with 0.00 indicating no relationship and 1 indicating a strong relationship (O'Rourke *et al.,* 2005). The coefficient of determination, R^2 was also calculated. R^2 is used to account for the proportion of variance of the dependent variable that can be explained by the independent variables (O'Rourke *et al.,* 2005). The *p* value was also calculated. The *p* value represents the probability of error in determining whether a finding is valid and representative of the population (O'Rourke *et al.,* 2005).

5.9.1 *Dependent Variable: Behavioural Intention*

Multiple regression analysis was run for the dependent variable, Behavioural Intention. The Scatter Plots for the predictor variables for Behavioural Intention can be found in Appendix H. The results of the multiple regression analysis were an R^2 value of 0.325, which means that the model explained about 33% of the variance in Behavioural Intention. Table 17 shows the regression model summary:

R	R Square	Adjusted R Square	Std Error of the Estimate
.570	.325	.310	.59827

Table 17: Regression model summary for Behavioural Intention

The ANOVA tests showed that the R^2 was significant. The regression model was significant in predicting the dependent variable Behavioural Intention with $p<0.001$. Table 18 shows the ANOVA test results.

ANOVA	Sum of Squares	Df	Mean Square	F	Sig
Regression	23.098	3	7.699	21.511	.000
Residual	47.962	134	.358		
Total	71.060	137			

Table 18: ANOVA Test for the R Square of Behavioural Intention

The results of the multiple regression analysis indicate that PE had the strongest relationship with BI, with a standardized beta of 0.420 with ($p<0.001$). SI was also found to have a significant relationship with BI with a standardized beta of .175. EE had a weak relationship with BI with a standardized beta of 0.126. Table 19 shows the *B* coefficient for each predictor variable. From Table 19 it can be seen that PE and SI were statistically significant. The hypothesis that Performance expectancy will positively influence behavioural intention to use agile methodologies was supported. The hypothesis that Social Influence will positively influence behavioural intention to use agile methodologies was supported. The implications of the results are that both Performance Expectancy and Social Influence determine Behavioural Intention. However Performance Expectancy determines Behavioural Intention more than Effort Expectancy and Social Influence. The perceived usefulness of agile methodologies in one's role and improved job performance is therefore a stronger drive than any other factor.

Hypothesis	Variable	Unstandardized *B*	Coefficients Std Error	Standardized Coefficient Beta	t	Sig
H2	PE	.354	0.66	.420	5.337	.000
H3	EE	.113	.069	.126	1.634	.105
H4	SI	.109	.048	.175	2.241	.027

Table 19: Beta coefficients for each Predictor variable for Behavioural Intention

5.9.2 *Dependent Variable: Usage*

Multiple regression analysis was also ran for the dependent variable Usage. The Scatter Plots for the predictor variables of Usage can be found in Appendix H. The regression model for Usage had an R Square of .245, which is approximately 25%. The regression model explained about 25% of variance in usage. Table 20 shows the regression model summary:

R	R Square	Adjusted R Square	Std Error of the Estimate
.495	.245	.234	.98845

Table 20: Regression model summary for Usage

The ANOVA tests for Usage showed that the R Square was significant with $p<0.001$. Table 21 shows the ANOVA test results.

ANOVA	Sum of Squares	Df	Mean Square	F	Sig
Regression	42.767	2	21.384	21.886	.000

ANOVA	Sum of Squares	Df	Mean Square	F	Sig
Residual	131.900	135	.977		
Total	174.667	137			

Table 21: ANOVA Test for the R Square Summary for Usage

FC had the strongest relationship with Usage, with a standardized beta of 0.462 ($p<0.001$). BI had a weak relationship with Usage with standardized beta of 0.117. Table 22 shows the *B* coefficient for each Predictor variable. The hypothesis that facilitating conditions will have a positive effect on use was supported. The implication of the result is that facilitating conditions are a strong determinant of usage compared to Behavioural intention. Availing the necessary support is important in the context of banking to enable usage of agile methodologies.

Hypothesis	Variable	Unstandardized B	Coefficients Std Error	Standardized Coefficient Beta	't	Sig
H5	FC	.388	.064	.462	6.092	.000
H1	BI	.183	.119	.117	1.539	.126

Table 22: Beta coefficients for each Predictor variable for Usage

5.10 Moderating variables

The effect of the moderating variables was explored using multiple regression analysis and the Simple Slope Analysis as prescribed by Aiken and West (1991). Section 4.6 of this document describes the steps that were taken to explore the moderation. Only the

moderating effect of agile experience on facilitating conditions and usage was found to be significant. Refer to Appendix J for the results of the remaining moderating effects that were not significant.

5.10.1 *Moderating effect of Agile Experience on Facilitating Conditions and Usage*

The section discusses the moderating effect of agile experience on facilitating conditions and usage. The regression model of the moderating effect of agile experience on facilitating conditions had an R Square of .263. Based on the ANOVA tests R^2 was significant with $p<0.001$. The Beta Coefficients confirmed the existing results were Facilitating Conditions were found to be a significant predictor of Usage with a weighting of .478 ($p<0.001$). Agile Experience was found to have a significant effect with p =.039 and B =.159. The moderating effect of agile experience on facilitating conditions and Usage was found to be significant. Tables 23, 24 and 25 below show the regression model results.

R	R Square	Adjusted R Square	Std Error of the Estimate
.513	.263	.247	.97983

Table 23: Regression model summary for Usage

ANOVA	Sum of Squares	Df	Mean Square	F	Sig
Regression	46.017	3	15.399	15.977	000
Residual	128.650	134	.960		
Total	174.667	137			

Table 24: ANOVA Test for the R Square

Variable	Unstandardized *B*	Coefficient Std Error	Standardized Coefficient Beta	t	Sig
Zscore(CompFC)	.540	.084	.478	6.448	.000
Zscore(AgileExperience)	.179	.086	.159	2.083	.039
ModeratorFCandAgileExp	-.155	.093	-.127	-1.661	.099

Table 25: Beta coefficients for each Predictor variable for Usage

A plot was created for varying levels of Agile experience, Low and High facilitating conditions. When facilitating conditions were low, higher levels of agile experience had a greater impact on usage than lower levels of agile experience. In other words higher levels of agile experience are required when few facilitating conditions exist for greater usage. When facilitating conditions are few, respondents with lower level of agile experience will have lower usage levels. However with more facilitating conditions, respondents with higher levels of agile experience still had more usage behaviour compared to respondents with lower agile experience. The results imply that agile experience moderates the relationship between usage of agile methodologies and facilitating conditions. Figure 8 shows the plot:

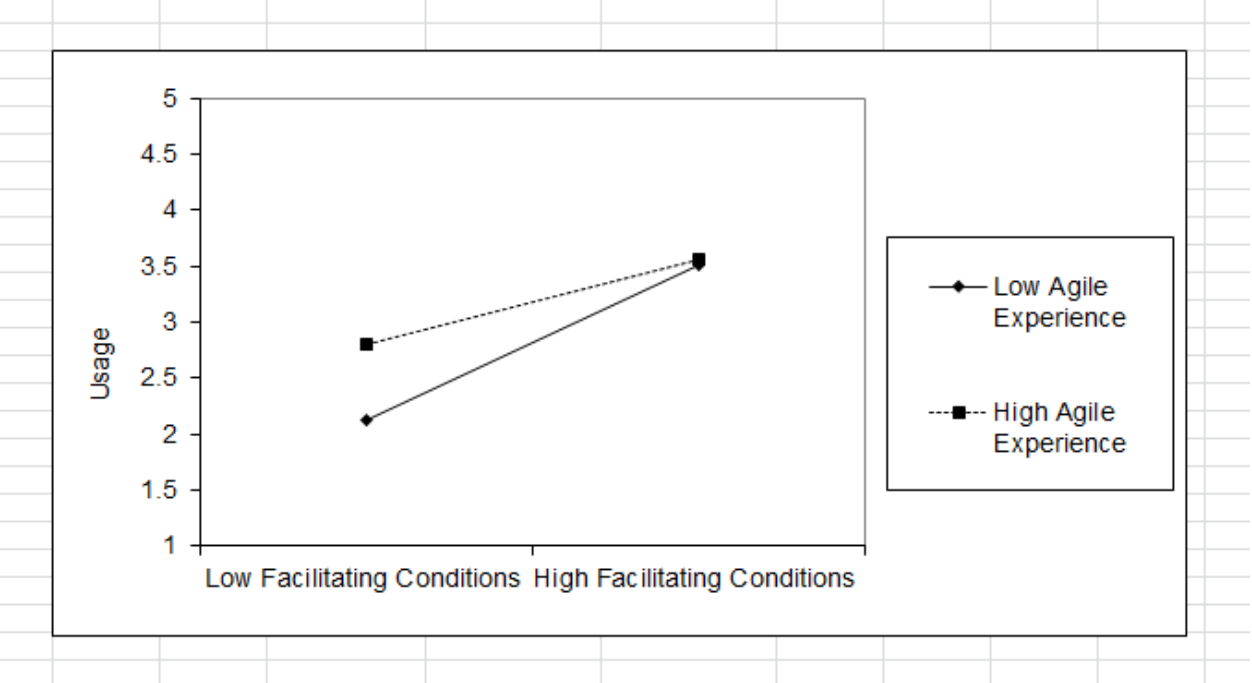


Figure 8: Interaction plot of agile experience on facilitating conditions and Usage

Across different standard deviations, the changes were more for respondents with lower agile experiences. In other words as agile experience increased and facilitating conditions increased, usage behaviour also increased. Figure 9 shows the plot:

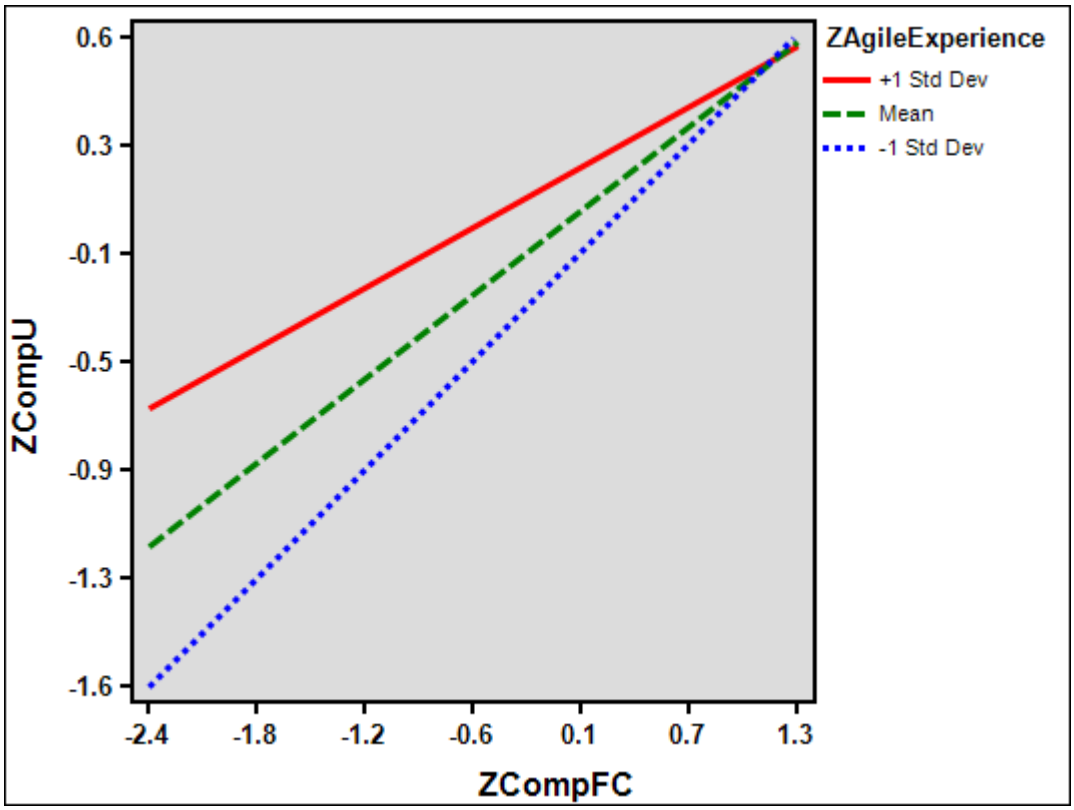


Figure 9: Plot varying SD of Agile Experience on Facilitating Conditions and Usage

5.11 Conclusion

The chapter discussed the process that was used to screen and analyse the data. Hypothesis H2, H4 and H5 were supported. Performance Expectancy and Social Influence were found to positively influence behavioural intention to use agile methodologies. Facilitating conditions were found to have a positive effect on use behaviour. The moderating effect of Agile Experience was found on the relationship between Facilitating Conditions and Usage. Table 25 shows the summary of the hypothesis of the dependent variables. Table 26 shows the summary of the exploration of the moderating variables:

Number	Hypothesis Statement	Decision	Result Summary
H1	Behavioural intention to use agile methodologies will have a positive effect on use behaviour.	Not Supported	BI had a weak positive relationship with Usage with a standardized beta of 0.117 (p=0.126).
H2	Performance expectancy will positively influence behavioural intention to use agile methodologies.	Supported	There was a strong, positive relationship of 0.420 (p<0.001) between PE and BI.
H3	Effort expectancy will positively influence behavioural intention to use agile methodologies.	Not Supported	There was a weak positive relationship of 0.126 (p=0.105) between EE and BI.
H4	Social Influence will have a positive effect on behavioural intention to use agile methodologies	Supported	SI had a strong positive relationship of .175 (p=0.027) with BI.
H5	Facilitating conditions will have a positive effect on use behaviour.	Supported	FC had a positive strong relationship of 0.462 (p<0.001) with Usage.

Table 26: Summary of the hypothesis of the dependent variables

Moderation Variable	Effect
Agile Experience	• Effect found on Facilitating Conditions and Usage. ○ No effect found on Behavioral Intention and Effort Expectancy. ○ No effect found on Behavioral Intention and Social Influence.
Age	○ No effect found on Performance Expectancy and Behavioral Intention. ○ No effect found on Behavioral Intention and Effort Expectancy. ○ No effect found on Behavioral Intention and Social Influence. ○ No effect found on Facilitating Conditions and Usage.
Gender	○ No effect found on Behavioral Intention and Performance Expectancy. ○ No effect found on Behavioral Intention and Effort Expectancy. ○ No effect found on Behavioral Intention and Social Influence.
IT Experience	○ No effect found on Effort Expectancy and Behavioral Intention. ○ No effect found on Social Influence and Behavioral Intention. ○ No effect found on Facilitating Conditions and Usage.
Voluntariness of use	○ No effect found on Social Influence and Behavioral Intention.

Table 27: Moderation exploration table summary

The next chapter discusses the results in relation to the literature and the research questions.

6 CHAPTER 6: DISCUSSION OF FINDINGS

6.1 Introduction

This chapter discusses the results presented in the previous chapter. The discussion reflects on the research questions and the hypotheses. Supported hypotheses are explained by reflecting on previous literature. Reasons for the possible failures are given for hypotheses that were not supported. The chapter begins by reviewing the study objective and then discussing the hypotheses.

6.2 Study Objective

The objective of the study was to examine the factors that influence IT personnel within the Banking sector to use agile methodologies. The literature review identified Performance Expectancy, Effort Expectancy, Social Influence, Facilitating Conditions and Behavioural Intention as possible factors. As per the UTAUT model Gender, Age, Experience and Voluntariness were explored for possible moderation.

6.3 Research Questions

6.3.1 *RQ1a. To what extent does Behavioural Intention to use affect usage of agile methodologies?*

The hypothesis stated that Behavioural Intention (BI) to use agile methodologies will have a positive effect on use behaviour. This hypothesis was not supported. The result was not consistent with studies that have tested UTAUT on an IT artefact. In these studies BI was found to be an important predictor of use (Venkatesh et al., 2012). The result could be attributed to the fact that the users had been exposed to agile methodologies and used them. Intention to use has been found to be more relevant in contexts where a technology is new and the users have not yet used it (Gupta *et al.,* 2008; Dasgupta and Gupta, 2010).

The hypothesis may also have not been supported because usage of agile methodologies was mandated in the settings of the study. In mandatory settings the user has to use the system irrespective of their intention (Koh *et al.,* 2010). The role of intention is minimal in mandatory settings (Koh *et al.,* 2010). Use is based on conformance to social norms and a belief that the system will enhance performance (Koh *et al.,* 2010). In mandatory settings it is performance expectancy and social influence that play a more significant role than the user's intention (Koh *et al.,* 2010).

BI may also have not been found to predict usage because of the perception of work. Managers have been found to care more about the perception that their employees are working rather than the actual productivity (Kamel *et al.,* 2017). So although employees may intend to use agile methodologies, they do not actually use them. Instead the employees focus on creating a perception of usage when they are actually not using agile methods. Perception of usage may be created by using some principles such as a Kanban or Scrum board, yet the employees still uses other methodologies for actual work. Perception of work can also be created when an employee could engage in visible signs and conversations of intent to use. This may end as conversation of intent and support of agile methodologies but does not lead to actual usage. So when BI is measured and usage, there will be no relationship as these were done to create perceptions of work.

6.3.2 *RQ1b. To what extent does Performance Expectancy affect Behavioural Intention to use agile methodologies?*

Hypothesis two stated that Performance Expectancy (PE) will positively influence Behavioural Intention (BI) to use agile methodologies. The multiple regression analysis supported this hypothesis. The result is consistent with the UTAUT findings where PE has been found to positively influence BI (Venkatesh *et al.,* 2003). Prior usage studies in agile methodologies also found PE to positively influence BI (Hardgrave *et al.,* 2003; Salo and Abrahamsson, 2008; Chan and Thong, 2009; Lambert, 2011; Ahmad, 2016). An increase in BI can be attributed to the perception that agile methodologies are useful

and have useful practices (Salo and Abrahamsson, 2008; Diebold and Dahlem, 2014; Theocharis, 2015).

The data analysis also found that PE always had a strong relationship with BI, in isolation or in the presence of other moderating factors such as gender and age. PE was found to be a predictor of BI despite the setting being voluntary or mandatory settings. Prior studies that tested UTAUT on methodologies have shown that PE is a strong predictor of BI in both voluntary and mandatory settings (Venkatesh *et al.,* 2003).

The finding suggests that PE is an important factor in IT personnel's intention to use agile methodologies. The implication of the finding is that agile methodologies need to be introduced when the usefulness of the methodology has been properly understood. An analysis of the practises that will be beneficial needs to be done. Dedicating time to understand the usefulness of agile methodologies in one's role and how an agile methodology can aid job performance is important before usage of the methodology. Since PE was a strong predictor of BI despite other factors, the techniques used to demonstrate agile methodologies usefulness can be used across different age groups, genders, in both mandatory settings and voluntary settings.

6.3.3 *RQ1c. To what extent does Effort Expectancy affect Behavioural Intention to use agile methodologies?*

Hypothesis three stated that Effort Expectancy (EE) will positively influence Behavioural Intention (BI) to use agile methodologies. The multiple regression analysis found that EE was not a predictor of BI in this study. This finding is contrary to previous UTAUT studies that tested UTAUT on methodologies. These studies found that EE positively influences BI (Venkatesh *et al.,* 2003). The finding suggests that the degree of ease of use, of agile methodologies does not lead to intentions of use.

EE might have not positively influenced BI because of the mandated use of agile methodologies, prior exposure to agile methodologies and a reluctance to change. The use of agile methodologies was mandatory all the settings where the research was conducted. Usage could have been influenced more by social influence in particular

pressure to conform rather than due to the easiness associated with the agile methodology.

The results show that all respondents had been exposed to agile methodologies for at least 1 to 3 years. This prior exposure could also have influenced the evaluation of the effort expectancy. If the evaluation of EE had been done a few weeks after exposure to agile methodologies then the result could have been different and possibly EE would have affected intention to use

A reluctance and unwillingness to change despite minimal effort expectancy could have affected intention to use agile methodologies. The respondents could have found that the effort required to change from a set routine was higher than the effort expectancy of using agile methodologies. So despite the evaluation of a high or low degree of effort expectancy, resistance and reluctance to change could have had more effect.

In the implementation of agile initiatives resistance to change by individuals has been found to be a normal response to the introduction of agile methodologies (Vijayasarathy and Turk, 2008; Rodríguez *et al.,* 2012). Resistance has been found when IT personnel have no clearing understanding of how to use agile methodologies (Asnawi *et al.,* 2011). In the context of mandated use of agile, Asnawi *et al. (*2011) found that there was a general passive resistance to agile methodologies.

Gandomani *et al.* (2014) note that agile methodologies are people centred. When introducing agile methodologies, the emphasis has to be placed on the mind-set and reaction of the people (Gandomani *et al.*, 2014). When people have the wrong mind-set about agile methodologies, they will exhibit a negative reaction to them and resist using the methodologies despite the benefits and easiness (Gandomani *et al.,* 2014).

The implication of this finding is that effort expectancy may not be a necessary criterion to cause intention to use (Wu *et al.,* 2007). Ease of use is not always enough to attract users (Wu *et al.,* 2007). The emphasis should rather be on factors that focus on performance expectancy, social influence and facilitating conditions (Wu *et al.,* 2007).

6.3.4 *RQ1d. To what extent does Social Influence affect Behavioural Intention to use agile methodologies?*

Hypothesis four proposed that Social Influence (SI) will have a positive effect on Behavioural Intention (BI) to use agile methodologies. This hypothesis was supported by the multiple regression analysis. Using agile methodologies can be considered a social norm. People tend to confirm to social norms (Ahmad *et al.,* 2016). The need to conform will influence a person's behavioural intention to use agile methodologies (Ahmad *et al.,* 2016). Social norms have been found to influence a person's intent to use agile methodologies (Vijayasarathy and Turk, 2012). In the study, SI was found to always have a relationship with BI, despite the presence of other moderating factors such as gender, age, agile experience, IT experience and voluntariness of use. SI was therefore an important factor in IT personnel's intention to use agile methodologies. Prior agile methodology usage studies by Hardgrave and Johnson (2003), Umarji (2005) and Lambert (2011) also found SI to positively influence BI. The finding is also supported by anecdotal evidence from the researcher's experience. In the researcher's environment when agile methodologies were introduced, there was a plethora of social influence. The leadership and management were enforcing agile usage, the work space was revamped to accommodate and remind everyone of the agile transformation. There were also many marketing initiatives that were created. The marketing signage was placed on posters, meeting rooms, elevators and stationary.

The implication of this finding is that to increase intention to use agile methodologies, sources that constitute social influence need to be reviewed. Sources of SI in the study as reflected by the measurement items were peers, colleagues, senior management and organizational marketing initiatives of agile methodologies. Making peers to be part of the agile champions that influence other peers could increase BI.

Increasing forums where peers share agile experiences could also increase BI. Management and Leadership also need to be actively involved throughout the agile process. Incentives for conformance could also be introduced to increase more individuals adhering to the norm of wanting to use agile methodologies. Increasing

organizational awareness of agile methodologies and creating a buzz could also influence BI. A hype and buzz around agile methodologies has been found to influence intention to use (Gregory *et al.,* 2015).

6.3.5 *RQ1e. To what extent do Facilitating conditions affect usage of agile methodologies?*

Hypothesis five stated that Facilitating Conditions (FC) will have a positive effect on use behaviour. In this study facilitating conditions were found to be the strongest predictor of use. Facilitating conditions remove any possible obstacles to use, and enable the use of agile methodologies with minimal effort (Chan and Thong, 2009). Prior agile usage studies have found that facilitating conditions play a pivotal role in the use of agile methodologies (Vijayasarathy and Turk, 2012; Gandomani *et al.,* 2014). Agile coaching in particular has been found to be a useful method to support users in the usage of agile methodologies (Senapathi and Srinivasan, 2014).

The study found that FC was a stronger predictor of use rather than BI. The implication of this finding is that facilitating conditions are a driver for use rather than a person's own intent of use. To ensure usage of agile methodologies, more facilitating conditions need to be presented. Facilitating conditions can be provided in the form of support from leadership to assist in coaching and mentoring of agile methodologies (Gandomani *et al.,* 2014).

In the researcher's personal experience facilitating conditions have made the agile transition smooth. In the researcher's environment on demand support was provided for the use of agile methodologies. Agile coaches and mentors were deployed and dedicated to assisting with any agile usage questions. Funding was also availed to study agile methodology related courses. Short but informative online courses were also created and available to all employees. There was also a walk in knowledge centre of excellence that was created and located on a specific floor of the organisation and employees could walk in and get assistance on agile methodology queries.

6.4 Moderators

This section discusses the findings of the exploration done for possible moderation on the existing hypotheses. As discussed in Chapter 3.3, there were no hypotheses formulated for the moderating variables. At the time of writing, there was limited literature found for moderation in the context of agile methodologies. The study however drew insight from behavioural studies and cognition studies. The study therefore aimed to explore the effect of the moderators on the existing hypotheses. The next section discusses the result of each moderator variable on the hypotheses:

6.4.1 *Agile Experience as a moderator*

The moderating effect of agile experience was tested on the following relationships 1) Facilitating Conditions (FC) and Usage, 2) Social Influence (SI) and Behavioural Intention (BI) and 3) Effort Expectancy (EE) and Behavioural Intention (BI). The moderating effect of agile experience was only found on FC and Usage. The moderating effect was not found in the relationship between SI and BI, and EE and BI.

The multiple regression analysis found that agile experience moderates the relationship between facilitating conditions and usage. The finding is consistent with prior UTUAT studies were experience has been found to moderate facilitating conditions and usage (Venkatesh *et al.,* 2012). When low facilitating conditions are present then more prior experience is required to increase usage (Venkatesh *et al.,* 2012). With low levels of prior experience, facilitating conditions need to be increased to support usage (Venkatesh *et al.,* 2011).

The implication of this finding is that facilitating conditions need to be proportional to the level of the agile experience an individual has. At the beginning of an agile initiative more facilitating conditions need to be present since the team will not have any experience. With continued use of agile methodologies, the facilitating conditions can be decreased. An agile coach can be involved in all of the agile ceremonies in the beginning of an agile

initiative and gradually play an advisor role as the team masters the principles of agile methodologies (Gandomani *et al.,* 2014).

6.4.2 *Age as a moderator*

The moderating effect of age was tested on 4 hypotheses: 1) PE on BI, 2) EE on BI, 3) SI on BI and 4) FC on Usage. None of the moderating effects of age were supported by the multiple regression analysis.

The moderation of age may have not been found because of the existence of facilitating conditions. The moderation of age comes into existence due to declining cognitive abilities that come with age (Morris *et al.,* 2005). In the study facilitating conditions were the strongest predictor of use. The presence of facilitating conditions implies that participants of all age groups were adequately supported and the effect of declining cognitive abilities would have been catered for. The large presence of facilitating conditions may have negated the moderating effects of age.

The composite score of EE indicated that all participants found it easy to use and learn agile methodologies. This means that despite the age group or any changes in age, the participants found agile methodologies easy to use. Age could therefore not be a moderator since participants in all age groups perceived agile methodologies as easy to use. There were also more younger participants in the sample compared to older participants. The implication of this, is that there may have not been much variance between the young and the older participants in the study. The results could have been skewed more towards the younger participants.

6.4.3 *Gender as a moderator*

Gender was tested as a moderating variable for PE and BI, EE and BI and SI and BI. All 3 hypotheses were not supported by the multiple regression analysis. This means that there is no difference in use of agile methodologies between men and women. Agile methodologies can be used well by both men and women. Gender was expected to be a

moderator since agile methodologies have been found to be aligned with Women's management style (Weilemann and Brune, 2015). Women's management style is based on core agile practises such as communication and building positive relationships (Weilemann and Brune, 2015).

The moderating effect of gender may have not been supported due to the small number of females in the study thereby reducing statistical power. Moderation by gender has been found to be based on stereotypes and the social differences between men and women (Hanson and Pratt, 1995; Lian and Chen, 2014). In the context of the study the effect of gender may have not been supported due to the reduced presence of stereotypes. The presence of Social influence indicates an environment governed by norms and conformance where gender stereotyping may not be prevalent. The absence of gender stereotyping therefore reduces the moderating effect of gender.

6.4.4 *IT Experience as a moderator*

The moderating effect of IT experience was tested on the following relationships between 1) EE and BI 2) SI and BI, 3) FC and Usage. The moderating effect of IT experience on all 3 hypotheses was not supported by the multiple regression analysis. Since the hypothesis for the effect of EE on BI was not supported in the study, the moderation of IT Experience on EE and BI was expected not be supported.

The moderation of IT experience may have not been supported for SI and BI, and FC and Usage because agile methodologies focus on team work. All IT related experience could have been shared and collaborated into the team, such that when measured the effect would not be significant. Each project also has a unique context, which may not require prior IT experience, so the level of IT experience would be uniform across the team and not moderate any relationship.

6.4.5 *Voluntariness of use as a moderator*

The moderating effect of voluntariness of use on Social Influence (SI) and Behavioural Intention (BI) was tested. The multiple regression analysis did not support this relationship. The moderating effect was not found because for the same site, some respondents were indicating voluntary usage and others mandatory usage. Varying responses for the same site could indicate levels of autonomy in the use of agile methodologies in a mandatory setting. The levels autonomy in a setting affects the moderating effect of voluntariness of use (Venkatesh, 2011). Levels of autonomy in the settings under study could exist when there is need for a trade-off between using any software development methodology and meeting a deadline vs using an agile methodology and failing to meet a deadline. In this case the choice will be to meet a deadline using any methodology and not necessarily to use agile methodologies.

The setting of the study was the Banking sector. The Banking sector has legacy mainframe systems that are difficult to change (Baskerville *et al.,* 2005; Lipton *et al.,* 2016). Some of the legacy mainframe systems were developed before agile methodologies existed. Subsequent upgrades and development on these legacy systems will most probably be done using a mixture of traditional methodologies and agile methodologies. So although there will be an organization wide drive to use agile methodologies the underlying legacy systems do not render themselves suitable to agile development methodologies. It is anticipated that these incompatibles between the organizational direction of using agile methodologies and the suitable software development methodology for a system can affect the moderation of voluntariness of use in a setting.

6.4.6 *Conclusion*

The chapter discussed the research questions and the hypotheses. 3 of the 5 hypotheses were supported. PE was found to be a predictor of BI, SI was found to be a predictor of BI, and FC was found to be a predictor of usage. Only the moderating effect

of agile experience was supported. The chapter also gave possible reasons why the hypotheses were not supported.

7 CHAPTER 7: CONCLUSION

7.1 Introduction

This chapter provides a review of the work done in the study. The chapter reflects on the aims of the study and summarises the research process. The chapter then reviews the contribution that the study on research and practice. Recommendations and suggestions for further studies are also discussed. The chapter ends by discussing the limitations of the study.

7.2 Summary of the study

The study aimed to investigate the factors that influence individual IT personnel to use agile methodologies within the banking sector. The context of the study was IT personnel from two major banks and personnel from an IT professional institution. The personnel selected were individuals that were using agile methodologies.

To meet the aim of the study 5 research question and 5 hypotheses were derived. The hypotheses were derived by reviewing prior literature. The research questions examined the effect of performance expectancy, effort expectancy, and social influence on behavioural intention to use agile methodologies. The research questions also examined the effect of facilitating conditions on the use agile methodologies. The effect of behavioural intention on usage was also examined. The study also explored the moderating effect of age, voluntariness of use, gender, IT experience and agile experience on the 5 hypotheses.

The study was informed by the positivistic paradigm. The study was conducted with a sample of 900 IT personnel and 154 participants responded to the survey. A cross sectional survey was sent to the participants using SurveyMonkey. The hypotheses were tested using multiple regression analysis. The moderating effects were tested using multiple regression analysis and the Simple slope analysis. The results of the analysis

were discussed by reviewing prior literature. The next section provides the contributions of the results to research and practice.

7.3 Contribution of the study

7.3.1 *Contribution to research*

The study adds to the agile body of knowledge by testing UTAUT in the South African banking context. The study provides support that Performance Expectancy and Social Influence affect Behavioural Intention. The study also provides support that the Facilitating Conditions influence usage.

The study also contributes to the limited number of academic surveys and empirical studies in the agile body of knowledge. The study also contributes to the limited number of agile studies done in the context of large scale agile implementation.

7.3.2 *Contribution for practise*

This study contributes by revealing the factors that must be in place to ensure the usage of agile methodologies. Understanding these factors ensures successful introduction of agile methodologies to IT personnel within the banking sector. The study found the following factors as influencing usage of agile methodologies: Facilitating Conditions, Performance Expectancy and Social Influence. Performance Expectancy implies that practice needs to implement agile methodologies when the usefulness of the method to one's role and day to day tasks has been fully understood. In the banking sector, performance expectancy needs to also assess the usefulness of agile methodologies in relation to the compliance need of the environment. A balance is required that will enable the realisation of the benefits of agile methodologies yet adhering to compliance regulations.

Facilitating Conditions imply that there is sufficient support needs to be in place for the successful usage of agile methodologies. Social Influence implies that more sources of

influence such as peers, management, a hype and buzz about agile methodologies needs to be in place. Effort Expectancy was found not to influence Behavioural Intention which implies that the easiness of agile methodologies does not affect intentions to use in the context of the South African banking sector. The facilitating conditions also need to address the cultural issues, where agile principles are divergent from the culture of banks. The facilitating conditions need to support the cultural transformation needed for the successful usage of agile methodologies in banks.

The moderating effects of age, voluntariness of use, gender and IT experience were found not to be significant. The implication of this finding is that there are no differences in the factors that influence males or females, younger or older IT personnel to use agile methodologies. IT experience does not affect an individual's intention to use agile methodologies. The same techniques therefore can be used to introduce and support agile methodologies for all IT personnel and do not require customization based on the IT personnel's, age, gender or level of IT experience. The context in terms of voluntary usage or mandatory usage also does not affect the intention to use agile methodologies.

The moderating effect of agile experience was supported. The implication for practise is that the facilitating conditions needs to be varied depending on the level of agile experience of the IT personnel. With lower levels of agile experience more facilitating conditions are required and with an increase in agile experience, less facilitating conditions are required.

7.4 Recommendations for future studies

Future studies can use a mixed mode approach and allow the participants the opportunity to justify their perceptions. Justification and elaboration of the perceptions will enable an even deeper understanding of the factors that influence usage of agile methodologies. Future studies can be conducted with larger sample sizes that possibly include the rest of the banks. Larger sample sizes enable more generalizations to be

made to the rest of the population. Future studies can also consider conducting a longitudinal study to monitor the usage pattern over a long period of time. The study did not focus on a specific agile methodology but assessed the general use of agile. Future studies can focus on the factors influencing usage per specific methodology.

Future studies can investigate specifically which facilitating conditions influence usage more. Since the moderating effect of agile experience was found between usage and facilitating conditions. Future studies can explore further the relationship between facilitating conditions and agile experience. In particular which facilitating conditions are required per level of agile experience.

Behavioural Intention has consistently been found to be a strong predictor of usage. In this study, behavioural Intention to use was not found to be a strong predictor of use. Future studies can test this finding to ascertain if it is only applicable in the South African banking context.

7.5 Limitations

Only participants from two banks could be accessed and not the rest of the banks. Accessing more participants from other banks would have allowed the results to be more generalised. Due to the timeline constraints, a cross sectional survey was done. Usage studies are typically done using longitudinal surveys.

The link to the survey was sent using email. Although mitigation strategies were implemented the use of email limited the study to respondents that check emails often. A low response rate made the study prone to non-response bias. The usage of agile was mandatory in all the settings surveyed. This made the study prone to social desirability bias as the respondents would provide responses that were socially desirable.

7.6 Conclusion

As a result of the study, the factors that influence usage amongst IT personnel within the banking sector are now known. These factors are Performance Expectancy, Social

Influence and Facilitating Conditions. Facilitating conditions were found to be the strongest predictor of use. IT personnel within the banking sector will use agile methodologies when adequate facilitating conditions are present. Only agile experience was found to be a significant moderator of use. Gender, age, IT experience and voluntariness of use were found not to moderate usage of agile methodologies. So when employers are implementing agile methodologies the focus has to be on Social Influence, Facilitating Conditions and Performance Expectancy. Not much focus should be placed on the moderating factors such as voluntariness of use, gender, IT experience and age.

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APPENDIX A: MEASUREMENT ITEMS

The following measurement items were used.

1. Demographic data was collected as follows:
    - Gender was collected using the options “Female”, “Male” and “Prefer not to say”
    - Age data was collected as a continuous values using the following intervals: 18 - 23 , 24 - 29, 30 - 35, 36 - 41, 42 - 47, 48 - 53, 54 years and older, Prefer not to say
    - Work experience using agile methodologies and work experience in the IT industry data was collected as continuous values using the following intervals: None, 1 to 3 years, 4 to 6 years, 7 to 9 years, 10 to 12 years, 13 to 15 years and More than 15 years.
    - The IT personnel role was collected using the following values: “Business Analysis”, “Software Development”, “Testing and Quality Assurance”, “Programme and Project Management”, “Architecture”, “IT Support” and “IT Executive Leadership and Management”.
    - The agile methodologies used by the respondents were also collected using the following value: “Scrum”, “Kanban”, “Xtreme Programming”, “Crystal”, “Feature Driven Development”, “Lean Software Development” and “Other” to specify any other agile methodologies.
    - The sector was measured using the following values: “Automotive and Transportation”, “Banking, Finance and Insurance”, “Mining, Energy, Oil and Gas”, “Food, Beverage and Manufacturing”, “Public Services, Government, Healthcare and Education”, “Real Estate, Retail and E commerce”, “Telecommunications”, “Research and Development, Products” and “Other” to specify any other industries.

- Voluntariness of agile usage was collected using the values “Voluntary”, “Compulsory” and Not sure.

2. The items for each construct are presented below and were measured on a seven-point Likert scale ranging from 1= Strongly disagree to 7= strongly agree.

Performance Expectancy

- (PE1) Using agile methodologies is useful in my role.
- (PE2) Using agile methodologies enables me to accomplish tasks more quickly.
- (PE3) Using agile methodologies increases my productivity.
- (PE4) Using agile methodologies enhances my effectiveness on the job

Effort Expectancy

- (EE1) I find it easy to use agile methodologies.
- (EE2) I clearly understand agile methodologies.
- (EE3) It would be easy for me to become an expert in using agile methodologies.
- (EE4) Learning to use agile methodologies is easy for me.

Facilitating conditions

- (FC1) I have all the resources I need to use agile methodologies.
- (FC2) I have the knowledge necessary to use agile methodologies.
- (FC3) A specific person (or group of people) is available to assist me with agile methodology related queries.

Social Influence

- (SI1) The Leadership and Management of my firm have been helpful in the use of agile methodologies.
- (SI2) People who influence me think that I should use agile methodologies.
- (SI3) My colleagues think that I should use agile methodologies.

- (SI4) In general, the organization has supported the use of agile methodologies

Behavioural Intention to Use

- (BI1) I use agile methodologies given the opportunity.
- (BI2) I predict I would use agile methodologies, given the opportunity.
- (BI3) I plan to use agile methodologies given the opportunity.

Actual usage

- (U1) I use agile methodologies on a regular basis.
- (U2) I prefer to use agile methodologies than other methodology.
- (U3) I currently use agile methodologies more than any other methodology.

APPENDIX B: SURVEY

Participant Consent Screen

Good Day

My name is Grace Mudarikwa and I am a Master's student in the Information Systems Division at the University of the Witwatersrand, Johannesburg. I am conducting research into the usage of agile methodologies. The purpose of my study is to investigate the factors that influence information technology personnel to use agile methodologies.

As a user of agile methodologies, you are invited to take part in this survey. The survey measures your perceptions and levels of agreements with statements about agile methodologies. Your response is important and there are no right or wrong answers. This survey is both confidential and anonymous. Anonymity and confidentiality are guaranteed by not needing you to enter your name on the questionnaire. Your participation is completely voluntary and involves no risk, penalty, or loss of benefits whether or not you participate. You may withdraw from the survey at any stage.

The first part of the survey comprises of 21 agile statements. Please indicate the extent to which you agree with each statement by selecting the appropriate circle. The second part of the survey captures some demographic data. Please select whichever circle is applicable.

The entire survey should take between 5 to 10 minutes to complete. The survey was approved by the SEBS Ethics Committee (Non-Medical), Protocol Number: CINFO/1164.

Thank you for considering participating. Should you have any questions, or should you wish to obtain a copy of the results of the survey, please contact me on (+27) 73 783 7634 or at 1272451@students.wits.ac.za. You can also contact my supervisor, Mr Thomas Grace on email: Thomas.Grace@wits.ac.za or Telephone number: 011 717 8154.

By submitting this survey you consent to the following:

- I agree to participate in this research project.
- I have read this consent screen and the information it contains and had the opportunity to ask questions about them.

I agree to my responses being used for education and research on condition that my privacy is respected, subject to the following:

- I understand that my personal details will not be included in the research so that I will not be personally identifiable.
- I understand that I am under no obligation to take part in this survey.
- I understand I have the right to withdraw from this survey at any stage.

Kind regards

Grace

1. **Part 1 - Section 1**

The following section asks about your perceptions on the usefulness of agile methodologies. Please indicate the extent to which you are agree with each statement by selecting the appropriate circle among the available options.

The following section asks about your perceptions of agile methodologies. Please indicate the extent to which you agree with each statement by selecting the appropriate circle among the available options.

Using agile methodologies is useful in my role.

Strongly Disagree	Disagree	Slightly disagree	Neutral	Slightly agree	Agree	Strongly Agree
❍	❍	❍	❍	❍	❍	❍

Using agile methodologies enables me to accomplish tasks more quickly.

Strongly Disagree	Disagree	Slightly disagree	Neutral	Slightly agree	Agree	Strongly Agree
❍	❍	❍	❍	❍	❍	❍

Using agile methodologies increases my productivity.

Strongly Disagree	Disagree	Slightly disagree	Neutral	Slightly agree	Agree	Strongly Agree
❍	❍	❍	❍	❍	❍	❍

Using agile methodologies enhances my effectiveness on the job

Strongly Disagree	Disagree	Slightly disagree	Neutral	Slightly agree	Agree	Strongly Agree
❍	❍	❍	❍	❍	❍	❍

2. **Part 1 - Section 2**

The following section asks about your perceptions of agile methodologies. Please indicate the extent to which you agree with each statement by selecting the appropriate circle among the available options.

I find it easy to use agile methodologies.

Strongly Disagree	Disagree	Slightly disagree	Neutral	Slightly agree	Agree	Strongly Agree
❍	❍	❍	❍	❍	❍	❍

I clearly understand how to use agile methodologies.

Strongly Disagree	Disagree	Slightly disagree	Neutral	Slightly agree	Agree	Strongly Agree
❍	❍	❍	❍	❍	❍	❍

It would be easy for me to become an expert in using agile methodologies.

Strongly Disagree	Disagree	Slightly disagree	Neutral	Slightly agree	Agree	Strongly Agree
❍	❍	❍	❍	❍	❍	❍

Learning to use agile methodologies is easy for me.

Strongly Disagree	Disagree	Slightly disagree	Neutral	Slightly agree	Agree	Strongly Agree
❍	❍	❍	❍	❍	❍	❍

3. **Part 1 - Section 3**

The following section asks about your perceptions of the support for the use of agile methodologies in your firm. Please indicate the extent to which you agree with each statement by selecting the appropriate circle among the available options.

I have all the resources I need to use agile methodologies.

Strongly Disagree	Disagree	Slightly disagree	Neutral	Slightly agree	Agree	Strongly Agree
❍	❍	❍	❍	❍	❍	❍

I have the knowledge necessary to use agile methodologies.

Strongly Disagree	Disagree	Slightly disagree	Neutral	Slightly agree	Agree	Strongly Agree
❍	❍	❍	❍	❍	❍	❍

A specific person (or group of people) is available to assist me with agile methodology queries.

Strongly Disagree	Disagree	Slightly disagree	Neutral	Slightly agree	Agree	Strongly Agree
❍	❍	❍	❍	❍	❍	❍

4. **Part 1 - Section 4**

The following section asks about your perceptions of agile methodologies. Please indicate the extent to which you agree with each statement by selecting the appropriate circle among the available options.

My colleagues think that I should use agile methodologies.

Strongly Disagree	Disagree	Slightly disagree	Neutral	Slightly agree	Agree	Strongly Agree
❍	❍	❍	❍	❍	❍	❍

The Leadership and Management of my firm have been helpful in the use of agile methodologies.

Strongly Disagree	Disagree	Slightly disagree	Neutral	Slightly agree	Agree	Strongly Agree
❍	❍	❍	❍	❍	❍	❍

People who influence me think that I should use agile methodologies.

Strongly Disagree	Disagree	Slightly disagree	Neutral	Slightly agree	Agree	Strongly Agree
❍	❍	❍	❍	❍	❍	❍

In general, the organization has supported the use of agile methodologies.

Strongly Disagree	Disagree	Slightly disagree	Neutral	Slightly agree	Agree	Strongly Agree
❍	❍	❍	❍	❍	❍	❍

5. **Part 1 - Section 5**

The following section asks about your intentions to use agile methodologies. Please indicate the extent to which you agree with each statement by selecting the appropriate circle among the available options.

Given the opportunity, I intend to use agile methodologies.

Strongly Disagree	Disagree	Slightly disagree	Neutral	Slightly agree	Agree	Strongly Agree
❍	❍	❍	❍	❍	❍	❍

Given the opportunity, I expect that I will use agile methodologies.

Strongly Disagree	Disagree	Slightly disagree	Neutral	Slightly agree	Agree	Strongly Agree
❍	❍	❍	❍	❍	❍	❍

Given the opportunity, I plan to use agile methodologies.

Strongly Disagree	Disagree	Slightly disagree	Neutral	Slightly agree	Agree	Strongly Agree
❍	❍	❍	❍	❍	❍	❍

6. **Part 1 - Section 5**

The following section asks about your use of agile methodologies. Please indicate the extent to which you agree with each statement by selecting the appropriate circle among the available options.

I use agile methodologies on a regular basis.

Strongly Disagree	Disagree	Slightly disagree	Neutral	Slightly agree	Agree	Strongly Agree
❍	❍	❍	❍	❍	❍	❍

I prefer to use agile methodologies than any other methodology.

Strongly Disagree	Disagree	Slightly disagree	Neutral	Slightly agree	Agree	Strongly Agree
❍	❍	❍	❍	❍	❍	❍

I currently use agile methodologies more than any other methodology.

Strongly Disagree	Disagree	Slightly disagree	Neutral	Slightly agree	Agree	Strongly Agree
❍	❍	❍	❍	❍	❍	❍

This section captures demographic data. Please tick whichever boxes are applicable to you.

7. Please indicate your gender:

Female	Male	Prefer not to say
❍	❍	❍

8. Please indicate your age:

18 – 23	24 – 29	30 – 35	36 - 41	42 – 47	48 - 53	54 year and older	Prefer not to say
❍	❍	❍	❍	❍	❍	❍	❍

9. Please indicate your work experience using agile methodologies:

None	1 to 3 years	4 to 6 years	7 to 9 years	10 to 12 years	13 to 15 years	More than 15 years
❍	❍	❍	❍	❍	❍	❍

10. Please indicate your work experience in software development:

None	1 to 3 years	4 to 6 years	7 to 9 years	10 to 12 years	13 to 15 years	More than 15 years
❍	❍	❍	❍	❍	❍	❍

11. Please indicate what your role mainly consists of:

Business Analysis	Software Development	Testing and Quality Assurance	Programme and Project and Management	Architecture	IT Support	IT Executive Leadership and Management
❍	❍	❍	❍	❍	❍	❍

12. Please indicate the agile methodology that you are most familiar with:

Scrum	Extreme Programming	Crystal	Feature Driven Development	Lean Software Development	Other (Please specify)
❍	❍	❍	❍	❍	

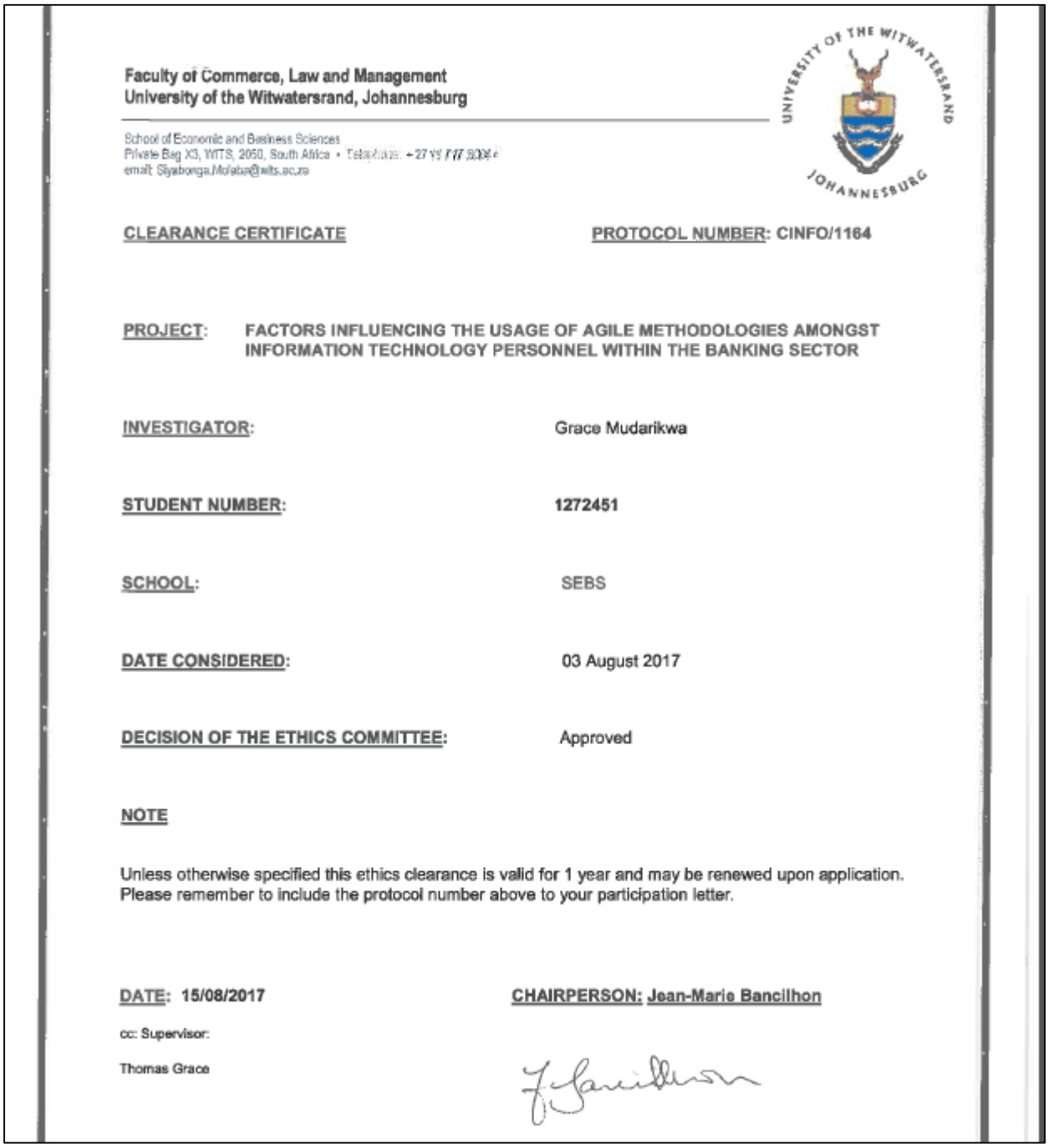
13. Please indicate the sector you mainly work or consult in:

- ❍ Automotive and Transportation
- ❍ Banking Finance and Insurance
- ❍ Mining, Energy, Oil and Gas
- ❍ Food, Beverage and Manufacturing
- ❍ Public Services, Government, Healthcare and Education
- ❍ Real Estate, Retail and E commerce
- ❍ Telecommunications
- ❍ Research and Development, Products
- ❍ Other (Please specify)

14. Please indicate whether or not the use of agile methodology is voluntary or mandatory in your role:

Voluntary	Mandatory	Not Sure
❍	❍	❍

APPENDIX C: ETHICAL CLEARANCE CERTIFICATE



Faculty of Commerce, Law and Management
University of the Witwatersrand, Johannesburg

School of Economic and Business Sciences
Private Bag X3, WITS, 2050, South Africa • Telephone: +27 11 717 8094
email: Siyabonga.Mofatsa@wits.ac.za

UNIVERSITY OF THE WITWATERSRAND JOHANNESBURG

CLEARANCE CERTIFICATE **PROTOCOL NUMBER: CINFO/1164**

PROJECT: **FACTORS INFLUENCING THE USAGE OF AGILE METHODOLOGIES AMONGST INFORMATION TECHNOLOGY PERSONNEL WITHIN THE BANKING SECTOR**

INVESTIGATOR: Grace Mudarikwa

STUDENT NUMBER: **1272451**

SCHOOL: SEBS

DATE CONSIDERED: 03 August 2017

DECISION OF THE ETHICS COMMITTEE: Approved

NOTE

Unless otherwise specified this ethics clearance is valid for 1 year and may be renewed upon application.
Please remember to include the protocol number above to your participation letter.

DATE: 15/08/2017 **CHAIRPERSON: Jean-Marie Bancilhon**

cc: Supervisor:

Thomas Grace

APPENDIX D: INDIVIDUAL KMO VALUES ANTI-IMAGE CORRELATION MATRIX

	PE1	PE2	PE3	PE4	EE1	EE2	EE3	EE4	FC1	FC3	SI1	SI3	BI1	BI2	BI3	U1	U3
PE1	.915[a]	-.424	-.103	-.130	-.057	-.014	-.097	.044	-.087	.008	-.173	.151	.034	-.001	-.004	-.077	.030
PE2	-.424	.874[a]	-.415	-.078	.088	.071	-.075	-.029	.041	-.031	.044	-.043	-.222	.147	.065	.034	-.114
PE3	-.103	-.415	.830[a]	-.553	-.149	.046	.141	-.149	-.060	.134	-.015	-.087	.130	-.147	-.039	-.079	.206
PE4	-.130	-.078	-.553	.874[a]	.083	-.068	-.013	.037	-.020	-.196	.124	-.132	-.128	.016	.089	.105	-.053
EE1	-.057	.088	-.149	.083	.894[a]	-.301	-.274	-.046	-.230	.092	.028	.164	-.133	.123	-.069	-.021	-.096
EE2	-.014	.071	.046	-.068	-.301	.894[a]	-.218	-.436	-.018	-.049	.048	-.044	-.044	-.095	.058	-.035	.062
EE3	-.097	-.075	.141	-.013	-.274	-.218	.889[a]	-.369	-.130	.077	-.037	-.106	.039	.033	-.093	-.052	.199
EE4	.044	-.029	-.149	.037	-.046	-.436	-.369	.874[a]	.018	.050	-.124	.119	.067	.011	-.025	.043	-.237
FC1	-.087	.041	-.060	-.020	-.230	-.018	-.130	.018	.822[a]	-.524	.123	-.141	.035	-.032	.152	.037	-.059
FC3	.008	-.031	.134	-.196	.092	-.049	.077	.050	-.524	.790[a]	-.125	-.020	.118	-.018	-.169	-.045	-.150
SI1	-.173	.044	-.015	.124	.028	.048	-.037	-.124	.123	-.125	.793[a]	-.597	-.069	.018	.020	-.052	.056

	PE1	PE2	PE3	PE4	EE1	EE2	EE3	EE4	FC1	FC3	SI1	SI3	BI1	BI2	BI3	U1	U3
SI3	.151	-.043	-.087	-.132	.164	-.044	-.106	.119	-.141	-.020	-.597	.808[a]	.042	-.064	-.063	-.022	-.175
BI1	.034	-.222	.130	-.128	-.133	-.044	.039	.067	.035	.118	-.069	.042	.786[a]	-.333	-.725	-.067	.069
BI2	-.001	.147	-.147	.016	.123	-.095	.033	.011	-.032	-.018	.018	-.064	-.333	.903[a]	-.220	.059	-.128
BI3	-.004	.065	-.039	.089	-.069	.058	-.093	-.025	.152	-.169	.020	-.063	-.725	-.220	.801[a]	.003	.005
U1	-.077	.034	-.079	.105	-.021	-.035	-.052	.043	.037	-.045	-.052	-.022	-.067	.059	.003	.789[a]	-.646
U3	.030	-.114	.206	-.053	-.096	.062	.199	-.237	-.059	-.150	.056	-.175	.069	-.128	.005	-.646	.714[a]

APPENDIX E: COMMUNALITIES

Communalities		
	Initial	Extraction
PE1	1.000	.771
PE2	1.000	.858
PE3	1.000	.873
PE4	1.000	.827
EE1	1.000	.787
EE2	1.000	.829
EE3	1.000	.831
EE4	1.000	.818
FC1	1.000	.844
FC3	1.000	.853

Communalities		
	Initial	Extraction
SI1	1.000	.878
SI3	1.000	.835
BI1	1.000	.923
BI2	1.000	.829
BI3	1.000	.913
U1	1.000	.874
U3	1.000	.875

Extraction Method: Principal Component Analysis.

APPENDIX F: TOTAL VARIANCE EXPLAINED

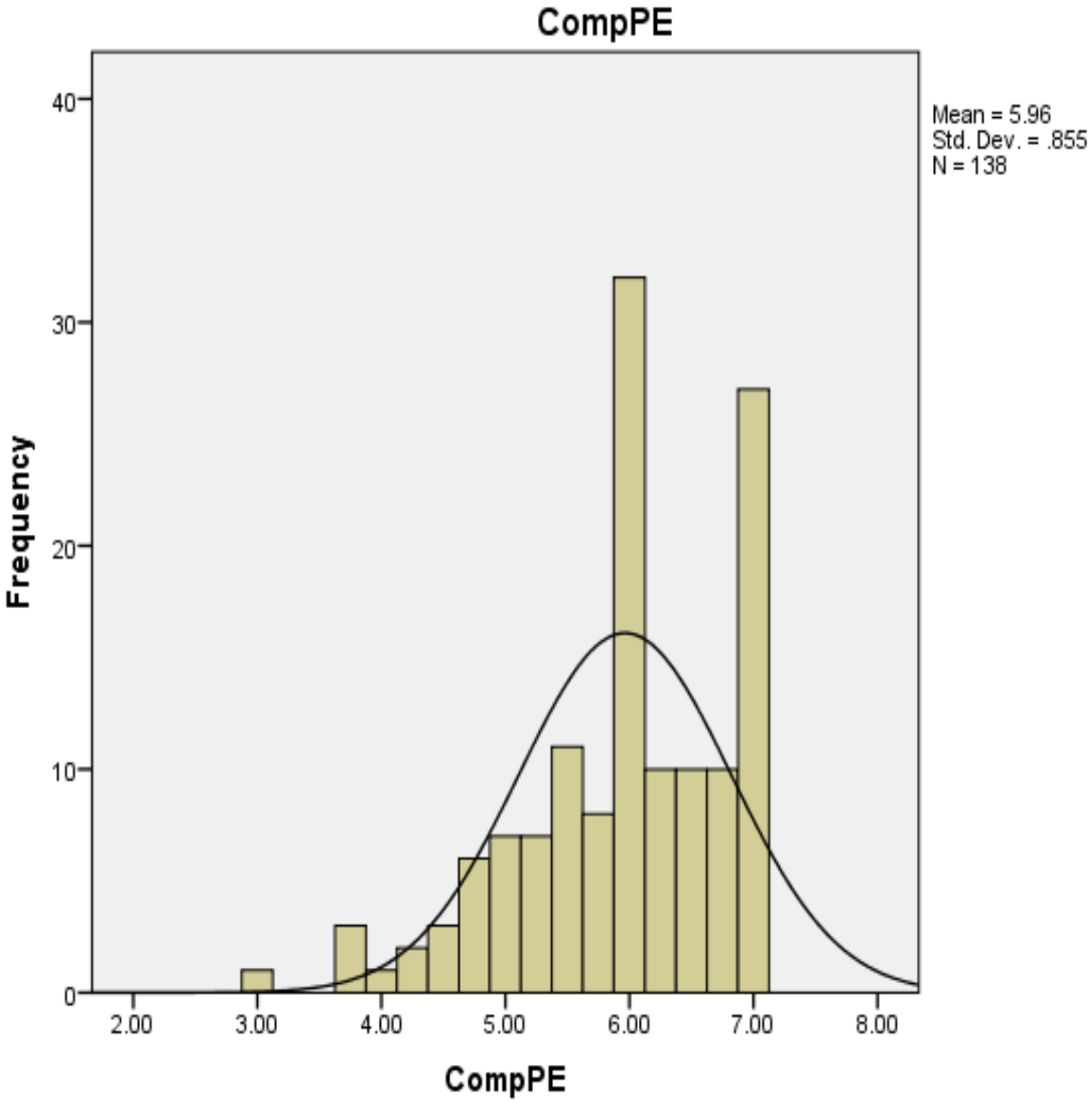
Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	6.890	40.529	40.529	6.890	40.529	40.529	3.331	19.595	19.595
2	2.026	11.916	52.446	2.026	11.916	52.446	3.319	19.522	39.117
3	1.896	11.155	63.601	1.896	11.155	63.601	2.711	15.949	55.066
4	1.839	10.820	74.420	1.839	10.820	74.420	1.797	10.573	65.639
5	.927	5.455	79.875	.927	5.455	79.875	1.665	9.795	75.433
6	.841	4.949	84.824	.841	4.949	84.824	1.596	9.391	84.824
7	.419	2.462	87.286						
8	.355	2.090	89.377						
9	.291	1.710	91.087						

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
10	.273	1.607	92.694						
11	.256	1.505	94.198						
12	.231	1.358	95.556						
13	.205	1.206	96.761						
14	.187	1.099	97.860						
15	.168	.986	98.846						
16	.119	.701	99.548						
17	.077	.452	100.000						

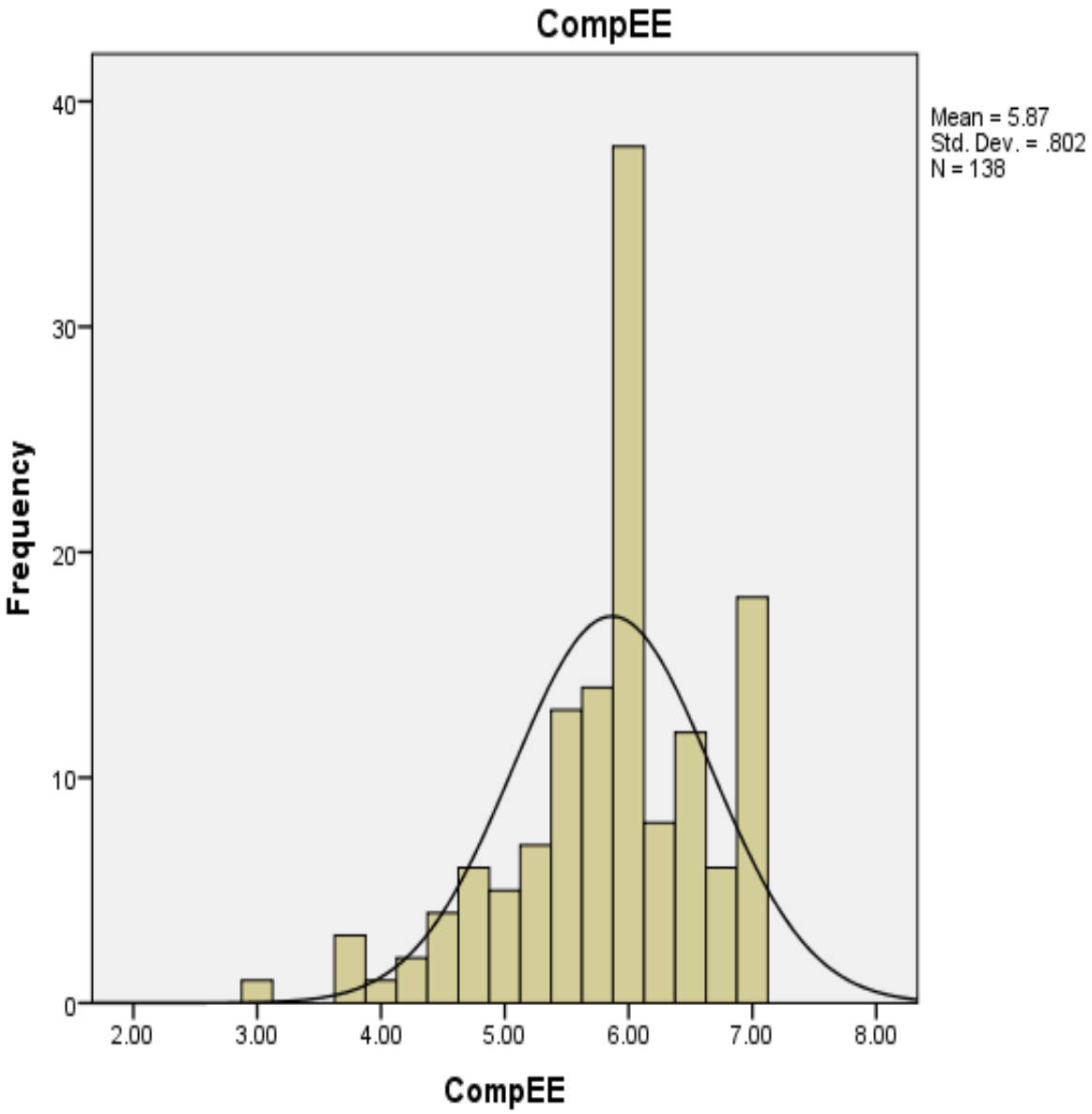
Extraction Method: Principal Component Analysis.

APPENDIX G: HISTOGRAMS FOR COMPOSITE VARIABLES

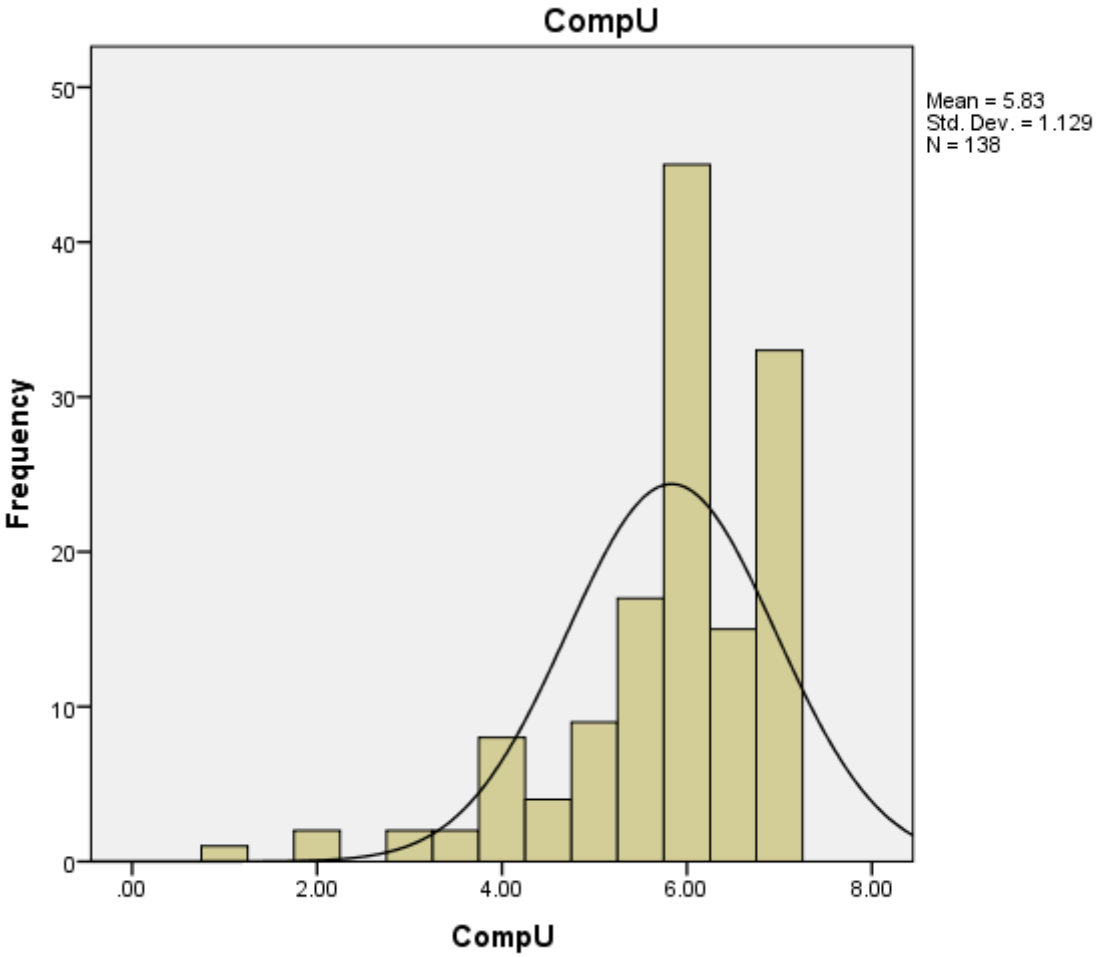
Histogram for normal distribution for the composite variable, Performance Expectancy



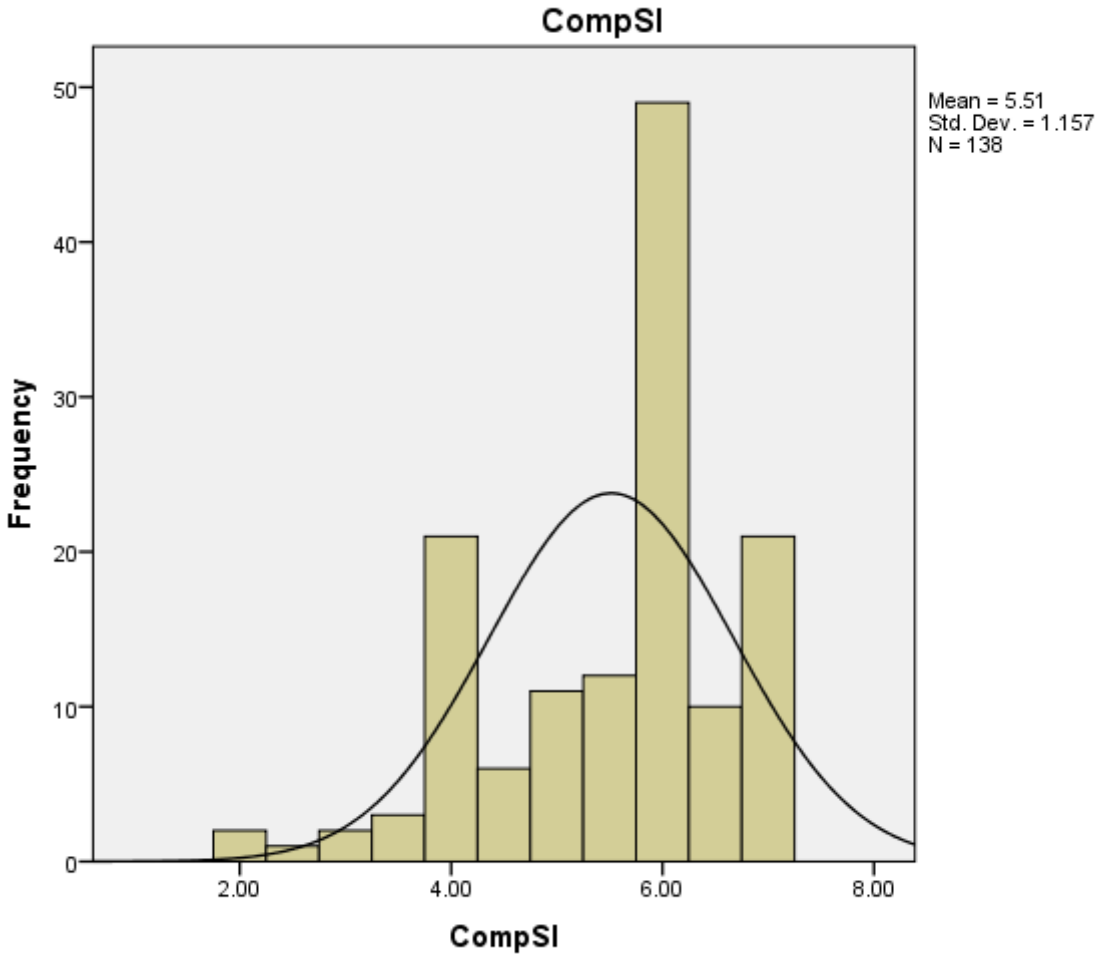
Histogram for normal distribution for the composite variable, Effort Expectancy



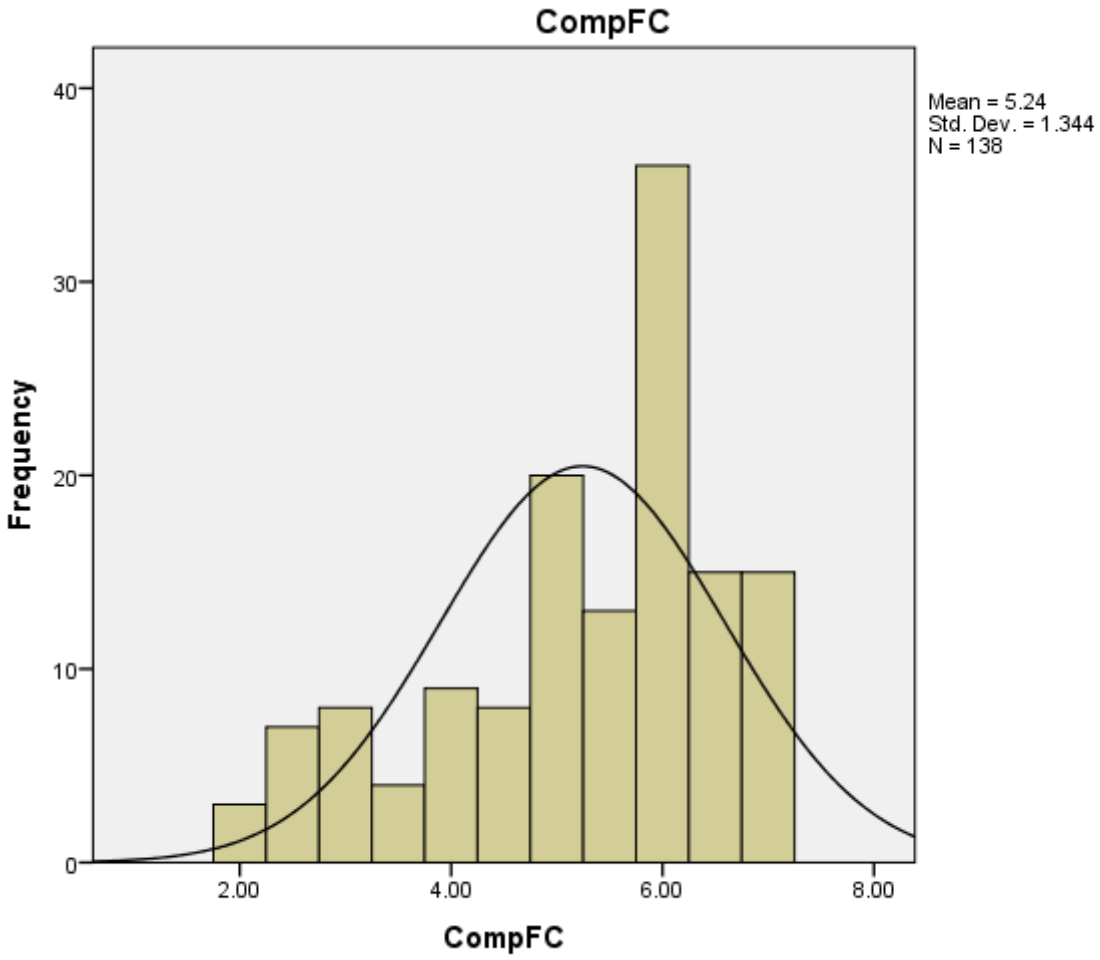
Histogram for distribution for the composite variable, Usage



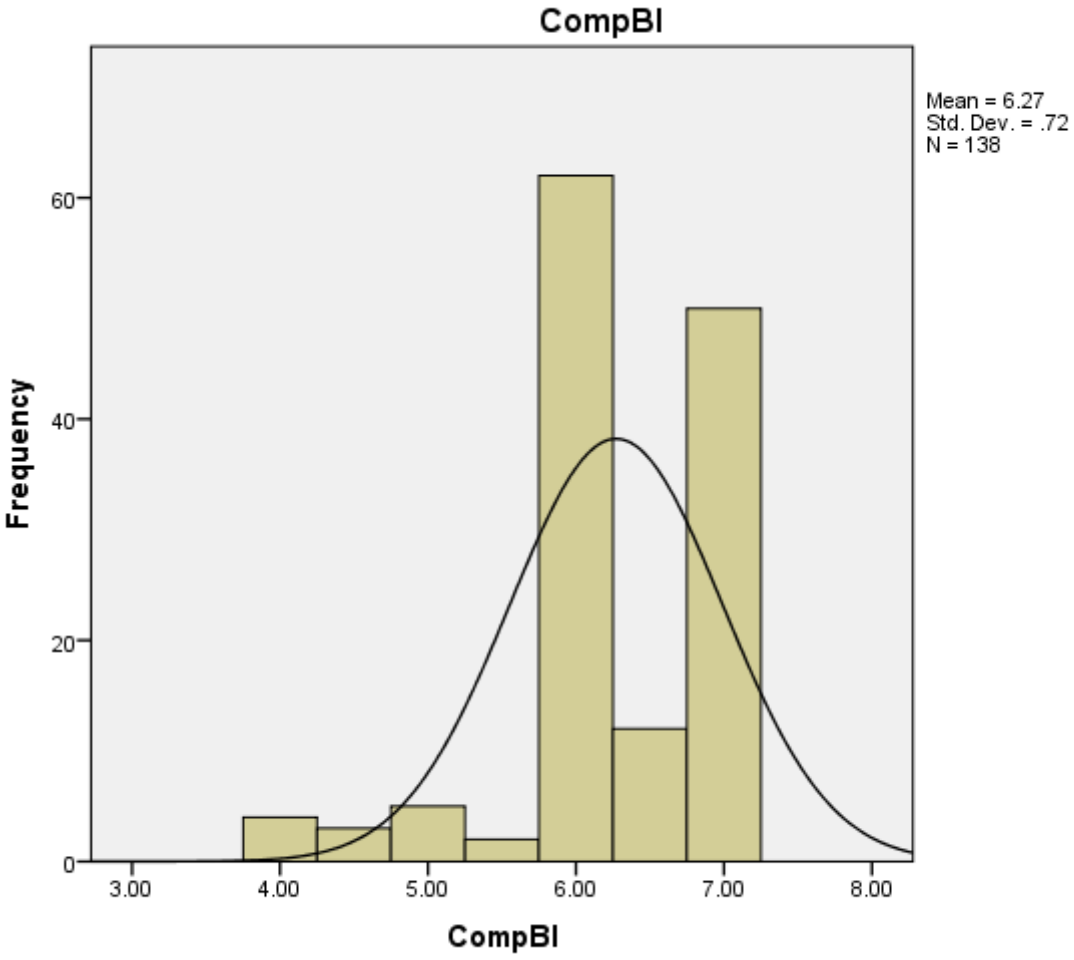
Histogram for normal distribution for the composite variable, Social Influence



Histogram for normal distribution for the composite variable, Facilitating Conditions



Histogram for distribution for the composite variable, Behavioural Intention

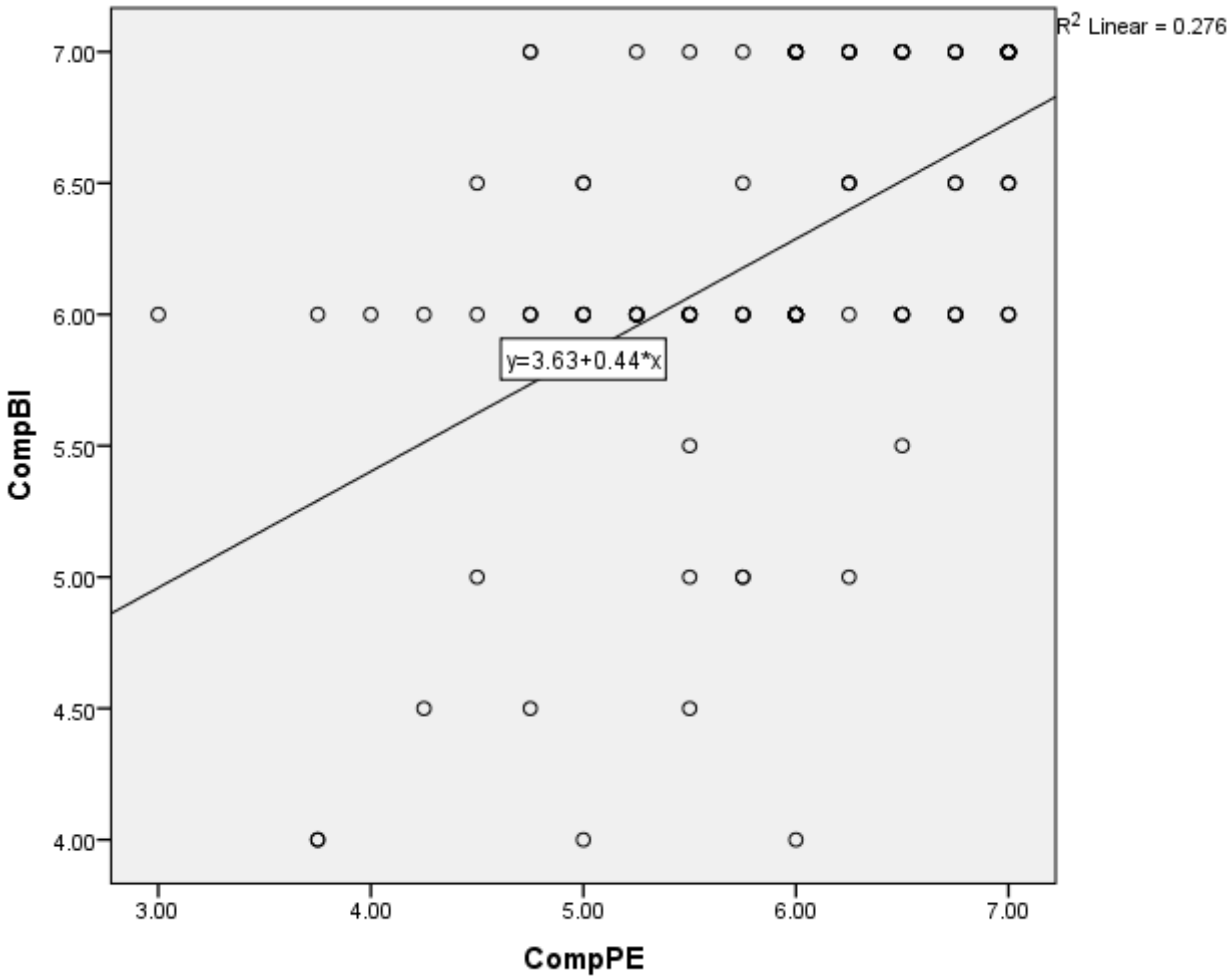


APPENDIX H: SCATTER PLOTS FOR BEHAVIOURAL INTENTION AND USAGE

Scatter Plot for Behavioural Intention and Performance Expectancy

Dependent Variable: Behavioural Intention

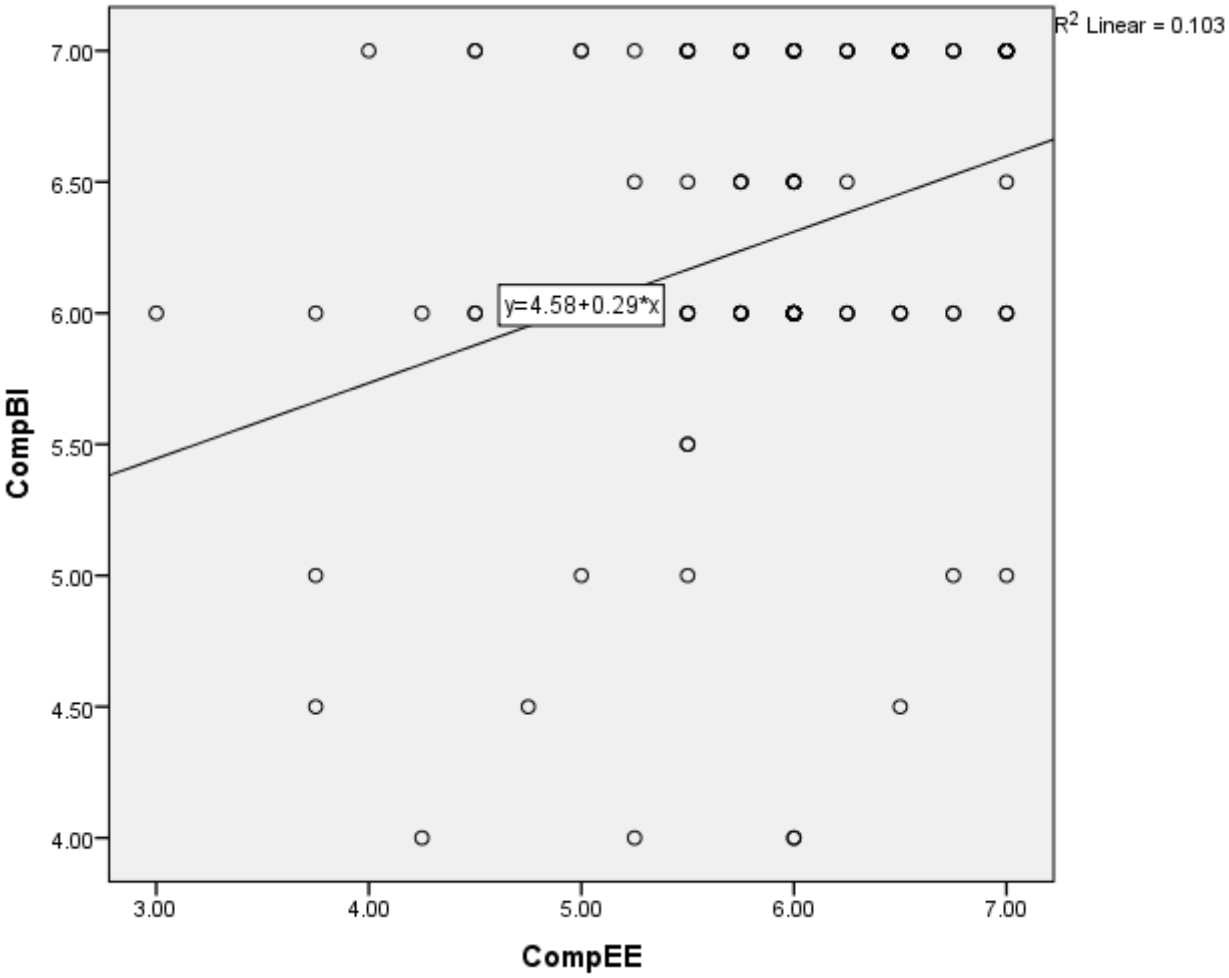
Independent Variable: Performance Expectancy



Scatter Plot for Behavioural Intention and Effort Expectancy

Dependent Variable: Behavioural Intention

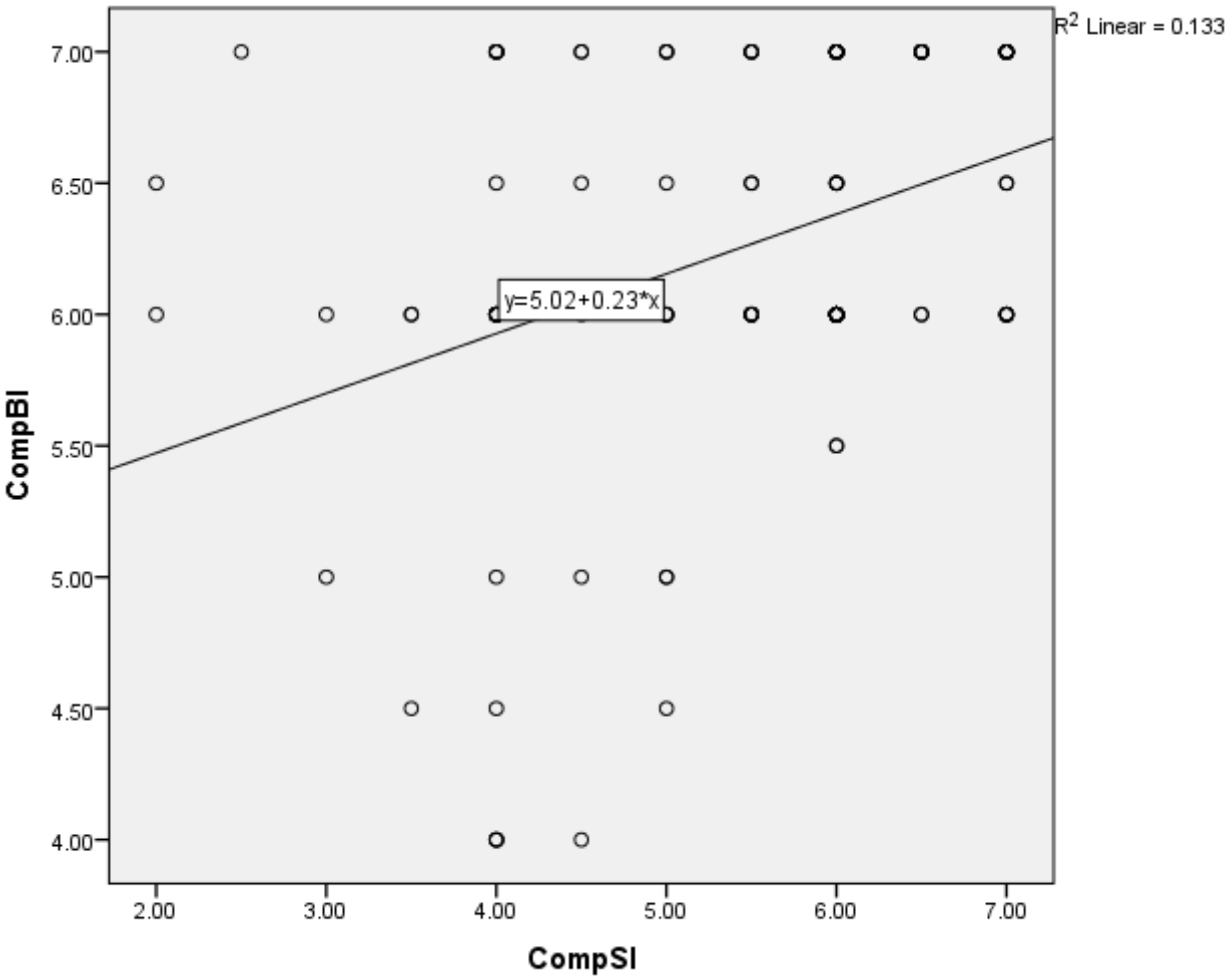
Independent Variable: Effort Expectancy



Scatter Plot for Behavioural Intention and Social Influence

Dependent Variable: Behavioural Intention

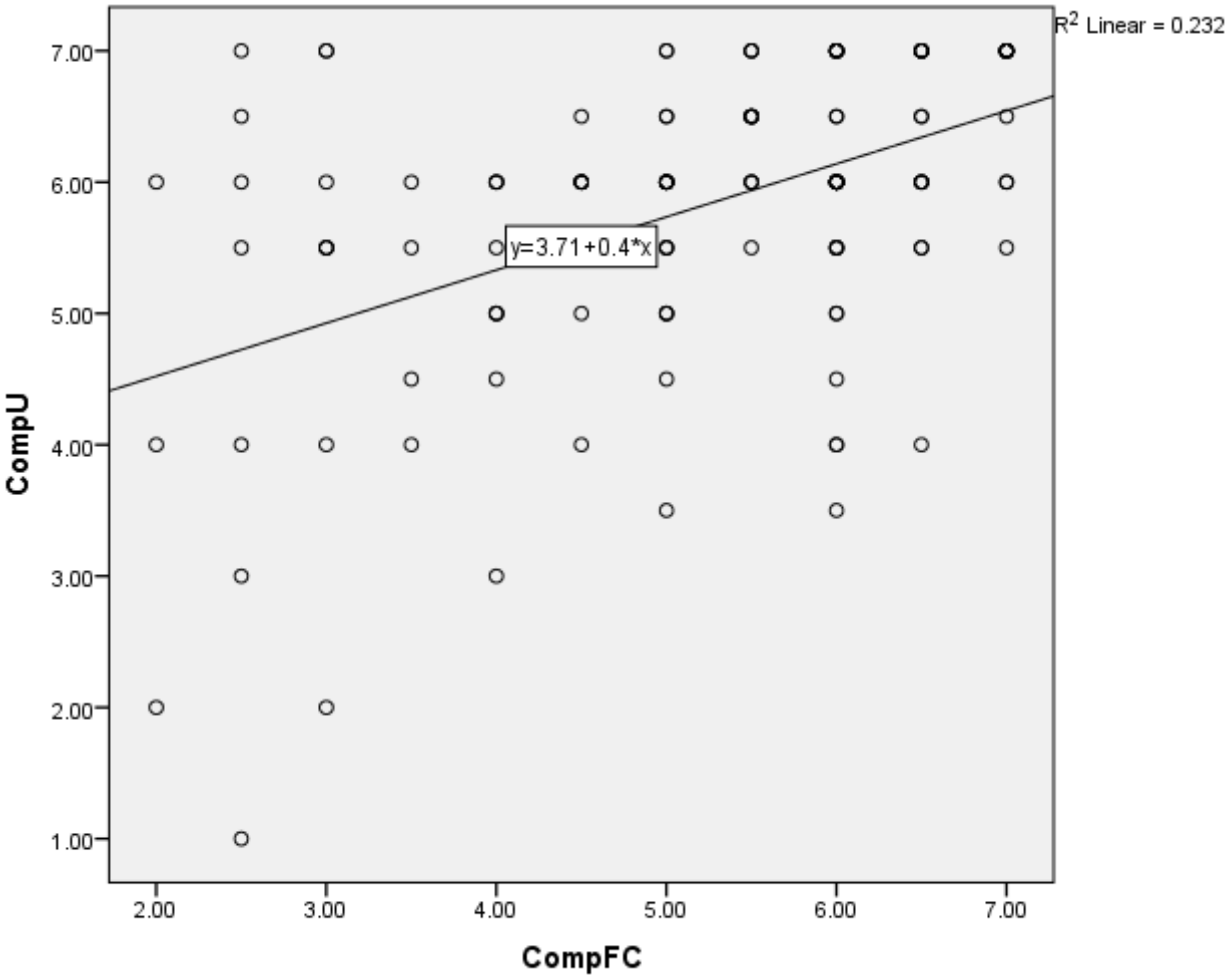
Independent Variable: Social Influence



Scatter Plot for Usage and Facilitating Conditions

Dependent Variable: Usage

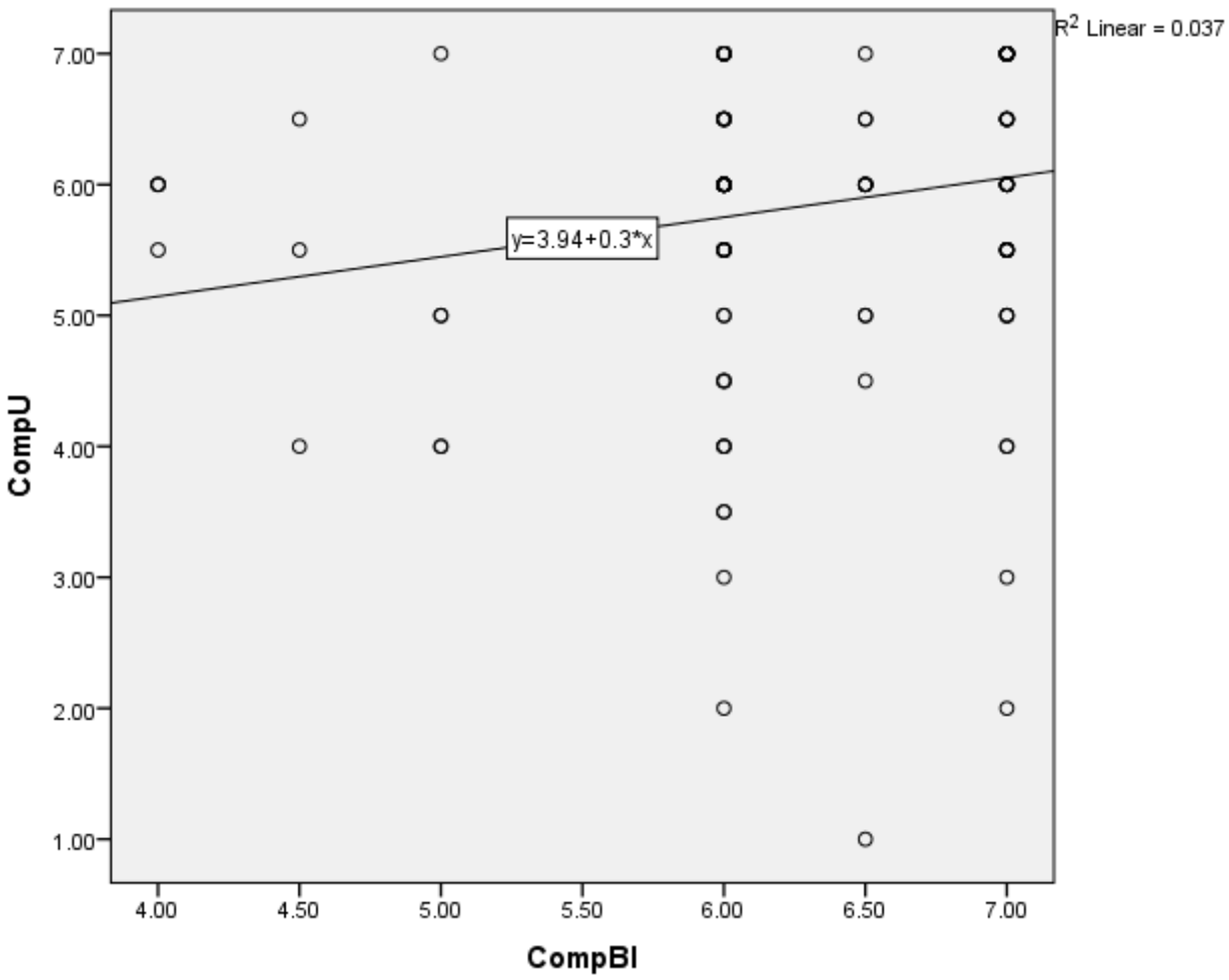
Independent Variable: Facilitating Conditions



Scatter Plot for Usage and Behavioural Intention

Dependent Variable: Usage

Independent Variable: Behavioural Intention



APPENDIX I: INTERACTION TERM DEFINITIONS

Interaction Term Variables	Independent Variable	Moderator Variable	Summary
ModeratorPEandGender	ZCompPE	ZGender	To test the moderating effect of Gender on Performance Expectancy and Behavioural Intention.
ModeratorPEandGender	ZCompPE	ZAge	To test the moderating effect of Age on Performance Expectancy and Behavioural Intention.
ModeratorEEandGender	ZCompEE	ZGender	To test the moderating effect of Gender on Effort Expectancy and Behavioural Intention.
ModeratorEEandAge	ZCompEE	ZAge	To test the moderating effect of Age on Effort Expectancy and Behavioural Intention.
ModeratorEEandAgileExp	ZCompEE	ZAgileExperience	To test the moderating effect of Agile Work Experience on Effort Expectancy and Behavioural Intention.

Interaction Term Variables	Independent Variable	Moderator Variable	Summary
ModeratorEEandITExp	ZCompEE	ZITExperience	To test the moderating effect of IT Work Experience on Effort Expectancy and Behavioural Intention.
ModeratorSIandGender	ZCompSI	ZGender	To test the moderating effect of Gender on Social Influence and Behavioural Intention.
ModeratorSIandAge	ZCompSI	ZAge	To test the moderating effect of Age on Social Influence and Behavioural Intention.
ModeratorSIandAgileExp	ZCompSI	ZAgileExperience	To test the moderating effect of Agile Work Experience on Social Influence and Behavioural Intention.
ModeratorSIandITExp	ZCompSI	ZITExperience	To test the moderating effect of IT Work Experience on Social Influence and Behavioural Intention.
ModeratorSIandVoluntari	ZCompSI	ZVoluntariness	To test the moderating

Interaction Term Variables	Independent Variable	Moderator Variable	Summary
ness		ofUse	effect of Voluntariness of use on Social Influence and Behavioural Intention.
ModeratorFCandAge	ZCompFC	ZAge	To test the moderating effect of Age on Facilitating Conditions and Usage.
ModeratorFCandITExp	ZCompFC	ZITExperience	To test the moderating effect of IT Work Experience on Facilitating Conditions and Usage.
ModeratorFCandAgileExp	ZCompFC	ZAgileExperience	To test the moderating effect of Agile Work Experience on Facilitating Conditions and Usage.

APPENDIX J: MODERATING VARIABLES RESULTS

I. Age on Performance Expectancy and Behavioural Intention

The moderating effect of Age in the relationship between Performance Expectancy and Behavioural Intention was tested. Multiple regression analysis was run. The R Square had a value of .284 which means the regression model explained about 28% of the variance in Behavioural Intention. The ANOVA tests showed that the R^2 was significant with $p<0.001$. Performance Expectancy was the strongest predictor of Behavioural Intention than Age. Performance Expectancy had a Beta Coefficient of .544 with $p<0.001$. Age had a Beta Coefficient of .025 indicating that there was a very weak moderating effect of Age with $p>0.5$. Age was found not to be a moderator in this relationship. Tables 28, 29 and 80 below show the regression model results.

R	R Square	Adjusted R Square	Std Error of the Estimate
.533	.284	.268	.61615

Table 28: Regression model summary for Behavioural Intention

ANOVA	Sum of Squares	Df	Mean Square	F	Sig
Regression	20.188	3	6.729	17.725	.000
Residual	50.872	134	.380		
Total	71.060	137			

Table 29: ANOVA Test for the R Square

Variable	Unstandardized *B*	Coefficient Std Error	Standardized Coefficient Beta	t	Sig
Zscore: CompPE	.392	.054	.544	7.277	.000
Zscore(Age)	.018	.053	.025	.340	.734
ModeratorPEandAge	-.058	.050	-.086	-1.160	.248

Table 30: Beta coefficients for each Predictor variable for Behavioural Intention

Using the Beta Coefficients in Table 29, an Interaction plot was created. The plot showed that the difference in change across the age variable was almost the same for different levels of Performance Expectancy. Varying the age or performance expectancy had no impact on Behavioural Intention. This indicates that age had no moderating effect in the relationship between Performance Expectancy Behavioural Intention. Figure 10 shows the Plot diagram, and indicates the level of change in age for Low Performance Expectancy and High Performance Expectancy:

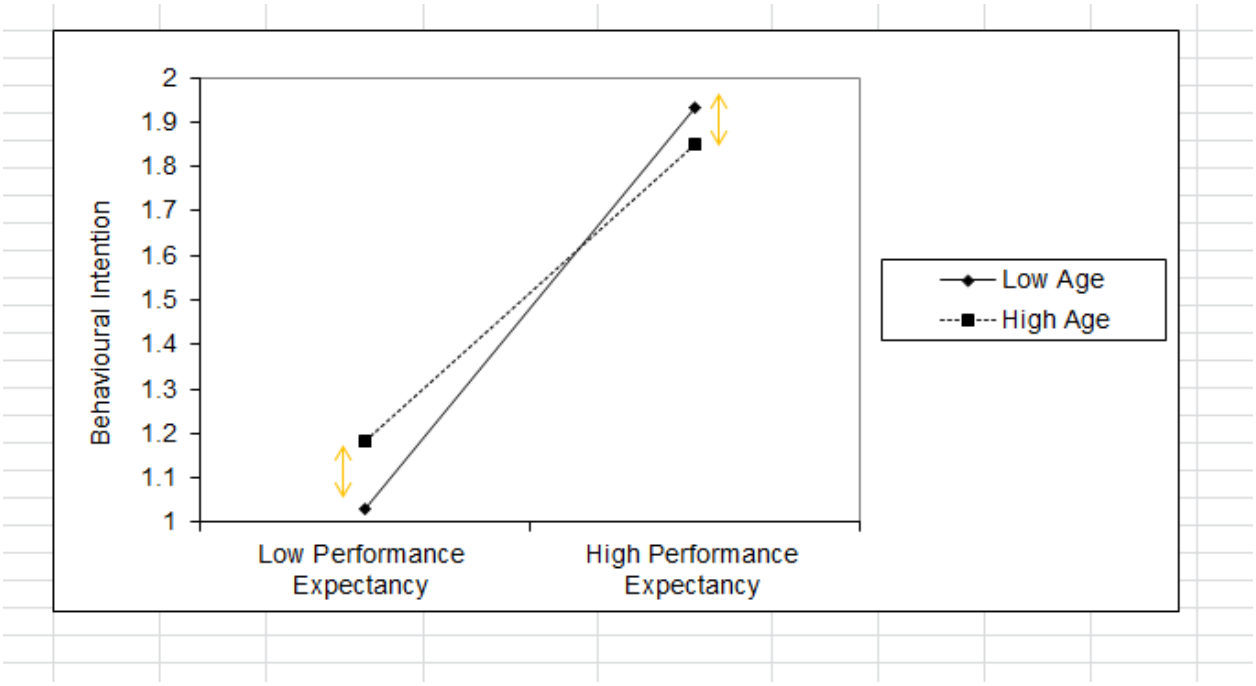


Figure 10: Interaction plot of Age on Performance Expectancy and Behavioural Intention

The second Interaction plot was created varying the standard deviations. The change in standard deviations also did not show any significant change in Performance Expectancy or Behavioural Intention. This also proved that age had no moderating effect in the relationship between Performance Expectancy Behavioural Intention. Figure 11 shows the interaction plot across different standard deviations:

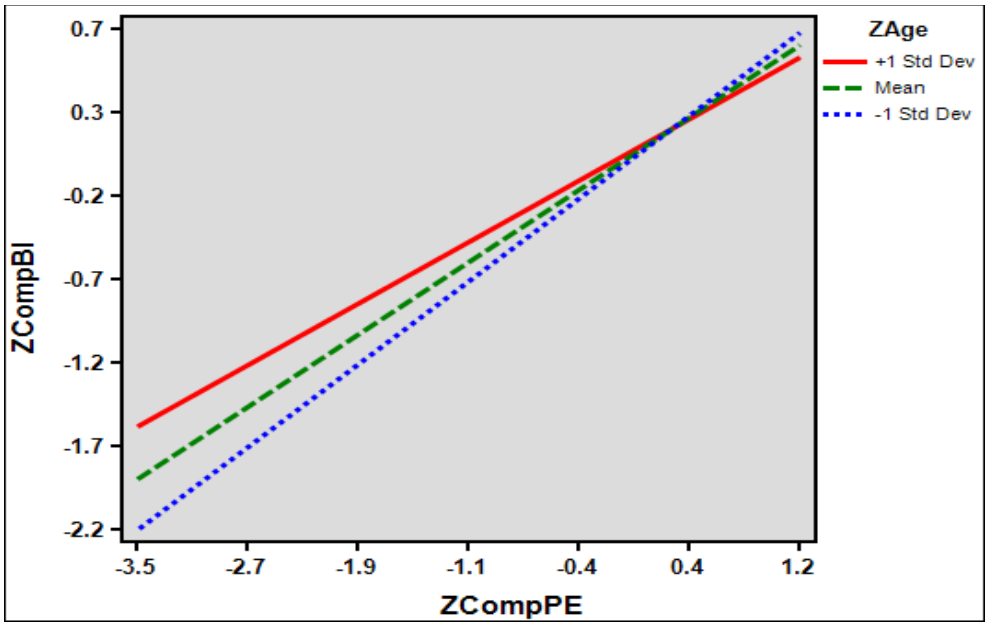


Figure 11: Plot varying SD of Age on Performance Expectancy and Behavioural Intention

II. Age on Effort Expectancy and Behavioural Intention

The test for the moderating effect of Age on Effort Expectancy and Behavioural Intention was done. The regression model had an R value of .323 and an R Square of .105 which means the model explained about 11% of the variance in Behavioural Intention. The ANOVA tests showed that the R^2 was significant with $p<0.002$. The Beta Coefficients however showed that there was a very weak moderating effect of Age with $p=0.695$. Age had a Beta Coefficient of .024. Age was found not to have a moderating effect on the relationship between effort expectancy and behavioural intention. Tables 31, 32 and 33 below show the regression model results.

R	R Square	Adjusted R Square	Std Error of the Estimate
.323	.105	.084	.68911

Table 31: Regression model summary for Behavioural Intention

ANOVA	Sum of Squares	Df	Mean Square	F	Sig
Regression	7.426	3	2.475	5.213	.002
Residual	63.634	134	.475		
Total	71.060	137			

Table 32: ANOVA Test for the R Square

Variable	Unstandardized *B*	Coefficient Std Error	Standardized Coefficient Beta	t	Sig
Zscore(CompEE)	.238	.061	.331	3.922	.000
Zscore(Age)	.024	.060	.033	.394	.695
ModeratorEEandAge	-.014	.058	-.020	-.238	.812

Table 33: Beta coefficients for each Predictor variable for Behavioural Intention

The first interaction plot had parallel lines implying that there was no interaction between the independent variables. Low Age and High Age had lines with a similar gradient, indicating a linear relationship irrespective of the age. A possible interaction would have been found at much higher levels of Effort Expectancy. The plot showed that age did not have a moderating effect in the relationship between Effort expectancy and Behavioural Intention. Figure 12 shows the first plot:

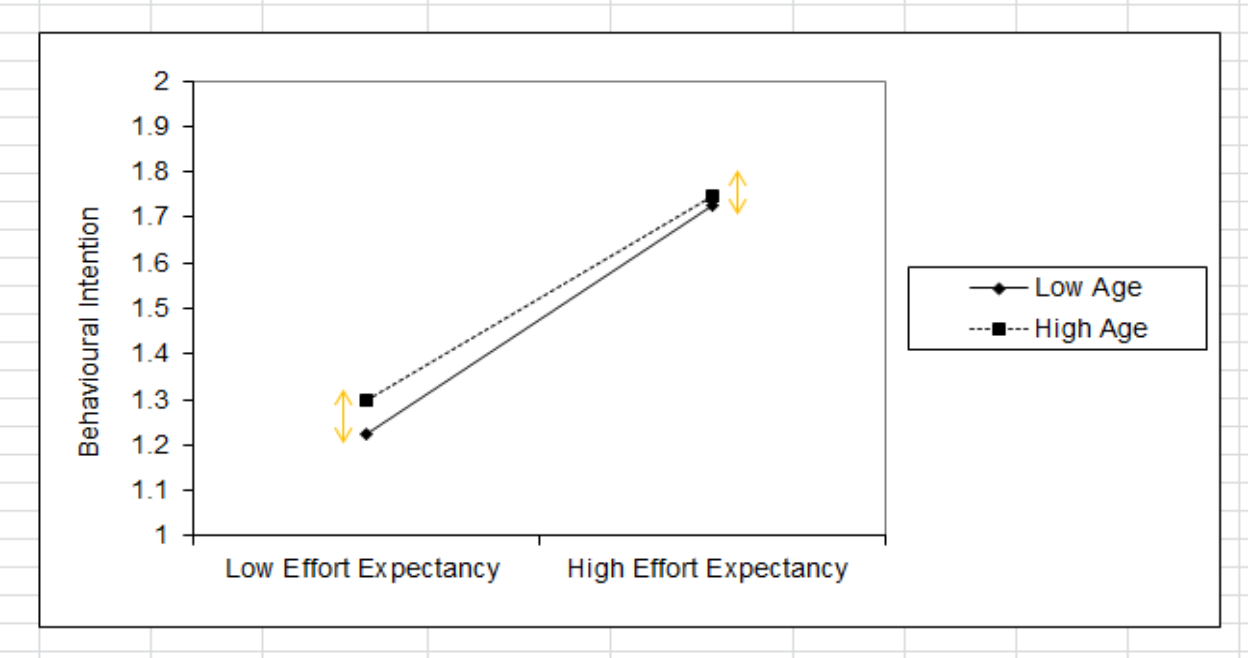


Figure 12: Microsoft Excel Interaction plot of Age on Effort Expectancy and Behavioural Intention

Another plot was created varying the standard deviation. Despite varying the standard deviation, there was a similar result to the first plot. There was no change in slope gradient despite the level of Effort Expectancy across different age groups. Figure 13 shows the plot:

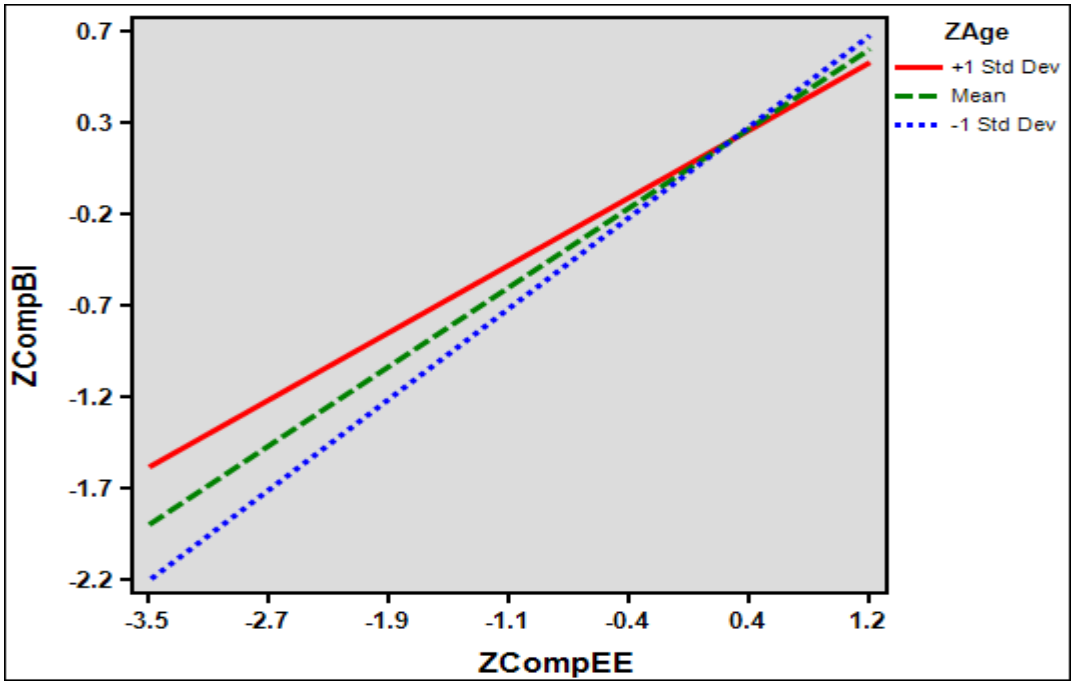


Figure 13: Plot varying SD of Age on Effort Expectancy and Behavioural Intention

III. Age on Social Influence and Behavioural Intention

The moderating effect of Age on Social Influence and Behavioural Intention was tested. The regression model had an R Square with a value of .134. The model could only explain about 13% of the variance in Behavioural Intention. The ANOVA tests showed that the R^2 was significant with $p<0.001$. The Beta Coefficients however showed that Age did not have any significance as a moderator with $p = .875$. Social influence was found to be a significant predictor of behavioural intention. Age was found not to have any moderating effect on Social Influence and Behavioural Intention. Tables 34, 35 and 36 below show the regression Model results.

R	R Square	Adjusted R Square	Std Error of the Estimate
.366	.134	.114	.67781

Table 34: Regression model summary for Behavioural Intention

ANOVA	Sum of Squares	Df	Mean Square	F	Sig
Regression	9.496	3	3.165	6.890	.000
Residual	61.564	134	.459		
Total	71.060	137			

Table 35: ANOVA Test for the R Square

Variable	Unstandardized *B*	Coefficient Std Error	Standardized Coefficient Beta	t	Sig
Zscore(Age)	-.009	.058	-.013	-.158	.875
Zscore: CompSI	.262	.058	.364	4.514	.000
ModeratorSIandAge	.006	.064	.007	.092	.926

Table 36: Beta coefficients for each Predictor variable for Behavioural Intention

The Microsoft Excel plot was created to show the visual relationship of the variables. The lines were almost overlaid on each other, indicating no difference in Social Influence across different age groups. Irrespective of any change in age there was no effect on Social Influence and Behavioural Intention. Figure 14 shows the interaction diagram:

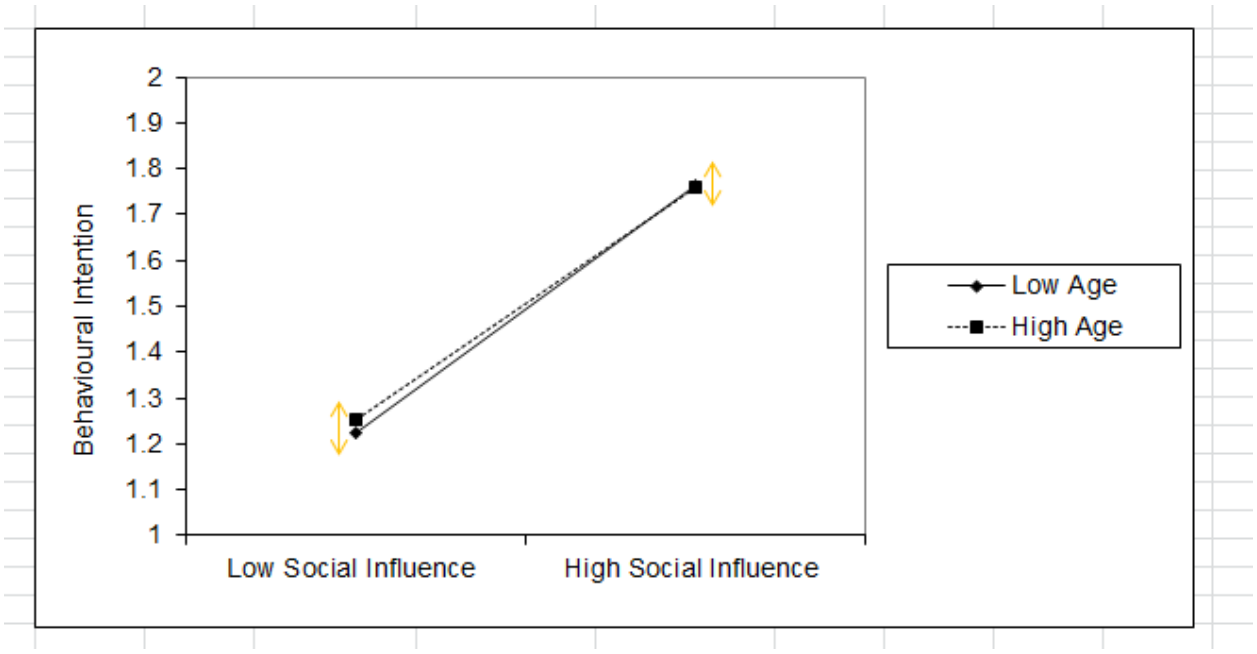


Figure 14: Interaction plot of Age on Social Influence and Behavioural Intention

The second interaction plot was created varying the standard deviations of age. The gradient and look of the graph was similar to the first plot. Any changes in age across Social Influence had no effect on Behavioural Intention. Figure 15 shows the second plot:

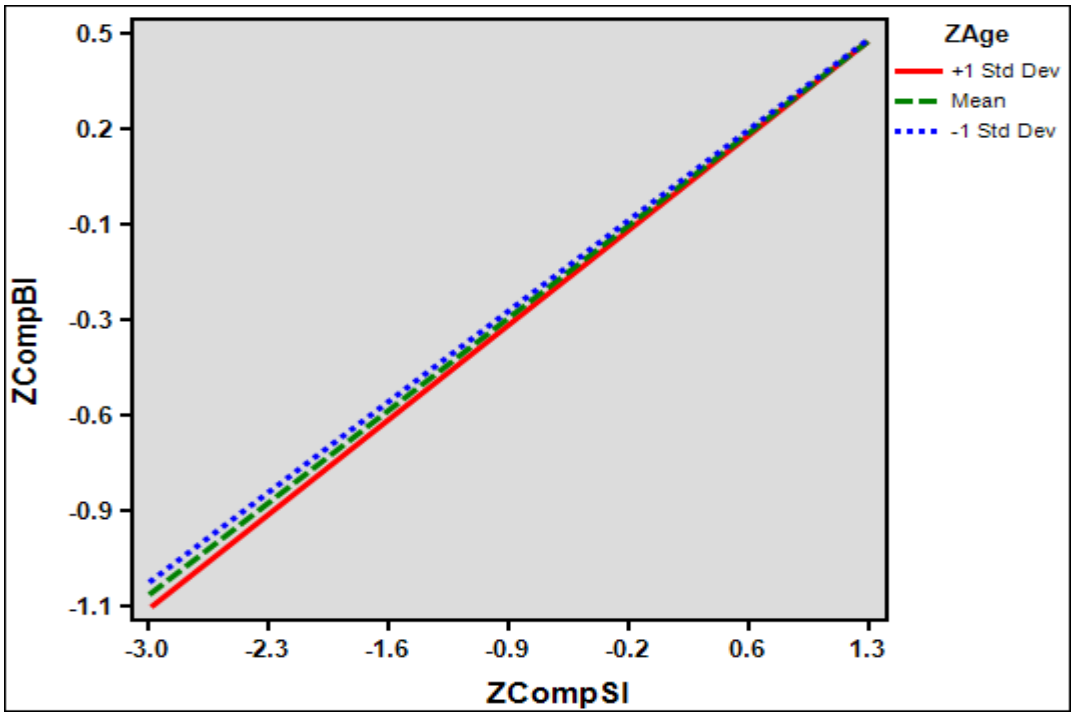


Figure 15: Plot varying SD of Age on Social Influence and Behavioural Intention

IV. Age on Facilitating Conditions and Usage

The moderating effect of Age on Facilitating Conditions and Usage was tested. The regression model had an R Square of .269 which means the regression model explained only about 27% of the variance in Usage. The ANOVA tests showed that the R^2 was significant with $p<0.001$. The Interaction variable indicated that the combination of Age and Social Influence did have an impact on Behavioural intention with a Beta Coefficient of .180 and $p<0.5$. Age on its own however did not have any significant effect. Age was found not to have any moderating effect on facilitating conditions and usage. Tables 37, 38 and 39 below shows the regression model results.

R	R Square	Adjusted R Square	Std Error of the Estimate
.519	.269	.253	.97603

Table 37: Regression model summary for Usage

ANOVA	Sum of Squares	Df	Mean Square	F	Sig
Regression	47.014	3	15.671	16.450	.000
Residual	127.653	134	.953		
Total	174.667	137			

Table 38: ANOVA Test for the R Square

Variable	Unstandardized *B*	Coefficient Std Error	Standardized Coefficient Beta	t	Sig
Zscore: CompFC	.535	.083	.474	6.415	.000
ModeratorFCandAge	.188	.077	.180	2.434	.016
Zscore(Age)	-.093	.084	-.083	-1.116	.267

Table 39: Beta coefficients for each Predictor variable for Usage

The first plot had parallel lines, with a similar gradient in slope. The parallel lines indicated that there was no moderation by age in the relationship between Facilitating Conditions and Usage. The similar gradient in Low Age and High Age indicated that irrespective of the age there was no effect on Facilitating conditions and Usage. Figure 16 shows the plot:

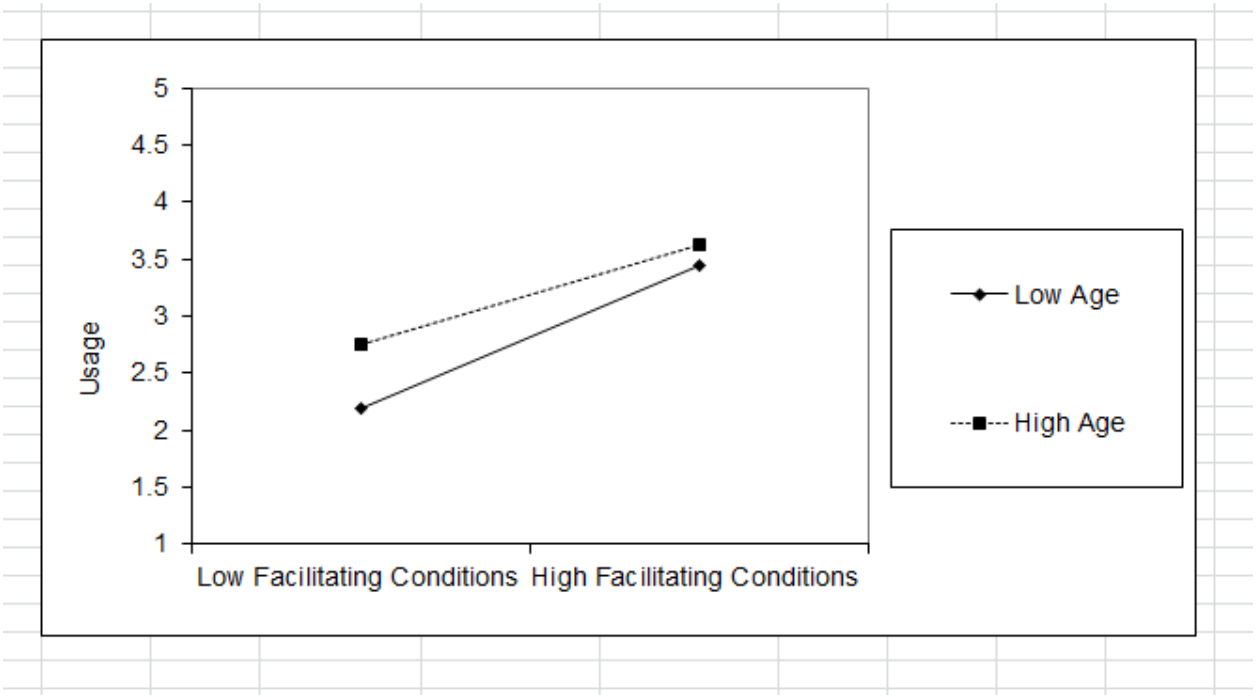


Figure 16: Interaction plot of Age on Facilitating Conditions and Usage

Across different standard deviations the change in usage was the same irrespective of the effect age and Facilitating Conditions. The second plot indicated the same result as the first Microsoft Excel plot. Figure 17 shows the plot:

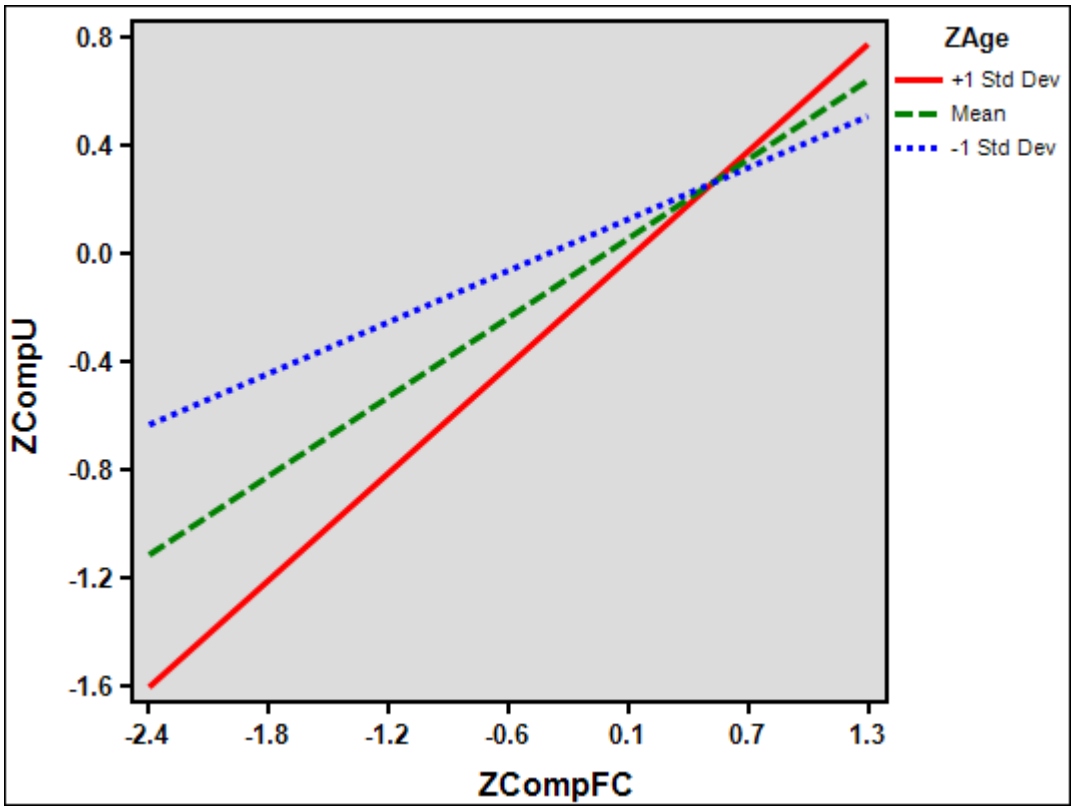


Figure 17: Plot varying SD of Age on Facilitating Conditions and Usage

V. Gender on Performance Expectancy and Behavioural Intention

The effect of Gender on Performance Expectancy and Behavioural Intention was tested. The R Square had a value of .277 which means the regression model explained about 28% of the variance in Behavioural Intention. The ANOVA tests showed that the R^2 was significant with $p<0.001$. The Beta Coefficients confirmed the existing results that Performance Expectancy was a significant and strong predictor of Behavioural Intention. Performance Expectancy had a weighting of .529 ($p<0.001$). Gender was found not to have a significant effect with $p=0.912$ and $B= -0.08$. Gender was found not to have any moderating effect on Performance Expectancy and Behavioural Intention. Tables 40, 41 and 42 below show the regression model results.

R	R Square	Adjusted R Square	Std Error of the Estimate
.526	.277	.261	.61914

Table 40: Regression model summary for Behavioural Intention

ANOVA	Sum of Squares	Df	Mean Square	F	Sig
Regression	19.692	3	6.564	17.124	.000
Residual	51.367	134	.383		
Total	71.060	137			

Table 41: ANOVA Test for the R Square

Variable	Unstandardized *B*	Coefficient Std Error	Standardized Coefficient Beta	t	Sig
Zscore(Gender)	-.006	.053	-.008	-.111	.912
ModeratorPEandGender	.019	.052	.026	.357	.722
Zscore: CompPE	.381	.053	.529	7.142	.000

Table 42: Beta coefficients for each Predictor variable for Behavioural Intention

Using the Beta Coefficients in the table above, an Interaction plot was created. The plot had parallel lines indicating that there was no moderation by age on Performance Expectancy and Behavioural Intention. The lines also indicated a linear relationship for males and females, meaning gender had on Performance Expectancy and Behavioural Intention. Figure 18 shows the Plot:

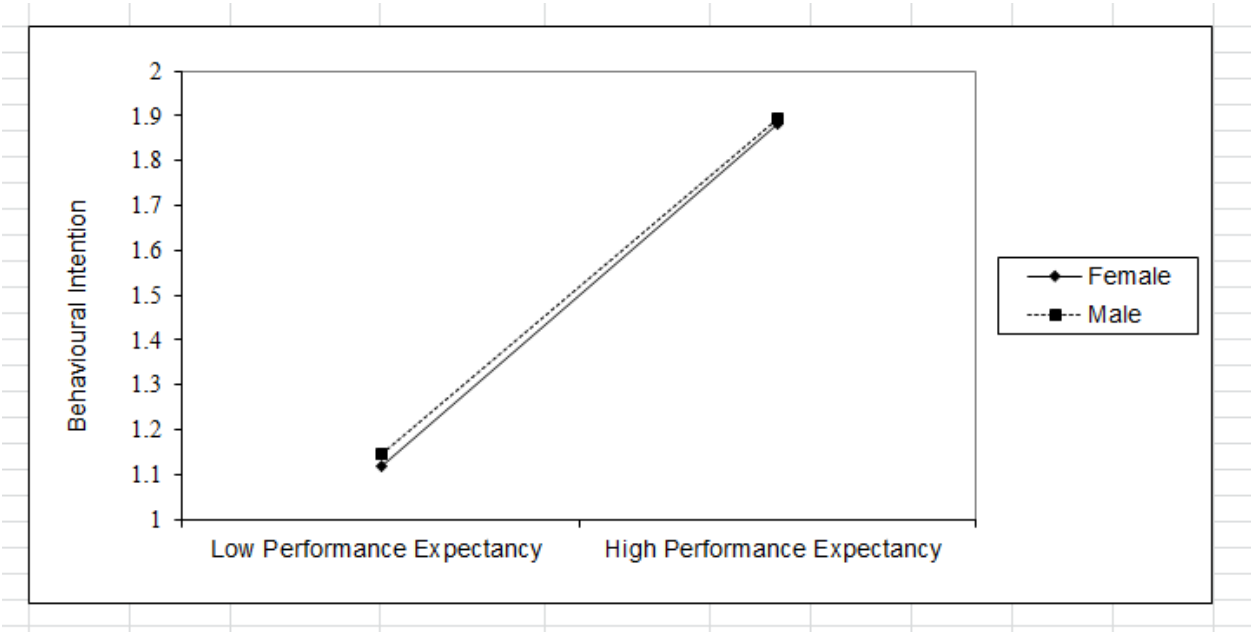


Figure 18: Interaction plot of Gender on Performance Expectancy and Behavioural Intention

The second plot also showed no effect of Gender on Performance Expectancy and Behavioural Intention. Despite varying the standard deviations the plot visually looked similar in gradient to the first plot. Figure 19 shows the Plot:

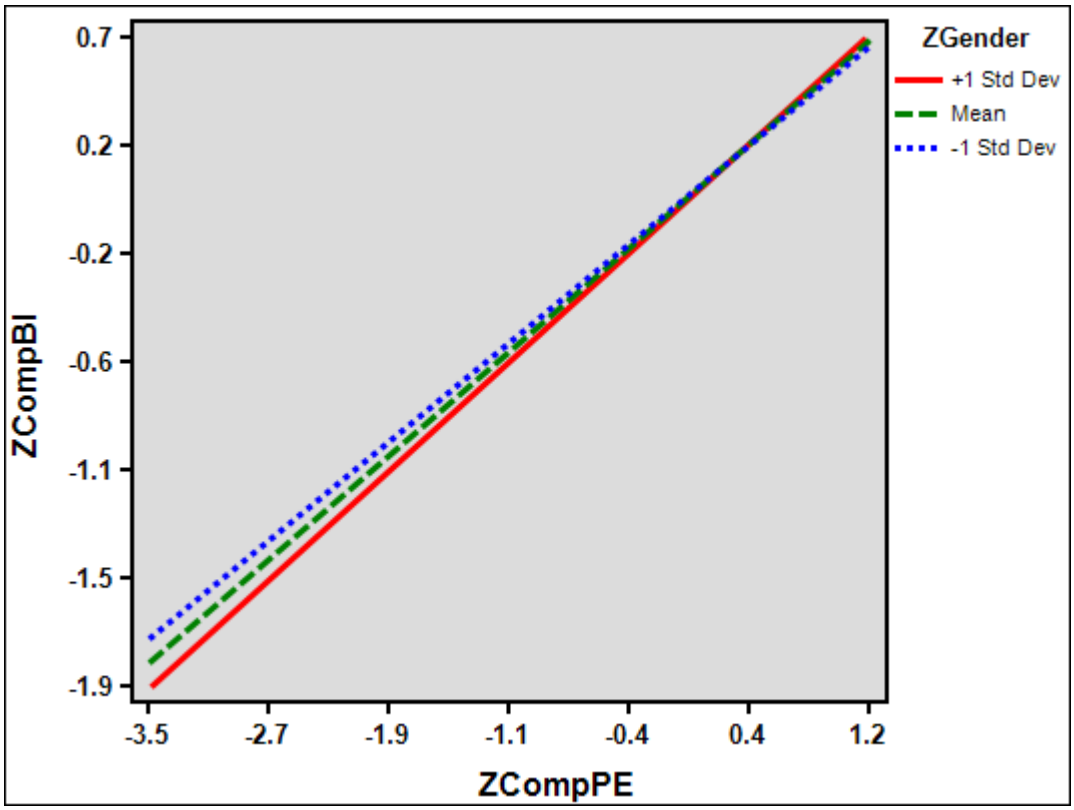


Figure 19: Plot varying SD of Gender on Performance Expectancy and Behavioural Intention

VI. Gender on Effort Expectancy and Behavioural Intention

The moderating effect of Gender on Effort Expectancy and Behavioural Intention was tested. The regression model had an R Square had a value of .103 which means the model explained about 10% of the variance in Behavioural Intention. The ANOVA tests showed that the R^2 was significant with $p<0.002$. The Beta Coefficients however showed that there was no significant relationship of Gender. Gender had a B value of .001 ($p=.987$). The model did however confirm that Effort Expectancy was a significant predictor of Behavioural Intention. Possible moderation by age was however not supported. Tables 43, 44 and 45 below show the regression model results.

R	R Square	Adjusted R Square	Std Error of the Estimate
.321	.103	.083	.68968

Table 43: Regression model Summary for Behavioural Intention

ANOVA	Sum of Squares	Df	Mean Square	F	Sig
Regression	7.321	3	2.440	5.130	.002
Residual	63.739	134	.476		
Total	71.060	137			

Table 44: ANOVA Test for the R Square

Variable	Unstandardized *B*	Coefficient Std Error	Standardized Coefficient Beta	t	Sig
Zscore(CompEE)	.231	.059	.321	3.913	.000
Zscore(Gender)	.001	.059	.001	.016	.987
ModeratorEEandGender	-.001	.059	-.002	-.022	.982

Table 45: Beta coefficients for each Predictor variable for Behavioural Intention

Using the coefficients above, an Interaction plot was created. The lines for females and males were overlaid on each other, showing that there was no effect of gender on varying levels of Effort Expectancy. Figure 20 shows the Plot:

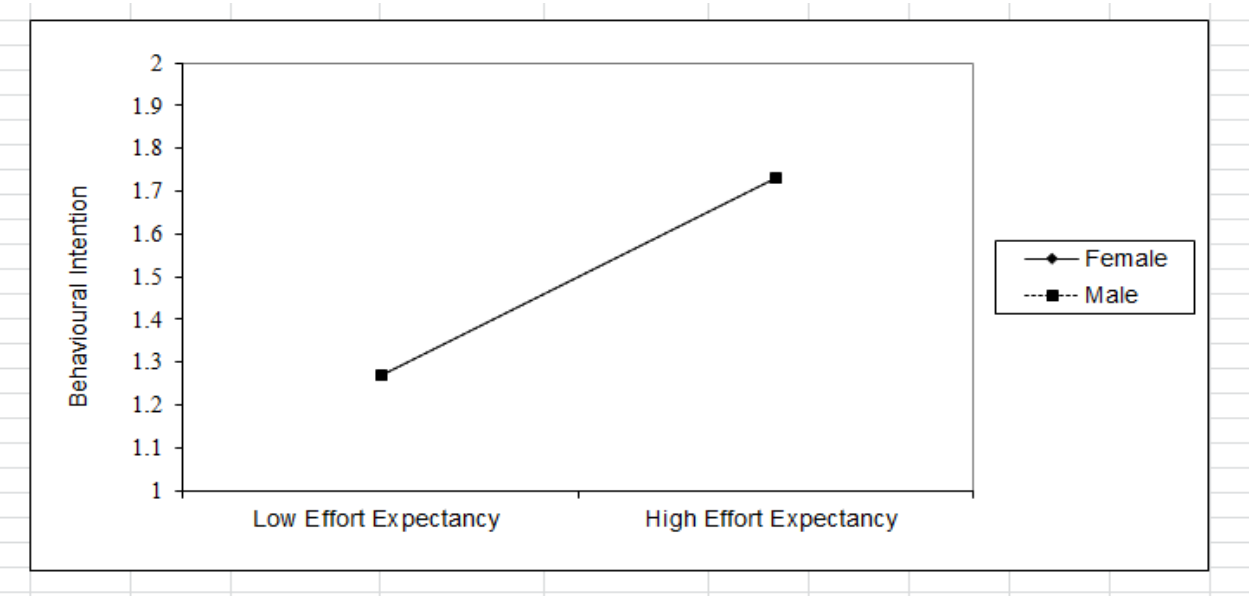


Figure 20: Plot of Gender on Effort Expectancy and Behavioural Intention

The visual representation of the mean, 1SD and -1SD also showed no moderating effect of gender. The lines were also almost overlaid on each other across different standard deviations varying levels of Effort Expectancy. The Interaction plot in Figure 21 shows the representation at varying standard deviations:

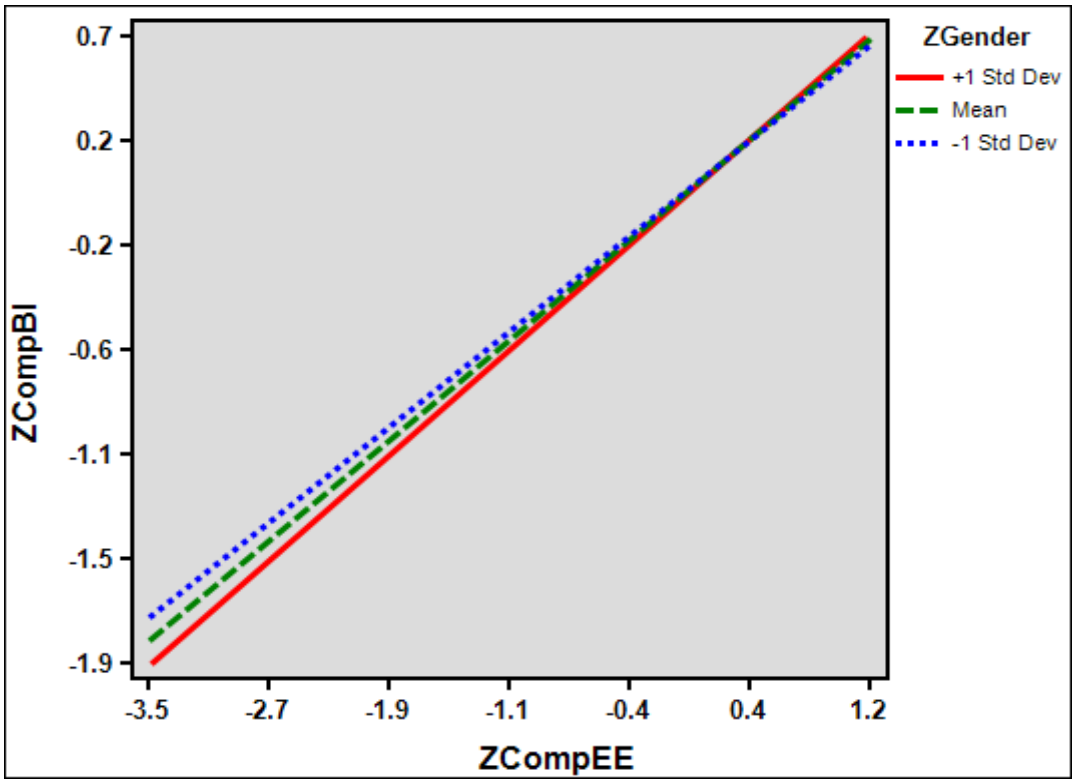


Figure 21: Plot varying SD of Gender on Effort Expectancy and Behavioural Intention

VII. Gender on Social Influence and Behavioural Intention

The moderating effect of Gender on Social Influence and Behavioural Intention was tested. The R Square had a value of .134 which means the model explained about 13% of the variance in Behavioural Intention. The ANOVA tests showed that the R^2 was significant with $p<0.001$. Social influence was found to be a strong predictor of behavioural intention. Possible moderation of gender on the relationship between social influence and behavioural intention was not supported. Tables 46, 47 and 48 below show the regression model results.

R	R Square	Adjusted R Square	Std Error of the Estimate
.367	.134	.115	.67751

Table 46: Regression model Summary for Behavioural Intention

ANOVA	Sum of Squares	Df	Mean Square	F	Sig
Regression	9.552	3	3.184	6.936	.000
Residual	61.508	134	.459		
Total	71.060	137			

Table 47: ANOVA Test for the R Square

Variable	Unstandardized *B*	Coefficient Std Error	Standardized Coefficient Beta	t	Sig
Zscore(CompSI)	.266	.058	.014	.168	.000
Zscore(Gender)	.010	.058	.014	.168	.867
ModeratorSIandGender	-.020	.057	.029	.354	.724

Table 48: Beta coefficients for each Predictor variable for Behavioural Intention

The first interaction plot showed that the difference in gender was almost the same for different levels of Social influence. This implies that irrespective of the gender, there was no effect in the relationship between Social Influence and Behavioural Intention. Figure 22 shows the plot:

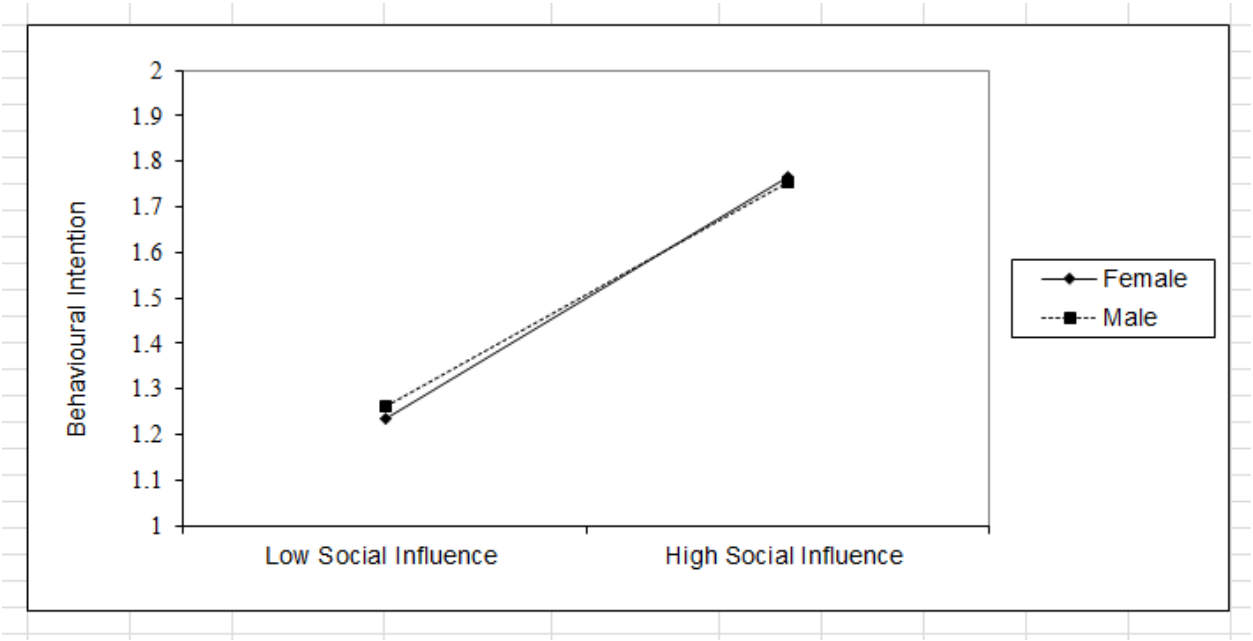


Figure 22: Interaction plot of Gender on Social Influence and Behavioural Intention

Another plot was created varying the standard deviation. Irrespective of the standard deviation, there were no changes in Social Influence. Gender did not show any significant effect on Social Influence and Behavioural Intention. Figure 23 shows the plot:

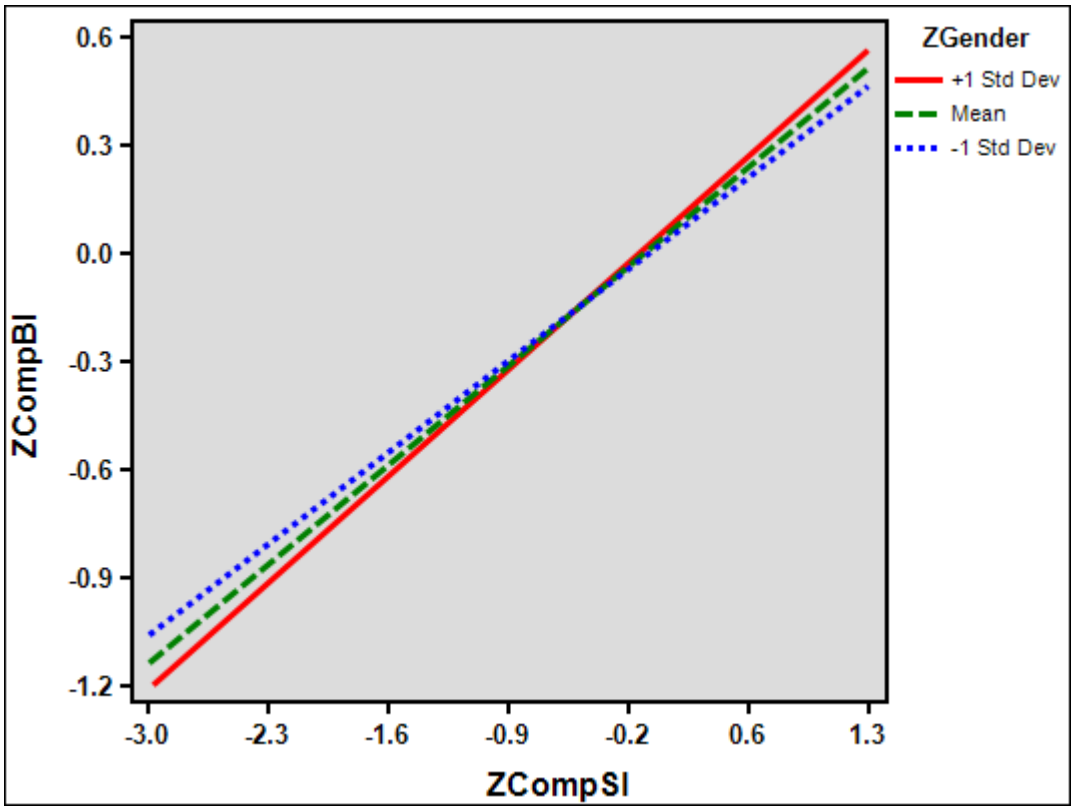


Figure 23: Interaction Plot of Gender on Social Influence and Behavioural Intention using different SDs

VIII. Agile Experience on Effort Expectancy and Behavioural Intention

The effect of Agile Experience on Performance Expectancy and Behavioural Intention was tested. The regression model had an R Square of .108. Based on the ANOVA tests R^2 was significant with p=0.001. The Beta Coefficients confirmed the existing results were Effort Expectancy was found to be a significant predictor of Behavioural Intention with a weighting of .325 (p<0.001). Agile Experience was found not to have a significant effect with p=.696 and B=-.035. The moderating effect of Agile Experience on Performance Expectancy and Behavioural Intention was not supported. Tables 49, 50 and 51 below show the Regression Model results.

R	R Square	Adjusted R Square	Std Error of the Estimate
.329	.108	.088	.68766

Table 49: Regression model summary for Behavioural Intention

ANOVA	Sum of Squares	Df	Mean Square	F	Sig
Regression	7.694	3	2.565	5.423	.001
Residual	63.366	134	.473		
Total	71.060	137			

Table 50: ANOVA Test for the R Square

Variable	Unstandardized *B*	Coefficient Std Error	Standardized Coefficient Beta	T	Sig
Zscore(CompEE)	.234	.060	.325	3.902	.000
Zscore(AgileExperience)	-.025	.064	-.035	-.391	.696
ModeratorEEandAgileExp	-.040	.066	-.053	-.605	.547

Table 51: Beta coefficients for each Predictor variable for Behavioural Intention

An interaction plot was created. The plot showed that varying levels of agile experience had almost the same effect for different levels of Effort Expectancy. This meant that changes in agile experience had no effect on Effort Expectancy and Behavioural Intention. Figure 24 shows the plot with the results:

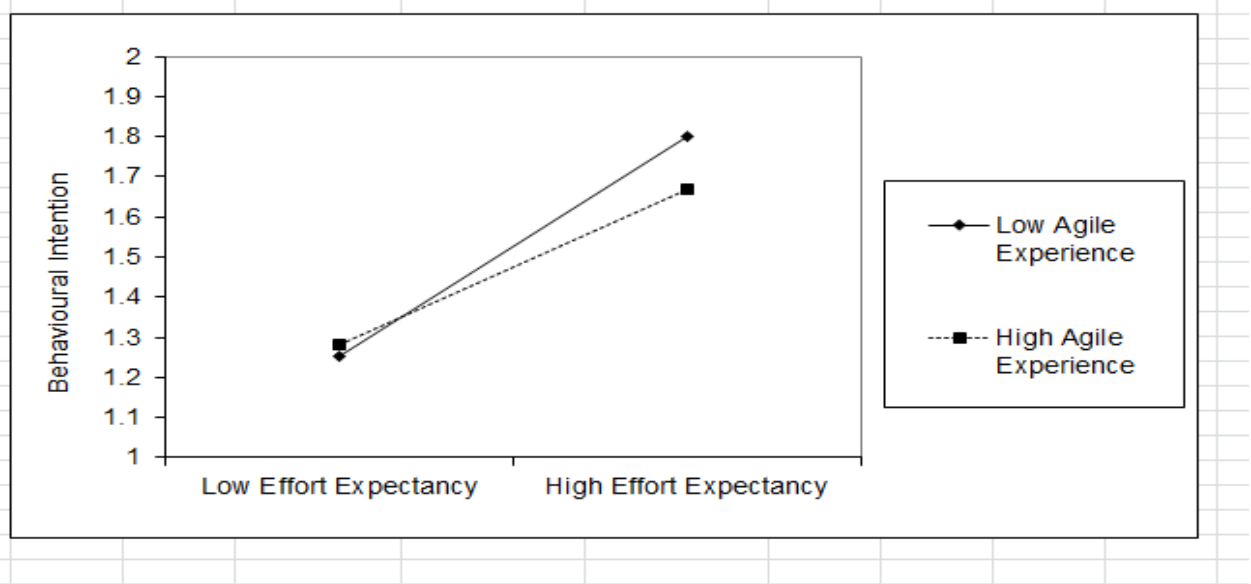


Figure 24: Interaction Plot of Agile Experience on Effort Expectancy and Behavioural Intention

The second plot showed the same change across different standard deviations. The lines were equally spaced from the mean. This implied that differences in agile experience did not result in any changes on the relationship between Effort Expectancy and Behavioural Intention. Figure 25 shows the results:

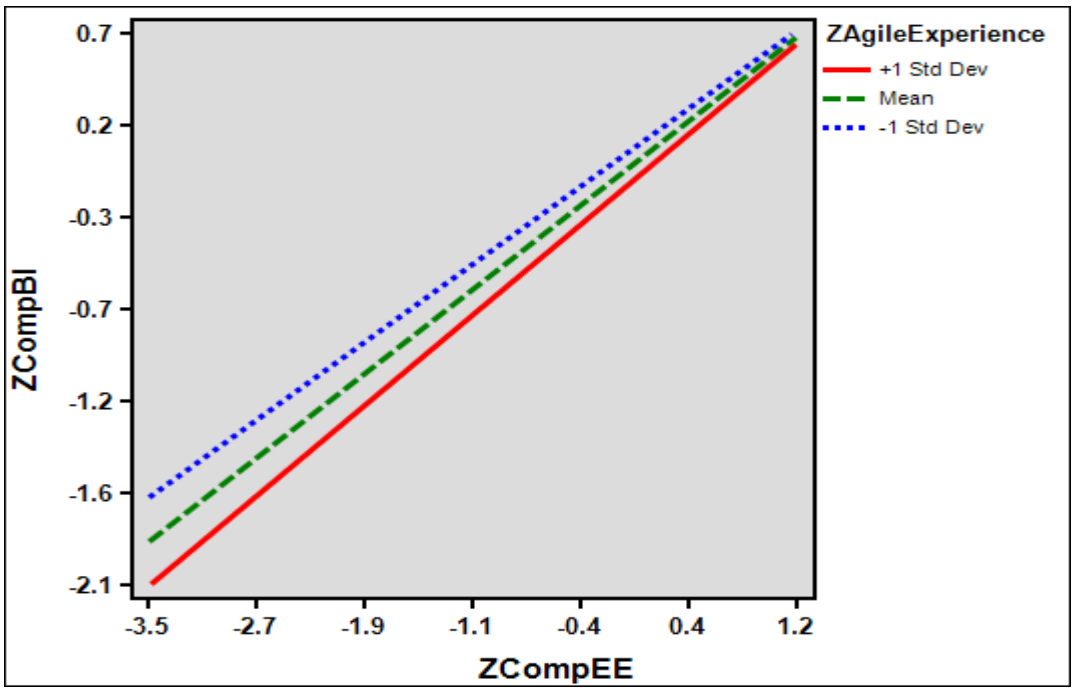


Figure 25: Plot of varying Standard Deviations of Agile Experience on Effort Expectancy and Behavioural Intention

IX. Agile Experience on Social Influence and Behavioural Intention

The moderating effect of Agile Experience on Social Influence and Behavioural Intention was tested. R Square had a value of .143, which means the model could only explain about 14% of the variance in Behavioural Intention. The ANOVA tests showed that the R^2 was significant with $p<0.001$. The Beta Coefficients indicated some interaction between Agile Experience and Social Influence with B= -.099 and $p<0.05$. However Agile Experience on its own was not significant. The possible moderation of agile experience on social influence and behavioural intention was not found. Tables 52, 53 and 54 below show the regression model results.

R	R Square	Adjusted R Square	Std Error of the Estimate
.378	.143	.123	.67432

Table 52: Regression model summary for Behavioural Intention

ANOVA	Sum of Squares	Df	Mean Square	F	Sig
Regression	10.128	3	3.376	7.425	.000
Residual	60.932	134	.455		
Total	71.060	137			

Table 53: ANOVA Test for the R Square

Variable	Unstandardized *B*	Coefficient Std Error	Standardized Coefficient Beta	T	Sig
Zscore: CompSI	.259	.058	.359	4.445	.000
Zscore(AgileExperience)	.007	.064	.010	.113	.910
ModeratorSIandAgileExp	-.079	.071	-.099	-1.122	.264

Table 54: Beta coefficients for each Predictor variable for Behavioural Intention

The 2 plots were created. The plots were similar in shape and gradient lines. Both plots showed that changing Agile experience had the same null effect for different levels of Social influence. Differences in Agile experience had no effect on the relationship between Social influence and Behavioural Intention. Figure 26 and Figure 27 show the plots:

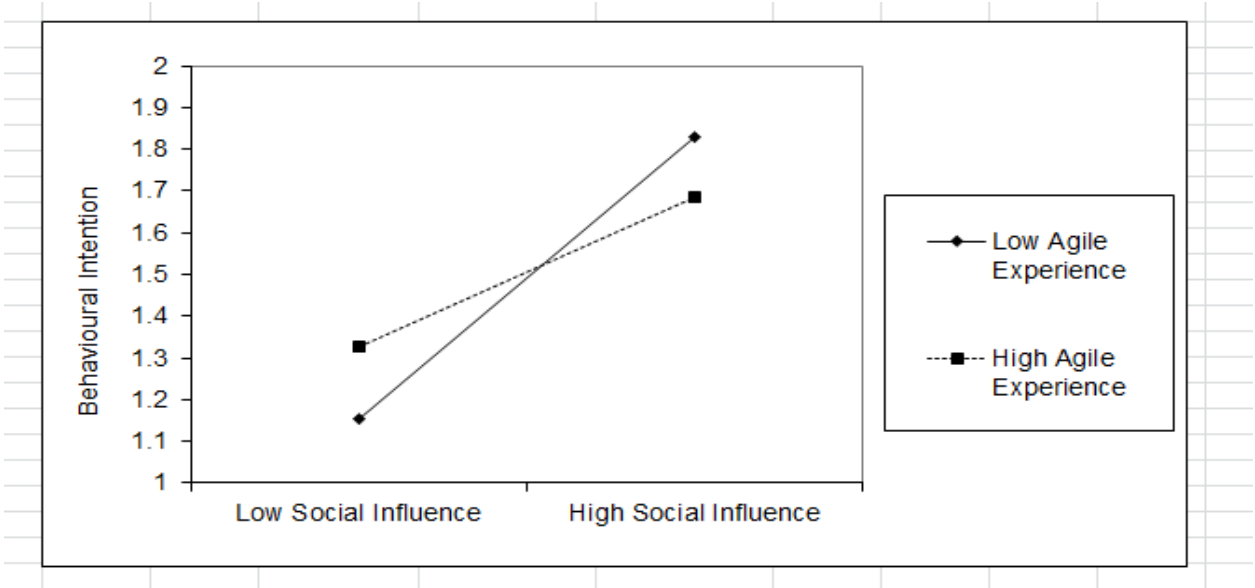


Figure 26: Interaction plot of Agile Experience on Social Influence and Behavioural Intention

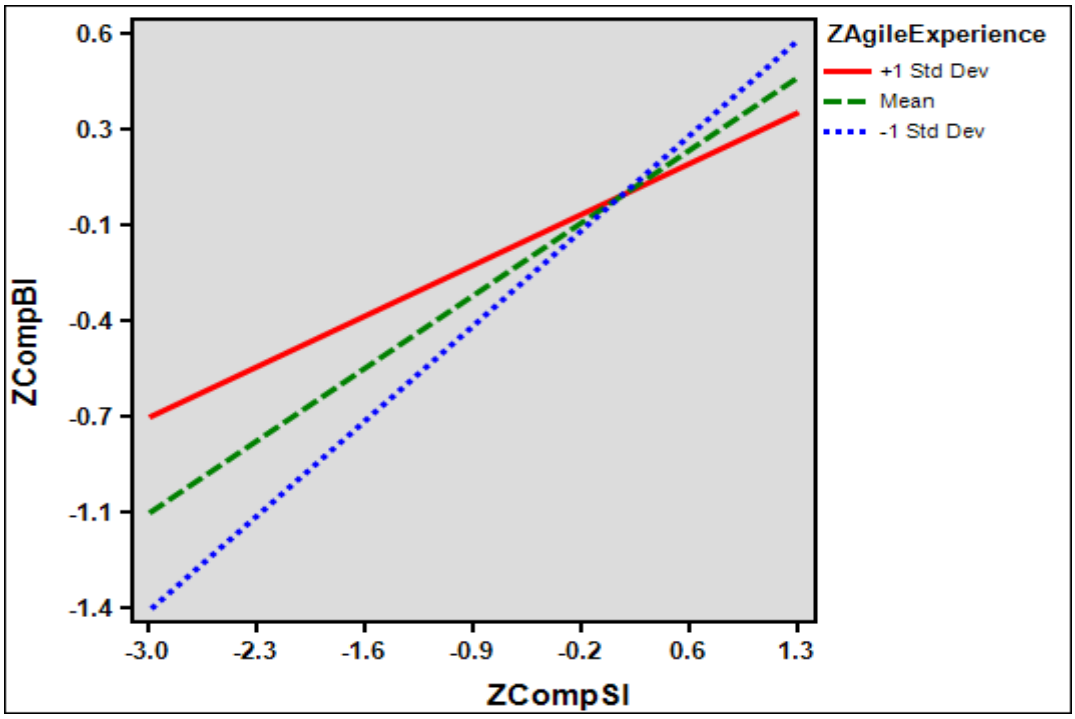


Figure 27: Plot varying SD Agile Experience on Social Influence and Behavioural Intention

X. IT Experience on Effort Expectancy and Behavioural Intention

The moderating effect of IT working experience on Effort Expectancy and Behavioural Intention was tested. The R Square had a value of .109 which means the regression model explained only about 11% of the variance in Behavioural Intention. The ANOVA tests showed that the R^2 was significant with p=0.001. The Beta Coefficients showed that there no significant moderating effect of IT Experience on Behavioural Intention. The possible moderation of IT experience on Effort Expectancy and Behavioural intention was not found. Tables 55, 56 and 57 below show the regression model results.

R	R Square	Adjusted R Square	Std Error of the Estimate
.331	.109	.089	.68722

Table 55: Regression model summary for Behavioural Intention

ANOVA	Sum of Squares	Df	Mean Square	F	Sig
Regression	7.776	3	2.592	5.489	.001
Residual	63.284	134	.472		
Total	71.060	137			

Table 56: ANOVA Test for the R Square

Variable	Unstandardized *B*	Coefficient Std Error	Standardized Coefficient Beta	T	Sig
Zscore: CompEE	.230	.059	.319	3.911	.000
Zscore(ITExperience)	.041	.057	.059	.720	.473
ModeratorEEandITExp	-.034	.059	-.047	-.573	.568

Table 57: Beta coefficients for each Predictor variable for Behavioural Intention

The first plot was created and it had parallel lines signifying that there was no moderation of IT Experience on Effort Expectancy and Behavioural Intention. The changes in different levels of IT experience had the same impact of almost 0.4 on Behavioural intention for different levels of Effort Expectancy. Figure 28 shows the plot:

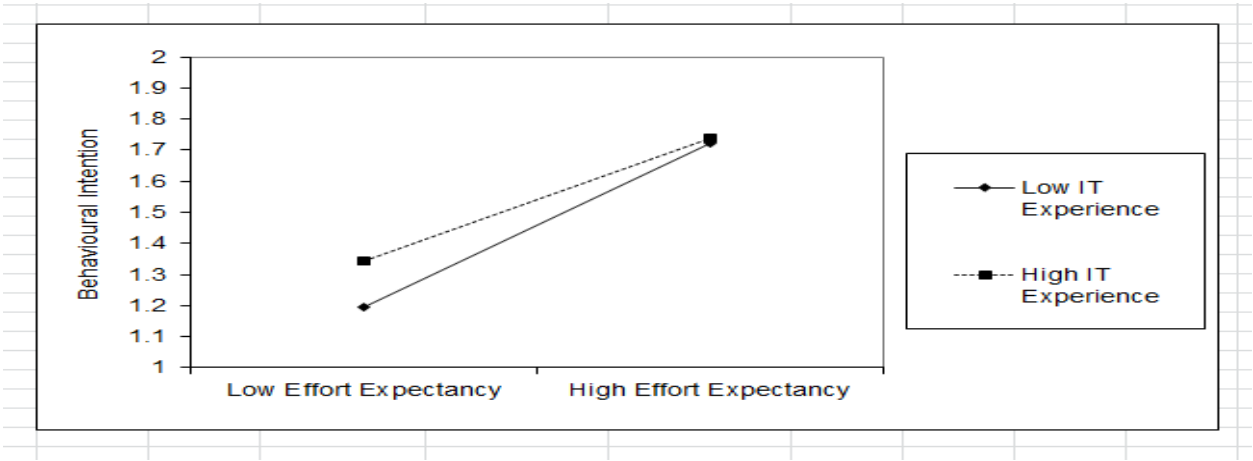


Figure 28: Plot varying SD of IT Experience on Effort Expectancy and Behavioural Intention

The second plot showed very small changes from each standard deviation. The lines were almost over laid on each other indicating that the change of IT Experience for increasing levels of Effort Expectancy had no effect on Behavioural Intention. Figure 29 shows the Plot:

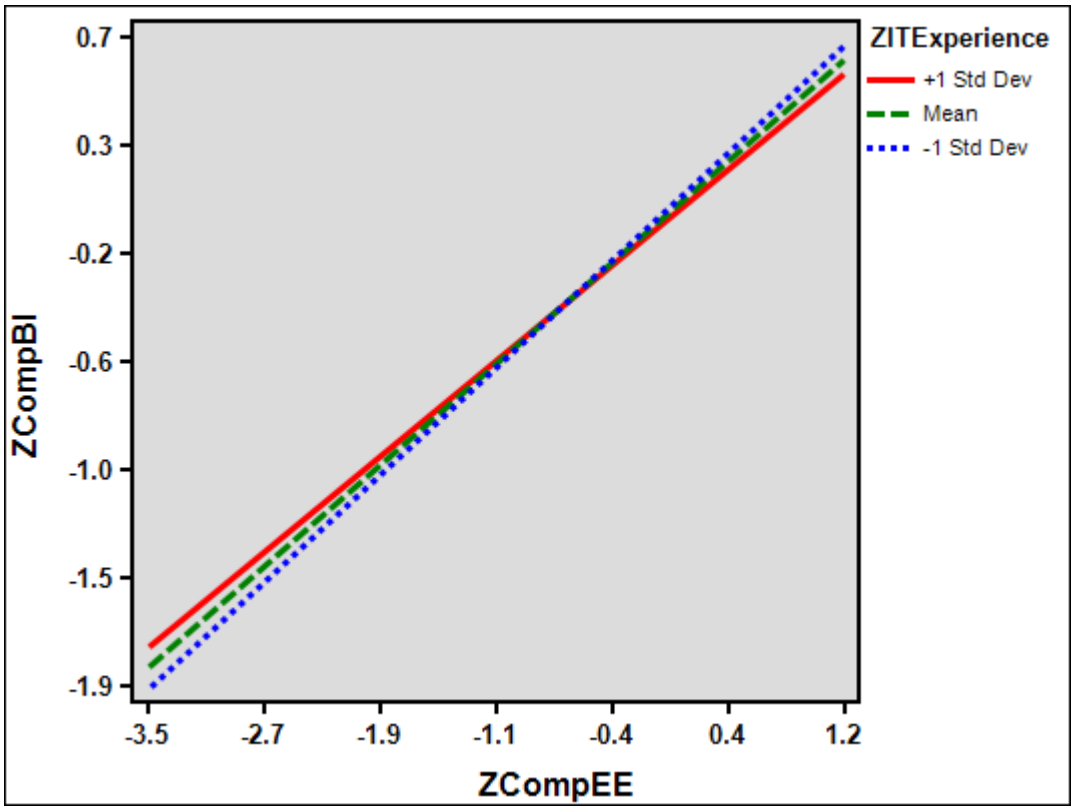


Figure 29: Plot varying SD of IT Experience on Effort Expectancy and Behavioural Intention.

XI. IT Experience on Social Influence and Behavioural Intention

This effect of IT working experience on Social Influence and Behavioural Intention was tested. The regression model had an R Square of .144 which means the regression model explained only about 14% of the variance in Behavioural Intention. The ANOVA tests showed that the R^2 was significant with $p<0.001$. The Interaction variable indicated that the combination of IT Experience and Social Influence did have an impact on Behavioural intention with a Beta Coefficient of .089 and $p<0.5$. However, IT Experience on its own did not have any significant effect. IT Experience as not found to have a significant moderating effect on Social Influence and Behavioural Intention. Tables 58, 59 and 60 below show the regression model results.

R	R Square	Adjusted R Square	Std Error of the Estimate
.379	.144	.125	.67378

Table 58: Regression model summary for Behavioural Intention

ANOVA	Sum of Squares	Df	Mean Square	F	Sig
Regression	10.226	3	3.409	7.508	.000
Residual	60.834	134	.454		
Total	71.060	137			

Table 59: ANOVA Test for the R Square

Variable	Unstandardized *B*	Coefficient Std Error	Standardized Coefficient Beta	t	Sig
Zscore: CompSI	.258	.058	.358	4.463	.000
Zscore(ITExperience)	-.036	.058	-.050	-.625	.533
ModeratorSIandITExp	-.034	.061	.089	1.116	.266

Table 60: Beta coefficients for each Predictor variable for Behavioural Intention

The first plot was created with varying levels of IT Experience and Social Influence. The plot had parallel lines indicating that there was no interaction between Social Influence and IT Experience. Figure 30 shows the plot:

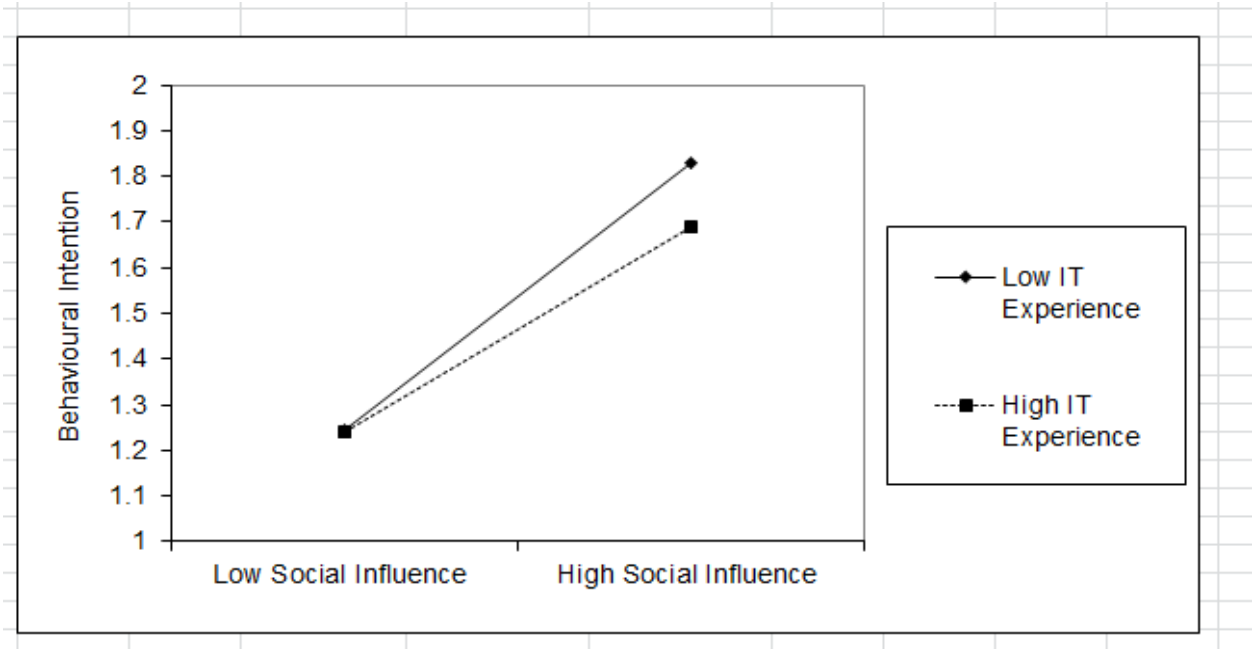


Figure 30: Interaction plot of IT Experience on Social Influence and Behavioural Intention

The plot with varying levels of standard deviation was created. The plot showed that the changes in standard deviation had the same nil effect for different levels of Social Influence. This means that despite changes in IT Experience and Social Influence there was no impact on Behavioural Intention. Figure 31 shows the Plot:

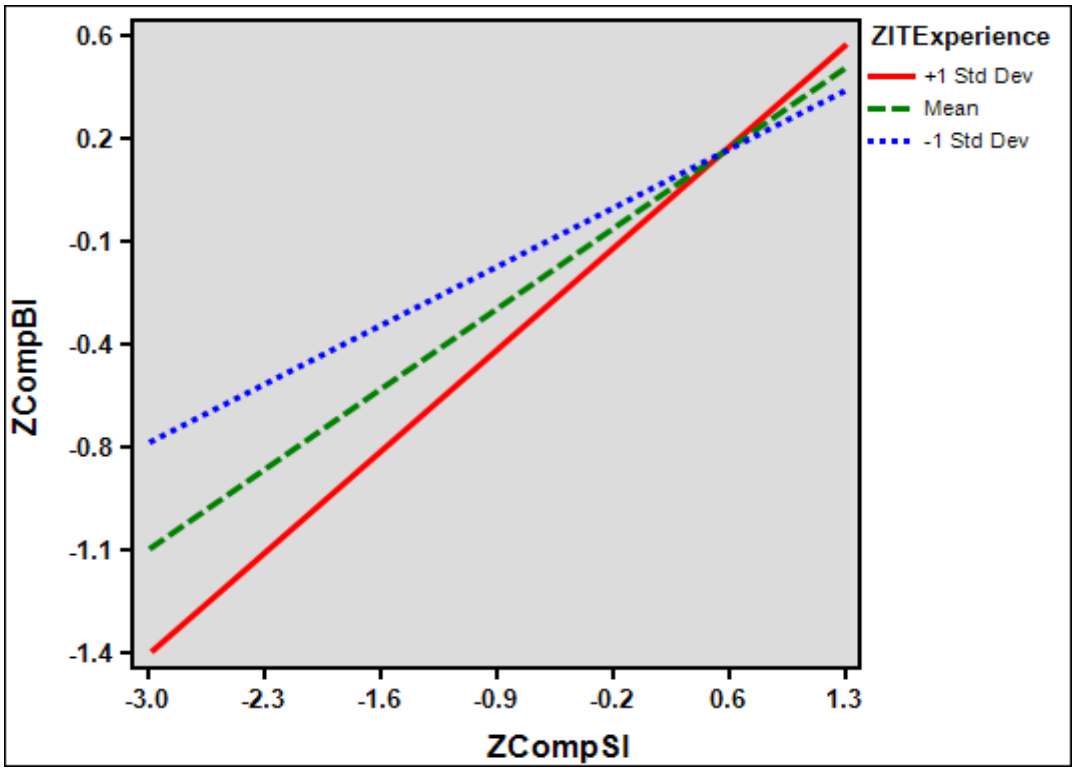


Figure 31: Plot varying SD of IT Experience on Effort Expectancy and Behavioural Intention.

XII. IT Experience on Facilitating Conditions and Usage

The moderating effect of IT working experience on Facilitating Conditions and Usage was tested. The regression model had an R Square of .238 which means the regression model explained only about 24% of the variance in Usage. The ANOVA tests showed that the R^2 was significant with $p<0.001$. IT Experience however did not have any significant effect as a moderator. The possible moderation of IT Experience on Facilitating Conditions and Usage was not found. Tables 61, 62 and 63 below show the regression model results.

R	R Square	Adjusted R Square	Std Error of the Estimate
.488	.238	.221	.99679

Table 61: Regression model summary for Usage

ANOVA	Sum of Squares	Df	Mean Square	F	Sig
Regression	41.526	3	13.842	13.931	.000
Residual	133.141	134	.994		
Total	174.667	137			

Table 62: ANOVA Test for the R Square

Variable	Unstandardized *B*	Coefficient Std Error	Standardized Coefficient Beta	t	Sig
Zscore: CompFC	.544	.085	.482	6.371	.000
Zscore(ITExperience)	.082	.086	.073	.953	.342
ModeratorFCandITExp	.024	.097	.019	.245	.807

Table 63: Beta coefficients for each Predictor variable for Usage

Both graphs had parallel lines indicating that there was no interaction of the variables. Changes in levels of IT Experience had no impact on Facilitating conditions and Usage. Figure 32 and 33 shows the plots:

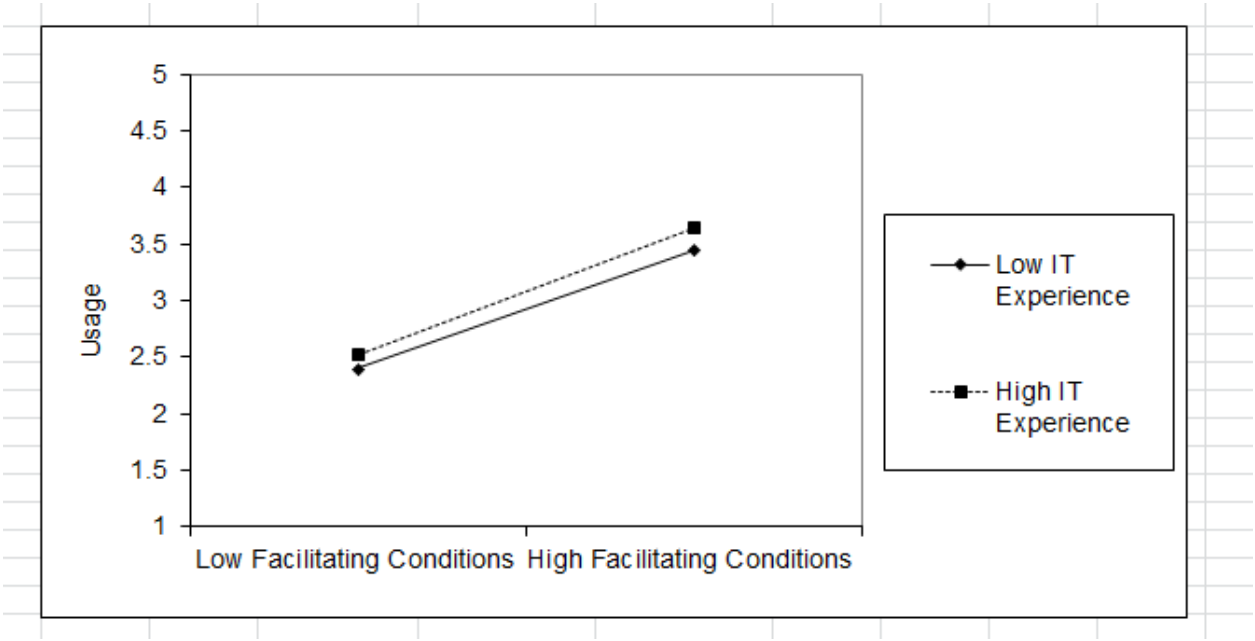


Figure 32: Interaction plot of IT Experience on Facilitating Conditions and Usage

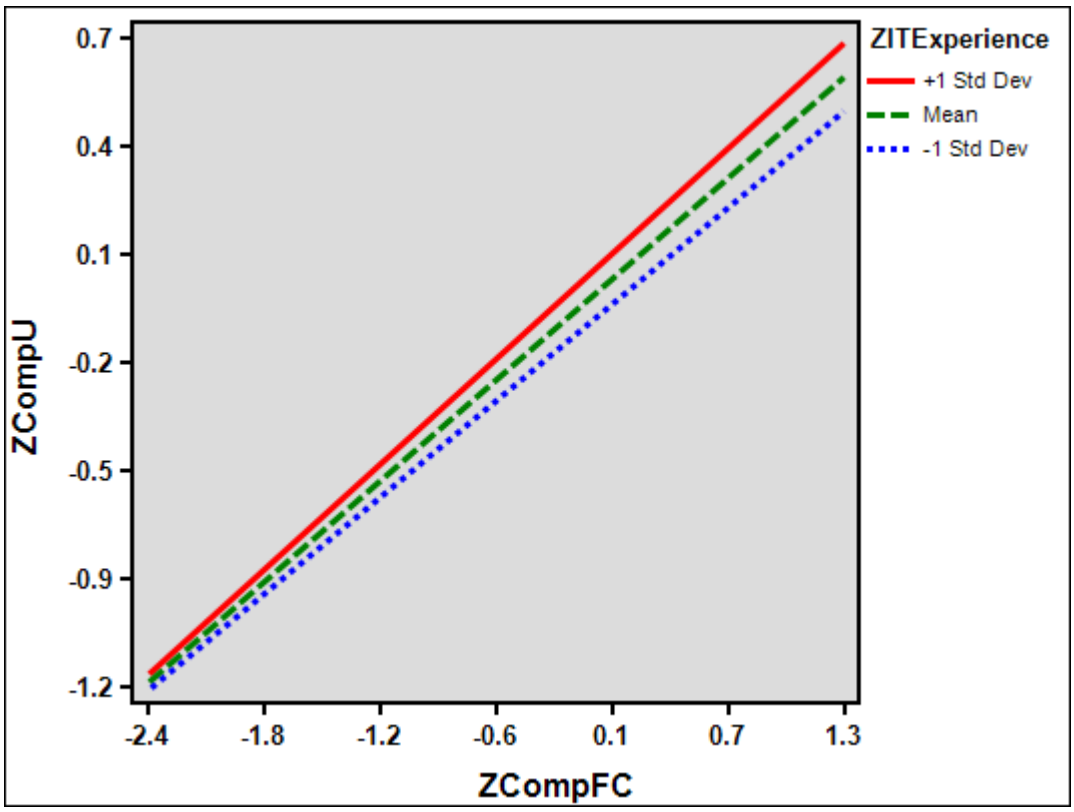


Figure 33: Plot varying SD of IT Experience on Facilitating Conditions and Usage

XIII. Voluntariness of use on Social Influence and Behavioural Intention

The moderating effect of Voluntariness of use on Social Influence and Behavioural Intention was tested. The regression model had an R Square with a value of .161. The model could only explain about 16% of the variance in Behavioural Intention. The ANOVA tests showed that the R^2 was significant with $p<0.001$. The Beta Coefficients showed that Voluntariness of use did not have any significance as a moderator with $p = .346$. The moderating effect of Voluntariness of use on Social Influence and Behavioural Intention was not supported. The results however showed that Social Influence was a significant predictor of Behavioural Intention. Tables 64, 65 and 66 below show the regression model results.

R	R Square	Adjusted R Square	Std Error of the Estimate
.401	.161	.142	.66696

Table 64: Regression model summary for Behavioural Intention

ANOVA	Sum of Squares	Df	Mean Square	F	Sig
Regression	11.452	3	3.817	8.582	.000
Residual	59.608	134	.445		
Total	71.060	137			

Table 65: ANOVA Test for the R Square

Variable	Unstandardized *B*	Coefficient Std Error	Standardized Coefficient Beta	t	Sig
Zscore(VoluntarinessofUse)	-.056	.059	-.077	-.945	.346
Zscore: CompSI	.268	.058	.372	4.634	.000
ModeratorSIand VoluntarinessofUse	-.122	.060	-.165	-2.035	.044

Table 66: Beta coefficients for each Predictor variable for Behavioural Intention

An interaction plot was created for Low Social Influence, High Social Influence, Voluntariness of use and Behavioural Intention. The change from Low Social Influence to High Social Influence did not have a big difference on Behavioural Intention. In other words changing Social Influence and Voluntariness of use did not significantly impact Behavioural Intention. Figure 34 shows the plot:

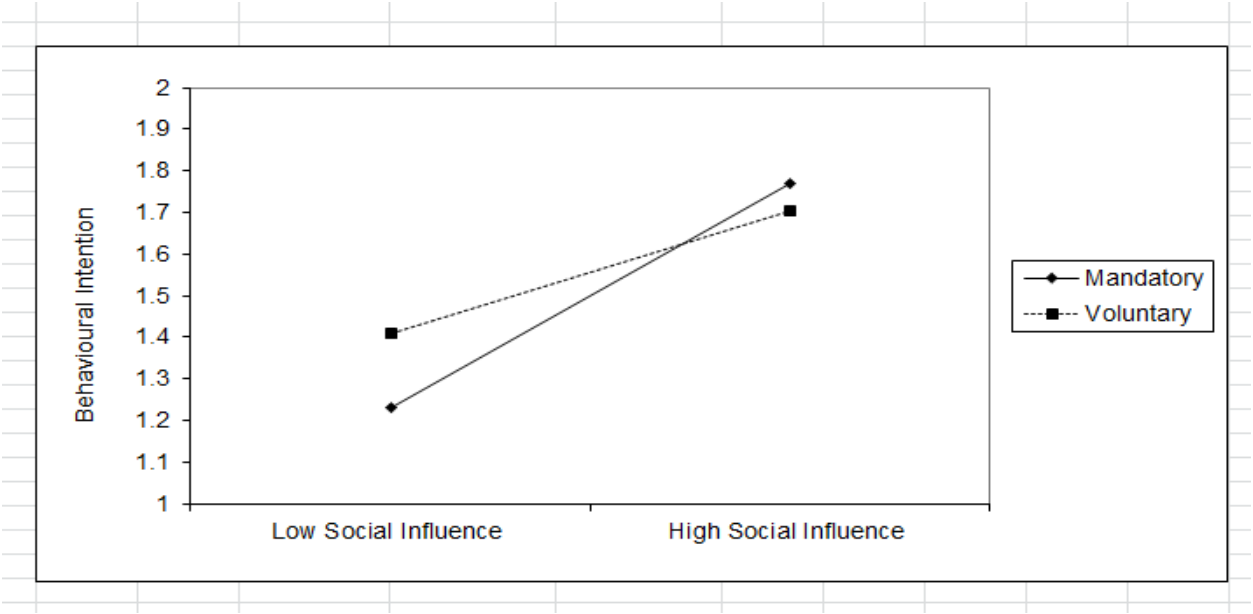


Figure 34: Plot of Voluntariness of use on Social Influence and Behavioural Intention

Varying standard deviations did not have an effect on the dependent variable. The impact on Behavioural Intention was the same for different Voluntariness of use levels. This indicates further that there was no effect of moderation by Voluntariness of use on Social Influence and Behavioural Intention. Figure 35 shows the plot:

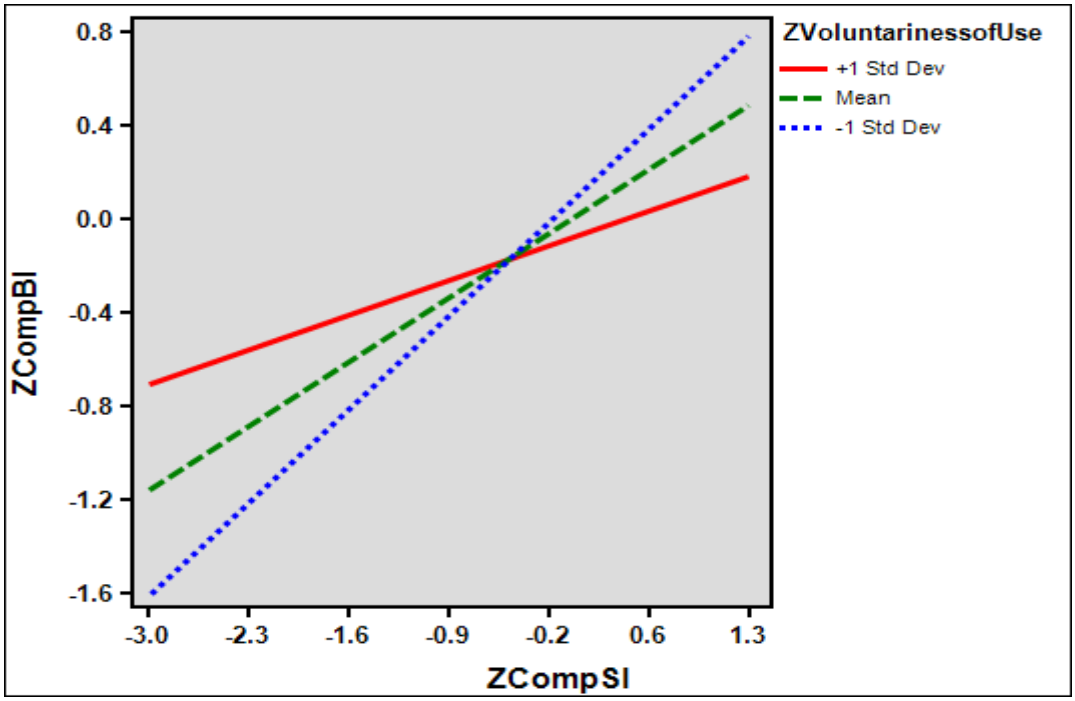
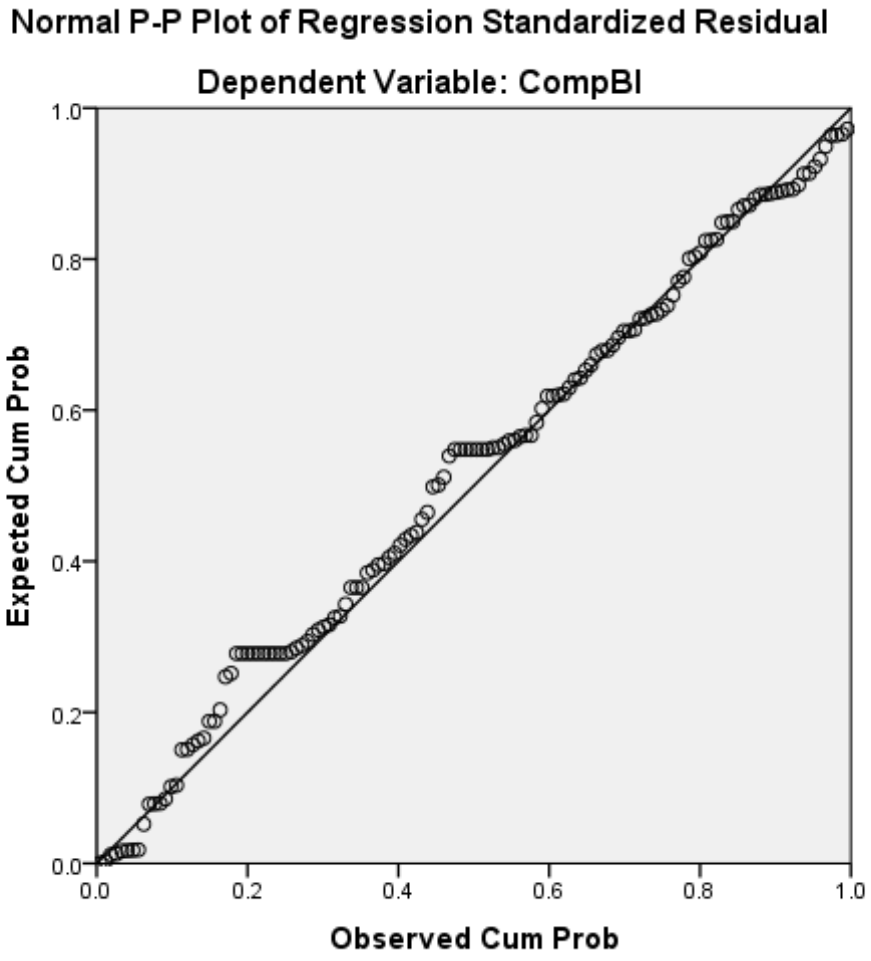
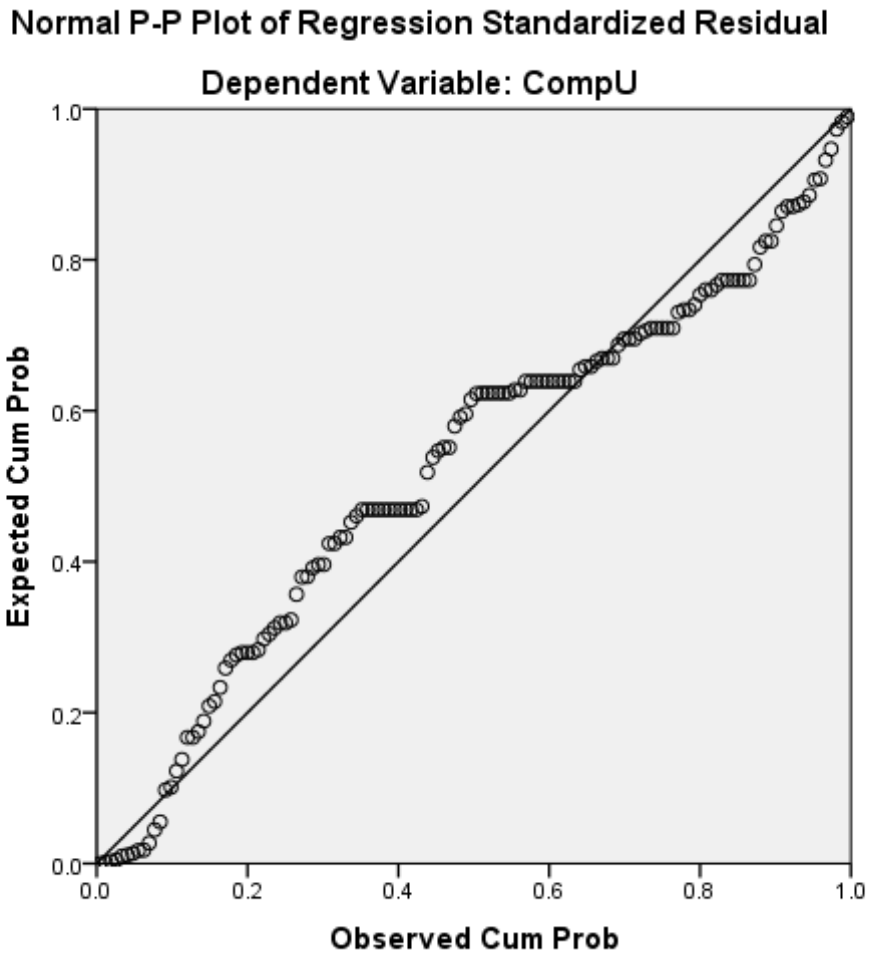


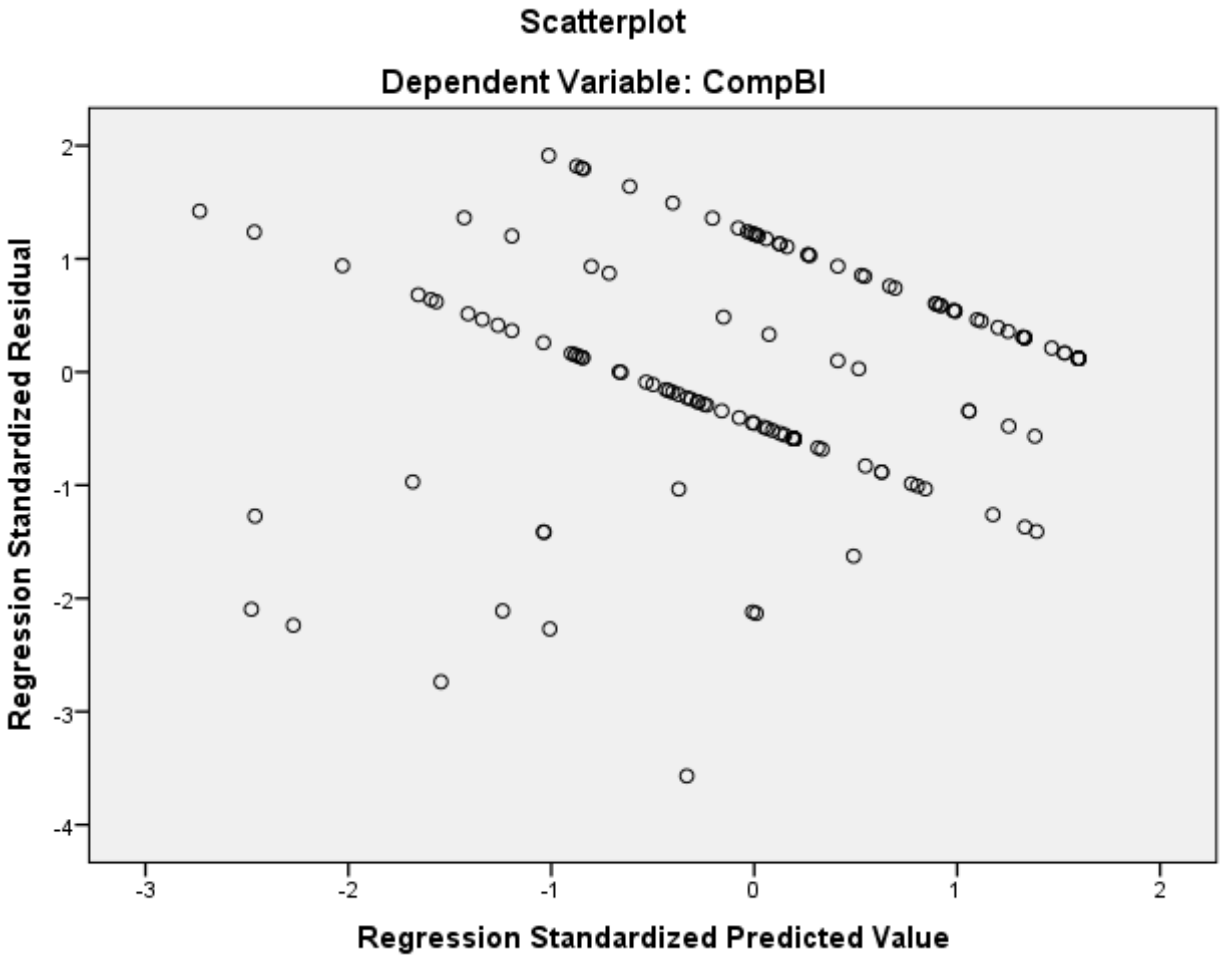
Figure 35: Interaction Plot of Voluntariness of use on Social Influence and Behavioural Intention

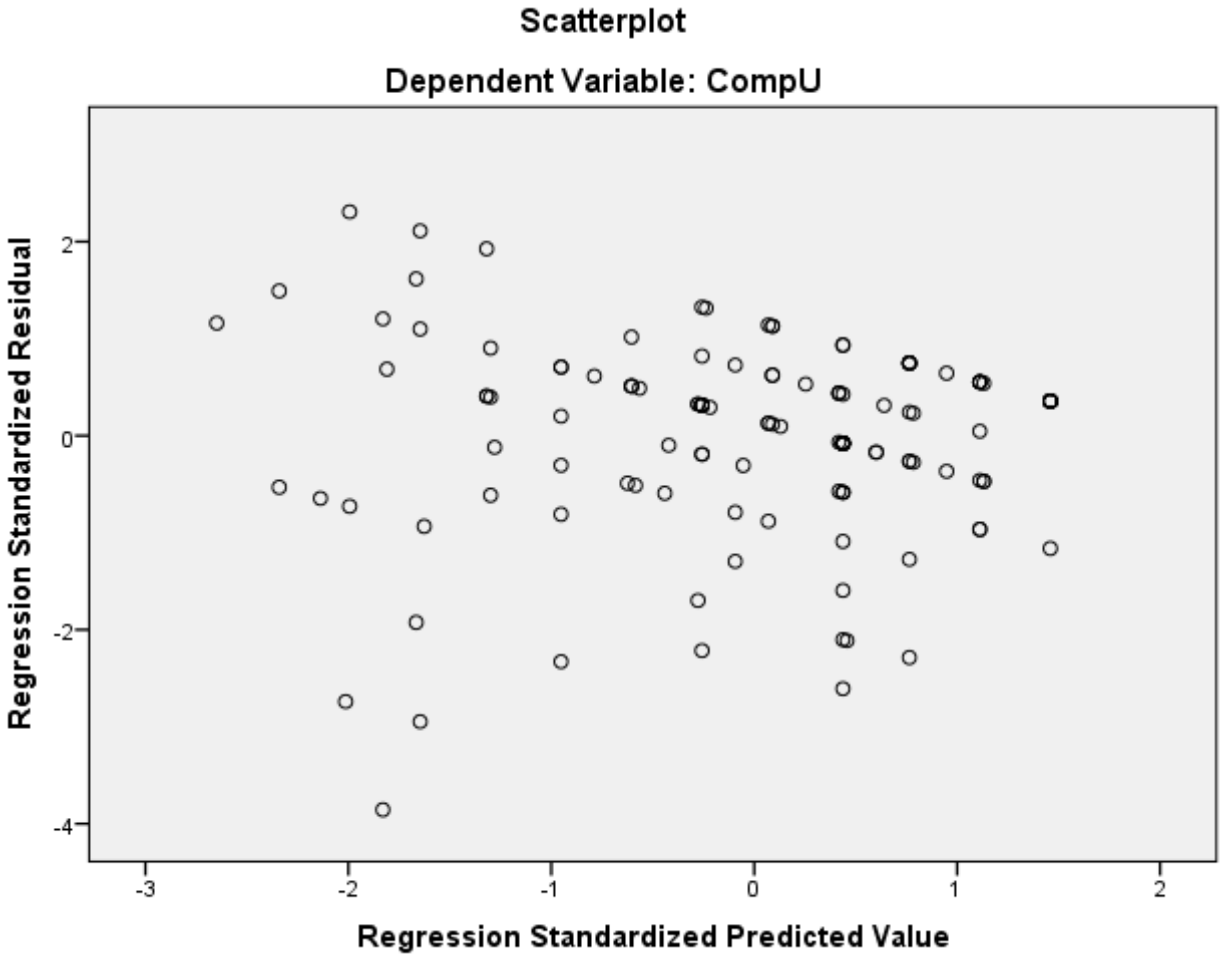
APPENDIX K: NORMAL PROBABILITY PLOTS



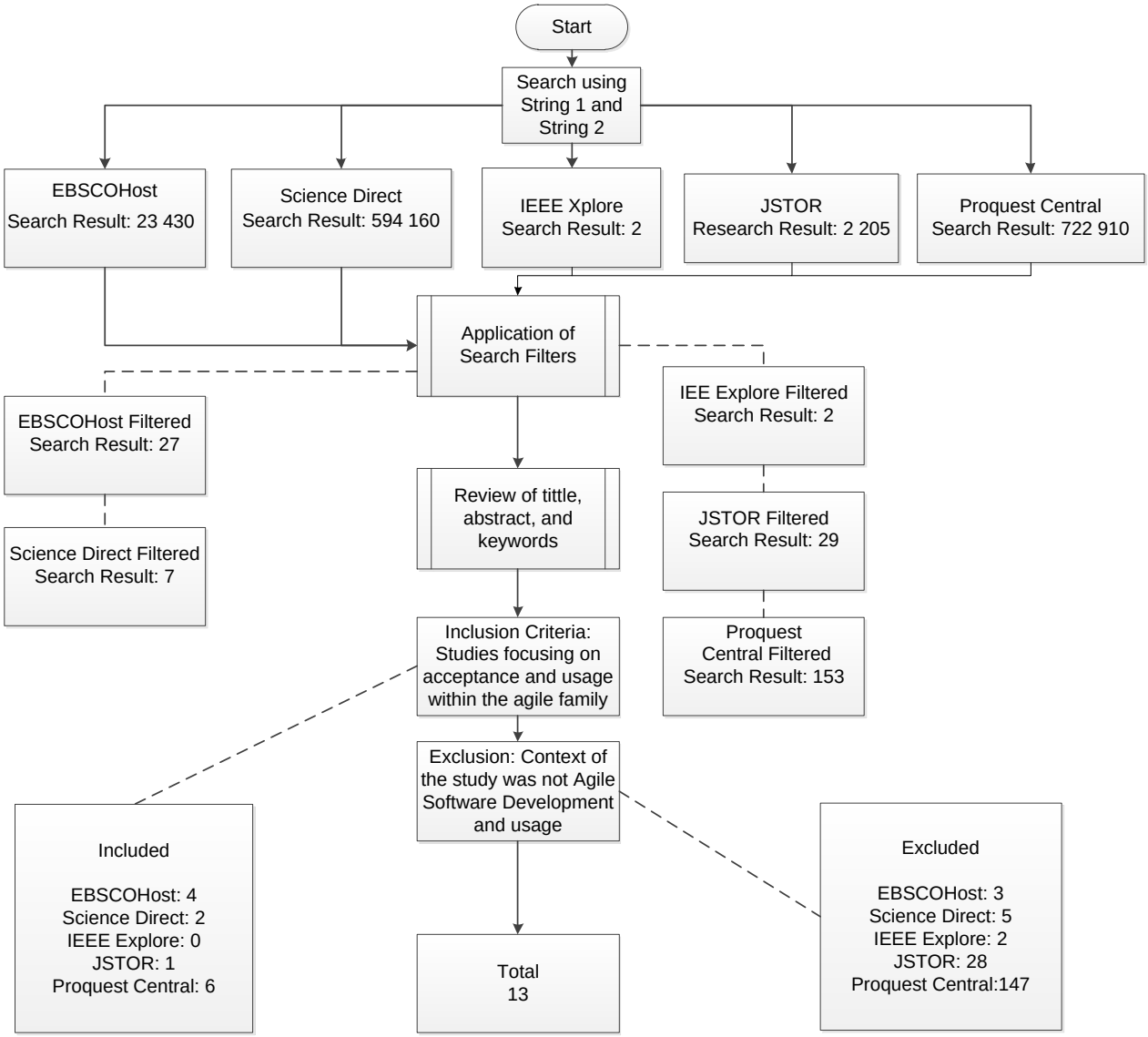

Normal P-P Plot of Regression Standardized Residual
Dependent Variable: CompU
Expected Cum Prob
Observed Cum Prob
0.0
0.2
0.4
0.6
0.8
1.0

APPENDIX L: SCATTER PLOTS FOR LINEARITY HOMOSCEDASTICITY




Scatterplot
Dependent Variable: CompU
Regression Standardized Residual
2
0
-2
-4
-3
-2
-1
0
1
2
Regression Standardized Predicted Value

APPENDIX M: SYSTEMATIC LITERATURE REVIEW FLOW CHART



Search Filters used per Database

1. EBSCHost Search Filters

- “Articles that are "Full Text", Scholarly (Peer Reviewed Journals)
- Source Types: Academic Journals, Journals and Reviews
- Subject: agile software development, agile manufacturing systems, data analysis software, research methodology, surveys, computer software development, information storage & retrieval
- Language: English
- Publication: MIS Quarterly, Journal Of The Association For Information Systems, Journal Of Modern Project Management, Journal Of International Technology & Information Management, Journal Of Information Systems Education, Information Systems Research, Informatica Economica, IEEE Transactions On Education, Electronic Journal Of Information Systems Evaluation, Behaviour & Information Technology, Academy Of Information & Management Sciences Journal, MIS Quarterly Executive, Journal Of Management Information Systems, Communications Of The ACM, IEEE Software, Information Systems Journal And Project Management Journal
- Thesaurus Terms: computer software development, software engineering, information resources management, best practices, project management, computer programming, innovation adoption, software productivity, business requirements analysis, change management, computer programming management, computer software, computer software developers, diffusion of innovations

2. Science Direct Search Filters

- Article type: Research articles
- Publication title: Journal of Systems and Software
- Access type: Open access
- JSTOR Search Filters

- Content Type: Journals, Research Reports
- Subject: Technology

3. Proquest Central Search Filters

- Full Text
- Source type: Scholarly Journals, Conference Papers & Proceedings
- Document type: Article, Literature Review
- Language: English
- Subject: Software
- Database: Computing