Development and Validation of Technology Acceptance Modelling for Evaluating User Acceptance of an E-learning framework

By

YALDA DANESH SEDIGH

A thesis submitted to The University of Birmingham for the degree of

MASTER OF PHILOSOPHY

The School of Electrical, Electronic and Computer Engineering

The University of Birmingham

11th June 2013

ACKNOWLEDGEMENTS

This thesis has been a great achievement for me and I would like to acknowledge the support of my supervisor, Dr Theodoros N. Arvanitis, throughout my study and support given by my co-supervisor Dr Alex Gibb in the initial year of my study. I am grateful for the financial and emotional support from my family. I would also like to thank my colleagues in the Human Computer Interaction Research Centre. A questionnaire surveyed by Oude Rengerink's (2011) aided this thesis. The thesis research work was carried out at the University of Birmingham; I enjoyed the facilities provided by the University, such as the Main Library and access to online databases of journal papers.

ABSTRACT

The thesis aimed to develop and validate a new theoretical model to assess Evidence Based Medicine (EBM) trainers' technology acceptance of an e-learning application associated to the EU EBM Teach the Trainers e-course. Modelling user interactions with e-learning applications allows the prediction of how EBM trainers are motivated to use the e-course in the clinical setting. As part of this research, a survey was constructed and analysed using an empirical model called the Technology Acceptance Model (TAM). The TAM was developed into the e-TAM, a new model, which can assess a user's adoption of online learning applications. This thesis used a survey to develop the e-TAM as an extension for technology acceptance of on-line publications such as the blended learning approach for EBM study. The thesis validated the TAM and e-TAM, which followed an assessment of EBM trainers' acceptance of the application. Statistical analysis, including reliability with Cronbach's Alpha, factor analysis and multiple-regression analysis, were carried out on TAM, e-TAM and data from the questionnaires that showed the models were valid for this field of study. This assessment found the EBM trainers' experience, perceived usefulness and attitude toward use as strong predictors of user behavioural intention and acceptance of the application. Overall, the most influential factor in the e-TAM model was Experience, which explained over a fifth of the total variance of the user acceptance of the e-learning application.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

1 INTRODUCTION

Medical practitioners have to adapt quickly to learn, understand and adopt new technology as general trends show a continuous integration of technology and new medical strategies into the workplace. There is a need for them to learn how to use e-learning technologies and associated innovative systems on a routine basis, because the integration and use of these systems in the workplace will improve patients' healthcare (Oude Rengerink, et al., 2011). This means trainers of new medical knowledge and evidence need to learn how to teach effectively the use of available information through e-learning systems, such as the e-learning framework for "teaching the trainers evidence-based medicine" (Thangaratinam, et al., 2009). Resulting from better training, medical practitioners can manage to use innovative approaches to handle information and knowledge, such as evidence-based medicine, while providing better healthcare practice on a daily basis. Overall, this development in the clinical environment will benefit patients with better diagnoses, treatment, and follow up processes.

E-health is a new approach to healthcare practice and is a framework facilitated by information systems such as libraries, the Internet, on-line clinical databases, research databases, decision support information systems, telephone support centres, etc. (Broderick & Smaltz, 2003). These facilities increase the accessibility and availability of information for healthcare services. E-health can be integrated into other frameworks, such as e-learning. E-learning utilises Information and Communication Technology (ICT) systems to give users access to knowledge worldwide. E-learning lets users study with the aid of interactive tutorials, pre-recorded lectures and other downloadable or streaming media (Arbaugh, 2004;

Singh, et al., 2005; Ngai, et al., 2007). The innovation of e-learning within the context of e-health in healthcare institutions can train healthcare practitioners how to use associated technology without restrictions on the practitioner's time or place.

1.1 Evidence-based Medicine

Evidence-based medicine (EBM) is a medical information framework and considered as a subset of e-health systems (Eysenbach, 2001). EBM can be supported by ICT technologies (Schaper & Pervan, 2007) and upgrades the traditional medical theory and practice by focusing more on the specific needs of patients (Coppus, et al., 2007). With the aid of training, medical professionals can access EBM information through online software-based technologies, as well as use and update medical evidence as an integral part of the routine (Kulier, et al., 2008b), as new theories and practices become available in real-time (Coppus, et al., 2007; Hatala, et al., 2006).

On-line training software applications can support professionals towards the use of evidence-based medical knowledge (Kulier, et al., 2008a) and thereby support the integration and use of EBM in the clinical environment; further discussion on this topic in Section 2.2. In addition, access to EBM information from an online medical database and support with e-learning training sessions has the potential to improve the accessibility, availability and awareness of medical information for medical professionals and trainers of EBM in the clinical environment (Coppus, et al., 2007; Hatala, et al., 2006). It is beneficial to utilise the advantages of e-learning for EBM study, specifically in terms of its ability in providing at hand information on a global scale.

Medical and healthcare evidence, available from online e-learning environments, can save teaching time when many people want to learn the EBM approach, in various locations and organisations. Moreover, publishing online can take media forms of e-books, and streaming audio or video, which allows a more cost-effective way of learning EBM compared to hard multimedia forms like CDs, DVDs or books (Kulier, et al., 2008a). When professionals submit and author EBM information from reliable sources, it provides official EBM support for practitioners and trainers (Hatala, et al., 2006).

EBM gives practitioners a solid reference for the duration of the of patient-healthcare practitioner interaction including diagnosis, treatment and follow up (Kulier, et al., 2008b). That reference allows EBM to provide a basis for convincing both patient and practitioner to make the right decision through each step in the continuity of healthcare. However, EBM-based decisions have a limited effect as a confidence builder if the practitioners are unsure about the use of EBM due to trainers lacking confidence in demonstrating its potential (Thangaratinam, et al., 2009). Trainers can teach EBM in various ways, which might explain a confusion over which curriculum to follow (Coppus, et al., 2007). If this is the case, then there should be a recognised and official course for teachers to use (Thangaratinam, et al., 2009).

On-line training for medical professionals has grown in demand in Europe, while the approach of e-learning needs approval as an official qualification (Oude Rengerink, et al., 2011). In addition, organisations have attempted to analyse how users accept such software-based systems (Schaper & Pervan, 2007) and therefore develop e-learning systems to increase its adoption in healthcare.

There are many barriers associated with the user acceptance of an online EBM training system (Oude Rengerink, et al., 2011), but these do not out-weigh the benefits of its widespread use. Because of this, the thesis considers finding influential barriers/factors important as it can aid the development of a technology acceptance model that can assess the Teaching the Trainers EBM (TTT-EBM) e-learning approach and thereby its adoption.

Thangaratinam (2009) pointed out that trainers of EBM should use the available clinical environmental facilities, teach EBM practice and demonstrate how to apply technology associated with EBM in everyday clinical activities for the benefit of the trainees. In her study, this teaching method is set into a curriculum called "Teaching the Trainers EBM (TTT-EBM)", which provides a blended learning approach, including an e-learning framework. The TTT-EBM project is also known as the EU EBM TTT project in Thangaratinam (2009), but this thesis refers to it as the former throughout the thesis. The TTT-EBM e-learning curriculum and its blended learning approach is part of a European-wide project, which plays a role in providing standardised continuing professional development for EBM trainers across the European Union (Thangaratinam, et al., 2009). This curriculum is accessed as an e-course and is the first example of e-learning training system, designed for building trainer confidence and integrating learning within the clinical environment. It includes learning and assessment facilitated by e-learning technology; there exist e-modules involved with the use of journal clubs, morbidity/mortality meetings and audit presentations, which together is considered an e-course.

Researchers can use the results presented in this thesis to improve the TTT-EBM project. As this thesis' outcome showed, the factors of Experience, Education Level, Technology Support

and Time Constraint accounted for over half of the variance in the user acceptance of the EBM e-learning application. Meaning those factors are influential to the TTT-EBM project's adoption. Therefore, that project can improve with developments focused on the elimination of non-essential barriers and the inclusion or reinforcement of the influential factors shown in this thesis.

1.2 Motivation

EBM trainers need to teach practitioners with confidence, which a proposed European-wide e-course can give, where acceptance of the e-course's application needs to be assessed to ensure its widespread use. Trainers need to be motivated and convinced to be involved with that application that teaches them how to teach medical practitioners the use and benefits of EBM in the workplace (Oude Rengerink, et al., 2011). However, there is a shortage of appropriate models to predict the user acceptance of that e-learning application. Therefore, this thesis proposes a new model for user acceptance assessment of the TTT-EBM e-learning curriculum, delivered via the e-course.

The need for EBM to achieve improved quality healthcare has been accepted and published in many countries, especially in European journals such as from Dawes et al. (2005), Davis et al. (2007), and Coppus et al. (2007). Ideally, the outcomes of the TTT-EBM project will help EBM trainers improve clinical staff's knowledge and skills of EBM practice in everyday clinical activities. Thus, moving healthcare and medical professionals to upgrade EBM knowledge independently, as Kulier (2008b) had pointed out. Hence, the central objective of this thesis is to evaluate the user acceptance and associated human factor considerations for integrating the TTT EBM blended e-learning approach for the workplace.

The work of this thesis contributed to user acceptance of technology research by eliminating irrelevant barriers and finding influential factors of a user's acceptance of the TTT-EBM project. The TTT-EBM project improves the European healthcare sector through the design, development, promotion and piloting of a European training programme (Thangaratinam, et al., 2009; Oude Rengerink, et al., 2011). That TTT-EBM project focuses on teaching healthcare trainers of EBM, through an intensive integrated e-learning curriculum within a clinical practice. The design of the curriculum and blended e-learning course should be beneficial for the flexibility of the trainers' time and place. This thesis focuses on how to improve the quality of that project by evaluating factors that influence acceptance, future attitudes and behavioural intentions of users enrolled on the TTT-EBM e-learning curriculum.

Modelling and predicting how users accept the e-learning application is a focus of this thesis, which it attempts to assess with the development of a technology acceptance models and associated factors, Section 1.3 further discusses this point. The models developed in the thesis evaluate surveys of professional clinicians in the scope of the TTT-EBM project, namely from European clinicians. In this thesis, our survey, although small in scale, takes a pan-European perspective of evaluating the TTT-EBM e-learning framework and develops a widely accepted empirical model to detect the influence of barriers associated to a user's adoption of the e-course.

1.3 Theoretical Modelling of User Acceptance

The Technology Acceptance Model (TAM) is a well-recognised empirical model for its ability in predicting how and why IT and computer systems users approach, start and continue using technology (Davis, 1986). It can determine the probability of acceptance a user has to a new

type of technology (Davis, 1986). The TAM has evolved into the TAM2 (Venkatesh & Davis, 2000b) and TAM3 (Venkatesh & Bala, 2008), with the implementation of additional factors (for more detail, see Section 2.4). These additional factors were used to produce results that are better suited for specific contexts such as a user's experience (Venkatesh & Davis, 2000b; Venkatesh & Bala, 2008), job relevance (Venkatesh & Davis, 2000b; Venkatesh & Bala, 2008) and computer self-efficacy (Venkatesh & Davis, 1996; Venkatesh & Davis, 2000b) as well as to further explain the variance of user behavioural intention of the TAM's original factors.

Numerous other studies have developed the TAM with additional factors of user acceptance of technology in healthcare IT to provide a specific research model to fit a study area (Holden & Karsh, 2010). The factors that this thesis considers for developing the TAM, also called social organisational barriers (Oude Rengerink, et al., 2011), include apparent challenges and limitations of the clinical environment for medical staff and trainers. Holden & Karsh (2010) reviewed the limitations of the TAM and found areas of healthcare IT relating to e-learning and Internet based systems such as web-based electronic medical records, mobile medical information systems, online disability evaluation systems, telemedicine technology, ICT and Internet-based health applications. He then evaluated those factors with the TAM.

Developing the TAM's contextual assessment to suit a blended learning approach, by adding factors related to e-learning in the healthcare context, is necessary because it would make it a valid model for users associated with this thesis, whereas Davis developed the TAM to assess IT and computer system users (Holden & Karsh, 2010). Even though e-learning applications are a subset of IT and computer systems, EBM and the concept of TTT-EBM can function independent of IT and computer systems, which means using the TAM to assess users of the

e-course would not necessarily fit within the original scope of the TAM. This clarifies the reasoning to develop the TAM with additional factors to achieve a stronger prediction of the user acceptance of technology for the application because no other models have the unique ability for assessing users in this specific context. An output of this thesis is the development of an extended technology acceptance model (e-TAM), which includes the chosen additional external factors. Section 3.2.2 has more information on the development and definition of the e-TAM.

1.4 Analysis of User Acceptance Information

Theoretical models represent a theory and researchers assume that the model can predict an outcome of the theory or identify influential factors, such as predicting users accepting e-learning technologies in the healthcare setting, by analysing individual data from multiple-choice questionnaires. The theoretical model's analysis shows the influence of factors related by predetermined hypotheses, which fit around the main theory of the subject, which in this thesis is the acceptance of technology and approach to deliver EBM training. Hypotheses and questionnaires, similar to research models, need a design that is specific for the research purposes to get reliable results for the model to analyse (see Section 3.4). This thesis has used two questionnaires designed in mind of understanding the user acceptance of e-learning technologies to study EBM in a clinical setting. Oude Rengerink (2011), who constructed one of the questionnaires from a literature review, distributed, surveyed and tested it "using the non-parametric Kruskal–Wallis test or the Wilcoxon Rank Sum test". That test found barriers and facilitators of teaching EBM in clinical environments.

Pre-testing questionnaires, with a reliability analysis, is normally a pre-requisite in the design process of questionnaires. It validates the results and assesses whether each question achieves the same score when put under different conditions from the same candidates, or from different candidates under the same conditions (Bailey & Pearson, 1983; Kripanont, 2007; Field, 2009). More information on the use of reliability analysis, in this thesis, is covered in Section 3.5. The Cronbach's Alpha approach, as used in this thesis, see Section 3.5, is widely used for reliability assessment because it has been recognised as one of the most significant tests of reliability in various fields of social science (Cortina, 1993). The reliability of the questionnaire directly relates to the quality of the results from the research models' evaluation. This thesis has validated both questionnaires to support the TAM and e-TAM models' results and findings.

Using technology acceptance models, such as the TAM, facilitates the collection of data for examining which factor has an influence on the user's adoption of the TTT-EBM e-learning application and draws out barriers toward its acceptance. This thesis predicts user behaviour, intention, attitude, user acceptance and adoption of an online application for trainers to teach EBM in a clinical environment. This includes the selection of factors associated to e-learning, as well as analysis of results from two research models (TAM and e-TAM). This evaluation also quantifies the effect of important barriers that improve the adoption of the TTT-EBM e-learning application.

1.5 Aim and Objectives

The aim of this thesis involves the theoretical testing of factors for the development of the TAM into a model that assesses a blended learning approach toward teaching EBM trainers in

a clinical setting. The factors come from an evaluation of previous research models and a literature review based on e-learning, EBM and TTT-EBM. This study has established the following objectives to reach that aim:

- to draw-out the influential factors of the TAM and e-TAM that have a role on the user acceptance, future attitudes and behavioural intentions of users of the blended learning approach adopted in the TTT-EBM project
- to find and evaluate the most influential factors of the TAM and e-TAM for predicting the user acceptance of the blended learning approach
- to critically select suitable external factors for use in the development of the TAM that have been weighed as barriers in e-learning
- to evaluate the TAM's ability in assessing individual data on the user acceptance of a blended learning approach to EBM study
- to evaluate the e-TAM in assessing the user acceptability of the blended learning approach
- to use a pretested questionnaire to validate TAM and assess the user acceptance of the TTT-EBM project and use another questionnaire to validate the e-TAM to find out the most important barrier to TTT-EBM
- to provide a basis for other researchers interested in continuing the development of research models and improvement of the blended learning approach
- to provide insight into how the e-learning application can be improved for the benefit of medical practitioners and the trainer's use of the application

1.6 Contributions

This study designed a questionnaire for the TTT-EBM e-learning curriculum and blended learning approach, and used it to study and evaluate the TAM. A different questionnaire designed by Oude Rengerink (2011) was used to evaluate the effectiveness of the e-TAM in assessing the user acceptance of the TTT-EBM e-learning application. Its results contribute to research involved with the evaluation of barriers and factors for the user acceptance e-learning technologies associated to e-health or more specifically EBM, where designers have blended the study material into the workplace. The thesis' results are beneficial to development of the TTT-EBM e-learning application because it has predicted the e-course's user acceptance.

There is contribution to theoretical modelling design and development research by developing the TAM with external factors and an establishment of a new model, the e-TAM. This thesis critically reviewed a wide range of research that had evaluated the effect of adding external factors to the TAM and its use in assessing e-learning applications.

1.7 Thesis Outline

1.7.1 Second Chapter: Background and Literature Review

Sufficient literature and background knowledge is reviewed to understand the merits of similar research to this thesis and to find potential gaps or theories that are unexplored in the context of developing technology acceptance models, e-learning, EBM and TTT-EBM. The literature review in Section 2.4 covers potential external factors that other research has evaluated the user acceptance of technology in different models, where some areas of research related to web-based learning or e-learning.

1.7.2 Third Chapter: Methods

The information from Chapter 2 explores the core concepts of developing models of user acceptance of technology for e-learning applications. This follows the design and development of two research models, the TAM and e-TAM, two questionnaires and three analysis methods, reliability, factor analysis and regression; used to evaluate the user acceptance of technology.

1.7.3 Fourth Chapter: Results TAM

This chapter provides and explains the results of the TAM's evaluation of the e-course. It shows how this study identified the most influential factor using reliability, factor and regression analyses. Finally, any anomalies in the results are explored, which are explained with reference to past works of other researchers.

1.7.4 Fifth Chapter: e-TAM Results

This chapter shows the developed TAM model, the e-TAM, and its assessment in being able to evaluate the user acceptance of technology for e-learning applications. A three-stage analysis process of reliability, factor and regression is used to evaluate the predictive strength of the new model and bring out any weakness for further development. The most influential factor of the e-TAM is identified, which constitutes as the greatest barrier for user adoption of the TTT-EBM e-learning application.

1.7.5 Sixth Chapter: Conclusion and Further Work

The further work chapter provides useful insight into how the TTT-EBM project may improve with the knowledge generated in this thesis. New opportunities are presented for researchers of technology acceptance and technology acceptance modelling. Finally, pointing out the

potential flaws of the e-TAM and questionnaires, as well as exploring how researchers could resolve those flaws.

2 BACKGROUND AND LITERATURE REVIEW

2.1 Introduction

Evidence-based medicine (EBM), when used effectively by medical practitioners, is considered beneficial for the quality of healthcare (Oude Rengerink, et al., 2011), job performance competency (Hatala, et al., 2006) and ethics of medical practitioners approaching the decision-making process of patient-practitioner interactions (Thangaratinam, et al., 2009). There is a large number of learning resources to teach EBM use, which may confuse the trainer of what curriculum to follow (Coppus, et al., 2007). Moreover, there is a need for modelling and prediction of how EBM trainers teach medical practitioners to use EBM in clinical environments. An approach to this challenge is modelling the trainer's acceptance of a blended learning approach to EBM study.

EBM trainers, as their profession, are responsible for providing medical practitioners an approach to practice EBM and related technologies in workplaces. This creates a link from the training given by EBM trainers to the better medical practice received by patients. Because of this link, we want to know and quantify the trainers' barriers associated to EBM teaching.

The identification of barriers affecting EBM teaching involves an assessment of tried and tested methods in similar areas. Factors can represent barriers for use in a research model; Section 2.4 discusses the categorization of factors. Establishing a research model of trainers' acceptance of innovative EBM training methods can provide a solid basis to improve EBM trainers' teaching methods. Ultimately it is assumed the outcomes of better EBM training

methods reflect in medical practitioners providing better EBM utilisation and thereby the patients receiving better healthcare.

Published research from the 1950's up to the present time have shown the development of models that have become increasing able to predict the user acceptance of innovative technologies, where present-day models can assess user adoption of e-learning technology and systems associated to e-health or healthcare. Outcomes of previous development on user acceptance modelling has shown a general trend of fitting models to specified users or applications - such as modelling trainers to further develop the innovation process of e-learning applications, as discussed in Section 2.4. By further understanding the reasons behind the outcomes of relevant research models, when developing ones' own model, it is possible to have a better approach to modelling by avoiding the pitfalls and setbacks of previous researchers. Moreover, the selection of external factors from previous research gives a background to compare results with this thesis.

The literature review addresses three research areas associated to developing models that predict user behavioural intention and assessment of EBM trainers that teach medical practitioners in a clinical environment. The first section, which explains the needs of patients, medical practitioners and EBM trainers, addresses the use of e-learning for EBM and Teach the Trainers EBM (TTT-EBM), where Section 2.2.4 explains more about the TTT-EBM project. The second section describes and explores theoretical modelling including models that can assess a user's acceptance of technology. This section also discusses similarities of the different properties of the models, such as factors and hypotheses, as well as what features of the models are better at assessing the user acceptance of innovative technologies including

e-learning. The final section discusses and analyses the important external factors considered as barriers or factors in research journals such as Ajzen and Fishbein (1980), Davis (1986), Masrom (2007), Thangaratinam (2009), Oude Rengerink (2011) and many other studies associated to technology acceptance modelling. These chosen external factors are used in the development of the e-TAM model, which fits the users of the TTT-EBM e-learning project and is illustrated in Section 3.2.2.

2.2 The use of e-Learning for EBM trainers and its acceptance

Knowledge of e-learning and how users feel about using it as a teaching technology application leads to understanding how clinicians can integrate the learning into a clinical setting (Sun, et al., 2006; Saadé & Kira, 2009; Pituch & Lee, 2006). Here are a few well-known benefits of e-learning in the context of this thesis:

- E-learning facilitates users to learn courses that are accessible online, which provides flexibility of time for the EBM-trainers to learn (Sun, et al., 2006; Ong, et al., 2004).
- EBM can be sourced on an e-learning framework, which gives EBM-trainers the freedom of learning in front of any Internet-enabled computer (Sun, et al., 2006; Masrom, 2007).
- An e-learning qualification, on how to teach EBM to medical practitioners, gives conformity to EBM-trainers on how to teach (Thangaratinam, et al., 2009; Oude Rengerink, et al., 2011; Coppus, et al., 2007).

The EBM-trainer before adoption of the e-learning EBM course, needs to consider whether it fits into their routine, encourages overall work productivity and delivers a learning achievement.

Generally, e-learning can be used for Internet-enabled learning of various subjects and has increasing importance in teaching systems (Pituch & Lee, 2006; Sun, et al., 2006; Ngai, et al., 2007). The adoption of e-learning into institutes worldwide has seen an increase in recent years (Sun, et al., 2006; Saadé & Kira, 2009). According to a report from the International Data Corporation, the e-learning market in the United States had an estimated increase from $2.2 billion to $23 billion from 2000 to 2004 (Pituch & Lee, 2006). E-learning is considered as an opportunity for higher education students to develop. Even though it has advantages over traditional education (Sun, et al., 2006), it is not considered as a replacement for the traditional classroom courses (Masrom, 2007).

2.2.1 E-Learning

E-learning systems use ICT (Information Communication Technology) to facilitate learning, which is beneficial for distance learners, learners with limitations of time and place as well as learners who like to learn collectively or as a group. Similar to the above statement, Singh et al. (2005) mentioned that there are various ways to define e-learning, such as distance learning, online learning and networked learning. The IEEE Learning Technology Standard Committee describes e-learning as a system similar to web-based learning systems, where users can access and learn their course material online. People may access this system through web-browsers, which is an interface for users to learn and practice with applications (IEEE, 2009). E-learning uses ICT so people can access information, such as medical records, that administrators could store on a single server, which is also updatable from a distance. Therefore using ICT for teaching and learning purposes is also considered e-learning (Masrom, 2007). These features facilitate and support learning for a mass population.

There have been many studies on the benefits of e-learning, such as shown in Hofmann (2002), Kekkonen-Moneta et al. (2002), Pituch & Lee (2006) and Ngai et al. (2007). Kekkonen-Moneta (2002) found students from e-learning classes have a similar progress as a group in face-to-face lectures. In favour of e-learning, Hofmann (2002) stated distance learning was better due to users needing a to become "active learners", or to develop a high self-esteem to learn individually without force from a teacher or supervisor. Pituch & Lee (2006) also stated e-learning as better suited to distance learners by giving the user freedom of time with advantages of providing synchronous or asynchronous communication between teacher and student. Moreover, Ngai et al. (2007) found that students have a positive approach to online learning and better learning outcomes using e-learning and WebCT (The University of Birmingham, 2012) compared to lecture-based courses. Overall, they showed that e-learning enables flexibility of study, study improvement as well as reduction of costs for academic institutions (Ngai, et al., 2007).

2.2.2 Learning EBM with e-learning

The fundamentals and reasoning behind the use of Evidence-Based Medicine (EBM) were discussed in Section 1.1. EBM is a medical decision-making approach, enabling practitioners to improve and evaluate patient care by finding the best available evidence through the consideration of up-to-date available information (Kulier, et al., 2008b; BMJ Publishing, 2009). Teaching and learning EBM in an e-learning training environment has similar advantages to other lecture-based lessons. Davis et al. (2007) found equal knowledge gains between e-learning and traditional courses, whereas Ngai et al. (2007), in a literature review, found "students taking the online course outperformed those taking the traditional classroom-based course". There are many different ways to get involved with EBM by attending courses,

conferences, workshops, journal clubs, educational meetings, including having access to medical literature and guidelines (Khan & Coomarasamy, 2006; Thangaratinam, et al., 2009).

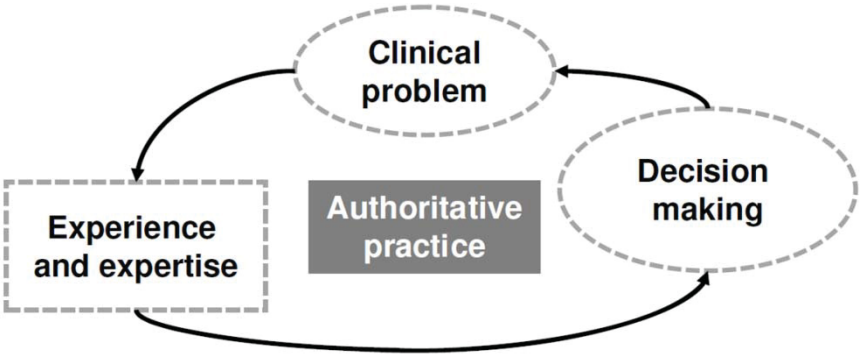

Figure 1: Traditional clinical practice and improvement cycle, reproduced from Thangaratinam et al. (2009)

Figure 1 illustrates the traditional approach to improving medical practice in the clinical environment (Thangaratinam, et al., 2009). The process involves medical practitioners assessing patients' problems by using their experience and understanding of medical practices. From that, they make a decision on a diagnosis, and the process continues with a self-improvement cycle from treatment to follow up. A significant limitation of this EBM framework is the lack of up-to-date knowledge, the lack of evidence to recognise a patients' problem and the lack of solutions for it (Hatala, et al., 2006). The study from Hatala et al. (2006) highlights the need for EBM to be integrated into the workplace and taught for use in clinician's daily activities. Hatala et al. (2006) suggest EBM and its training facilities be improved to increase the quality of the decision making process in clinical practice.

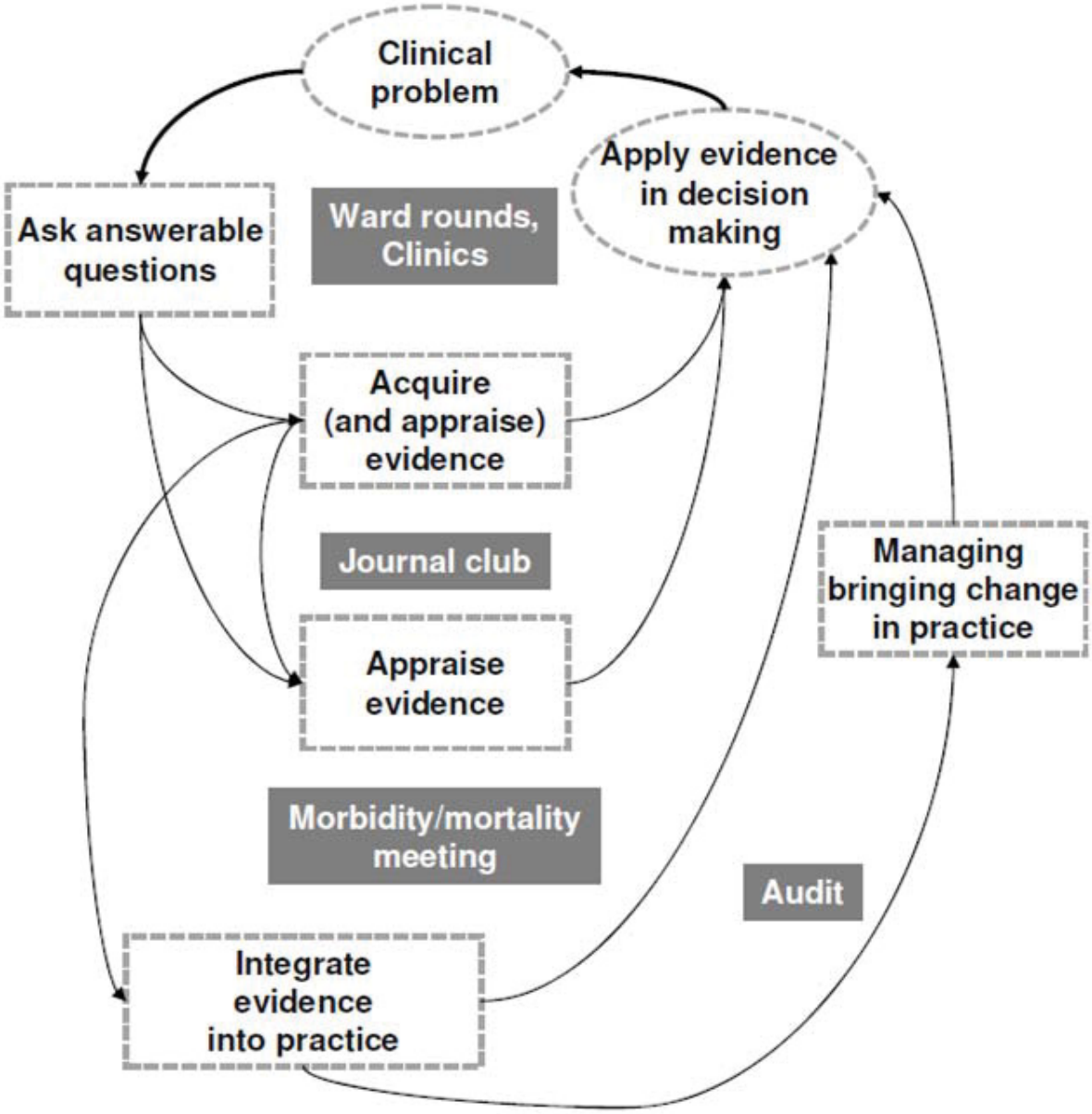

Figure 2: Improved learning and use of EBM in clinical environment with additional learning resources, reproduced from Thangaratinam (2009)

An improvement model to Figure 1 is Figure 2, where several EBM learning processes are proposed to be blended into the workplace (Thangaratinam, et al., 2009). This includes a blended learning approach with e-learning courses that directly relate to EBM practice. Such e-courses include audit meetings, journal clubs, mortality meetings and ward rounds. The blended learning approach meets the demand for clinicians to learn EBM in the workplace, as other EBM courses interrupted the flow of routine clinical activities (Khan & Coomarasamy,

2006). Clinicians should learn to work with EBM so they can utilise the benefits of improved job performance and approach medical decisions with confidence, but more importantly, trainers need to train clinicians to use EBM without it disturbing clinicians' workflow. The impact of predicting the technology acceptance of the blended learning approach with an e-course would allow e-learning designers to develop an application that fits the needs of clinicians and their routine.

2.2.3 Improving EBM use with TTT-EBM

Trainers have traditionally taught medical practitioners EBM outside the context of the trainees' workplace; this has caused a gap between learning and practice (Korenstein, et al., 2002). Korenstein et al. (2002) undertook a study that would change the curricula of EBM trainers, by placing EBM training into the clinical setting. Dawes et al. (2005) also studied the skills and training needed to practice EBM approaches and curricula. In their discussion, they pointed out the need for clear training that connects to skills: people who work in healthcare organisations need to have the ability to process new knowledge by obtaining, quantifying, using and involving it in their jobs (Dawes, et al., 2005). Meaning their careers will involve taking on progressive developments of evidence, training and practices.

Davis et al. (2007) studied computer-based lecturing for postgraduates and undergraduates. In support of Kekkonen-Moneta's (2002) results, Davis et al. showed that computer-based teaching is as-good-as face-to-face lecturing for EBM. The two studies from Davis have introduced computer-based teaching as an effective and innovative means of teaching EBM. Computer-based learning and teaching has an advantage over face-to-face teaching and learning as follows:

- Flexibility in time and work place
- Interactive for learners with controllable progress such as pause or revise
- Standardised teaching quality for a mass audience

Learners have a proven acceptance of EBM while using computer-based teaching systems (Davis, et al., 2007). Their results highlights that computer-based teaching or e-learning systems can be used to reach the same learning outcomes as the traditional approach.

The trainers of EBM can both give traditional and e-learning courses to medical practitioners, but trainers must understand the different contexts of their training sessions. Before the TTT-EBM project initiated, the need to move the teachers from standalone courses to more integrated work-based teaching was proven by other studies such as, Del Mar et al. (2004), Khan and Coomarasamy in (2004; 2006), Coppus et al. (2007) and Thangaratinam et al. (2009). These authors summarised the reasons for this kind of training because trainers had a lack of confidence:

- In demonstrating EBM in the workplace
- In teaching how to apply EBM at the same time as other clinical activities
- In understanding about the available opportunities and facilities to teach EBM in a clinical workplace to distinguish, incorporate and apply up-to-date evidence to improve healthcare

2.2.4 TTT-EBM e-learning curriculum

EBM-trainers' lack of confidence was a challenge to address for Thangaratinam et al. (2009), who designed an e-learning curriculum for teaching the trainers, aiming in the successful

delivery of EBM training sessions in everyday clinical practice. This curriculum aims to help clinicians becoming familiar with the facilities available to train EBM, such as online learning in a multimedia format see Figure 3, and thereby give them confidence in providing the EBM training course. A main objective to the TTT-EBM project is to standardize a European-wide curriculum of teaching EBM in clinics, which is integral to clinicians' work schedule. The course uses e-learning to incorporate training and on the job practice, while carrying out routine tasks, which gives the doctors flexibility of time and place. The overall goal is this e-learning application increases EBM trainers' confidence leading to the delivery of better healthcare provision and organisations that benefit the patient (Zanrei, 2009).

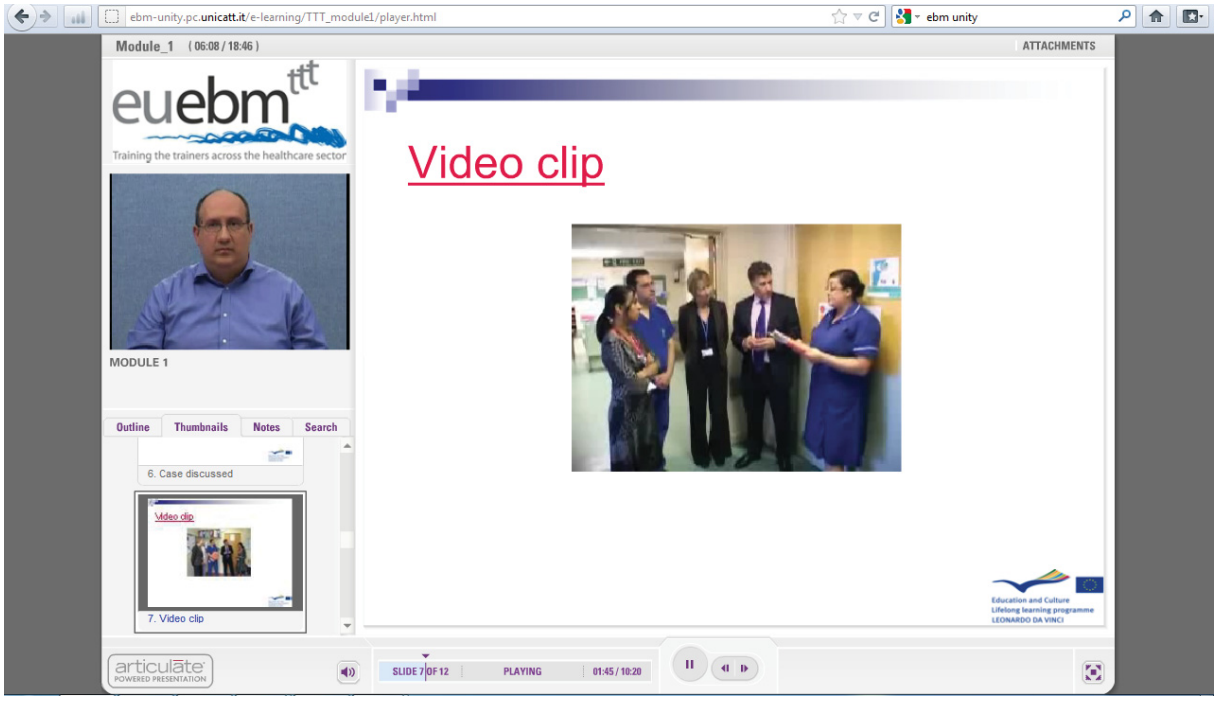

Figure 3: TTT-EBM e-learning course accessible via the Internet: Module 1 – Ward Round

The TTT-EBM e-learning curriculum contains six steps that are accessible in five different languages and covered in the following sequential order: ward round, evidence-based journal club, formal clinical assessment, outpatient clinic, formal clinical meetings and clinical audit meetings (Thangaratinam, et al., 2009) as sown in Figure 4. Each course comprises of different

learning material including video clips of real world EBM practice and e-learning content to inform how to teach EBM, which also provides resources on the modules (Zanrei, 2009). An example of the e-learning part of one module includes a 10 – 15 minute seminar followed by an online multiple-choice question test.

Figure 4: The six clinical settings that are taught in the TTT-EBM e-learning curriculum, reproduced from (Zanrei, 2009)

The TTT-EBM project has as its main purpose to help European healthcare overall. As stated in the introduction of this thesis, this study supports the aims of the TTT-EBM project by developing the TAM into a model that has factors to assess EBM trainers' acceptance of an e-learning application, where the TTT-EBM designed the application. In Chapter 4 and Chapter 5, this study used technology acceptance models to analyse questionnaires related to the TTT-EBM project, where the questionnaires' study group were EBM trainers. A significant outcome of those chapters was not just evidence to support the models, but also provided results that the TTT-EBM project may use to improve the user acceptance of their e-learning course. The next section goes into the detail of theoretical modelling and collates factors for development of this thesis' e-TAM model; the design of the model is covered in Section 3.2.2.

2.3 Theoretical Modelling of User Acceptance: From Theory and Modelling to Practice and Analysis

EBM-trainers can use e-learning's advantages of time and place flexibility when studying EBM; however, the disadvantage is they must accept new technology into their working lives. Design and development of theoretical models facilitates the measurement of a user's acceptance of technology. A user, being either medical practitioner or EBM-trainer, will have individual reactions to technology. These reactions are classified into behavioural constructs, also known as factors, which EBM course designers or managers can try to influence, or barriers they can reduce to improve their system.

Researchers often develop their own technology acceptance model based on empirical evidence or knowledge of established models, such as the Technology Acceptance Model (TAM) see Section 2.3.1.5. They may develop a model into a model that has factors specific to the application, which represents a demographic user group's acceptance of technology, such as Ngai et al.'s (2007) model for the acceptance of Web-based learning systems. Section 2.3.2 shows some other application specific models.

Various sources of research try to explain people's behaviour, intention, belief and attitude towards using technology. Research in this field has developed theoretical frameworks of user technology acceptance to improve the users' adoption of new technology, such as e-learning systems. This section of the chapter continues with examples of such studies in the field of e-learning, and the use of the associated technology acceptance theories. These build up a strong information basis for the development of a specific model for use within the context of the TTT-EBM blended e-learning approach, as discussed in Section 2.4.

2.3.1 Theory and Modelling of User Acceptance of Technology

This section discusses the following frequently cited eight research models related to user behaviour assessment:

- Innovation Diffusion Theory
- Theory of Reasoned Action (TRA)
- Social Cognitive Theory
- Theory of Planned Behaviour (TPB)
- Technology Acceptance Model (TAM)
- Technology Acceptance Model 2 (TAM2)
- The Unified Theory of Acceptance and Use of Technology
- Technology Acceptance Model 3 (TAM3)

The review considers the TAM's development, as well as study the use and predictive power of other well-known models for user acceptance of technology. This study uses this information to develop a new model.

2.3.1.1 Innovation Diffusion Theory

Innovation Diffusion Theory explains the innovation-decision process (Kripanont, 2007), being the events leading up to the acceptance or rejection of using an innovation. Rogers (1995) developed and implemented this theoretical model. It is the process of adapting innovation by predicting how users adopt it, have an attitude toward it, decide to accept or refuse it, put it to effective use and validate their reason to use it (Rogers, 1995; Kripanont, 2007). The theoretical model is mainly popular among researchers to model and predict the innovation-decision process of users.

Innovation diffusion can succeed using a process of five steps over time, resulting in a decision making process as shown in Figure 5. Rogers (1995) came up with the following elements in the process:

1. Knowledge - a user's understanding or acquaintance with an innovation
2. Persuasion - an individual's positive or negative attitude towards innovation
3. Decision - an individual weighs advantages and disadvantages of accepting or rejecting an innovation
4. Implementation – a user starts using the innovation - it helps the individual realise the usefulness of the innovation
5. Confirmation - when the relation between an innovation and a user's decision is verified

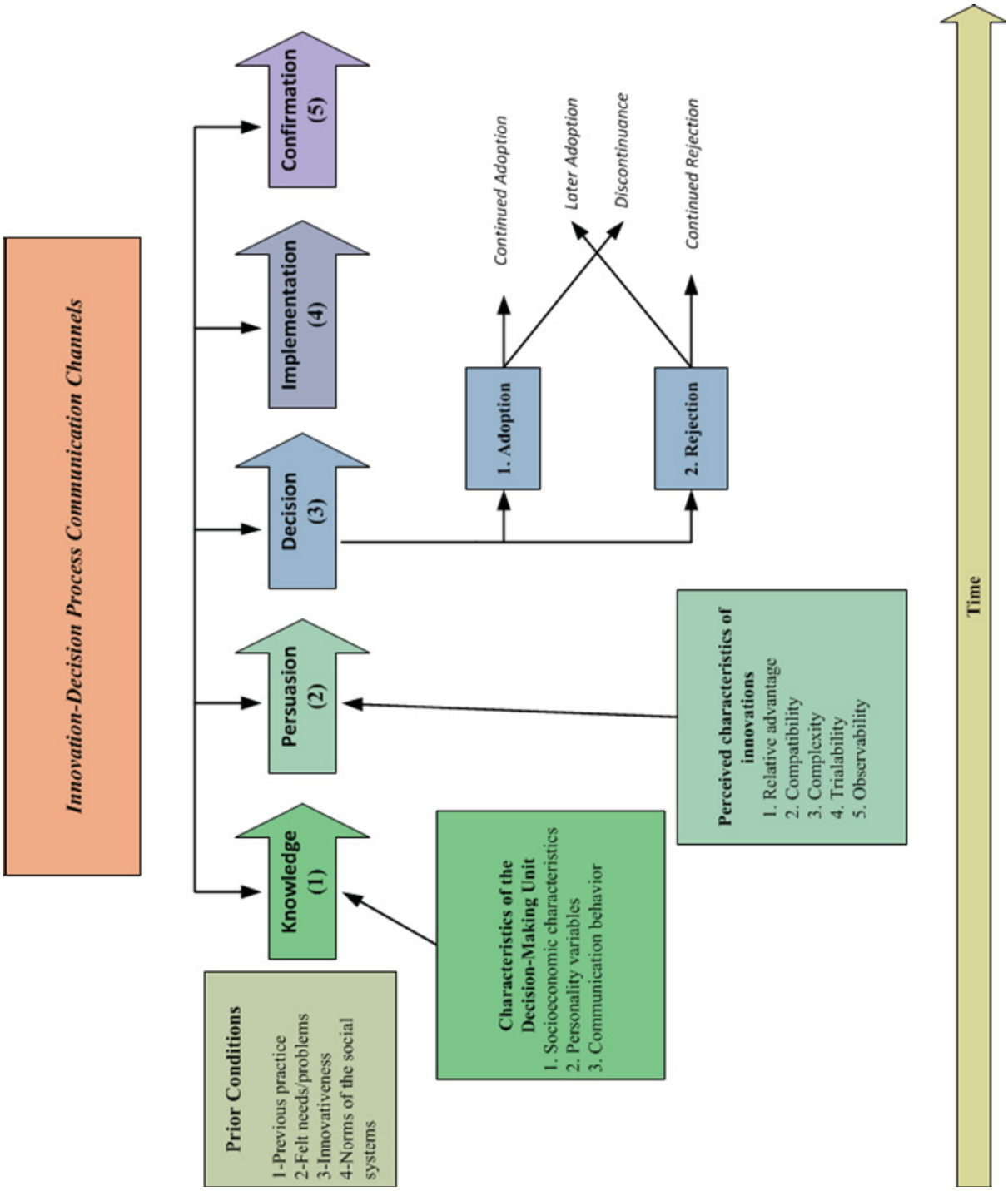

Figure 5: The Innovation-Decision Process Communication Channels, reproduced from Rogers (1995)

Venkatesh (2003) presented the application of Innovation Diffusion Theory with seven core constructs, based on Moore and Benbasat's (1991) study of individual technology acceptance as follows:

1. Relative Advantage – how much it is perceived as being better than present or past technology
2. Ease of Use - how much it is perceived as being difficult to use
3. Image - how much the use of it is perceived to enhance one's reputation or social status
4. Visibility - how much awareness there is of others using it
5. Compatibility - how much it is perceived as being consistent with the existing values, needs, and past experiences of potential users
6. Results Demonstrability - the tangibility of the results to use it, including their ability to observe and communicate
7. Voluntariness of Use - how much the use of it is perceived as being voluntary, or of free will

Innovation Diffusion Theory has been used to understand the linear and time dependent connection between an innovation and the decision processes associated to that new technology or idea. Rogers (1995) initially put the process into a linear format. Then the properties of the innovation-decision process were categorised by Venkatesh (2003) into seven core constructs for studying individual technology acceptance. It is useful to categorise behavioural properties of users, because it is an initial step in developing a theoretical model. To sum up Innovation Diffusion Theory has been used to aid the development of other theories and models, shown below, which have the ability to understand the fundamental and core constructs of how new technologies or ideas can be adopted by users.

2.3.1.2 Theory of Reasoned Action

The Theory of Reasoned Action (TRA) is a model that has been used to predict the behaviour of individuals, when they want to accomplish a voluntary pre-determined task or objective (Sheppard, et al., 1988). Fishbein and Ajzen (1975) have developed it; it has also contributed to the initial development of the TAM, (as discussed in Section 2.3.1.5). TRA has been used in studies to identify the relationships between behavioural intention (BI), attitude (A) and subjective norm (SN), where "BI = A + SN", where this equation predicts a user's behaviour in doing a voluntary action (Davis, 1986).

Fishbein and Ajzen (1975) and Ajzen and Fishbein (1980) defined behavioural intention, attitude, belief and subjective norm as follows: Behaviour can be commonly described as being unpredictable and as either rebelling or conforming to social acceptance. For example, culture, attitudes, emotions, values, ethics, authority, rapport, persuasion and coercion can influence human behaviour. Intention is the action of a person that drives them to do something specific, it is the relation between a person and their action. An attitude is an individual's state of mind or perception that either favours or disfavours something. It can be a type of bias for evaluative response, which is positive or negative. Belief is a form of connection that people assume between the attitudes of each other or to inanimate objects. Subjective norm is the influence from other people on ones' behaviour. It also shows the impact other people have on one's beliefs, which has a consequential effect on behavioural intention. More information regarding behavioural intention and attitude can be found in Section 2.3.1.5.

As outlined by Venkatesh (2003), the core constructs of TRA are attitude toward behaviour and subjective norm, which have a direct influence on the user's behavioural intention to do a task. This complements Sheppard's (1988) explanation of how a user's behavioural intention to accomplish a certain task is very dependent on their attitude or behaviour toward the necessary processes in doing that task and how much they regard it as a subjective norm. As illustrated in Figure 6, when a user has a strong attitude or behaviour toward doing a task and a high regard of their task being a subjective norm, they will ultimately have a strong behavioural intention to carry out their task. TRA has been a successful model in predicting the user intentions and behaviour when wanting to carry out a voluntary action (Sheppard, et al., 1988).

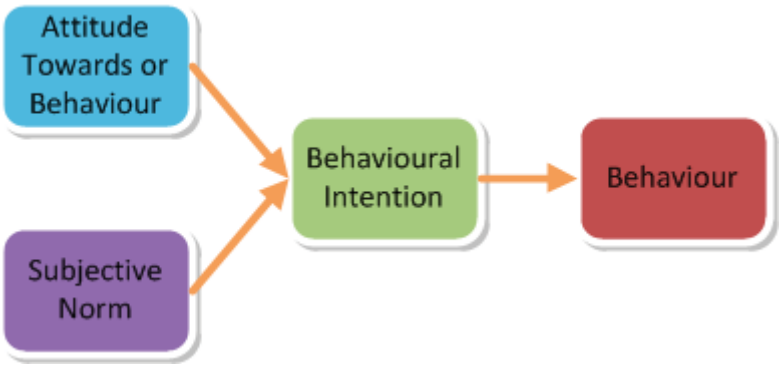

Figure 6: Original version of Theory of Reasoned Action (TRA), reproduced from Ajzen & Madden (1986)

Ajzen and Fishbein (1980) included new theories to the model shown in Figure 6, and further expanded and illustrated it as shown in Figure 7. As the figure illustrates, a user has a belief and evaluation about carrying out a behaviour, which has a direct influence on attitude. The user would also have a normative belief from their society, i.e. beliefs that follow those of people close to them, such as family or friends, and a degree of motivation to behave in accordance with their society's beliefs. These two factors combined have an effect on the intentions of the user, which depends on how much the user feels their social group is

pressurizing them - peer pressure. The attitude or behaviour toward use of technology and subjective norm are directly related to a user's behavioural intention. Meaning the user's belief, subjective norm and evaluation on how to act as well as motivation to comply have an overall effect on the behavioural intention of a user to do their voluntary action.

This model presents the positive or negative outcome of a system. The outcome is positive if the behaviour of a person develops into a positive attitude about the behaviour and if it is a negative outcome, it is vice versa (Kripanont, 2007).

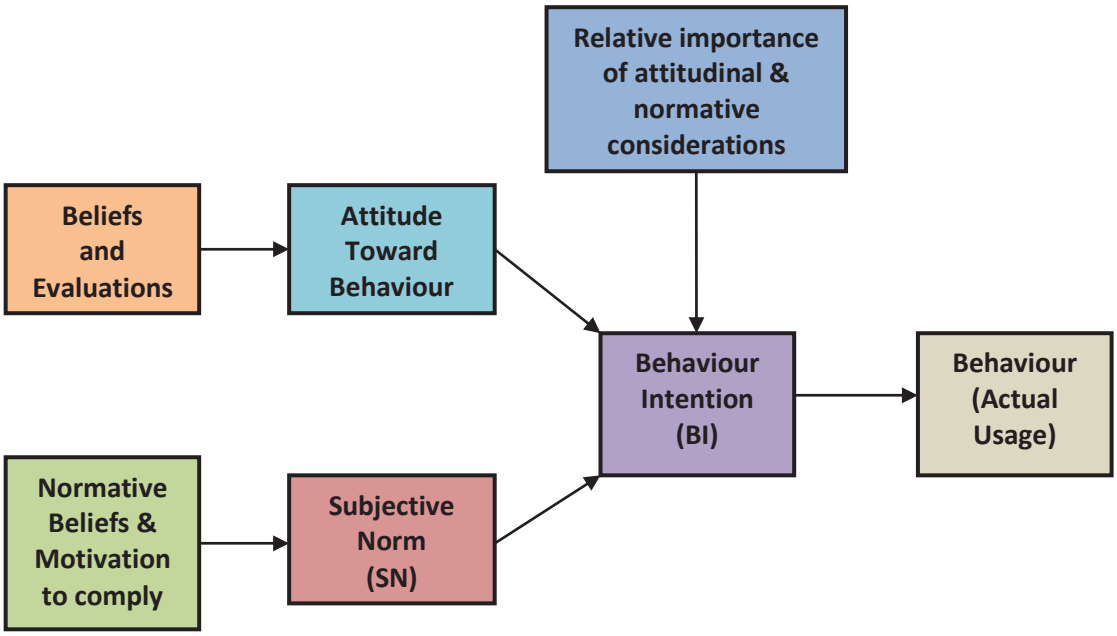

Figure 7: Theory of Reasoned Action (TRA), reproduced from Ajzen & Fishbein (1980)

TRA is well known as being the backbone for the majority of studies associated to the relation of attitude and behaviour. However, Bagozzi et al. (1992) identified a weakness of TRA in the determinants of attitudes and predicted intentions, stating that determinants closely link to actual behaviour. Sun and Zhang (2006) also identified a weakness of TRA in its ability to assess fully the technology acceptance of users. They reached this conclusion by comparing the

explained variance of explanatory powers of the Technology Acceptance Model with TRA (Sun & Zhang, 2006).

Since 1975, when TRA was first introduced by Fishbein and Ajzen (1975), this model has been analysed and developed to improve its ability of predicting a user's behavioural intention to carry out a voluntary action. Davis (1986) addressed some challenges of the TRA in assessing a user's behavioural intention and thereby developed it into a new theoretical model, which he later validated, as shown in Section 8.1.

Modelling behavioural intention, attitude and subjective norm, as well as other beliefs in the TRA model, has provided insight into a user's intention to perform a voluntary action. Section 2.3.1.1 discussed how studies used innovation diffusion theory, which similar to TRA explains how a user's perception of technology has an effect on its adoption. As shown in Section 2.3.1.5, Davis (1986) considered the core constructs of TRA to develop his technology acceptance model. Background information on innovation diffusion theory and TRA represents the basis of the core constructs of Davis' model, which was needed for this thesis to understand and develop Davis' model into the e-TAM. The following paragraphs report further theories and associated models to distinguish advantages from disadvantages and use them for implementing this thesis' model.

2.3.1.3 Social Cognitive Theory

The user's behavioural intention to carry out a voluntary action may change depending on the influence from their situation, society and government legislation. This can happen if a person has a change in their lives, which has a direct impact on their voluntary action, such as when

wanting to use an e-learning system, but their Internet service provider decreases their usage allowance and therefore creating a barrier to using e-learning.

Social Cognitive Theory provides a model to predict the human behavioural changes, as introduced by Bandura (1986). He assumed that the person, behaviour, and environment are all combined to create learning in an individual. The model shown in Figure 8 represents the link between a person and their behaviour, this relation includes the person's thoughts and actions.

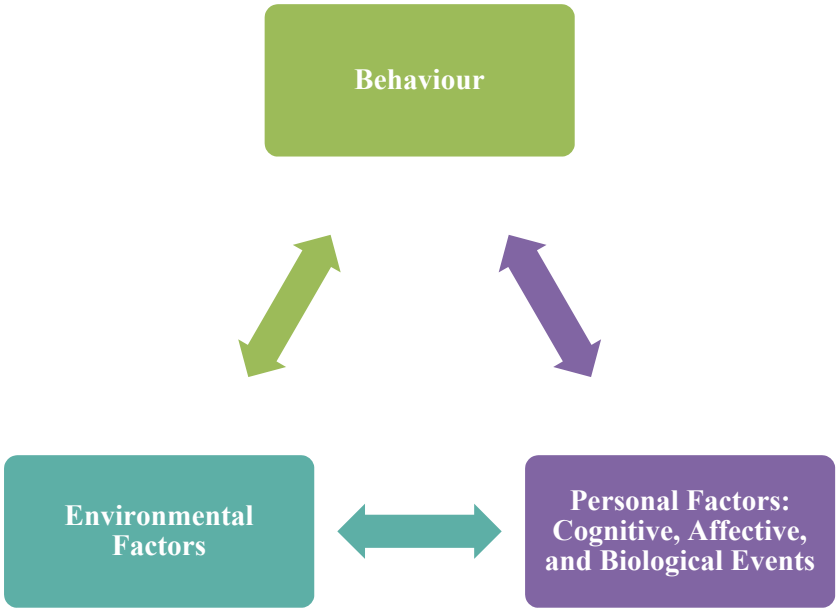

Figure 8: Social Cognitive Theory, reproduced from Bandura (1986)

People learn by observing others, where the environment, behaviour, and cognition are factors that influence their development. Venkatesh et al. (2003) studied the theories related to an individual's acceptance of technology. He stated that Social Cognitive Theory is one of the most powerful theories that can describe the behaviour of people. In addition, he commented on how researchers used Social Cognitive Theory in the context of computer utilisation. He listed the behavioural constructs of this model as personal and performance expectations, as well as self-efficacy, affect and anxiety.

Personal or performance expectations are what the user assumes to get as an outcome of achieving a personal or job-related goal. A user's self-efficacy is their ability and skill in using technology. Venkatesh (2003) described the user's emotions to using technology as "liking" it, as the affect, and having doubts toward its use, as the anxiety.

2.3.1.4 Theory of Planned Behaviour

A user's behaviour to carrying out a voluntary action is related to the influential effect of their surroundings and their ability and motivation for adopting that behaviour. The Theory of Planned Behaviour (TPB) has the ability to assess the user's behavioural intention, based on their attitude, social cognition and intentional motivation, for specific activities or voluntary actions (Ajzen, 1985). This being useful because, as stated by Ajzen (1985), the user's behavioural intention differs depending on the voluntary action, they also recommend avoiding assessing the user's behavioural intention in general voluntary activities.

TPB was introduced by Ajzen (1985) and it completes the TRA model by adding perceived behaviour control as a factor. The latter is defined as how people see their behaviour to their intended action as easy or difficult (Ajzen, 1991). In addition, Ajzen and Cote (2008) identified it as the potential that a person has to complete a specific behaviour. The perceived behaviour control section was added to TPB to solve the apparent challenges with the TRA, such as when dealing with behaviours over which people have incomplete freedom of control (Kripanont, 2007).

TPB explains human behaviour as an action that is influenced by behavioural beliefs, normative beliefs and control beliefs, which as Figure 9 illustrates are predictors for attitude toward the behaviour, subjective norm and perceived behaviour control respectively. There

was an assumption that supporting those user constructs will increase the person's acceptance of the voluntary action and will convince the person to perform that voluntary action (Kripanont, 2007).

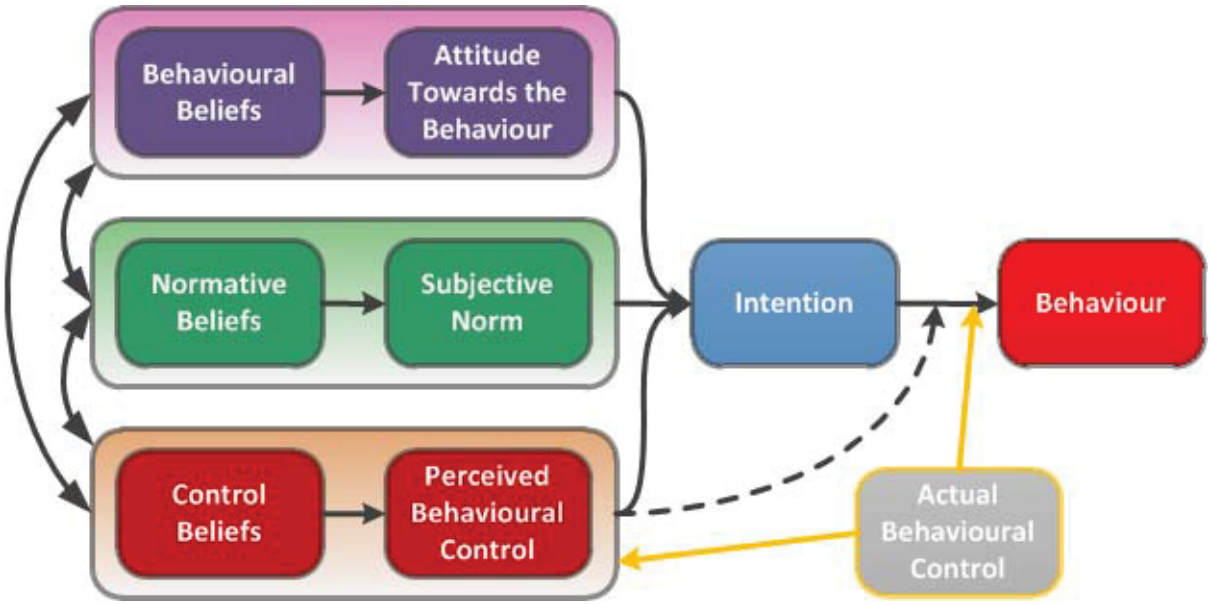

Figure 9: Theory of Planned Behaviour, reproduced from Ajzen and Cote (2008)

Behavioural beliefs are those that are produced from positive or negative attitudes towards the behaviour (Kripanont, 2007). Normative beliefs are those of individuals or groups that come from perceived behavioural expectations (Kripanont, 2007). Control beliefs are those that arise from the existence of factors that can influence the behaviour and specify people's feelings of being in control. This could increase the power of perceived behaviour control (Kripanont, 2007). Attitude toward the behaviour is identified as an analysis of the user behaviour that is biased either to encourage or to discourage an action (Ajzen & Cote, 2008). The subjective norm is identified as the influence that society has on the behaviour of a person. The influence of society can change the user's original plan or behaviour to that voluntary action negatively or positively (Ajzen & Cote, 2008).

TPB is known as the most populated social-psychological model for behavioural studies (Ajzen & Cote, 2008). However, Mathieson (1991), Chau and Hu (2001; 2002) evaluated the TPB model and found that perceived behaviour control, one of its factors, is generally weaker than the factors of the TAM in their ability to predict the user acceptance of technology. More on the TAM and the reasons behind its choice as the base to develop the thesis' model follows.

2.3.1.5 Technology Acceptance Model

The Technology Acceptance Model (TAM), established as an empirical model, is also a theoretical framework that designers use to predict the user's behavioural intention toward new technology. TAM can be applied to evaluate data collected from a questionnaire or survey of a target group of users of a system; the model outputs an assessment of the users' acceptance of technology and identifies the most influential technology acceptance factor, represented as the core constructs of the user. The TAM has been widely used and studied, the following reviews how it developed including its strengths and weaknesses as a basis for its development into the thesis's model, the e-TAM.

The TAM was derived from TRA to model the user acceptance of IT systems (Davis, 1986). This model has enabled designers to understand the advantages and disadvantages of design elements of technology, while the technology is in early implementation stages, and thereafter they can improve the systems' design.

Davis (1986) initially tested the characteristics of user acceptance of computer-based information systems. The TRA as studied in Section 2.3.1.2 and the TAM shown in Figure 10 have similarities, because Davis used the TRA as a basis for model development. The core constructs of the TAM are Perceived Usefulness and Perceived Ease of Use, while the other

core concepts of Behavioural Intention and Attitude Toward Use have been adapted from the TRA model. Their generic meanings are as follows.

- Perceived Ease of Use (PEOU), a user's point of view of how hard or easy doing an action is (Davis, 1989)
- Perceived Usefulness (PU), a user's confidence that using a system will improve their job performance (Davis, 1989)
- Behavioural Intention (BI), a user's motivation to start, continue and complete an action (Fishbein & Ajzen, 1975)
- Attitude Toward Use (ATU), a user's positive or negative interest to using the system (Fishbein & Ajzen, 1975)

Figure 10 shows the connection between the four factors of the TAM; they have arrows to indicate a correlation between each of them. Each arrow represents a theoretical relationship, or hypothesis, that predicts one factor will have an effect on the other. The TAM outputs a magnitude and direction for each hypothesis, more information on hypotheses in Section 3.3.

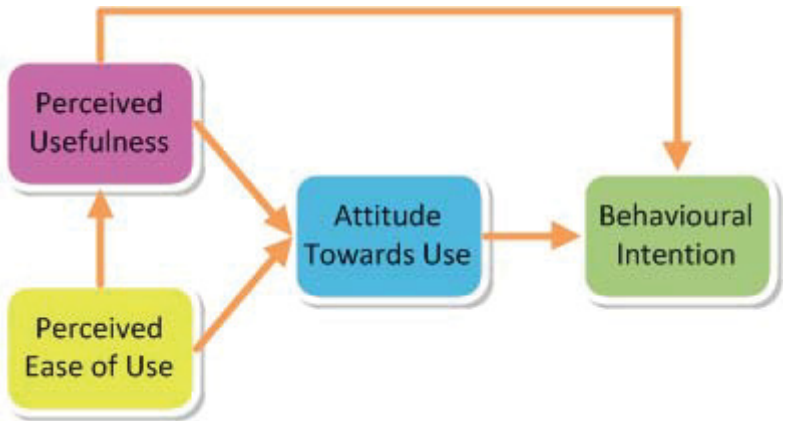

Figure 10: The TAM model based on (Davis, 1989)

Davis (1989) reviewed a wide range of articles purposely to estimate the factors he needed in the TAM. He found hypotheses between the main factors (from the original TAM),

represented with solid lines 1 to 6 in Figure 11, and predicted the influence of external factors, design features and performance impact, on the main factors, which are hypotheses shown by dashed lines 7 to 9 in Figure 11.

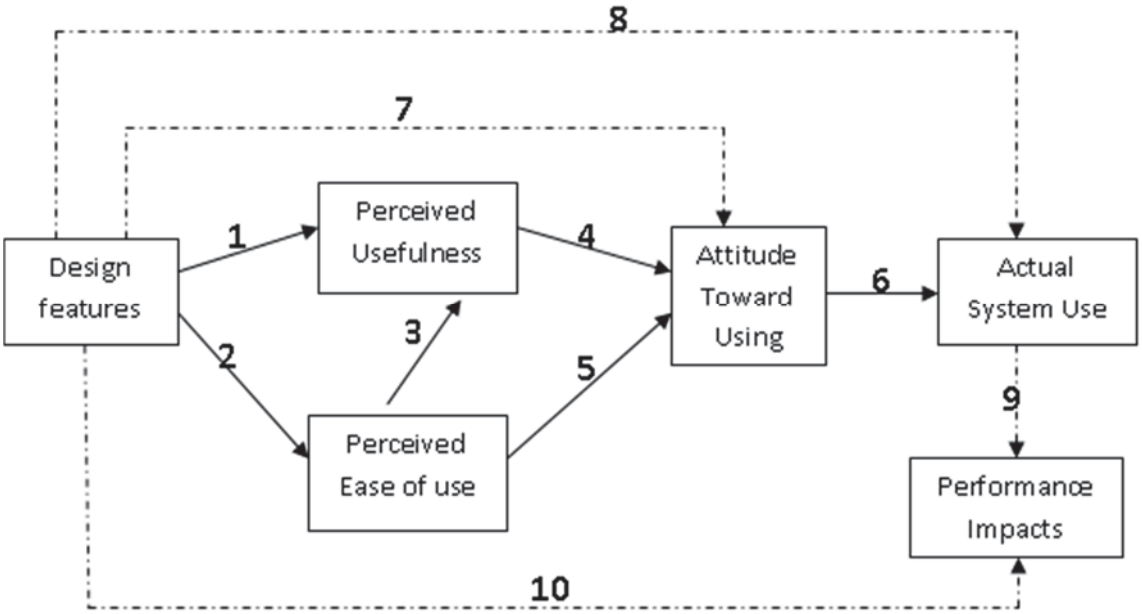

Figure 11: TAM with numbered links between the factors and external factors, reproduced from Davis (1986)

Initially, it was popular to use the TAM in the areas of Information Systems and IT (Information Technology) however, up to now it has been used in several other areas. The TAM is popular among researchers for modelling a user's intention to use innovative systems, where their research outcomes have indicated how to motivate individuals to adopt and use technology. These include using e-learning (Ngai, et al., 2007; Moon & Kim, 2001; Zhang, et al., 2008) (see Section 2.2.1), healthcare event reporting systems (Wu, et al., 2008; Chau & Hu, 2002; Goetzinger, et al., 2007), personal computers (Igbaria, et al., 1997), word processors and spread sheets (Chau, 1996), knowledge management in agriculture (Folorunso & Ogunseye, 2008) and predicting intranet and portal usage (Chang, 2004).

Since the TAM's introduction in 1986, Davis and other researchers have been evaluating the predictive ability of the TAM to expand its ability in predicting user intention and thereby proposing improvements for assessing user acceptance of technology. Davis (1993) stated that improvements to the TAM should be able to explain a user's motivation to use a system because of the influence from management or hierarchical structures in their society.

Researchers have improved the TAM's capability to predict user behavioural intention toward using technology. Venkatesh and Davis (2000b) did this by introducing a development of the TAM, called the TAM2. The TAM2 is a significant advancement in predicting user behavioural intention and acceptance of technology (Venkatesh & Davis, 2000b); more on TAM2 in Section 2.3.1.6. Moon and Kim (2001) have also made developments from the original TAM. They extended the TAM model through the addition of a predictor called Perceived Playfulness, which signifies how much a user believes the system as playful; associated to fun activities like games. With hypotheses, Moon and Kim's model connects PEOU to Perceived Playfulness and Perceived Playfulness to ATU and BI. Their study included an analysis of 152 graduate students using the worldwide web (Moon & Kim, 2001). After comparing analysis results of their extended TAM with the original TAM, they found that their extended TAM had a 5% greater explanation of the variance in attitude and 4% greater explanation of the variance of behavioural intention from the group.

In Chapter 4 of this study the ability of the TAM is assessed in modelling EBM trainers as users of the TTT-EBM e-learning system, providing as basis for the TAM's development into the e-TAM by adding factors that explain the variance of the TAM's core constructs.

2.3.1.6 Technology Acceptance Model 2

Theoretical modelling of user behavioural intention and acceptance of technology should have a good balance between generalisation and being specific in terms of choosing factors. Generalisation of factors into groups allows researchers to apply the outcomes of a study to various applications, whereas being specific drowns out some determinants of main factors that are irrelevant to a users' acceptance of technology.

Venkatesh and Davis (2000b) have developed the TAM to become less generalised and more specific to produce results that allow them to design organizational interventions, by including external factors of experience, image, job relevance, output quality, subjective norm and voluntariness. Experience and voluntariness are moderators to the hypotheses of subjective norm, where both moderate the influence of subjective norm on intention to use and experience also moderates subjective norm's influence on perceived usefulness. These additional or external factors were added to see the effect that determinants of the original factors of the TAM have on the user's behavioural intention, as shown in Figure 12.

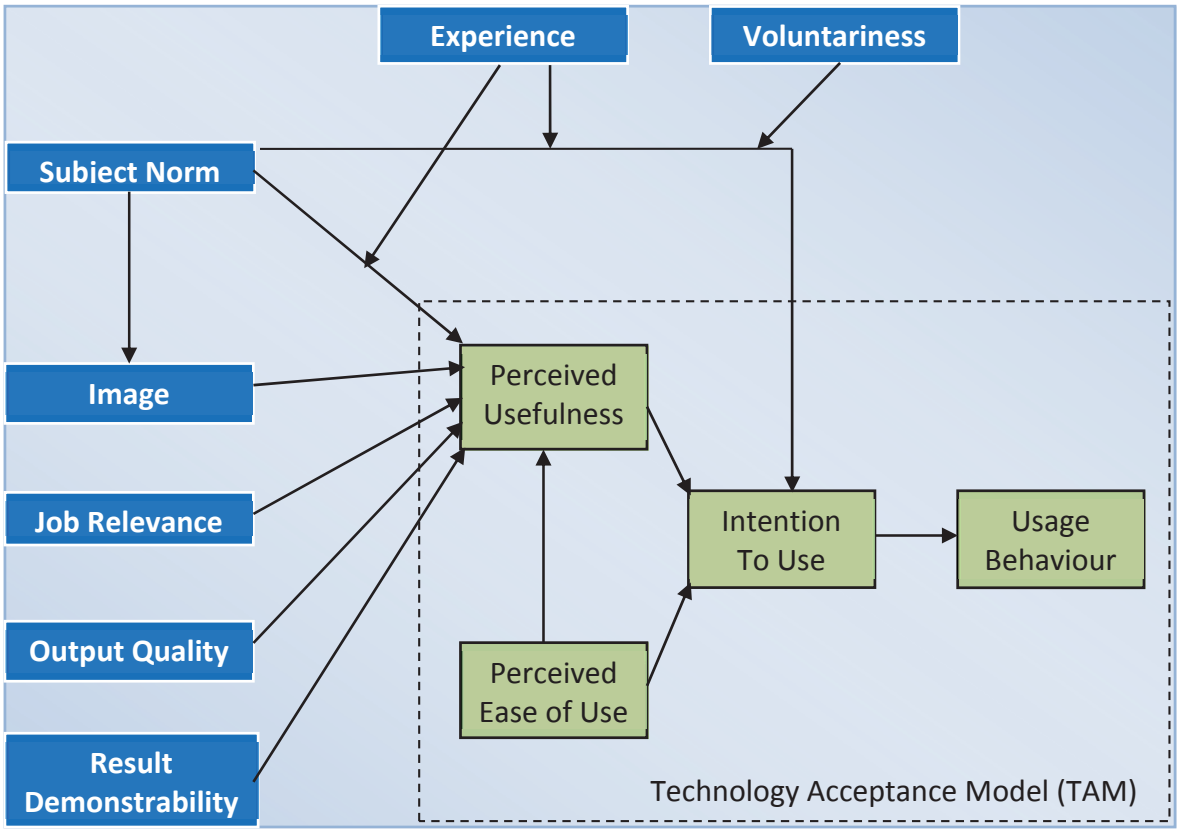

Figure 12: TAM2 - Extension of the TAM, reproduced from Venkatesh and Davis (2000b)

Figure 12 shows in white font the external factors, Experience, Job Relevance, Image, Output Quality, Result Demonstrability, Subject Norm and Voluntariness see the Glossary, Section 8.4 for the definition of each term. These additions along with the TAM became the Technology Acceptance Model 2 (TAM2). Each additional factor, apart from experience and voluntariness, represents the direct determinants of PU, which can explain and predict a user's PU and hence the user acceptance of technology (Venkatesh & Davis, 2000b).

Venkatesh and Davis (2000b) conducted a study for the TAM2 to evaluate 156 participants from four different organisations. They chose two organisations where participants were given voluntary usage of the system in their study and another two organisations where participants were given mandatory usage of the system. This division of voluntary and mandatory usage was designed in order to quantify the effects of a user having a choice to

carry out the action and “to explicitly examine the theorized moderating role of voluntariness” (Venkatesh & Davis, 2000b). Venkatesh & Davis (2000b) collected the longitudinal data from four systems in four organisations and tested the TAM2 at pre-implementation, at one month after post-implementation and at three months after post-implementation. The results showed the TAM2 accounted for “40%–60% of the variance in usefulness perceptions and 34%–52% of the variance in usage intentions” (Venkatesh & Davis, 2000b). Subjective norm in the TAM2 exerted “a significant direct effect” on the user’s behavioural intention, which was greater than the TAM’s perceived usefulness and perceived ease of use, but only when organizations make use of the systems “mandatory” (Venkatesh & Davis, 2000b). They also found the role of social influence on perceived usefulness decreased as the user gained experience over time (Venkatesh & Davis, 2000b). Therefore, there is a significant positive effect of adding new predictors of subjective norm, experience and voluntariness to the TAM.

Based on evidence from this literature review, there is an argument that adding direct determinants of the TAM’s factors as external measurable variables can give greater analysis of the original factors of the TAM or predictability of the users’ intentions. It follows the idea that this thesis has of finding barriers to the TTT-EBM e-learning course and integrate them as additional factors to the TAM (see Section 2.4.). This just as Venkatesh and Davis (2000b) had done, is specific enough to fit the context of this study while being general enough to apply it to other online learning courses. This thesis’ work has selected factors specific to users of an EBM online course, which are general enough for application to other fields of e-learning. Section 3.2.2 shows the evolution of the TAM into the e-TAM, which models users enrolled on an EBM e-learning course.

2.3.1.7 Unified Theory of Acceptance and Use of Technology

The models previously mentioned in this chapter; Innovation Diffusion Theory, TRA, Social Cognitive Theory, TPB, TAM and TAM2 have different abilities in predicting the user acceptance of technology. Venkatesh et al. (2003) decided that it would be beneficial if there were one model to explain the user's technology acceptance that is comparatively better than the majority of technology acceptance models. He presented the Unified Theory of Acceptance and Use of Technology (UTAUT), which takes into account conceptual and empirical similarities across the eight models. The model is shown in Figure 13.

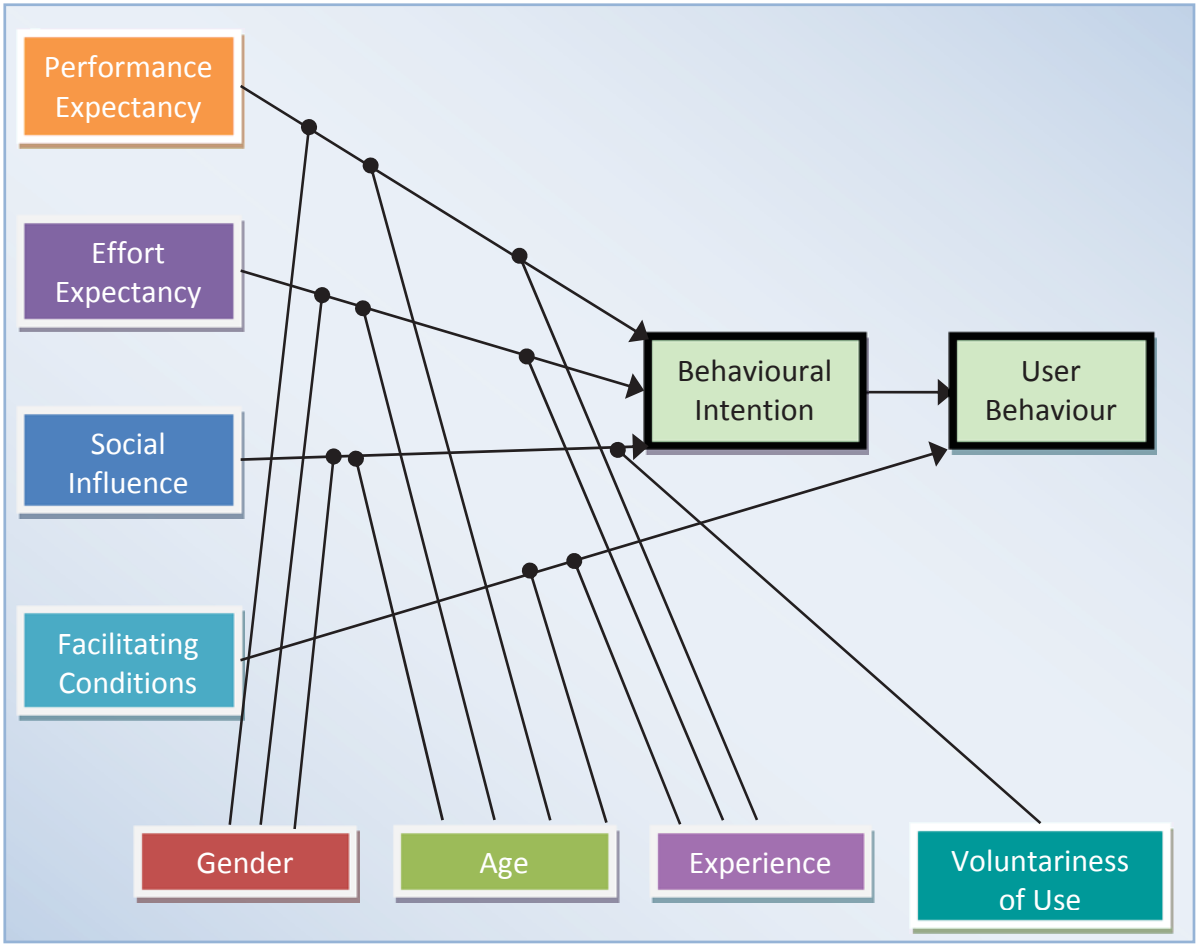

Figure 13: Unified Theory of Acceptance and Use of Technology, reproduced from Venkatesh et al. (2003)

These similarities were summarised after reviewing a wide range of literature to cross-examine the eight research models. These are as follows: the TRA, the TAM, the motivational model, the TPB, the combined model of the TAM and the TPB, the model of personal computer utilization, the Innovation Diffusion Theory and the Social Cognitive Theory (Venkatesh, et al., 2003). They compared the models with data collected from questionnaires as adapted from Davis (1989) and Davis et al. (1989). Venkatesh (2003) applied his study three times over a six-month period to four organisations. The results from the study led them to identify four predictors as direct determinants for user acceptance and usage behaviour namely performance expectancy, effort expectancy, social influence, and facilitating conditions. Venkatesh (2003) explained these as follows:

- Performance expectancy is how much a user believes using a system will improve their job performance
- Effort expectancy is the amount of work the user thinks they need to put in to use a system
- Social influence is the effect a user gets from the weight that is put on them by associated peoples' ideas
- Facilitating conditions is the confidence level a user has of the support from an organisation or technical centre

Venkatesh (2003) analysed the UTAUT, the results indicated it as a strong theoretical model. In Venkatesh's (2003) study the UTAUT accounted for 70% of the variance in usage intention compared to the eight models, which explained 17 to 53% of the variance in user intentions to use information technology.

They showed its main benefactors to predicting user behaviour and their acceptance. Firstly, it provides the direct influence of performance expectancy, effort expectancy, and social influence on intention. Secondly, the direct influence of intention and facilitating conditions on usage behaviour. Finally, the most important founding was that the factors of age, experience, gender and voluntariness were found as having a strong influence and as essential to use in UTAUT (Venkatesh, et al., 2003).

The UTAUT is in agreement with TAM2; the development of those two models is similar to how this thesis chooses the best factors from other models to explain user intention. It has shown that combining the factors of other models to form one had given good results for their study, which is what this thesis explains for the e-TAM in Section 3.2.2. The factors were taken from other models, which is a similar method used in this thesis, where factors are critically reviewed in Section 2.4

2.3.1.8 Technology Acceptance Model 3

Venkatesh and Bala (2008) introduced the Technology Acceptance Model 3 (TAM3) for further explanation of how and why users accept and use IT in the workplace. They focused their work on clarifying the user acceptance and the predictors of the Perceived Usefulness (PU) and Perceived Ease of Use (PEOU), which originate from the TAM. They mentioned how important user acceptance is from an organizational point of view for development of projects, when their users have a greater acceptance and better use of IT. Adding it would give organizations an opportunity to reduce the risk of project failure and a huge financial loss (Venkatesh & Bala, 2008). They drew-out a few examples of projects that did not succeed due to having a lack of information on user adoption of technology. For instance in 2004, Hewlett-Packard had a $160

million failure while trying to implement IT. In addition, Roland Wolfram who was the general manager of Nike's Asia-Pacific division in 2000 had a 20% stock loss costing him $100 million (Koch, December. 1, 2004; Koch, Jun, 15, 2004; Venkatesh & Bala, 2008). They emphasised the value of user acceptance because of its 5.1% growth in research from 2000 to 2004 and 7.7% from 2004 to 2008. The growth occurred because the academic and industrial disciplines agreed on the need for managers to develop and incorporate better IT training methods for their staff (Jasperson, et al., 2005; Venkatesh & Bala, 2008).

Venkatesh and Bala (2008) used the TAM model with focus on the Behavioural Intention (BI) as the base for their model. They also used the TAM2's predictors for PU, which was introduced by Venkatesh and Davis (2000b), see Section 2.3.1.6 and PEOU as predictors, which was introduced by Venkatesh (2000a) as anchor, adjustments and experience. The TAM3 itself, was finally introduced with two sets of predictors, one for PU: subjective norm, image, job relevance, output quality, result demonstrability and the other for PEOU: computer self-efficacy, perceptions of external control, computer anxiety, computer playfulness, perceived enjoyment and objective usability, see Figure 14. These changes made the TAM3 different from the TAM2 with three new relations:

1. between experience, PEOU and PU
2. between computer anxiety and PEOU
3. between PEOU and BI

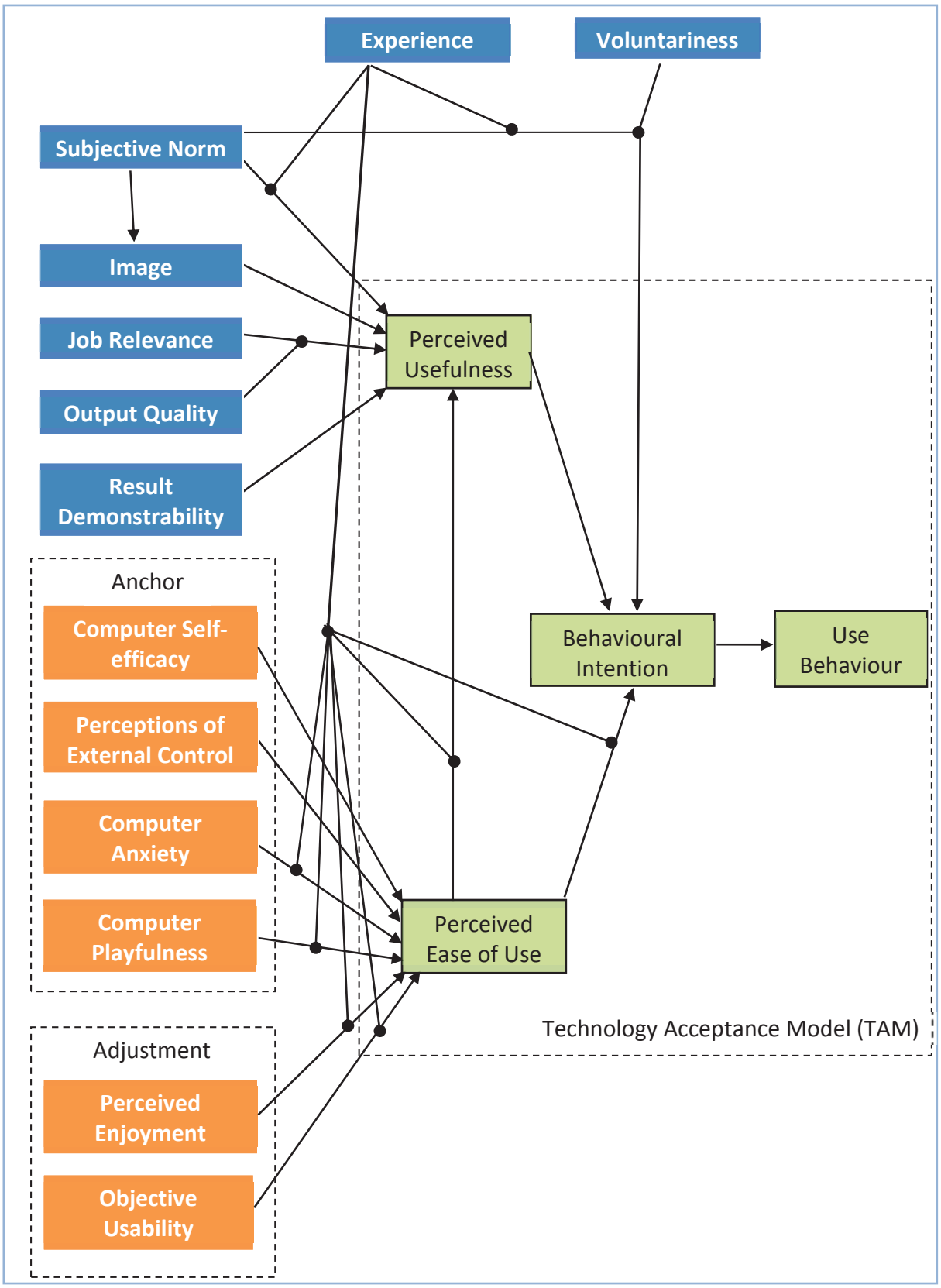

Figure 14: Technology Acceptance Model 3 (TAM3), reproduced from Venkatesh and Bala (2008)

Venkatesh and Bala (2008) studied the TAM and TAM2 for developing a model to predict technology acceptance in the workplace. Their model was similar to the development of the TAM2 in finding the determinants of PU, but different because they also found the determinants of PEOU. As shown in this section, the development of the TAM3 was designed in a way that supports the ideas of developing research model for this thesis, see Section 2.4. The significance of the TAM3 is its ability to assess technology usage in the workplace, which is similar to the aims of this thesis. As shown in Section 3.2.2, this thesis develops a model specific to the working environment of its users – the clinical environment of EBM trainers.

2.3.2 Technology Acceptance of e-Learning

E-learning has been introduced and explored for its use in Section 2.2. This showed that there is a need for EBM trainers to learn how to teach medical practitioners in their workplace and e-learning can facilitate widespread time-independent learning. To gain the full benefits of learning with e-learning, it is needed to know more about how users or EBM trainers interact and accept e-learning technology. This section reviews studies that developed research models and have assessed the user's technology acceptance of e-learning.

Ong et al. (2004) studied barriers that influence an engineer's acceptance of e-learning systems. Using the TAM as a base, they developed new constructs, such as perceived credibility and computer self-efficacy and excluded attitude towards use. Both of these became additional factors in their model to enhance the prediction of user acceptance.

Perceived credibility was defined as the degree to which a person believed that using a particular system, such as an e-learning application, would be free of privacy and security threats (Ong, et al., 2004). Computer self-efficacy was defined as ''an individual's perceptions

of his or her ability to use computers in the accomplishment of a task rather than reflecting simple component skills'' (Compeau & Higgins, 1995).

In Ong et al.'s (2004) study, they examined how applicable the TAM was concerning their project. Stating that there was a significant increase in user acceptance because of a shift from "product-based to knowledge-based economy" (Ong, et al., 2004), this being an increase in demand of intelligent users for complex systems. One method that helps the shift is using e-learning, which provides education and training and thereby increases a user's knowledge of a system. Their literature review presented the benefits of e-learning when involved with limitations of time and location, coupled with other benefits such as: "reduced cost, regulatory compliance, meeting business needs, retraining of employees, low recurring cost, and customer support" (Ong, et al., 2004).

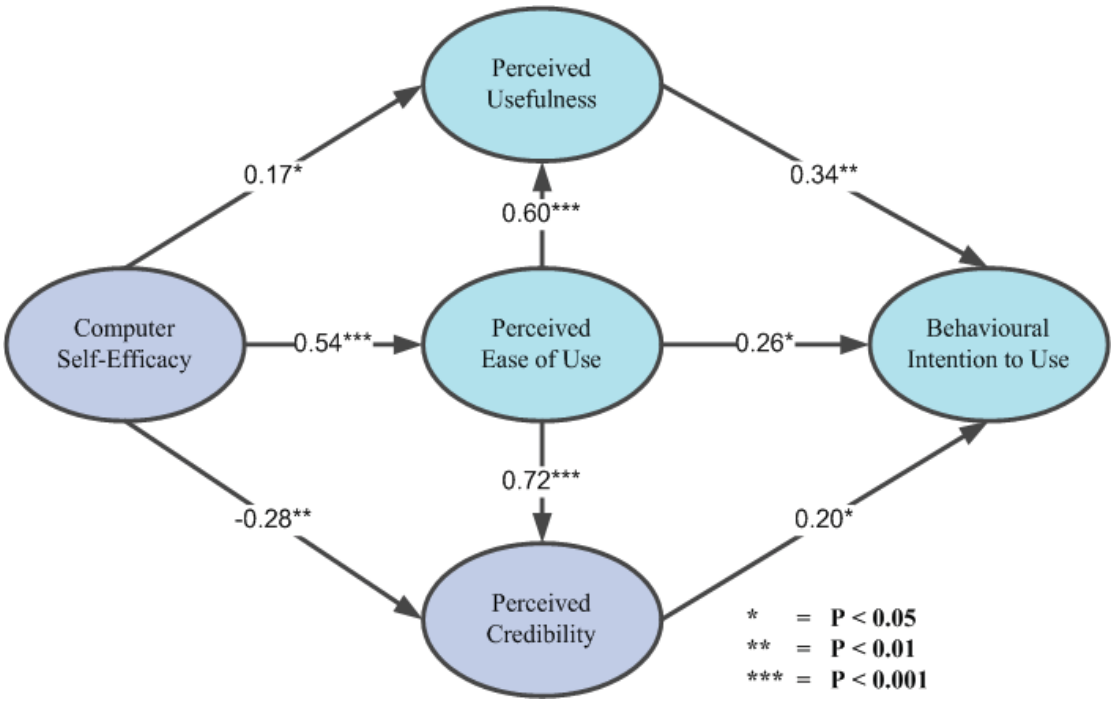

Figure 15: Research model and results of the hypothesis test, reproduced from Ong et al. (2004)

Figure 15 shows the results of the hypothesis test, where they used the CALIS[1] procedure of SAS 8.1, which "provides estimates of parameters and tests of fit for linear structural equation model" (Ong, et al., 2004). As shown in the diagram computer self-efficacy has a negative effect on perceived credibility. However, the most significant overall effect was that of Perceived Ease of Use (PEOU) on Behavioural Intention (BI) (Ong, et al., 2004). The model supported all of the hypotheses where it explained 44% of the variance of a user's behavioural intention. The additional factors of computer self-efficacy and perceived credibility managed to explain the variance of the TAM's original factors. Out of the two additional factors, computer self-efficacy had the greatest influence, which was on PEOU, indicating the greater proficiency a user has with computers the easier the system seems to use. This result initially proved that the TAM could be applied for e-learning and suggested that if an engineer had a higher computer self-efficacy then they would also have greater doubts towards the system.

Pituch and Lee (2006) studied what effect e-learning has on learners and they developed theoretical models to test participants and thereby provide information on how to improve e-learning. Using questionnaires, they collected data from 259 college students. For this work, they used the extended TAM, shown in Figure 16 as the base for their models and added system and participant characteristics. They used an institutional learning environment that is similar to WebCT, called Cyber University, which is an advanced e-learning system. The benefit of the system was flexibility in the time and location of study.

[1] The statistics software package SAS has a procedure, CALIS, which is a general structural equation modelling (SEM) tool that estimates and finds a linear fit to the SEM.

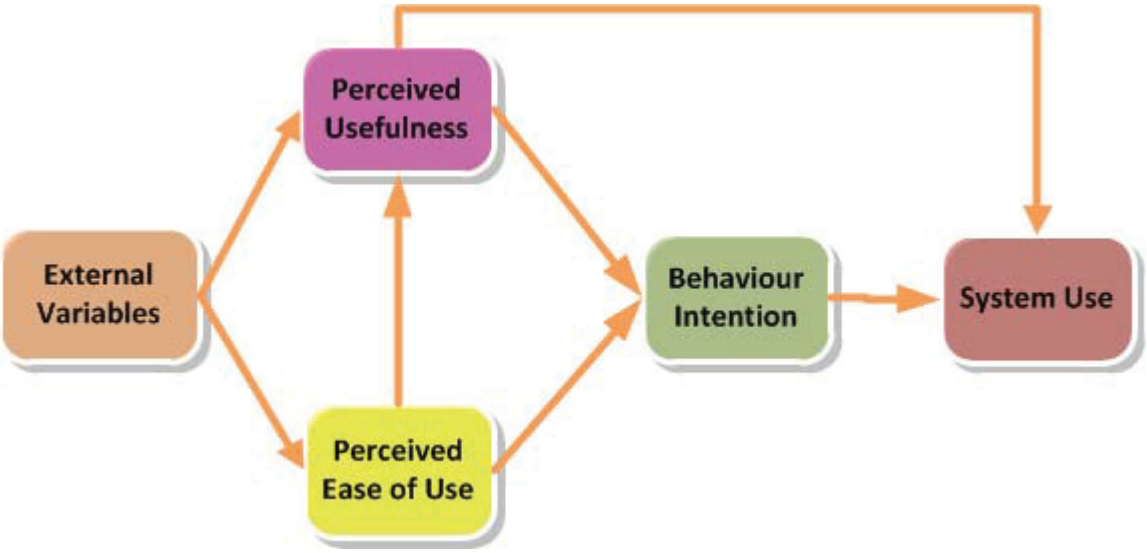

Figure 16: The technology acceptance model, considered as a base for the new model by Pituch and Lee, reproduced from Pituch and Lee (2006)

Pituch and Lee's (2006) first research model introduced important predictors of the beliefs of users in other technology adoption studies, which can improve the development of an e-learning system, see Figure 17.

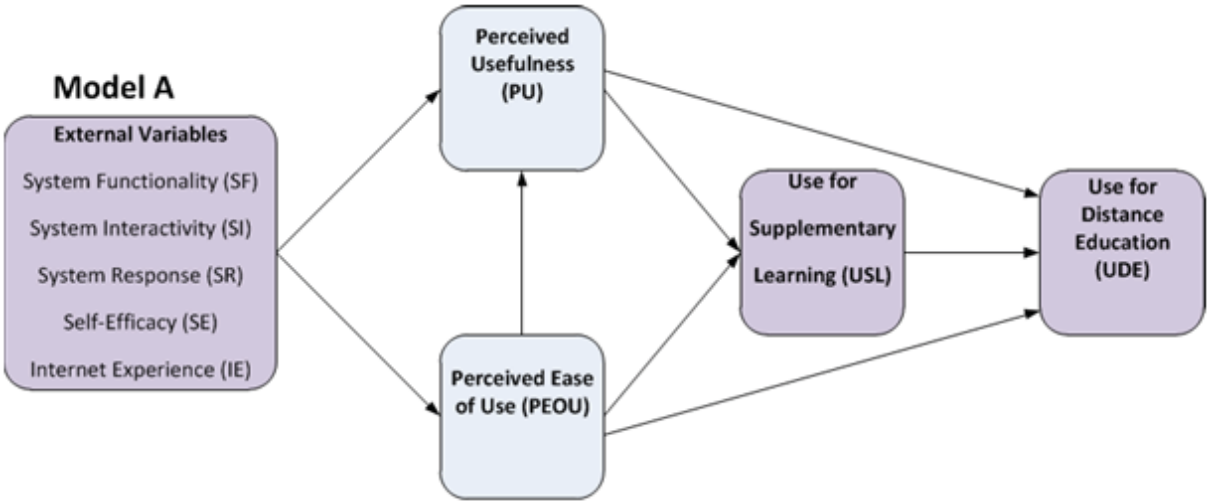

Figure 17: Model A shows 'fully mediated model' for e-learning used by Pituch and Lee (2006), based on the TAM with external variables

Model A in Figure 17 has external variables of system functionality, system interactivity, system response, self-efficacy, Internet experience, use for supplementary learning and use for distance education. These were found to be important predictors of the users' beliefs for

adopting technology. System functionality, system interactivity, and system response are categorised as system characteristics. System characteristics are well-established predictors because of their influence on users' beliefs and their acceptance of technology. Pituch and Lee (2006) divided system characteristics into three parts:

- System functionality, defined as the accessibility of facilities that an e-learning system has to present training and assessment media to users
- System interactivity, defined as being the interaction of learning procedures to facilitate development between individual students and students with the faculty
- System response, defined as when the user experiences prompt reaction times from the e-learning system, which are reliable and practical to their area of work or study

Pituch and Lee (2006) categorised self-efficacy and Internet experience as user attributes. They defined self-efficacy as a user's proficiency in learning specific tasks from the e-learning system. They also defined Internet experience as how much understanding a person has of using the Internet and the effect that this has on the use of e-learning. Pituch and Lee (2006) stated that the increased use of supplementary learning and distance education are outcomes of their study. These outcomes are two specific purposes of the Cyber University e-learning system.

The second model from Pituch and Lee, Model B shown in Figure 18, has the same variables and hypotheses between factors as Model A, apart from three additional relations explained as follows. In Model B, it predicts improvements in system functionality will increase the use of the e-learning system as a complement to the classroom learning experience, denoted Use for Supplementary Learning (USL) on the diagram. In addition, the diagram illustrates that

direct effects on both system functionality (SF) and system interactivity (SI) will boost a user's intention to use the e-learning system to aid learning where distance presents a barrier, also called Use for Distance Education (UDE).

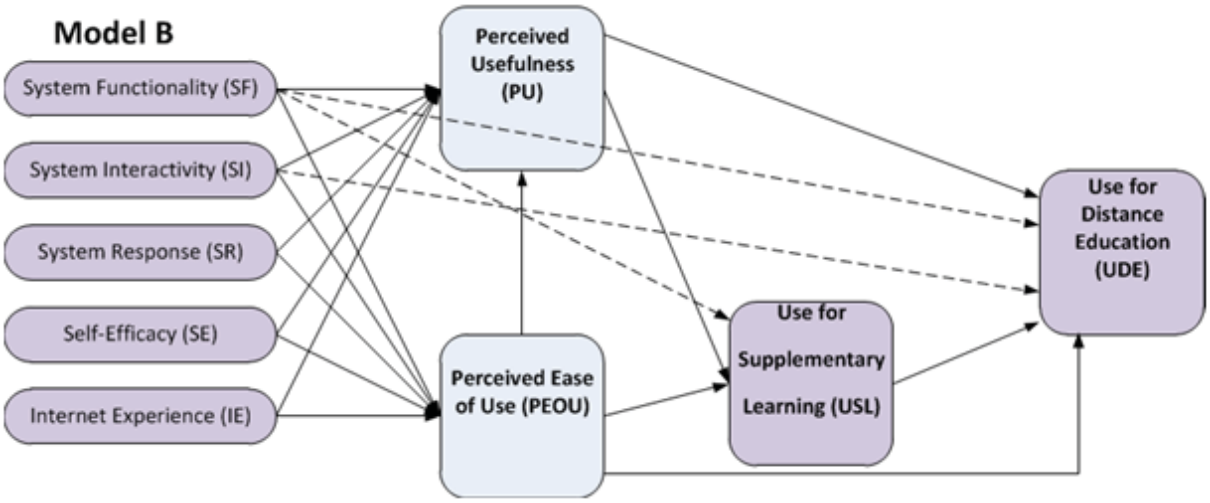

Figure 18: Model B shows the 'partially mediated model' for e-learning use, **reproduced from** Pituch and Lee (2006)

The most important findings from Pituch and Lee (2006) are summarised as follows:

- System functionality has the strongest effect on both outcomes
- System interactivity has a strong effect on Perceived Usefulness (PU)

Overall, the system characteristics are the most important factors for user acceptance of the e-learning system. Similar to Pituch and Lee, an objective of this study's aim is to find suitable system characteristics (external factors) from a range of research to develop a theoretical model (see Section 3.2) that can effectively assess the user acceptance of technology for a TTT-EBM e-learning application.

Ngai et al. (2007) also studied the user acceptance of an Institutional Learning Environment, called WebCT, when students and learners in higher education were using it as an e-learning facility. Similar to Pituch and Lee (2006), Ngai et al. (2007) used an extension to the TAM and

aimed to identify the factors that influence user acceptance and to assess the capability their model has at identifying those factors. They summarised literature based on e-learning, user satisfaction and adoption of technology to develop the TAM model into a new theoretical model, see Figure 19.

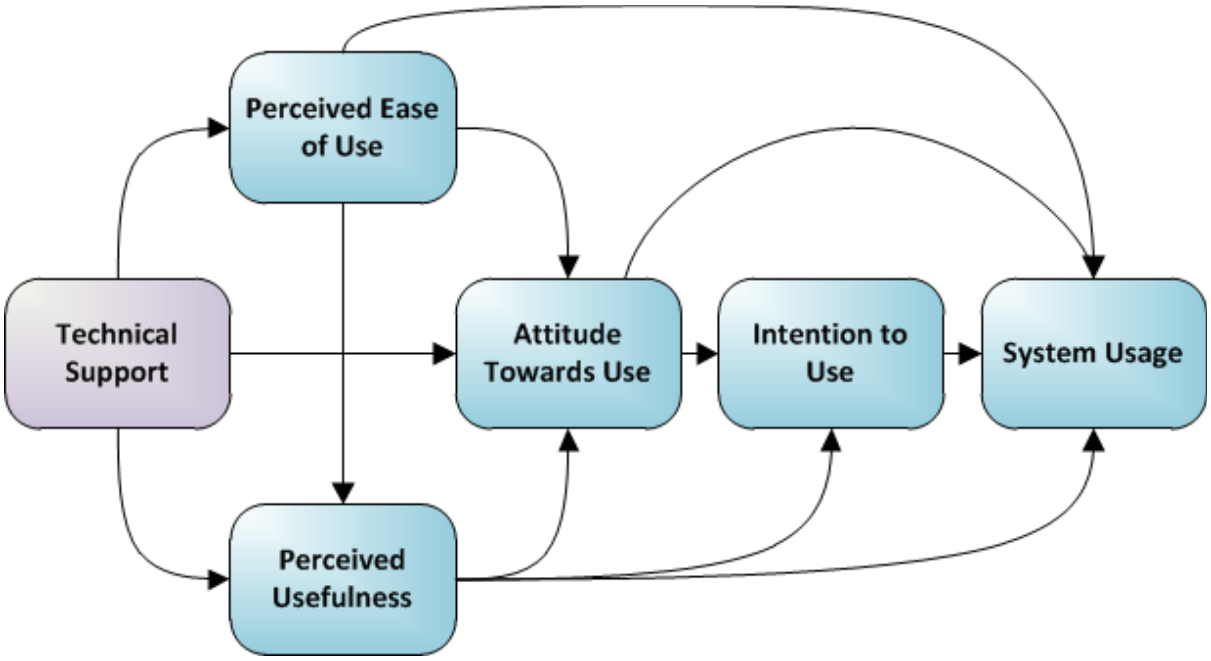

Figure 19: The model for the acceptance of Web-based learning systems, reproduced from Ngai et al. (2007)

This model included technical support as an extension to the TAM with the purpose of improving the user acceptance of web-based learning systems. Technical support includes the assistance from trained and experienced employees for the use of computer hardware and software products, and can involve help desks, hotlines, online support services, machine-readable support knowledge bases, faxes, automated telephone voice response systems, remote control software and other facilities (Wilson, 1991; Ngai, et al., 2007). Ngai et al.'s (2007) study used a questionnaire to collate individual data from 1263 surveys. The analysis results proved that the TAM is a strong empirical model in demonstrating the user acceptance for the web-based course application, WebCT, as an e-learning course for higher education.

In addition, they underline the significant direct effect of technical support on the PEOU and PU, and the strong indirect effect on attitude.

Masrom (2007) used the TAM with two important predictors, PEOU and PU, to examine e-learning in universities as being effective for learning work-related tasks. He, similar to Pituch and Lee (2006), and Ngai et al. (2007), used the TAM to test the hypotheses presented by Davis, such as ATU predicts BI, in the context of a user's adoption of e-learning. He introduced e-learning as an application that gives new opportunities for teaching and learning between teachers and students. The outcomes of his work helped draw-out factors that have an effect on a user's behavioural intention towards e-learning.

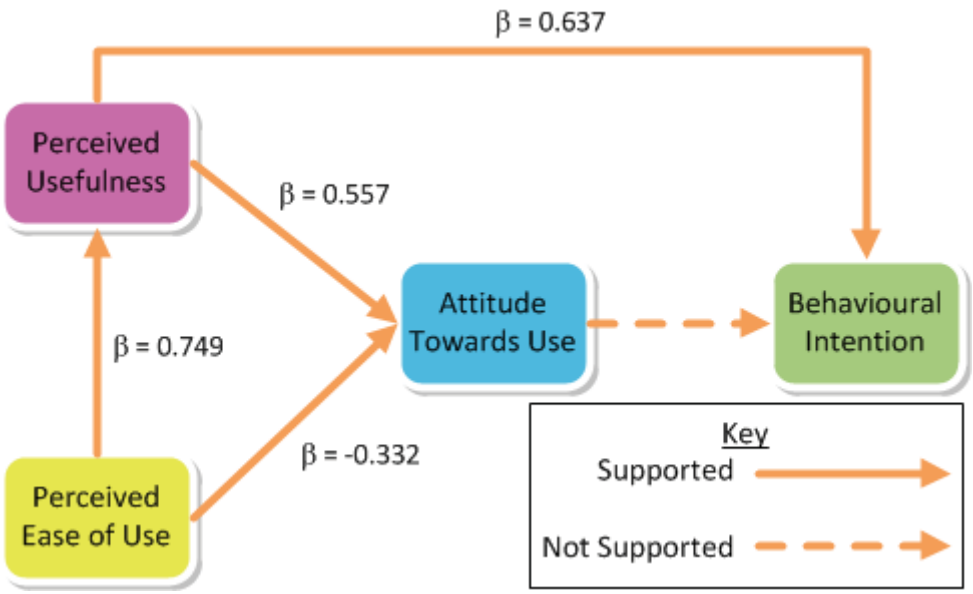

Figure 20: The result of regression analysis, reproduced from Masrom (2007)

Figure 20 shows the results of the regression analysis and factor analysis in Masrom's study, and illustrates the support for the relation between PU and BI, PEOU and ATU, PU and ATU and PEOU and ATU. The β coefficient shows the strength of the theoretical relation between each factor, where a value closer to ±1 is strong and a value closer to zero is weak; the magnitude shows the direction of the correlation between factors (see further discussion in

Section 3.9.). The strongest influential relationship is between PEOU and PU with $\beta = 0.749$. However, the relation between ATU and BI is not supported because of the result from Masrom's factor analysis. The results from his study show how the TAM can be applied in general, where there was a small limitation on the relation between ATU and BI (Masrom, 2007).

The review in this section has summarised the strengths and weaknesses of the theoretical models this thesis wants to apply in its method. Most research studies in this section have established research models that they had developed from a base of the TAM, explained in Section 2.3.1.5 to evaluate user acceptance of e-learning technology. They used external factors that are linked to PU and PEOU. Ong et al. (2004) as well as Pituch and Lee (2006) made further developments by linking to and modifying behavioural intention and system usage of the TAM. This thesis has similar objectives of finding the user acceptance of an e-learning application, associated to the TTT-EBM curriculum. Section 2.4 determines barriers to the system and Section 3.2.2 shows the development of the TAM into an e-TAM that is specific to an EBM trainer user group.

2.4 External Factors for the TAM Model

This section reviews papers that developed technology acceptance models and collects background information about factors that influence a user's adoption of an innovation. The review is useful for the selection of additional factors for developing the TAM (more information on TAM in Section 2.3.1.5) into this thesis' model, the e-TAM. Selection of the technology acceptance factors should be related to TAM as well as clinical environments, EBM, e-health and e-learning (see Section 2.2). External factors chosen as part of developing the e-TAM include Age, Gender, Time Constraint, Experience, Education Level, Organisational Support and Quality. After analysing the additional factors, Section 3.2.2 and 3.3.2 choose factors and hypothetical links to develop the e-TAM. The choice of the factors, also called positive moderators or moderating factors, allows investigation of their moderating effect on an EBM trainer's technology acceptance.

2.4.1 Age

There is a wide variation of age between users of a system in this modern technologically minded society such as, computer, internet or mobile phone users, who can be from as young as a child to a senior. However, in terms of EBM users accepting e-learning applications, the age range falls into a more distinct adult aged group. Many other studies have considered Age as a factor that influences a user's adoption of technology, such as from Venkatesh et al. (2003), Morris et al. (2005), Lu et al. (2006) and Morris and Venkatesh (2000).

Morris and Venkatesh (2000), as well as Sun and Zhang (2006), found that Age is an important factor for the adoption of technology and that it moderates the user's judgment. They state that it is stronger than the majority of other moderating factors, with the exception of Gender.

Morris and Venkatesh's (2000) found that younger workers were affected by their attitude to using technology whereas older workers, in contrast were influenced by subjective norm and perceived behaviour control to use technology. Just as Morris and Venkatesh (2000) had found it important for technology acceptance modelling; Venkatesh et al. (2003) also found it as being the main influential factor of their model. They stated that younger users have greater behavioural intentions to use technology when there is a performance-based reward and this motivates their attitude towards using that system. However, older users felt it hard to process complicated interfaces and it would pose a barrier to their attention on the job, leading to increased effort expectancy. Older users have behavioural intentions toward using technology depending on their working conditions and available facilities (Venkatesh, et al., 2003); moreover, Lu et al. (2006) found that older women have a large tendency to choose whether to use technology depending on their job environment.

There is a link between Age and other moderating factors, such as Experience or Gender; a more detailed discussion on Experience follows in Section 2.4.4. Venkatesh et al. (2003), similar to Morris and Venkatesh (2000), stated that older users have a greater dependence on social influence and this decreases with greater experience. The link of Age and Gender is that younger men have greater performance expectancy and older woman have greater effort expectancy (Venkatesh, et al., 2003). Morris et al. (2005) and Lu et al. (2006) also found that Age and Gender are interrelated in their effect on adoption and use of technology; they suggested that factors of Age and Gender should be regarded in unison. The difference of technology-based usage decisions between genders becomes more prominent with increasing age; the contrary happens with younger users and leans toward a unisex pattern (Morris, et al., 2005).

In terms of Internet usage, age has an impact on the determinants of behavioural intention and directly on the user's behavioural intention (Kripanont, 2007). Kripanont's (2007) review found that young users had a higher probability to use the Internet. He supported the work of Venkatesh et al. (2003), stating age has an influence on attitude, subjective norm and perceived behavioural control of a user of the Internet. Kripanont's findings indicated that older users needed more attention to improve their Internet use by focusing on social influence and facilitating conditions, which supports Lu et al.'s (2006) findings. Kripanont concluded by adding that older users could have an increase in behavioural intention by building "self-efficacy via training" for Internet use.

2.4.2 Gender

There are assumptions that men and women may have different perceptions and may use information and communication systems (ICT) differently. Many studies consider Gender as a factor that has influenced the use of technology; these include Gefan and Straub (1997), Speier and Venkatesh (2002), Venkatesh et al. (2003), Venkatesh et al. (2004), Schuler (1975) and Venkatesh et al. (2000d). Some of these studies had researched the joint effect of Age and Gender, as discussed in Section 2.4.1. This section explores the effect that Gender has on users' behavioural intentions and the determinants of behaviour intention.

Venkatesh et al. (2000d) found that there are large gaps between male and female co-workers' technology acceptance in an organisation. Their findings supported Gefan and Straub's (1997) views by highlighting the importance for managers to assess their employees, especially with consideration to gender, so they could improve their employees' productivity in the workplace (Venkatesh, et al., 2000d). Venkatesh et al. (2000d) stated that the

employees' appraisals, from a good productivity viewpoint, should be in relation to their gender, since men and women value performance benefits differently. Both Gefan and Straub (1997) and Venkatesh et al. (2000d) concluded that the satisfaction of women about a computer based system, such as e-learning, is affected by the PEOU and the satisfaction of men is affected by PU (Venkatesh, et al., 2000d).

Schuler (1975) found that women, compared to men, had a greater desire to work with colleagues who were well mannered. In contrast, they found men desire to influence other people in the workplace and to be the dominant decision maker. In Arbaugh's (2002) review, he argued about the perception men have when interacting with cyberspace, stating they use it for communication and educational purposes, to get lower costs and greater access worldwide. In agreement with Schuler (1975), Arbaugh stated that men often use cyberspace in a competitive behaviour that would either boost their 'ego' or degrade others. This also backs up men having a greater intent to technology use based on its PU as stated by Venkatesh et al. (2000d). Arbaugh argued women's interaction with cyberspace differs from men's usage. He said women perceive cyberspace as a communication gateway, where each additional member of a public network can contribute to the learning level of a group who have joined an online network, such as a blog or chat room. He also mentioned that women have a greater involvement in web-based learning class discussions compared to traditional classrooms (Arbaugh & Duray, 2002).

2.4.3 Time Constraint

Workplaces are naturally time-constrained environments such as in a clinical setting, where the organization sets a schedule for clinicians. However, despite the schedule, trainers and

clinicians may be able to find some free time within their routines. This free time, however frequent or infrequent it may be, creates a flexibility of time in the trainer's schedule. Clinical EBM trainers could use a part of their free time, whenever they find it, to study EBM. Hence, EBM study methods need to fit into a trainer's schedule. In other words, because a user's routine is time dependent, to be compatible with a trainer's schedule, EBM learning needs to be time independent.

E-learning systems feature content the user can repeatedly access and view at any time. This time independency gives users an opportunity to study in a way not featured in traditional classroom lessons. The blended learning approach for EBM users has this time independency attribute by providing 24-hour access, however, how much users perceive it as beneficial in the workplace needs quantification.

Studies that considered the effect of Time Constraints and the use of web-based learning applications, such as Arbaugh and Duray (2002) and Arbaugh (2004), modelled the effect of a user's constraint of time on their behavioural intention to use a web-based course.

Arbaugh and Duray (2002) combined the effect of a user's Time Constraint together with restraints in their location or place. They then modelled how these two barriers, which they defined as Perceived Flexibility, change the user's perception of the benefit of an online course. They found that when participants of the online course thought it had fewer constrictions on time and place, they would strengthen their perceptions about the course contributing to their learning. Moreover, they found users perceiving the course with fewer constraints on time and place would be more satisfied with the web-based course.

Arbaugh (2004) studied how students participated with multiple online learning courses. He identified the difference between traditional classroom and web-based courses. In support of Arbaugh and Duray (2002), one of the factors Arbaugh discovered beneficial in online learning was greater flexibility of time and place. The factor of Time Constraint was one important aspect in learning online for users (Arbaugh, 2004). Arbaugh and Duray (2002) also pointed out the strong connection between Perceived Flexibility and Experience, more on Experience below.

2.4.4 Experience (Knowledge and Skills)

The use of e-learning applications on a regular basis over time builds experience with that system. Speeds at which users can learn something new through experience with the application, varies between the levels of aptitude of the users. EBM trainers may naturally encounter challenges when interacting with the application, to which they would make a decision to tackle or move on from the challenge. Then if the user discovers the decision made was right, they would presumably reuse the successful method.

Users should also be able to adapt their experience from one technology application to another. Experience gained from similar applications to the blended e-learning EBM course should be a basis for users to refer back to when using the e-course. As an external factor to the TAM, Experience could be a strong predictor of a user's usefulness perceptions, attitude and behavioural intentions to use the e-learning technology.

Many researchers have considered the factor of Experience as a moderator of technology acceptance, such as from Taylor and Todd (1995), Szajna (1996), Venkatesh (2000c), Venkatesh et al. (2000d), Venkatesh and Davis (2000b), Arbaugh and Duray (2002), Venkatesh

and Speier (2002), Venkatesh et al. (2003), Venkatesh et al. (2006), Sun et al. (2006), Jones (2008) and Saadé and Kira (2009). Section 2.4.1 included a partial study of Experience combined with Age. This section reviews a few important studies on Experience as a moderator.

Sun and Zhang (2006) considered Experience as a moderating factor that influences the PEOU. They stated that Experience is achievable and the level of the user's experience has an effect on the PU and BI. Therefore, because of its overall influence on behavioural intention and behavioural intention's determinants, they stated that Experience has a direct effect on the decisions users make about their actual use of the system (Sun & Zhang, 2006).

Venkatesh (2000c) discussed whether Experience has a direct effect on PEOU. In addition, he studied how the level of experience had an effect on the perception of the system, for example the comparison of early stage experience with a well-grounded experience. He analysed other research studies on Experience, particularly emphasising that the judgment of users is based on three aspects - past experience, context or background and stimulus.

2.4.5 Education Level

The factor of a user's Education Level, similar to Experience, contributes to a user's ability to handle technology, such as e-learning systems. Users of the blended learning approach for EBM study would have different education and intelligence levels. Education levels of EBM users, particularly EBM trainers in the clinical environment, are most likely to have a medical science degree from undergraduate to post-doctorate level. Intelligence levels are also likely to vary between users, which could have an implicit relation to the user's education level, and could have an effect on how quickly the user adopts the technology. Reasons why the factor

of Education Level needs assessment in this study's context includes a need to quantify the effect of education on the user's behavioural intentions to use the e-learning course and to see if the level of education mediates that effect.

Technology acceptance studies have rarely studied education for its use as a moderating factor (Kripanont, 2007). Venkatesh et al. (2000d) investigated Gender and other factors, such as the effect education has on the adoption of using technology in the workplace. From their review, they found that Education Level is considered as linked to Gender as an influential moderator. However, education on its own had an insignificant influence on the behavioural intention of users to do the action (Venkatesh, et al., 2000d). They suggested that a better indicator of a user's intelligence was needed rather than levels of their education to give a clearer indication of this moderator's influence.

Contrary to Venkatesh et al.'s (2000d) review, recent studies (Abu-Shanab, 2011; Mardikyan, et al., 2012) have shown the significant influence of Education Level as a moderating factor. Abu-Shanab (2011) found that education influenced users' acceptance of Internet banking technology as a moderator. Mardikyan (2012) supported this by stating its use, adoption and integration increases with a gain in the user's education.

Clearly, there is a greater need to realize the impacts of a user's education on their behavioural intention to carry out a voluntary action. Venkatesh et al. (2000d) suggested improving the categorisation of education to include intelligence ratings. Other moderating factors show a connection, i.e. Age and Gender with Education Level, on influencing behavioural intention and behavioural intention's determinants. Perhaps the improvement of education as a moderator could be by looking into its links with other factors, such as those of the TAM.

2.4.6 Organisational Structure

This thesis focuses on modelling the user acceptance of an e-learning application that EBM users would study in the clinical setting. A clinical organizational structure is unique, but also has similarities to most businesses, such as needing job roles, coordination and management. In the scope of EBM trainers, this includes trainer-trainee, trainer-trainer and trainer-supervisor relations. Generally, the clinical environment is considered as a flat or hierarchical structure, which directly influence the trainer with organisational aims set by supervisors, collaboration or competition between trainers and dependence or expectations from trainees. These features of the workplace could either reinforce or weaken a trainer's behavioural intentions to use the e-course (Singh, et al., 2005). As an external factor to the TAM, this thesis can weigh the effects an organisation's structure has on user perceptions, attitude to use and behavioural intention.

Venkatesh et al. (2000d) reviewed other researchers who had studied organisational structures that indicated its positive influence on behavioural intention. However, after their study, they concluded that the factor of Organisational Structure has a weak effect on behavioural intention.

Singh et al. (2005) reviewed other research papers on organisational structures and realised that the factor is a barrier to e-learning. He suggested that organisations should move towards a structure with greater flexibility: Flexibility being an organisation's ability to incorporate new technologies into the structure of companies, institutions or workplaces. In addition, a flexible structure could emphasise as to whether an institution can adopt new technologies such as e-learning (Singh et al., 2005).

2.4.7 Quality

An e-learning system for EBM trainers, just like other applications, should consider quality as a design factor that is flexible around the user's needs. Some determinants of quality in the context of this study include how the user interacts with the application, learns or understands how to use it as well as ensuring there is minimal system downtime, i.e. being reliable or providing troubleshooting guidelines. However, the extent of these features and measuring their effect on the user's acceptance of the e-learning system is needed. This thesis proposes the factor of system quality as a determinant of the TAM's behavioural constructs.

System quality has frequently been one of the factors that raise the level of user satisfaction (Sun & Xiao, 2006; Sun, et al., 2006; Venkatesh & Bala, 2008). It is also a topic of discussion in the area of web-based research, like e-learning, where a hypothetical connection has been established between factors of the Knowledge Support and satisfaction of Technology Support.

2.4.7.1 Knowledge Support (Evidence Availability)

Knowledge Support is one of the factors that represent the quality of the e-learning application for EBM trainers. The user needs to understand how to use the system with help from the application itself, a manual or other source of information. Presenting the knowledge support in a free, easily accessible and user friendly way should improve a user's perceptions of the system's usefulness. Other research has recognised this factor as important in predicting a user's satisfaction. The significance of this factor has been proven by other research, such as that by Sun (2006), who considered knowledge support as integral to the

quality of a system. In addition, Sun (2006) showed that knowledge support had a significant effect on user satisfaction in web-based learning.

Venkatesh (2000c) and Venkatesh et al. (2003) studied the use of a factor called the Perceptions of External Control, which explains a user's assurance in knowing that there are enough resources from an organisation or technical centre to provide support for the system, such as "availability of knowledge, resources, and opportunities required to perform the specific behaviour". They found the user's perception of available knowledge resources had a significant effect on the PEOU. This factor could be influential to a user's adoption of the e-learning application, which this thesis has modelled in Section 3.3.2.

2.4.7.2 Technology Support

Technology Support can increase the trust EBM users have with the use of e-learning applications, as there are fewer system failures. Also in the result of a failure, the downtime would be limited to how quick the support can restore the system's functionality. The factor of Technology Support should influence users' perceptions of usefulness and ease of use of the e-learning course because when the system is reliable the user believes that their work is safe in the result of a system crash. This thesis has modelled this factor to quantify its effect on the user acceptance of the e-learning application.

In many studies, the inclusion of technology support has shown that it has a significant effect on the satisfaction of users. Roca (2006) and Sun (2006) showed the quality of technology support provided directly influences the user satisfaction and their adoption of technology. Sun also mentioned that regarding user satisfaction, quality (technology and knowledge support) had a stronger effect than flexibility.

In another paper, Piccoli (2001) reported an improvement in user acceptance with the inclusion of Technology Support as a factor in assessing user acceptance. This factor, as shown in the results from Piccoli, shows the direct effect that the quality of technology support has in a learning environment. Arbaugh (2004) also noted a strong connection between user satisfaction and system quality in Internet based learning systems. He concluded that the user becomes more satisfied from higher quality system characteristics compared to superior user characteristics. The studies from Pituch (2006) also found out that external factors have an influence on the adoption of e-learning systems. He emphasised that the quality of the content was an important factor, which also had an effect on the level of the user satisfaction.

2.5 Summary

This chapter identified external factors as preliminary work for developing the TAM, including a relevant review of research models that assess user acceptance of technology to seek out the potentials and flaws of the TAM for supporting development of this thesis' model, the e-TAM. The critical information collected in this literature review forms the basis of developing this thesis' extended technology acceptance model, questionnaires and information that can be used to analyse and validate the results.

EBM was explained and studies were reviewed to identify the benefits and drawbacks associated with training EBM in workplaces. E-learning was introduced and explained as an aid for teaching of trainers of EBM. The introduction of the TTT-EBM project showed that there is a need to improve the EBM trainers' acceptance of using the e-learning system to develop their experience, knowledge and skill of using EBM in the workplace.

The literature review included papers published on theories of various methods to predict user perceptions of usefulness, ease of use, attitude and behavioural intentions. Some of the papers in the critical review developed the TAM with external factors, which demonstrated an improved explanation of the variance of the TAM's factors.

The next chapter is the method chapter, which explains each step of this study and all the special considerations for achieving the aim and objectives of TTT-EBM projects.

3 METHOD

3.1 Understanding the core concepts of the project

As the literature review states, when medical practitioners use EBM on a regular basis their performance on their duties are improved and they are able to improve their abilities to correctly diagnose, make therapeutic decisions and follow up the health and wellbeing of their patients. Due to the active nature of EBM, clinicians need to learn and practice it in the workplace. EBM learning needs integration into the full-time jobs of practitioners, which can be facilitated by an online learning system. Moreover, the lacking confidence of EBM trainers in teaching EBM for a clinical environment needs improvement. These challenges led the Teach the Trainers EBM (TTT-EBM) project to emerge as a solution to improve EBM practice with an official European-wide curriculum for teachers to follow. The project is using an e-learning framework, which this thesis aims to assess by developing a theoretical model that fits, or models, the EBM trainers as users and therefore finds factors that can predict their behavioural intention to use the e-learning EBM application.

This thesis predicts how EBM trainers use the TTT-EBM e-learning application. The method was by designing a questionnaire and evaluating the factors of the Technology Acceptance Model (TAM). This followed by developing a theoretical model based on the TAM, an established model, by integrating additional factors that could have a decisive effect on the user's behavioural intention. The new model can evaluate the EBM trainer's acceptance of the TTT-EBM project from a questionnaire, as carried out in Chapter 5, and thereby state insight in how to improve the e-learning application.

The methodology of this thesis uses background information on modelling and literature review of factors, as discussed in Chapter 2, to develop the TAM into the extended TAM (e-TAM), which can predict EBM trainer's acceptance of the TTT-EBM e-learning application. The TTT-EBM e-course uses a blended learning approach to EBM training, which combines e-learning into the clinical workplace for a European-wide EBM e-learning curriculum - the TTT-EBM project was covered in Section 2.2.4. The factors reviewed in Section 2.4 are chosen for the e-TAM based on their significance of being a determinant of the TAM's factors and relevance of predicting the trainer's acceptance of EBM in a clinical environment. The additional factors are connected with hypotheses, with respect to the TTT-EBM e-course, to the constructs of the TAM model.

Two research models, the TAM and e-TAM, are developed with hypotheses, where each hypothesis acts as a link between factors. Hypotheses allow evaluation of the influential relationships between factors, which is a quasi-quantitative evaluation. In the e-TAM, the chosen additional factors also have hypotheses that relate to the TAM's factors including Perceived Usefulness (PU) and Perceived Ease of Use (PEOU), Attitude Towards Use (ATU) and Behavioural Intention (BI). Overall, the e-TAM as a new model is developed from the TAM, where both models are assessed to see if they can predict EBM trainers' acceptance of the TTT-EBM application.

This chapter covers the design of two questionnaires that were used to collect participant data, which was used to evaluate the TAM and e-TAM. The design of a questionnaire should collect, filter and categorise information from users or EBM trainers. Following a review of questionnaire design, Section 3.4 discusses scale-sizing matters. This study has designed a

questionnaire related to EBM trainers' acceptance of the e-learning course, which was used to evaluate the TAM. The process revealed the most influential factor of the TAM for the e-course. A different questionnaire is used to validate and find the most important factor of the e-TAM. This study tests the reliability of the factors of TAM and e-TAM and the questions of the questionnaires.

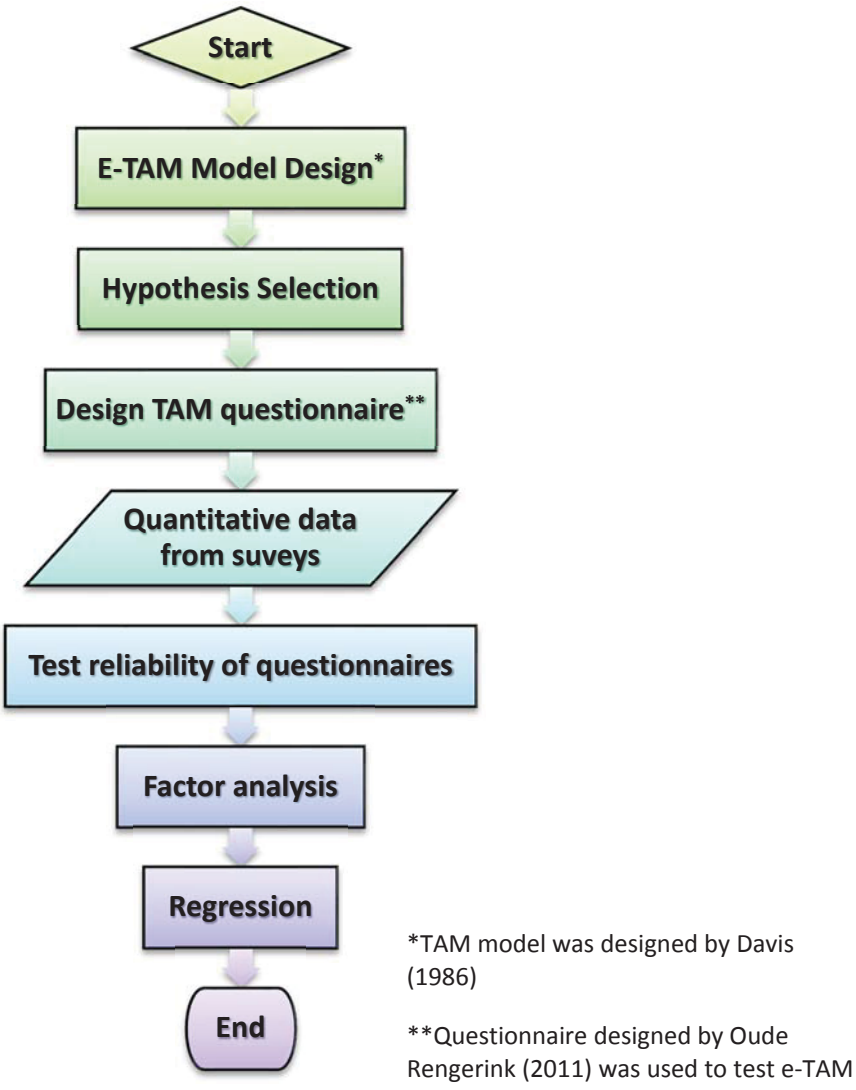

Figure 21: Flowchart of the methodology showing the process

Figure 21 shows a flowchart of the relevant steps needed to produce results from the TAM and the e-TAM for assessing the user acceptance of the application. In addition, it shows the

validation process used in the results from the TAM and the e-TAM. As shown, this thesis uses a step-by-step process to its methodology from start to end. It is important to mention that the process shown in the diagram starts with the TAM and leads into the e-TAM development as follows:

1. Assessment and validation of TAM for its capability in predicting the user acceptance of the e-course.
2. The TAM model, now valid for the e-course, can be developed into the e-TAM with additional factors.
3. The additional factors of e-TAM are validated and the most influential factor is found.

3.2 Technology Acceptance Modelling

Technology acceptance models or models that predict a user's behavioural intention toward a system try to find factors that can influence a user to adopt technology. This thesis develops a predetermined model, the TAM, to assess how users can adopt e-learning technology that teaches EBM in the workplace. Some models and factors relevant to the aims of this thesis were reviewed in Section 2.3, where the TAM was used as a basis for developing new models. Other literature shows the TAM as a strong predictor of user intention, hence this thesis assume it to have predictive power in assessing the EBM trainers' acceptance of the TTT-EBM e-learning course. In the following section, the TAM's factors are reclassified into terms suitable for this project. Section 3.2.2 includes the addition of external factors to the TAM that are potential barriers to the course. This makes it the first research model for the assessment of the user acceptance of the TTT-EBM's blended learning approach.

3.2.1 TAM

Section 2.3 discussed theoretical model developments including the TAM by Davis (1986), its predecessors and successors. Section 2.3.1 explained the purpose of the TAM, which is to model and predict relationships between system characteristics and user acceptance. The TAM model contains four main behavioural constructs, which are stated below in terms relative to the TTT-EBM e-learning curriculum as the e-course:

- Perceived usefulness (PU); how an EBM trainer values the e-course as having a positive effect on achieving or working towards using and implementing it
- Perceived ease of use (PEOU); the assumed or experienced level of ease or simplicity an EBM trainer has when taking part in the e-course
- Attitude towards use (ATU); being the motivational feelings and interest an EBM trainer has to carry out and continue learning from the e-course
- Behavioural intention (BI); how an EBM trainer has desires and inspirations to motivate themselves in achieving their goals in the e-course

Other definitions of the TAM's constructs are detailed in Section 2.3.1.5 and the Glossary, Section 9.4.

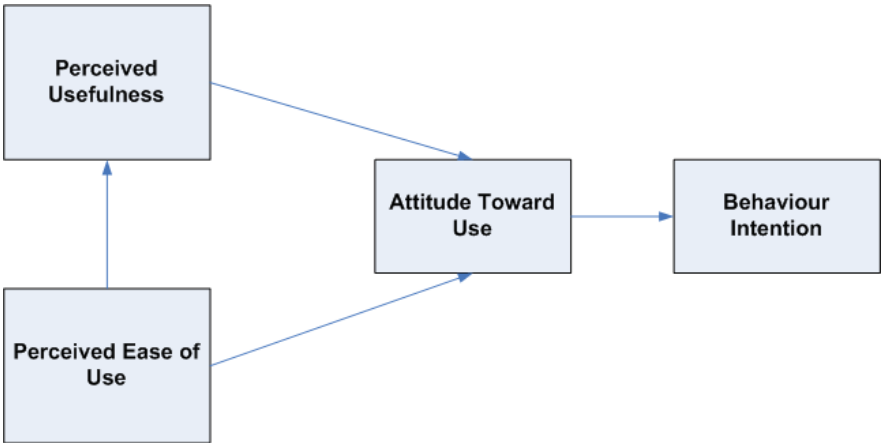

Figure 22: The original TAM considered for this research

Figure 22 shows the connections between the four parts of the TAM. Section 3.3 introduces these connections as hypotheses. Chapter 4 covers the analysis of the results from the TAM and relative questionnaires, where it shows the quality of the model in terms of assessing EBM trainers' technology acceptance.

3.2.2 E-TAM

The e-TAM, as introduced in Section 1.3, is a purpose built theoretical model for e-learning technologies and the TTT-EBM project. The e-TAM's roots come from the TAM and this study has chosen factors from a wide research-based survey on e-learning and technology acceptance, see Section 2.4. This found a suitable set of moderators that had an impact on users' behavioural intention and the factors related to the behavioural intention. This thesis, for the e-TAM's development, considers moderators as factors because their basis is formed from theoretical results of other researchers. As well as standing for an extension to the TAM, the 'e' in the e-TAM stems from the category of all similar designations, such as e-learning, e-health and EBM, which is similar to how Eysenbach (2001) described the 'e' in e-health.

Therefore, the e-TAM model is designed for assessing users of those subjects and especially for EBM trainers of the TTT-EBM e-learning curriculum.

In this section, we show the grouping of external factors and their relation to the TAM's factors, which forms the base of the e-TAM. The term external factors in this study represent the new group of predictors or barriers for the e-TAM. The chosen external factors are organisational barriers to the TTT-EBM e-learning project, which include Age, Gender, Experience, Education Level, Organisational Structure, Time Constraint, Knowledge Support and Technology Support.

Figure 23 shows the basis of the TAM with a blue box representing the placement of the external factors and hence the TAM's extension.

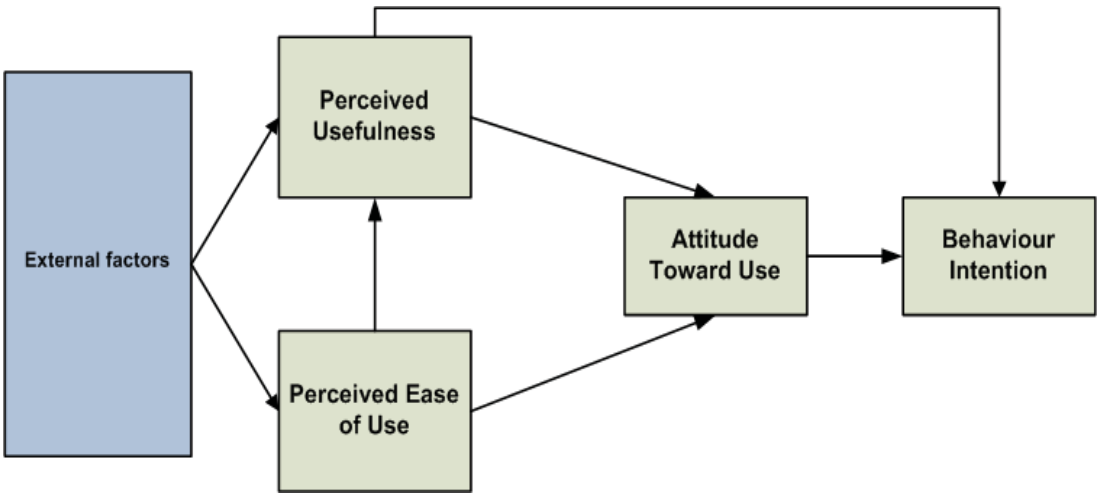

Figure 23: Shows the extended TAM

The external factors to the e-TAM have three divisions. These are human dimension, design dimension and quality, see Figure 24. Each user has their own personal attributes, such as Age, Gender, Experience, and Education Level; therefore, these factors are part of the human dimension field, which is similar to how Piccoli (2001) and Sun (2006) defined them as

discussed in Section 2.4. The other classification of these factors could be individual characteristics (Venkatesh & Agarwal, 2006), learner dimensions or human effectiveness (Sun, et al., 2006).

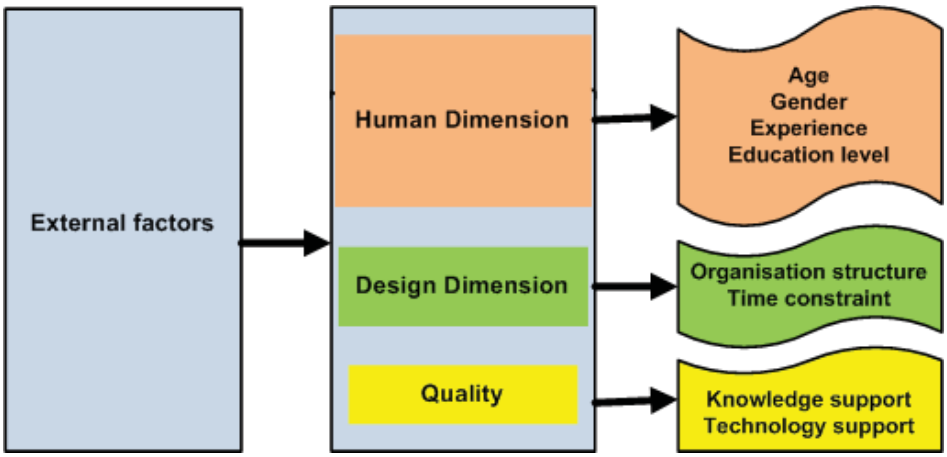

Figure 24: Shows grouping for external factors

The Organisational Structure consists of the effects of management, level of help from other trainers and demand of trainees to learn EBM coinciding with a system. Time Constraint includes the routine of EBM trainers, where tasks in their workplace each have an allotted amount of time. The flexibility of a trainer's routine in the workplace, as stated in Section 2.4.3 and 2.4.6, depends on their work's demand or restriction of time and place. This thesis assessed the trainers' acceptance of the e-course's application in the workplace, where the application needs a design that blends into their routine. Hence, the design dimension field includes Organisational Structure and Time Constraint.

Similar to other e-learning systems, TTT-EBM e-learning application needs technology, including a computer with an internet connection, to facilitate the distance learning process. Therefore, the quality of the application includes both knowledge and Technology Support; see Figure 24, because these factors tell the user how to use the system and keep the system

from crashing or having faults. The quality of the system is part of the design dimension because designers of the application need to consider the systems quality.

Figure 25 shows the e-TAM, a new model that includes the external factors and the TAM's factors of Perceived Usefulness (PU), Perceived Ease of Use (PEOU), Attitude Toward Use (ATU) and Behavioural Intention (BI). Section 3.3.2 describes the methodology behind the connection of these parts, where each arrow represents a hypothesis to describe their correlation.

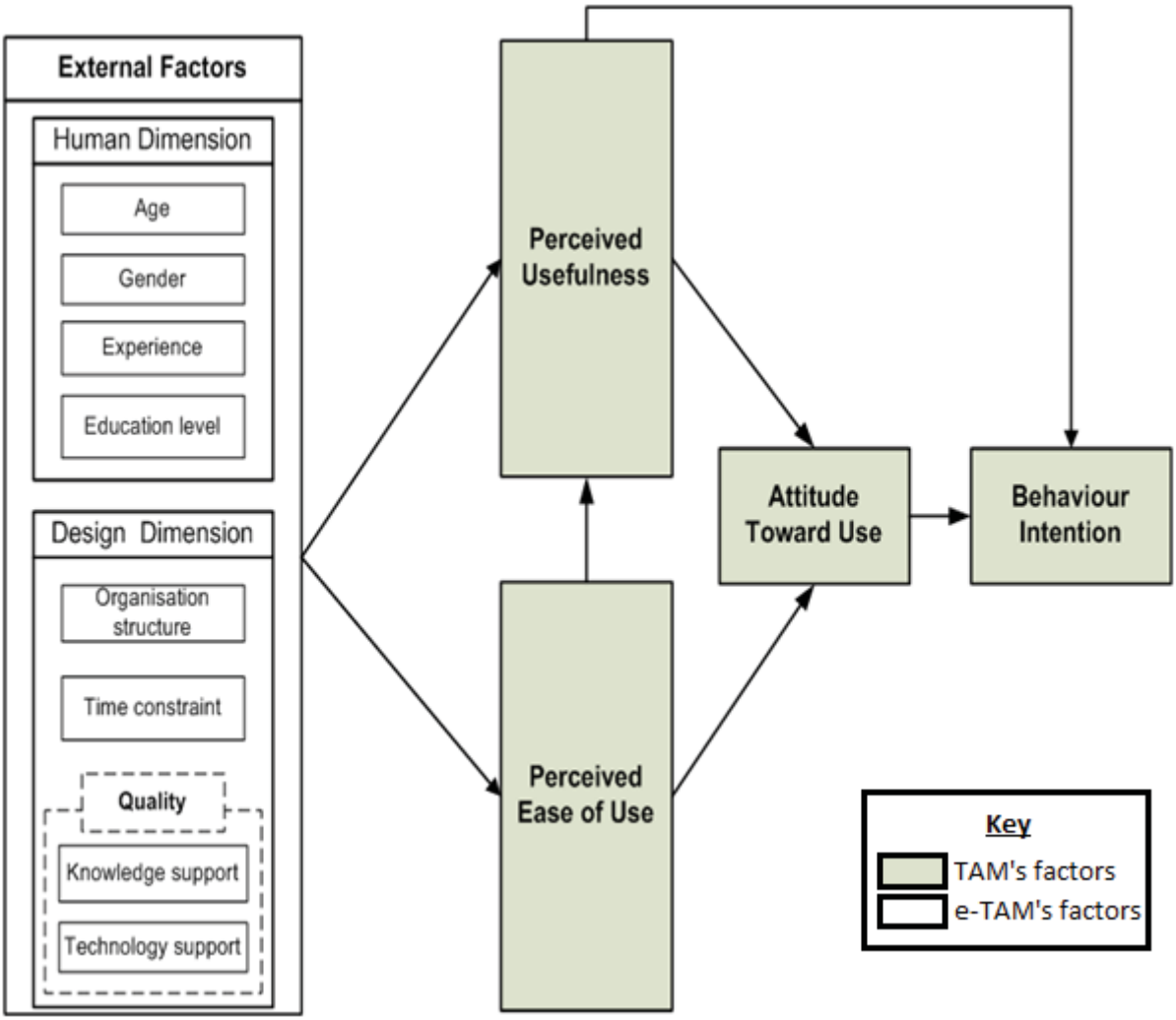

Figure 25: Showing external factors grouping and the method of connection to the TAM

The critical literature review in Section 2.4.1 and 2.4.2 showed Age and Gender to be interrelated factors that had a strong influence on the user's acceptance of technology in e-learning and other ICT applications. However, this thesis has omitted these two factors from the model shown in Figure 25. This was decided after preliminary testing because of their instability with low sample sizes from the questionnaire. In addition, the literature survey showed that they had been thoroughly analysed in other research and they have a strong moderating effect together. Moreover, their elimination allows other factors to be studied in greater depth. In this study, there is no further analysis of the effect of Age and Gender. However, this study considers these factors as further work, needing more participants for assessment of Age and Gender. Section 4.3 and 5.3 discuss the extent of the effects of sample size on this study.

Figure 26 shows the final configuration of the model. This section has shown how the included factors relate to the TAM's factors. As shown in Chapter 5, this thesis used the e-TAM to assess EBM trainers' acceptance of the TTT-EBM e-course and application by using participant data from a questionnaire. The analysis of the factors with data from the questionnaire discovers the most influential factor of e-TAM toward adoption of the e-course's application, it also shows the explained variance of all added factors on the TAM's constructs. The next section shows the selection of hypotheses that predict relationships between factors and the EBM trainers' behavioural intention toward use of TTT-EBM's e-learning application.

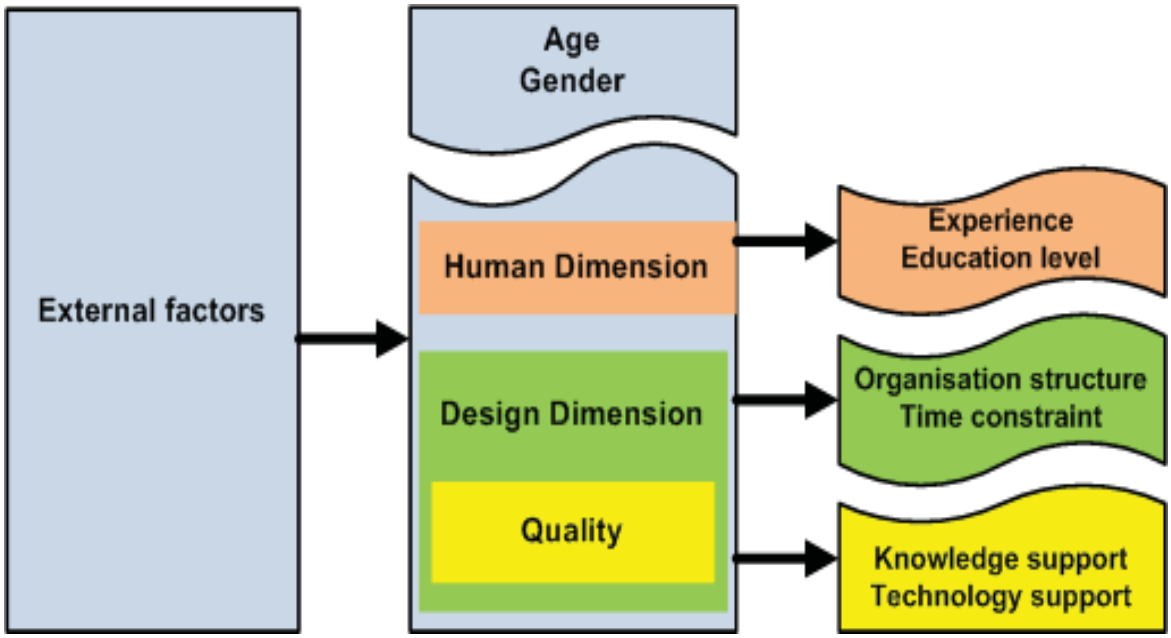

Figure 26: New illustration of the generalisation of external factors, where Age and Gender have been omitted, and quality is considered as part of a design dimension.

3.3 Hypotheses

As stated in Section 3.1 the factors in the TAM and e-TAM have relations depending on their hypotheses. This section shows how hypotheses were generated, tested and measured to give a significance level with positive or negative relations. The literature review on theoretical modelling and external factors, in Section 2.3 and 2.4, as well as background knowledge on the concepts of e-learning, EBM and TTT-EBM, in Section 2.2, provides the basis of generating the hypotheses.

These hypotheses enable testing of relationships between an EBM trainer's construct and their behavioural intention to the TTT-EBM e-learning application. The results and analysis following in Chapters 4 and 5 identifies the strongest hypothetical connection and hence draw-out the most significant factors, of TAM and e-TAM respectively, in assessing EBM trainers of the TTT-EBM project. The proof or rejection of hypotheses clarifies which construct the TTT-EBM project should focus on to improve their e-course's application.

3.3.1 TAM

The TAM as shown in Section 2.3.1.5 has five connections between its factors, which Davis (1986) had established. This study has generated its hypotheses for the TAM model based on the five connections of Davis' model. Testing and analysis of the hypotheses builds on research of the TAM as well as draws out constructs that motivate EBM trainers to use the system. For example, when an EBM trainer considers the e-course's application as easy to use, they are more enthusiastic about using it and therefore will have a greater performance while using the system.

Figure 27 shows the diagram of the hypotheses generated between PEOU, PU, ATU, and BI. The arrow indicates the direction of the hypothesis, e.g. for H1, PEOU will have a significant effect on PU and so on. In context, where e-course means the blended e-learning approach to EBM study, these mean:

H1. EBM trainers who perceive the e-course as easy to use will believe it is useful for them

H2. EBM trainers who perceive the e-course as useful will have a driven attitude to use it

H3. EBM trainers who perceive the e-course as easy to use will have a driven attitude to use it

H4. EBM trainers who have an attitude that motivates them to use the e-course will have a behaviour intention to the system

H5. EBM trainers who perceive the e-course as useful will have a behaviour intention to the system

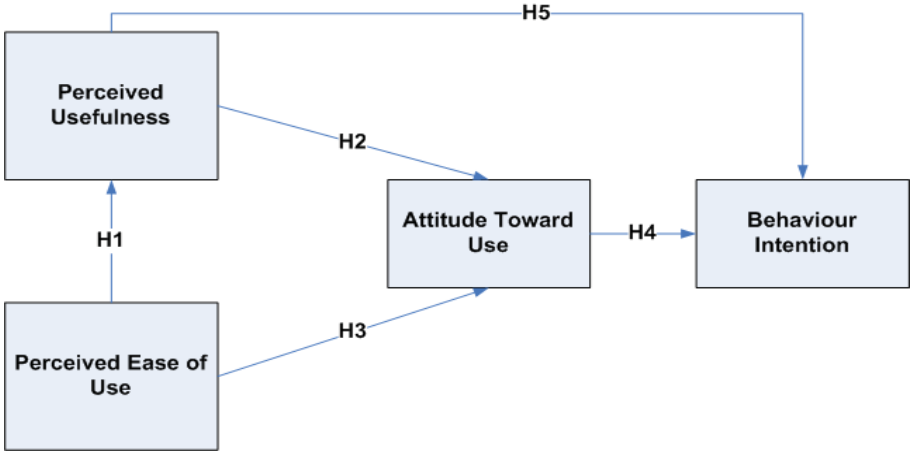

Figure 27: The Technology Acceptance Model (TAM), showing the hypotheses assumed for this research

The direction of a hypothesis not only signifies a relationship, but also shows what variables a factor depends on. The performance of a dependent variable (DV) is shown to be moderated by an independent variable (IV). In the case of H2 and H3, where the DV is ATU, which has IVs of PU and PEOU respectively, this means "an EBM trainer's point of view or attitude toward using the e-course depends on whether they believe the course is beneficial or they think it is easy to use, or both". Table 1 shows the categorisation of IVs and DVs related to the hypotheses of Figure 27.

Hypothesis	Dependent variables (DV)	Independent variables (IV)
H1	Perceived Usefulness (PU)	Perceived Ease Of Use (PEOU)
H2	Attitude Towards Use (ATU)	Perceived Usefulness (PU)
H3	Attitude Towards Use (ATU)	Perceived Ease Of Use (PEOU)
H4	Behaviour Intention (BI)	Attitude Towards Use (ATU)
H5	Behaviour Intention (BI)	Perceived Usefulness (PU)

Table 1: A list of the hypotheses that distinguish between dependent and independent variables

3.3.2 E-TAM

The e-TAM model, as described in Section 3.2.2, has external factors connecting to the PU and PEOU factors of the TAM. Each connection represents a relationship between two factors, as studied in Section 2.4. This study generates hypotheses to test and analyse relationships of

factors in the e-TAM and to identify the most significant construct of EBM trainers, as shown in Figure 28. This study has generated its hypotheses for the e-TAM based on the factors this thesis assumed were predictors of a user's behavioural intention.

The factors discussed in Section 2.4 were found to explain the variance of PU or PEOU for other studies; this study has also hypothesized the relations of the chosen external factors for the e-TAM. Organisational Structure and Time Constraint are part of the clinical environment and are important to assess because EBM training needs to be an integral into EBM trainers' routines, see Section 1.2. The clinical environment can also include facilities for Knowledge and Technology Support, which when moderated could change the EBM trainer's perception of using the e-course' application, see Section 2.4.7. Moreover, researchers rarely studied Education Level as a moderating factor; Experience is almost a converse to education and they are both members of human dimension. Hence, following Figure 25 we have generated two additional hypotheses connecting Education Level and Experience to ATU and BI. Therefore, in total, this research project assumes sixteen hypothesis links for the external factors that connect to PEOU, PU, ATU and BI which are relevant to the TTT-EBM e-learning application.

Proving the hypotheses may produce results in support of other research; on the other hand when disproved, it would present the opportunity for an in-depth study of the contradictory result. The results and analyses of the influence of factors and proof of the hypotheses are shown in Chapter 5.

Figure 28 from H1 to H16 shows the generated hypotheses with respect to the TTT-EBM e-learning curriculum and blended learning approach, also denoted as the e-course here. In the context of this thesis, their grouping is as follows:

Set 1. (H1,H3,H13,H14): An improvement in an EBM trainer's ability and know-how of e-learning, EBM training systems or similar e-courses will increase their acceptance of the e-course

Set 2. (H2,H4,H15,H16): When EBM trainers are greater informed and trained in the use of the online training systems and EBM teaching practice, they will have an overall greater acceptance of the e-course

Set 3. (H5,H7): An EBM trainer whose clinical environment is flexible in place and is better equipped with facilities for e-learning and EBM will find it easier to use the e-course and will have a stronger belief that its use is advantageous

Set 4. (H6,H8): A more flexible working schedule for EBM trainers to use the e-course will enhance their ability to use it and they will have stronger feelings to its value

Set 5. (H9,H10,H11,H12): When the quality of support for ICT and information resources of the e-course increase, EBM trainers will think it is easier to use and will believe that it is beneficial for them

The hypotheses in Figure 28 have directions as indicated by the arrows that shows the influence of one factor on another.

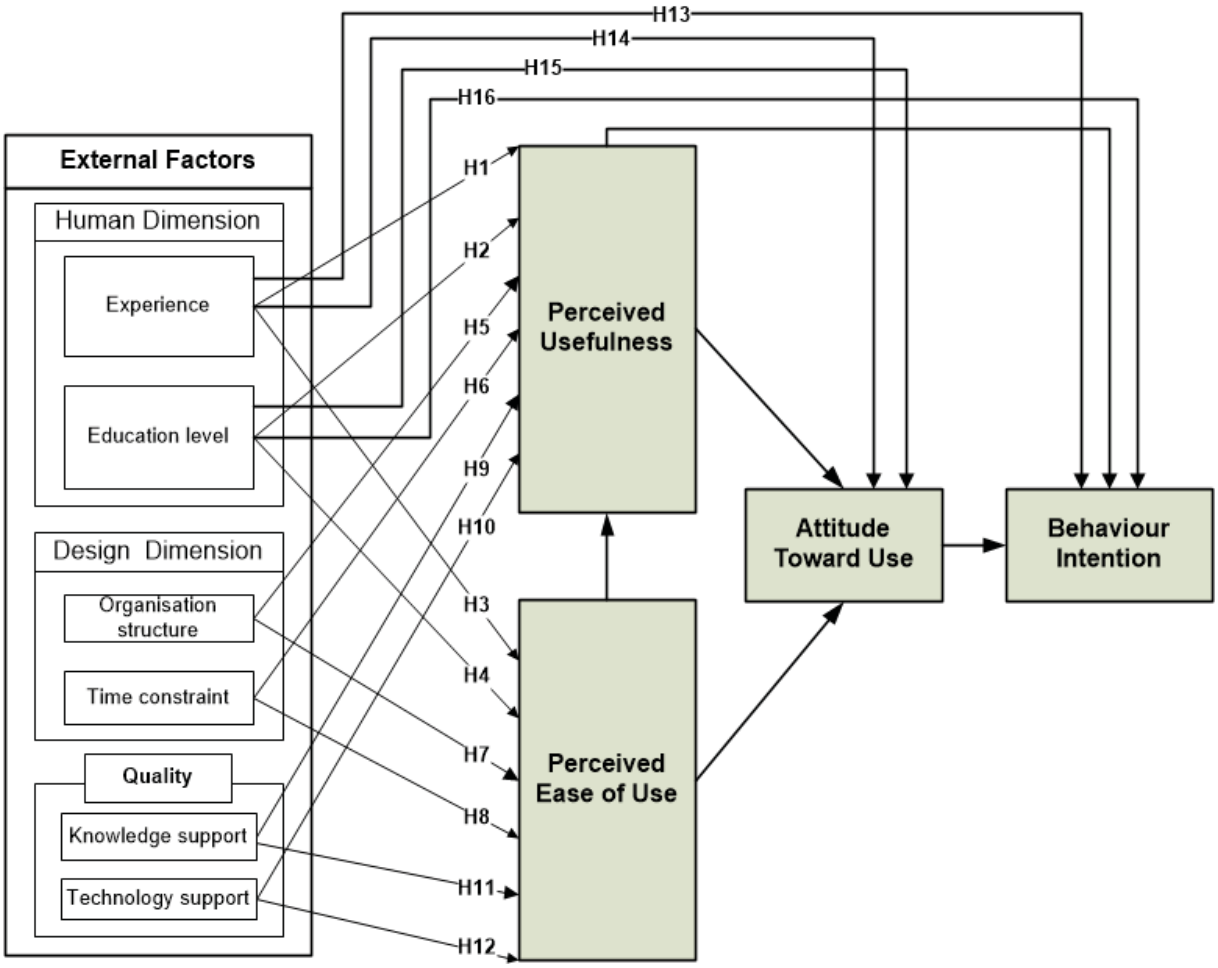

Figure 28: Extended Technology Acceptance Model (e-TAM), showing the hypotheses assumed for this part of research

Table 2 shows how IVs and DVs of the e-TAM model are categorised based on the explanation of IVs and DVs from Section 3.3.1.

Hypothesis	Dependent variables (DV)	Independent variables (IV)
H1	Perceived Usefulness (PU)	Experience (Ex)
H2	Perceived Usefulness (PU)	Education Level (EL)
H3	Perceived Ease Of Use (PEOU)	Experience (Ex)
H4	Perceived Ease Of Use (PEOU)	Education Level (EL)
H5	Perceived Usefulness (PU)	Organisational Structure (OS)
H6	Perceived Usefulness (PU)	Time Constraint (TC)
H7	Perceived Ease Of Use (PEOU)	Organisational Structure (OS)
H8	Perceived Ease Of Use (PEOU)	Time Constraint (TC)
H9	Perceived Usefulness (PU)	Knowledge Support (KS)
H10	Perceived Usefulness (PU)	Technology Support (TS)
H11	Perceived Ease Of Use (PEOU)	Knowledge Support (KS)
H12	Perceived Ease Of Use (PEOU)	Technology Support (TS)
H13	Behaviour Intention (BI)	Experience (Ex)
H14	Attitude Towards Use (ATU)	Experience (Ex)
H15	Attitude Towards Use (ATU)	Education Level (EL)
H16	Behaviour Intention (BI)	Education Level (EL)

Table 2: List of the hypotheses that distinguish between dependent and independent variables

Now the initial development of the e-TAM is complete. This section has included hypotheses to connect the external factors to the factors of the TAM. It has also generated hypotheses for the TAM. Both sets of hypotheses are with respect to adoption of the TTT-EBM e-learning application and have a predicted direction. Chapter 4 includes the assumed directions of these hypotheses, which this thesis tests for the TAM and for the e-TAM in Chapter 5.

A main objective of this thesis is to develop and test the e-TAM because it has a potential to improve the TTT-EBM curriculum and blended learning approach. The e-TAM assessed a questionnaire designed by Oude Rengerink (2011), which is a questionnaire that uses the Likert 7-scale rating, as explained in Section 3.4. The model can assess the user acceptance by identifying factors that have an influence on the user's adoption of the e-course and drown

out irrelevant barriers. This thesis has analysed the results from that questionnaire, as discussed in Chapter 5.

3.4 Properties of the Questionnaire

A questionnaire in its final form is a set of questions on a main topic that requires people to answer each question. The purpose of the questionnaire is to provide information to researchers as evidence to support their hypotheses and research claims. When designing a questionnaire there should be a procedure (Diem, 2004). There should be a measurable scale for the answers, so the participants can accurately quantify their answer. These design steps are aimed at giving reliable information so the hypotheses can be answered and measured. To answer the research aims, questions are designed around user constructs, hypotheses and a research topic (Diem, 2004).

Each factor of the TAM and e-TAM has a group of components that describe a part of the factor, also called components. The components of factors have a similar meaning to the questions, which serves as their relationship. Table 3 lists components of the TAM's questionnaire and relations to TAM's factors. These components become the basis of questions in the questionnaire, which then frames the questions. Kim and Mueller (1978) recommended extracting at least three components per factor when designing a questionnaire. Hence, the amount of factors and questions are directly related, where more factors means more questions.

	Factors	Components
Technology Acceptance Model	**Perceived ease of use (PEOU)**	• Easy to use. • Easy to learn. • Easily understandable interaction. • Finding information easily. • Making user productive quickly.
	Perceived usefulness (PU)	• Enhance effectiveness in learning. • Improve performance. • Increase productivity at work. • Useful.
	Behavioural intention (BI)	• Plan for future use. • Used on all occasions. • Intended for use in case of need. • Interacting with other knowledge holders.
	Attitude towards use (ATT)	• Favourable during use. • Good idea. • Positive tool. • Pleasant experience.

Table 3: Showing each factor and related component for each factor separately

Scale measurements of questions have different formats and researchers have to select the right type to gain better reliability in their results. They usually choose multi-scale measurements over single-scale measurement because of their greater ability to indicate the user's satisfaction level (Davis, 1986). In addition to that, researchers generally choose Likert scale formats that limit the range of answers to a few verbal statements or numbers for each question (Dawes, 2008). The ranges in the Likert scale are usually in 5, 7 or 10-point rating scales, however 5 and 7-point rating scales have a greater likely-hood of giving "higher mean scores relative to the highest possible attainable score, compared to that produced from a 10-point scale" (Dawes, 2008). The answers available for the participants to select usually range from strongly disagree to strongly agree, but can have similar phrases to distinguish points in

the scale. Figure 29 shows the Likert scale format that is a type of the multi-scale format, as used in this thesis's questionnaire and the questionnaire used from Oude Rengerink (2011).

Q1. I find the EBM-TTT interactive e-learning material easy to access						
Very Unlikely		Unlikely		Likely		Very Likely
1	2	3	4	5	6	7

Figure 29: Example of the Likert scale format used in the questionnaires

Likert scales help to control a large number of answers from questions, enabling their measurement as a single construct; this makes the questionnaire more reliable. To elaborate, this means instead of using words or other formats of answers, the answer is a number with a specific meaning.

Shown in the Appendix, Section 8.2 and 8.3, are the questionnaires used in this study that gathered information for models that have assessed EBM trainer's acceptance of the TTT-EBM e-course, namely the TAM and the e-TAM. The design of the TAM questionnaire was developed from Davis' (1986) questionnaire, whereas the e-TAM questionnaire was designed by Oude Rengerink (2011). These questionnaires have a multi-scale measurement with a 7-point rating scale format, which Davis (1989) and DeCoster (2000) defined as being the most reliable rating scale. These two individual questionnaires have been used separately and only by the relevant model in this thesis. This is because the amount and type of questions in each questionnaire are related to the factors in the models. Hence, each model's analysis of the participant data of the relevant questionnaires will be different, but when the results are combined it effectively means two questionnaires have been analysed by models for assessing the EBM trainers' technology acceptance of the e-course.

This thesis initially structured the TAM questionnaire's questions on Davis' (1986) questionnaire, which constructs already fitted the TAM's factors. Based on that this study then developed the questions to suit the hypotheses of this study. A statistical analysis of the questions with a pre-test indicated whether the questions were suitable for providing the right type of information, from the questionnaire's participants, for the TAM. The pre-test was carried out in a reliability test using the Cronbach's Alpha, discussed further in Section 3.5. After verifying the TAM questionnaire as reliable, Dr T. Arvanitis carried out the survey on EBM trainers, who answered the TAM questionnaire in March-April 2009. The participants were a total of 56 including 34 men: two in their late twenties, nine in thirties, 19 in forties, and four above 50-years old; and 22 women: five in their late twenties, six in thirties, seven in forties, and four above 50-years old. The next section covers the e-TAM's questionnaire in depth.

3.4.1 E-TAM

The e-TAM questionnaire has a similar structure to the TAM questionnaire. It uses a multi-scale measurement, the Likert scale, as described in Section 3.4. Oude Rengerink (2011), designed the structure, developed the questions and conducted the survey. There are 23 questions in the questionnaire and this thesis has analysed them using the e-TAM. One-hundred-and-twenty clinical EBM teachers from 12 countries including Belgium, Canada, Finland, Germany, Greece, Hungary, Italy, Netherlands, Poland, Switzerland, United Kingdom, and the United States completed the questionnaire online, or on paper. This study has used the same participants from the TAM questionnaire, being 56 clinicians.

This thesis has grouped the questions into factors that relate to the e-TAM model. Factorising the questions is a step in designing the model (Field, 2009). We found the list of topics in the

questionnaire are attitude, available time, hospital hierarchy, level of understanding English, available resources, knowledge & skills of trainers and requirements for EBM teaching in curricula or at workplace. Similarities between those topics and hypotheses of the factors were found and their relevance was consulted with Dr T. Arvanitis.

		Sub Factors		Components
External Factors which added to TAM	Human Dimension	Age		<30 30-39 40-49 50-59 60+
		Gender		Male Female
		Experience		Previously used of PC Worked with databases Understands the system Determining the system Defining the system Appraising the system Applicability of using the system to help patients
		Education Level		Undergraduate Postgraduate Medical education degree
	Design Dimension	Organisation Structure		Flat Pyramid
		Time Constraint		Teachers time Learners time
		Quality	Knowledge Support	Resource availability Lack of evidence Too much knowledge
			Technology Support	Database access Internet Lack of assistance

Table 4: Showing each factor and related component for each factor separately

Table 4 shows the factors and components of the e-TAM. This study has drowned out each predictor (component) in the list of external factors from those questions. Shown in the Appendix, Section 8.4, are the lists of questions from the TTT-EBM e-learning curriculum's

questionnaire that have been grouped into factors of Experience, Education Level, Organisational Structure, Time Constraint, Knowledge Support and Technology Support.

This section has discussed that designing questionnaires needs a lot of consideration to fit user constructs, hypotheses and factors. These steps increase the likelihood of obtaining reliable results. The next section discusses some significant methodologies available to examine the reliability of the questionnaire.

3.5 Testing Reliability of Factors within the Questionnaire

When multiple components are measured, they might produce different results depending on the testing conditions. Pre-testing the questionnaire or estimating the reliability of the factors in the questionnaire is important for researchers. They can use it to determine the ability of a measure. For example, it is a good measure when it produces the same result from components under different situations (Field, 2009). This study has also used pre-testing of the TAM and e-TAM questionnaires as a step toward validating them, which is discussed in Section 4.2 and 5.2. This is an initial step in finding the reason behind the influential factor of the TAM and e-TAM models because the results should be trustable.

Researchers often use pre-testing as a prerequisite to the validation of research questionnaires. Pre-testing questionnaires is a survey on a small selection of participants. This process involves the identification of questions that have a low reliability, as shown in Field (2009), Kinnear & Gray (2008) and Schumacker & Lomax (2004). This thesis uses pre-testing to identify any anomalies or restraints within the questionnaires, which is a way to get better results.

Reliability of questions is a step this thesis takes to verify the accuracy of the research models' assessments because the data they are analysing comes from the questionnaires. The best way to define reliability is to put it in context of an example, as follows. Firstly, a group is tested using different measurement processes, i.e. given a questionnaire to fill out, where the questionnaire has questions relevant to the factors of the model and the answer to each question has a weight (1 to 7, or strongly disagree to strongly agree). After that, it is possible to compare the variation between the results of each application of the measurement process. If there were a small variation between measurements, then the participants would have produced similar results, which is a way of declaring the questionnaire's reliability (Rudner, et al., 2001).

Nunnally (1978) defined reliability as the level of trust or proven accuracy of the results from experiments. The trustworthiness of the results is proportional to the amount of repetitions of the experiment where it has produced the same set of results. Repeating the experiment several times, replicates the results. This repetition will reveal the number of errors that have occurred in the measurement process and allows each error in the process to be quantified (Nunnally, 1978).

There are different processes to measure reliability such as split-half reliability and Cronbach's Alpha. Split-half reliability is a method that divides a data set into two random parts. If the source of the data is reliable, the results from the reliability will be the same or similar. However, this method of measuring reliability has difficulties when wanting to divide the data into two separate parts each time in different ways. Cronbach's Alpha solves this problem and is a more popular method (Hinton, et al., 2004; Field, 2009). Cronbach's Alpha was initially

introduced in 1951, and it shows the correlation between the components. Many researchers have used it as a reliability scale, such as Nunnally (1978), Davis (1989) and Hinton (2004).

After a review of many related papers (Davis, 1989; Hinton, et al., 2004; Field, 2009), it is conclusive that the Cronbach's Alpha method is a better way to test the questions of the TAM and e-TAM questionnaires. The results of the Cronbach's Alpha calculation can be categorised into levels of reliability:

- Cronbach's Alpha with 0.6 or higher is an acceptable reliability
- Cronbach's Alpha with 0.8 or higher is a good reliability
- Cronbach's Alpha with 0.95 or higher is a very high reliability

The reliability and Cronbach's Alpha is also discussed in the context of a measure of reliability in Section 3.6, whereas in Section 4.2 and Section 5.2, this thesis analyses the results of Cronbach's Alpha for the TAM and e-TAM respectively.

3.6 Testing the reliability of the questions

Field (Field, 2009) defined reliability as "the ability of a measure to produce consistent results when the same entities are measured under different conditions." So, in terms of a questionnaire's scale that measures a group of users, the amount of random error in the results shows the questionnaire's reliability. Reliability can be assessed using different methodologies as discussed in Section 3.5. This thesis assesses the TAM and e-TAM questionnaires reliability to show the credibility of the results from the questions. Reliability also has a direct effect on the correlation and regression analysis, which this thesis shows in

Section 4.4 and 5.4. Therefore testing the reliability of the questions is important because it explains deviations in measurements in the questionnaire.

This research uses Cronbach's Alpha as a method to measure the reliability of the questions in the questionnaires. Cronbach's Alpha is a reliability assessment method and has been used by most researchers such as, Nunnally (1978), Davis (1989) and Hinton et al. (2004) because of its' accuracy as indicated by Field (Davis, 1986). Nunnally suggested that a reliability level of 0.8 is enough for testing the reliability in simple examples. Davis, based on Nunnally's research, considered 0.8 as an acceptable level of reliability in his analysis. He did this because increasing the reliability level above 0.8 is not necessary as it has very little effect on the correlation level.

The value of Cronbach's Alpha explains the internal validity, being the degree of certainty that a hypothesis between factors has the right direction or not, and consistency of the questions that were used in the questionnaire. In this study, Cronbach's Alpha, is calculated using the "Scale if item deleted" method, which is shown in Section 4.2 and 5.2. This method assesses the questionnaire's reliability under conditions where a question could have been eliminated. According to this method, a questionnaire and all its questions have a good reliability after meeting three conditions:

1. If the value of the standardised Cronbach's Alpha is greater than 0.8
2. If all the values of the "Cronbach's Alpha if Item Deleted" (CAIID) column are around the same value as the standardised Cronbach's Alpha
3. If the values in the "Corrected Item-Total Correlation" (CITC) column are from 0.2 to 0.3 or higher

Condition No. 1 above relates to the reliability levels shown in Section 3.5. In the event of condition No. 1 being less than 0.8, but higher than 0.6, the questionnaire has an acceptable reliability, but not a good one. In that case, the standardised Cronbach's Alpha may be increased by looking at condition No. 2. Deleting the CAIID values that are higher than the standardised Cronbach's Alpha increases the standardised Cronbach's Alpha to the higher value of the deleted CAIID. When condition No. 3 is not met, the item/question below 0.2 or 0.3 may not be measuring what other items are measuring (Field, 2009), which means its result is not consistent with the other items and it should be deleted to increase the reliability. When all three conditions have been satisfied, the reliability of each question and the whole questionnaire has been shown to be good.

The next section covers factor analysis. Factor analysis is the first statistical analysis method this study applies to the data of the questionnaires.

3.7 Factor Analysis

Assessing data from questionnaires with the TAM and e-TAM should be able to prove or disprove the hypotheses and draw out the influential factor to a user's behavioural intention. This thesis used SPSS to calculate the factor analysis, which shows the relationships between components and factors to choose the best component for each factor. Factor analysis is a method that identifies factors, or correlates components with factors. Factor analysis is the statistical analysis technique used to reduce the data set into a fewer amount of components (Dancey & Reidy, 2002). Mulaik (1986) defined factor analysis as a method that is used to condense information, giving the researcher a greater ability in defining factors. This study has used the Principal Axis Factoring extraction method in SPSS to reduce the data.

There are three main areas reported by Pedhazur (1991) as beneficial for using factor analysis, as follows:

- When there is not enough information about the relationship of a component
- When researchers are not sure about the results from other authors questionnaires
- When there is a problem with the scale of the sampling, size of the sample, the number of factors taking the method of extraction or the rotation of factors.

The method of factor analysis finds out whether the right component has been chosen for each factor and whether the factor should be loaded or not (Spearman, 1904; Thurstone, 1947; Guilford, et al., 1954). It also validates each factor that is used in the TAM and e-TAM models.

To carry out factor analysis, this study has used correlation to find out the connection between the components and factors in the TAM and e-TAM models. The calculation of the correlation for K components is shown below:

$$\frac{K(K-1)}{2}$$

where K is the number of the items. The factor analysis of a factor can be represented as (Field, 2009):

$$Factor_i = b_1 component_{1i} + b_2 component_{2i} + \dots\dots + b_n component_{ni} + \varepsilon_i$$

Where b_n represent the factor loading and ε_i represent error.

After, this thesis has identified which factors can be indicated as valid for the model, the next logical step in the methodology, being similar to that of by Dancey & Reidy (2002), is regression analysis and hypotheses testing.

3.8 Regression analysis

This thesis uses a regression analysis on the questionnaires to show how factors of the TAM and e-TAM complement each other in influencing an EBM trainer's behavioural intention toward the e-course. For instance, say the regression analysis finds a relation between the user's experience and their time constraints, which directly relates to their higher test score at the end of the e-course's module. For this instance, we can assess the outcome by comparing an individual's time constraints with their experience.

Regression is explained as a statistical analysis that first discovers whether there is a relationship between the variables and secondly finds the best correlation between DVs, or outcomes, and IVs, or predictors, as shown in Hinton et al. (2004). Hinton et al. (2004) stated correlation was the analysis of how data from two variables influence each other. The change of data from one variable could affect the other variable. It is interesting to see the variation that one variable has on the other because it shows the dominant factor.

There are two main types of regression analysis - linear regression and multi-regression. Regression is a method that also finds the best fit for a data set. The best fit of the data can be represented as a line. A line is plotted between the data points by considering the smallest amount of variance between each data element. Three examples of the fitted line are shown below in Figure 30 (Pedhazur, et al., 1991; Sapsford, et al., 2006).

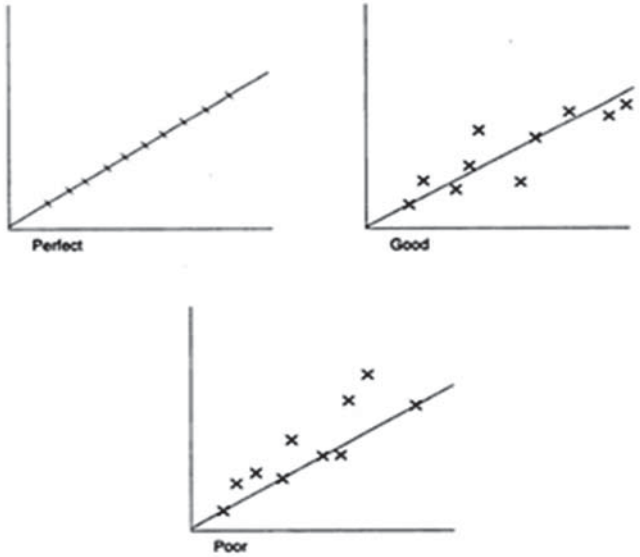

Figure 30: The examples of the fit line (Sapsford, et al., 2006)

A good fit has a regression within ±1, however a value closer to zero means there is a weaker relation or poor fit. A good fit is defined by the correlation coefficient. The correlation coefficient can be estimated by considering the distance between the data point clusters and the fitted line. Figure 31 shows an example of the correlation coefficient (r-value) for a data set (Pedhazur, et al., 1991; Sapsford, et al., 2006).

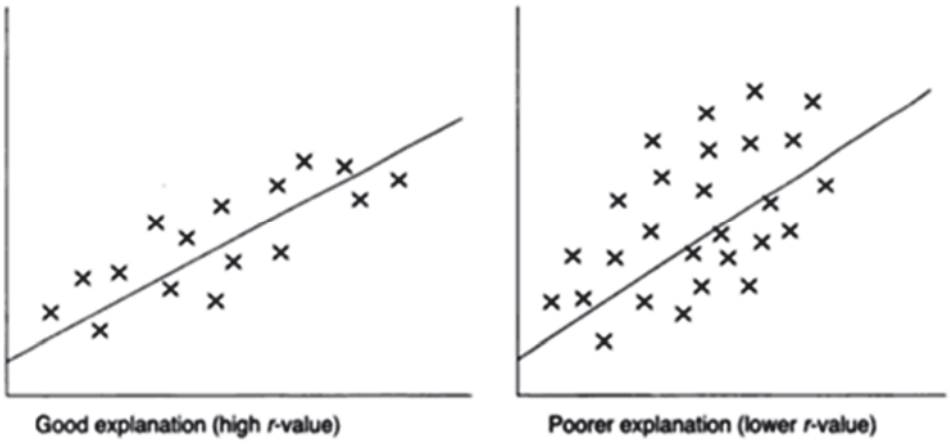

Figure 31: An example of the correlation coefficient (r-value) (Sapsford, et al., 2006)

The regression analysis shows the association between the hypotheses of a particular model. Moreover, it also identifies the validity of the relations, or hypotheses, between the DVs and

IVs. This thesis carries out regression analysis in Section 4.4 and Section 5.4 to identify the causal relationship in the TAM and e-TAM models.

3.9 Regression and hypotheses testing

The TAM and e-TAM models need validation to ensure that a consistent level is maintained so it produces the same resulting theoretical assessment for topics related to e-learning. Validity is defined as the degree to which a measurement (i.e. TAM or e-TAM models and questionnaires) can achieve the standard levels in which it was intended to measure, as presented in the statistical book by Field (2009). Regression is the validation method chosen because it has been shown to prove the significance level of the hypothesis, which this thesis considers as a good way to prove that the model has been designed correctly (Field, 2009).

This research used simple and multi-regression methods to calculate the standardised regression coefficient (β), which shows the impact of factors on each other. β "indicates the strength of relationship between a given predictor and output in standardised form" (Field, 2009). This coefficient should be nonzero and vary between ±1. The closer it gets to +1 or -1, the stronger relation or effect there is between the factors. If β is less than zero it shows the connection assumed is in the wrong direction (Miller, et al., 2002; Muijs, 2004; Field, 2009). For example, while referring to adoption of the TTT-EBM e-learning application, if the hypothesis says PEOU will have a significant effect on PU, which results in value of β equalling -0.87. That result means the PU had a significant effect on the PEOU (Miller, et al., 2002; Muijs, 2004; Field, 2009) .

Multiple-regression is a statistical technique that enables a study of the relation between the DV with two or more IVs (Davis, 1986; Sapsford, et al., 2006). By using the regression analysis,

it is possible to find out the significance level of the hypothesis. The confidence or significance level of the hypothesis is called the P value.

The P value indicates confidence in the validity of a hypothesis. The standard cut-off values for the P value are:

- P value < 0.05 means less than 5 in 100 chance of the error in the significance level of the hypothesis
- P value < 0.01 means less than 1 in 100 chance of the error in the significance level of the hypothesis
- P value < 0.001 means less than 1 in 1000 chance of the error in the significance level of the hypothesis

In Sections 4.4 and 5.4, this thesis explains the results of the regression analysis for TAM and e-TAM respectively.

3.10 **Summary**

This chapter has explained how the e-TAM, an extension to the TAM, was developed with the addition of research-based external factors. Hypotheses were generated to form the e-TAM with links from the external factors to the behavioural constructs of the TAM. The TAM was also implemented with hypothetical links between its factors. This chapter also explored how to develop questionnaires based on the TAM and e-TAM models' factors and its preliminary testing of reliability. The design of two questionnaires was discusses; stating that the questions need to fit the user group under assessment, categorise the answers using a Likert scale and provide reliable results to answer hypotheses of the TAM and e-TAM. Reliability of

the chosen factors and the questions in the questionnaires were explored with a study of methods including factor, regression and reliability analyses. Altogether, this methodology has established a new theoretical model, the e-TAM, as well as drawn up hypotheses for both models' assessment of a user's acceptance of the TTT-EBM's e-course and blended learning approach. Chapter 4 and 5 analyse the results of the TAM and e-TAM respectively to find the influential factors, drown out barriers and discuss the impact of the results on the e-course's application.

4 TAM RESULTS

4.1 Introduction

The thesis has so far discussed the benefit of integrating online learning into the workplace and improving an Evidence Based Medicine (EBM) trainer's efficacy to teach medical practitioners how to use EBM in the patient's diagnosis, treatment and follow up stages. The Teach the Trainers EBM (TTT-EBM) project has designed an e-learning application to train EBM study in a workplace and this thesis has proposed a set of hypotheses and developed a questionnaire for the application's assessment using the Technology Acceptance Model (TAM), as introduced in Section 3.2.1 and 3.3.1. The results and analysis of this chapter has found the TAM's most influential factor at predicting the EBM trainer's user acceptance of the TTT-EBM e-learning application. This chapter has put hypotheses between factors into the context of adoption of the online learning system to discover the most influential factor and then visualise where improvements are possible on the TTT-EBM project. However, the actual improvement of the TTT-EBM project is out of the scope of this thesis.

This section involves an in-depth analysis and discussion of the results from the questionnaire that has been analysed using the TAM model. The results of the analysis are categorised into three parts, reliability, factor analysis and regression, where Section 3.5 to 3.9 covered their methodologies. The reliability section shows the calculation of Cronbach's Alpha for each question from the questionnaire, and as an average value for the whole questionnaire. The factor analysis section includes a study of the chosen factors that were used for validation and their apparent connection to the related group of questions. The regression section shows the

impact of each factor on the whole of the system, including the connections between each part of the TAM model.

4.2 Reliability

Table 5 shows the total and standardised averages of Cronbach's Alpha and Table 6 shows Cronbach's Alpha for each question and the correlation values. The standardised Cronbach's Alpha has been calculated giving a result of 0.961, as explained in Section 3.5, this means that the TAM questionnaire has a very high reliability. Therefore, the questionnaire has been well designed for its use in this study and the TAM has the appropriate factors for assessing the questions.

To look at the results more closely, Table 6 shows the values of Cronbach's Alpha for each question from the questionnaire, which this study calculated with the "Scale if item deleted" method. As illustrated in Figure 32, all but one of the values from the CAIID column are lower than the standardised Cronbach's Alpha (red horizontal line). The one above is PEOU1 with 0.963, which is 0.002 above the alpha. Deleting PEOU would increase the alpha, but this would have been insignificant in terms of the classification of the questionnaire's reliability. The lowest is BI1 with 0.956, which makes it the most reliable item. The values from the CITC column, illustrated in Figure 33, are all greater than 0.3, where the lowest is PEOU1 with 0.412 and highest is BI1 with 0.86. PEOU1 is indicated in the CITC column as measuring the same as the other factors; however, it has a slight different measure than the rest. Overall, the results of Table 6 meet the three stated conditions in Section 3.5 for the results to be reliable; therefore, this study regards this questionnaire and all its questions including the factors of the TAM as having a very high reliability.

Number of questions	20
Total Cronbach's Alpha	0.960
Standardised Cronbach's Alpha	0.961

Table 5: Average reliability analysis

Questions	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation (CITC)	Squared Multiple Correlation	Cronbach's Alpha if Item Deleted (CAIID)
PEOU1	97.48	410.545	0.412	0.689	0.963
PEOU2	97.29	400.244	0.655	0.840	0.959
PEOU3	97.57	404.904	0.555	0.697	0.960
PEOU4	97.48	399.745	0.759	0.764	0.958
PEOU5	97.64	403.361	0.648	0.708	0.959
PU1	97.27	399.581	0.747	0.805	0.958
PU2	97.57	390.431	0.820	0.868	0.957
PU3	97.54	391.817	0.809	0.932	0.957
PU4	97.52	397.200	0.758	0.851	0.958
PU5	97.52	395.200	0.743	0.850	0.958
ATU1	97.11	412.206	0.510	0.530	0.961
ATU2	97.05	403.215	0.755	0.854	0.958
ATU3	96.96	401.853	0.753	0.860	0.958
ATU4	97.57	395.195	0.803	0.801	0.957
ATU5	97.52	394.800	0.796	0.825	0.957
BI1	96.95	392.924	0.860	0.897	0.956
BI2	97.21	387.662	0.818	0.866	0.957
BI3	97.38	392.711	0.814	0.905	0.957
BI4	97.27	392.709	0.790	0.835	0.957
BI5	97.27	395.654	0.766	0.838	0.958

Table 6: Reliability analysis in detail for each question

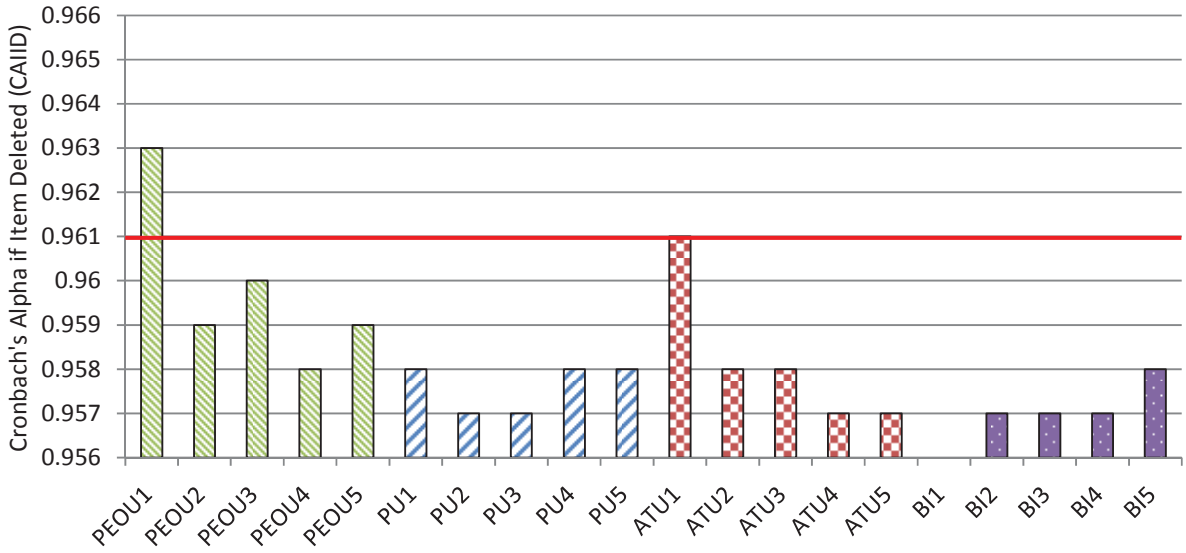

Figure 32: Cronbach's Alpha if Item Deleted (CAIID) with red horizontal line showing the standardised Cronbach's alpha

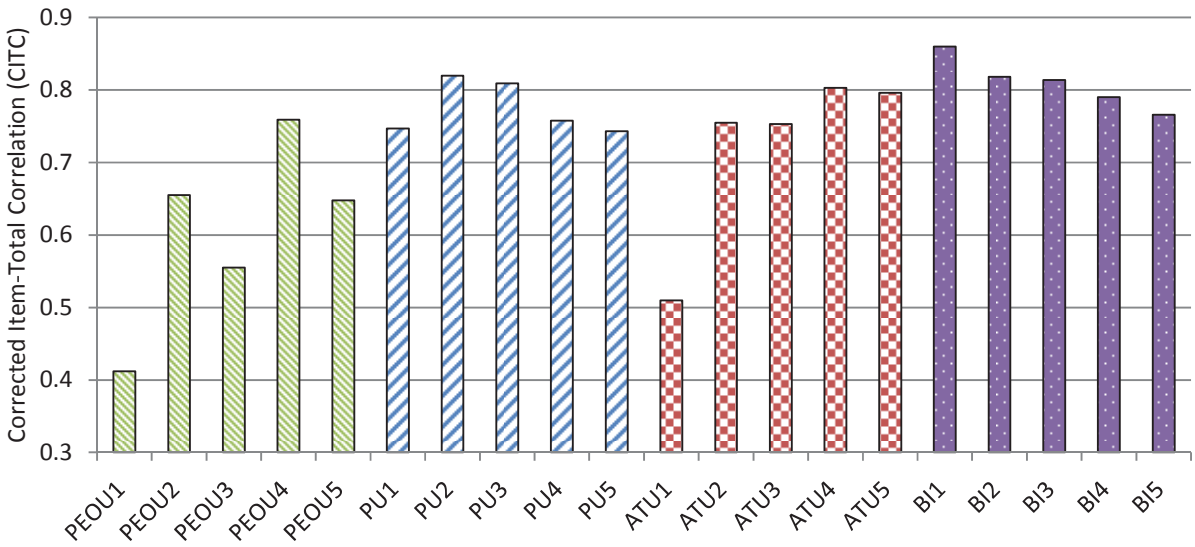

Figure 33: Corrected Item-Total Correlation (CITC) with y-axis set to minimum recommended value

The next step is to use factor analysis, which has the ability to show the number of factors that can fit the data set with their components.

4.3 Factor analysis

Factor analysis is the assessment of a factor with what it depends on. This analysis can determine the influence of known or unknown components of a factor and examine the

hypotheses of the factors; see Section 3.7 for more on the methodology of factor analysis. The link between each question/component and the factors were defined as hypotheses in Section 3.3.1. Hypotheses are setup so the factor analysis can determine the influential factor of the TAM model for each component in the questionnaire.

This section validates the number of components from the 20 questions in the TAM questionnaire are four factors of the model, where the results are shown in Table 7. Factor analysis was carried out using statistics software called SPSS, which recommends a cut-off variance above or equal to 0.5 to draw out components with significant variance. This study has chosen to assess components with the Principal Axis Factoring extraction method, which is integral to the statistics software.

Illustrated in Figure 34, Factors 1 to 4 account for a large amount of variance, and their components are greater than 0.5 in their groups of PU{2,3,4,5}, BI{1,2,3,4,5}, PEOU{1,2,3,4} and ATU{2,3} respectively. The table shows the percentage variance explained after rotation for Factors 1 to 4 is 26%, 19%, 18% and 13% respectively, which explains three-quarters of the total explained variance in user acceptance of the application. Factor 1, PU has a high variance and Factors 2 to 4 have a medium variance in their components, which means that they are valid. Factor 4, with a percentage variance of 13% is only partly validated by ATU{2,3}, because it has two components above 0.5, which makes it eligible for deletion, however for research purposes and because of its variance this thesis considers it as being supported.

Question	Factor 1	Factor 2	Factor 3	Factor 4
PEOU1	0.070	-0.005	0.803	0.098
PEOU2	0.194	0.133	0.837	0.290
PEOU3	0.185	0.161	0.802	0.054
PEOU4	0.264	0.379	0.584	0.375
PEOU5	0.579	0.271	0.137	0.269
PU1	0.295	0.205	0.594	0.520
PU2	0.793	0.236	0.304	0.248
PU3	0.921	0.286	0.137	0.183
PU4	0.765	0.355	0.118	0.198
PU5	0.833	0.247	0.211	0.102
ATU1	0.104	0.315	0.319	0.376
ATU2	0.297	0.354	0.269	0.721
ATU3	0.291	0.337	0.253	0.784
ATU4	0.405	0.459	0.403	0.374
ATU5	0.551	0.484	0.308	0.218
BI1	0.493	0.667	0.245	0.312
BI2	0.594	0.601	0.219	0.171
BI3	0.496	0.677	0.114	0.340
BI4	0.479	0.688	0.116	0.295
BI5	0.385	0.759	0.099	0.318
Percentage Variance	26.0%	18.6%	17.6%	13.1%

Table 7: Rotated Factor Matrix of TAM rotated with Varimax with Kaiser Normalization and less than 0.5 cut-off to draw-out factors (dark grey shade), 0.3 cut-off (light grey shade)

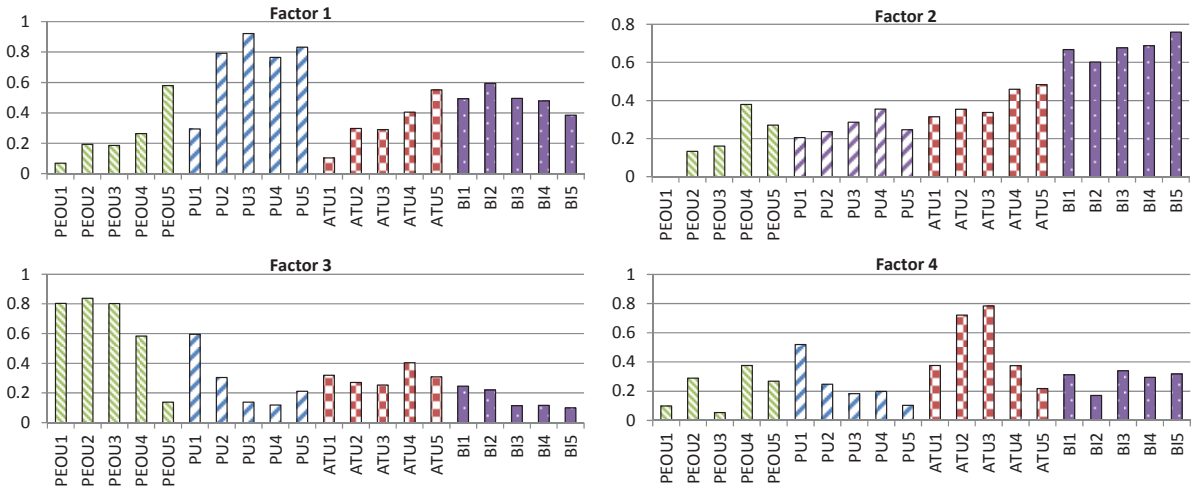

Figure 34: Factor loading for each Factor 1 to 4 from top-left to bottom-right

As stated in the SPSS guidebook, factors validate when greater than three components of one group have a variance greater than 0.5. According to SPSS guidelines, Factor 4 has a weak validity, which might be due to the questionnaire's sample size. However, 0.5 as a cut-off variance is not obligatory to choose. Other literature has defined the cut-off variance as insignificant below 0.3 (Pahnila, 2006; Child, 2006), where a factor loading above 0.3 is high and above 0.6 is very high (Burgess, 2006). The 0.3 cut-off variance would validate Factor 4 with ATU{1,2,3,4} and the other three factors would not be affected, shown in Table 7 with light grey shade. For the purposes of research, ATU is loaded as a factor based on its medium variance and this thesis continued with regression analysis of ATU along with the other factors.

4.4 Regression

As previously described in Section 3.9, multi-regression analysis involves the comparison of connections between a dependent variable and two or more independent variables. For example, an EBM trainer's behavioural intention toward using the e-course depends on how much they believe it to help them and their attitude to using the system. Table 8 shows the detail of multiple regression analysis done on the results from the TAM questionnaire. As

shown in the results, all hypotheses are true because the estimated p value is less than 0.05 and the regression coefficient (β) is between 0 and 1. The hypotheses were defined in Section 3.3.1.

Hypotheses	Dependent variables (DV)	Independent variables (IV)	Standardised regression coefficient (β)	Significant level (p value)
H1	Perceived Usefulness (PU)	Perceived Ease Of Use (PEOU)	0.65	0.0001
H2	Attitude Towards Use (ATU)	Perceived Usefulness (PU)	0.77	0.0001
H3	Attitude Towards Use (ATU)	Perceived Ease Of Use (PEOU)	0.68	0.0001
H4	Behaviour Intention (BI)	Attitude Towards Use (ATU)	0.82	0.0001
H5	Behaviour Intention (BI)	Perceived Usefulness (PU)	0.80	0.0001

Table 8: Multiple regression result of Technology Acceptance Model

Figure 35 shows the clear connection between the factors that had been considered in this research project. As shown, the strongest is ATU to BI with 0.82 and the weakest is PEOU to PU with 0.65. This means that the EBM trainer's approach or attitude to using the TTT-EBM e-learning application has the greatest influence on their intention to use the system. In addition, increasing their perception of the system's usefulness for improving their job performance encourages them to use it more compared to how easy they perceive its use.

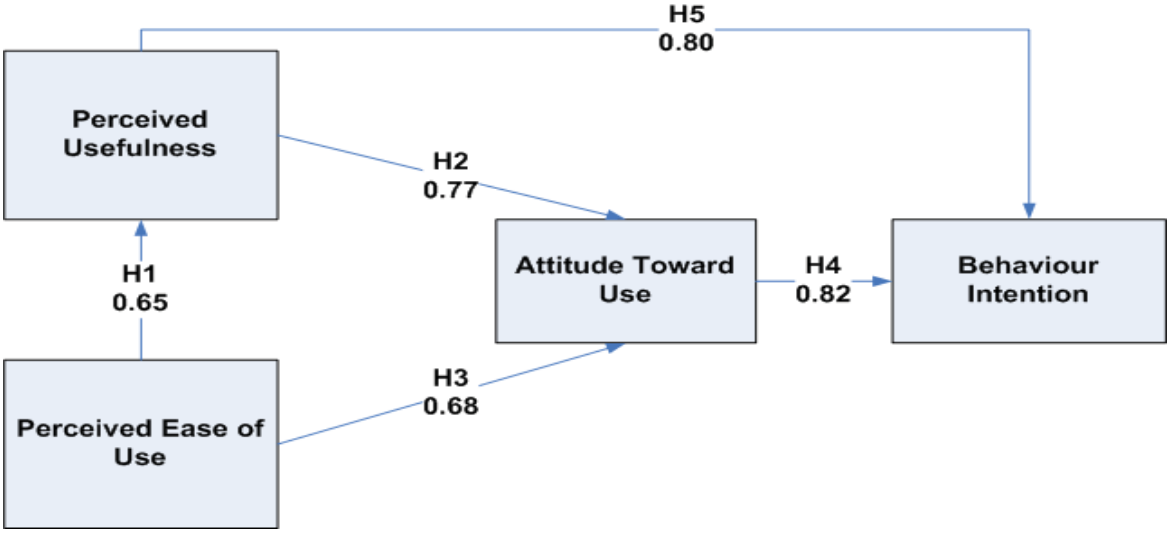

Figure 35: The Technology Acceptance Model shows the weight of each factor on each other with a β coefficient

The test of the regression has resulted in all the hypotheses of Section 3.3.1 being proven as true for EBM trainers using the TTT-EBM e-learning application. The results support the findings of Davis (1986), who originally founded the TAM, by proving the user's PEOU and PU have an influence on the determinants of behavioural intention and PU has a direct effect on the user's intention to use technology. The results of the factor analysis loaded all factors, including ATU as a factor despite needing a lower cut-off variance of 0.3.

The regression results have shown there is a significant link between the EBM trainer's attitude and their behavioural intention to the e-course and their beliefs of its benefits for their work is a moderator of their attitude. Therefore, the results are indicating that the TTT-EBM project should focus on the usefulness of the e-course and place emphasis on motivating and influencing the EBM trainer's attitude to using the application.

4.5 Discussion

This chapter has evaluated the TAM's ability to explain the acceptance of the TTT-EBM e-learning curriculum and blended learning approach based on data collected from 56 clinical

EBM trainers. The reliability analysis of Cronbach's Alpha showed the quality of individual questions and the whole questionnaire. This was a necessary step before applying factor analysis. It proved that the questionnaire is a reliable and valid measurement instrument that other researchers can use as an example in further work.

The overall result supports the findings of Davis (1986), but ATU had a slightly weaker variance than the other factors, which could be due to the sample size. The results of the factor loading in the factor analysis showed ATU accounted for a medium amount of total variance and two of its four loaded components had a medium variance. Masrom (2007) had also identified from factor analysis a weaker connection between ATU and BI, see Section 2.3.2.

This project had a sample size of 56 participants, which is only 6 more than the minimum recommended sample size of 50. Field (2009) defined the acceptable loading level of the factors as being dependent on the sample size. He mentioned that if a study had a sample size of 50 or greater, it would need to have a loading level equal or greater than 0.7. Masrom (2007) commented on a similar topic and declared 0.6 or above as a suitable value for factor loading. This research considered 0.5 and above as an acceptable value of the factor loading, which was based on research from the SPSS guidelines, Chenesy (2006) and Dancey (2002).

As a rule of thumb, the sample size of the TAM questionnaire should be five times the amount of variables (Hatcher, 1994) or a reasonable size related to the research type (Walker & Madden, 2009). In that case, the sample size should have been 100 participants for the TAM questionnaire's 20 items. A greater sample size would have given more results and perhaps a greater variance. Contrary to these sample size guidelines, the results of the Keiser-Meyer-Olkin test gave 0.889, which is indicating a suitable sample size because its value is above 0.5

(Field, 2009). Therefore, it is not certain that the sample size is the main cause for the medium variance of ATU.

A solution to this lower than acceptable variance, is a repetition of the TAM questionnaire's survey with 100 or more participants and recalculation of reliability, factor analysis and reliability for the TAM model. However, this thesis has accepted the medium variation of ATU and loaded it because it is the strongest influence on behavioural intention for EBM trainers using the TTT-EBM e-learning application.

4.6 **Summary**

Overall, the results from the three analyses have explained why EBM trainers use the TTT-EBM e-learning application. It has shown the TAM's ability to demonstrate the user acceptance of the application and found the user's attitude to using the e-course as the most influential factor in determining the EBM trainer's behavioural intention to use the system. Moreover, their perceived usefulness of the system has a strong influence on their behavioural intention to use it as well as it having a strong moderating effect on their attitude to use. The systems ease of use and how beneficial it is to their jobs were found to have a strong influence on their approach to using the system, which supports the findings of Davis (1986) who mentioned that perceived usefulness and perceived ease of use are two important predictors of attitude. The perceived usefulness of the e-course was found to have a slightly greater effect on their attitude compared to how they see it as easy to use. In addition, this study found that when an EBM trainer thinks the e-course is easy to use, they will have greater belief of its usefulness. Overall, it was shown that all the hypotheses were significantly positive

and proven; additionally all of the factors support the TAM in explaining the acceptance of TTT-EBM as an e-learning application for use in a clinical environment.

Included in this chapter was an in-depth discussion over the results to support cut-off values of variance and the relation of the results to the sample size. The next part of this study focuses on barriers that may have an effect on the TTT-EBM project in a clinical environment. It includes the use of a new theoretical model; developed from the TAM, that includes the addition of several key external factors that have been used to predict the TAM's constructs.

5 EXTENDED TAM RESULTS

5.1 Introduction

An Evidence Based Medicine (EBM) trainer is responsible for teaching clinicians how to use EBM on the job. Research has shown the need for greater confidence of EBM trainers in giving training sessions so medical practitioners may use EBM in their clinics. The literature review illustrated the necessity of improving the teaching methods of EBM trainers to get a better performance from medical practitioners. The Teach the Trainers EBM (TTT-EBM) project has attempted to do that with the integration an e-learning platform and training sessions that relate to the real working environment. The EBM trainer should adopt this technology, which this thesis found out how and why they would do that in the last Chapter with the TAM. In this chapter further exploration of user behavioural components of that application is achieved with the evaluation of user technology acceptance using a new research model.

In Section 3.2.2, we have developed the e-TAM model to assess the EBM trainers' technology acceptance of the system. In addition, this thesis has designed a suitable scale to measure the users' answers for questions from a questionnaire, as introduced in Section 3.4.1, so the e-TAM can assess the questionnaire's data. All this methodology and development is with the objective of finding the e-TAM's most influential factor in predicting the EBM trainer's acceptance of the e-course.

This chapter includes an analysis of the results from the external factors of the e-TAM. This study used the e-TAM to find out the effects that the external factors of: Age, Gender, Experience, Education Level, Organisational Structure, Time Constraint, Knowledge Support

and Technology Support have on the adoption of the TTT-EBM e-learning application. Section 2.4 explained in detail these external factors including their grouping. The effects of the external factors can be seen from the relation between them and Perceived Ease of Use (PEOU), Perceived Usefulness (PU), Attitude Toward Use (ATU) and Behavioural Intention (BI), as shown in Figure 28, Section 3.3.2.

This chapter shows results from three analyses: Reliability, testing the consistently of the questionnaire under different scenarios, factor analysis, testing the questionnaire's structure with the e-TAM, and regression analysis involving the linear modelling to fit the individual data with the e-TAM.

5.2 **Reliability**

This thesis introduced the e-TAM questionnaire in Section 3.4.1; this section assesses the e-TAM's reliability. Similar to the methodology of the TAM, in Section 4.2, the initial stage of reliability testing is calculating the average Cronbach's Alpha.

Shown in Table 9, the standardised Cronbach's Alpha resulted in a value of 0.841. This value is high and has a 0.159 difference from 1, which proves that the questionnaire has a high overall reliability, as categorised in Section 3.5.

Number of questions	23
Total Cronbach's Alpha	0.836
Standardised Cronbach's Alpha	0.841

Table 9: Average reliability analysis

Table 10 shows the reliability analysis results for each question, where Section 3.6 explains the columns and method of their analysis. One of the important columns from that table is the "Corrected Item- Total Correlation", which shows the correlation of each question with

the total score from the questionnaire. As shown in Figure 36, some of values in that column are less than 0.3, namely for the factors of Organisational Support{1,2} (OS1, OS2), Knowledge Support{3} (KS3) and Education Level{1,2} (EL1, EL2). In that same column Time Constraint{3} (TC3), Technology Support{1,2} (TS1, TS2) and Education Level{3} (EL3) are also below 0.3; however, after rounding to two significant figures, all apart from TS2 are equal to 0.3. In the column "Cronbach's Alpha if Item Deleted", TC3, TS1, TS2 and EL3 are within acceptable limits; the explanation of the limitation is below.

For reasons of time limitation on the study and since they all passed one criteria, this thesis accepts those four questions and continues the study of these variables with factor and regression analyses. For the other questions, some of their values are very close to the limit of 0.3, which is not ideal, but acceptable.

Question	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Cronbach's Alpha if Item Deleted
OS1	97.50	217.127	0.188	0.475	0.837
OS2	99.30	211.124	0.200	0.584	0.841
TC1	99.87	205.675	0.434	0.683	0.827
TC2	99.71	206.390	0.396	0.557	0.829
TC3	100.93	215.631	0.271	0.689	0.833
TC4	100.96	213.344	0.328	0.736	0.832
KS1	97.52	212.000	0.435	0.521	0.829
KS2	98.52	203.818	0.426	0.577	0.828
KS3	98.14	215.797	0.203	0.428	0.837
TS1	97.89	210.679	0.283	0.633	0.834
TS2	96.95	218.452	0.249	0.439	0.834
TS3	98.30	206.397	0.382	0.633	0.830
Ex1	98.36	200.052	0.549	0.741	0.822
Ex2	97.07	214.468	0.442	0.635	0.829
Ex3	98.04	202.617	0.635	0.713	0.821
Ex4	98.48	195.600	0.734	0.895	0.815
Ex5	98.43	198.140	0.617	0.896	0.819
Ex6	98.80	198.015	0.552	0.884	0.822
Ex7	98.68	195.531	0.646	0.851	0.817
EL1	100.66	214.956	0.235	0.835	0.835
EL2	101.09	210.119	0.462	0.826	0.827
EL3	101.00	213.745	0.269	0.717	0.834
EL4	100.79	215.553	0.184	0.642	0.838

Table 10: Reliability analysis in detail for each question

The next important column to analyse from Table 10 is “Cronbach’s Alpha if Item Deleted”, which shows the reliability of the questionnaire if it were excluded. A good result is one where the reliability is lower than, or approximate to the standardised Cronbach’s Alpha, which if true, is a confirmation that these specific questions are reliable (Field, 2009). As shown in Figure 37 all the components are below the Alpha value with the exception of OS2, which has a value that is equal to the standardised Cronbach’s Alpha, this is considered acceptable as stated in the above explanation.

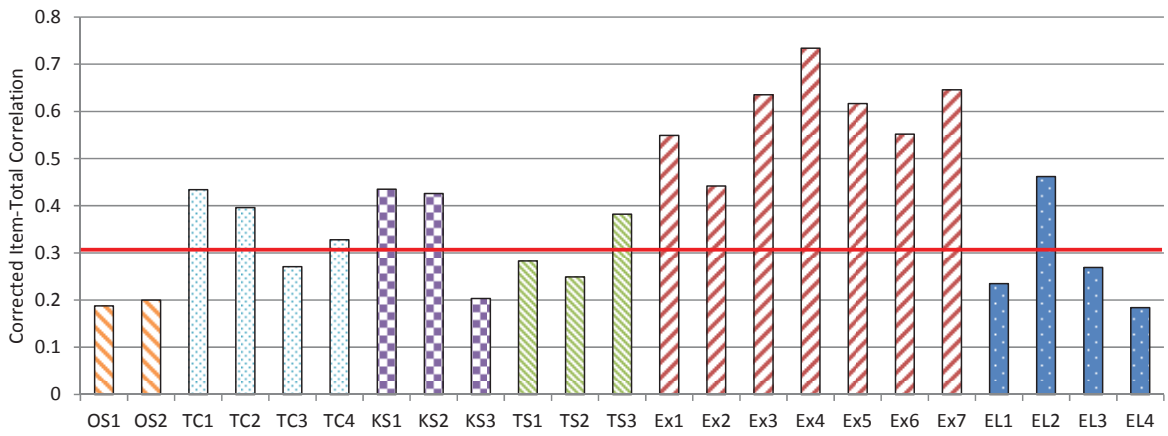

Figure 36: Corrected Item-Total Correlation with red horizontal line showing the minimum recommended values

Two processes can be applied after considering the results from the reliability. To delete the questions that had irregularity in the results, however this would change the value of the total Cronbach's Alpha of the questionnaire. Alternatively, it is possible to continue the project with all questions included, and then to analyse their consequential effect after factor analysis. There is still an opportunity with the second process to reiterate the reliability of the questionnaire. This should be done if the results from the factor analysis are unacceptable. This thesis used the second process because of the apparent high average Cronbach's Alpha.

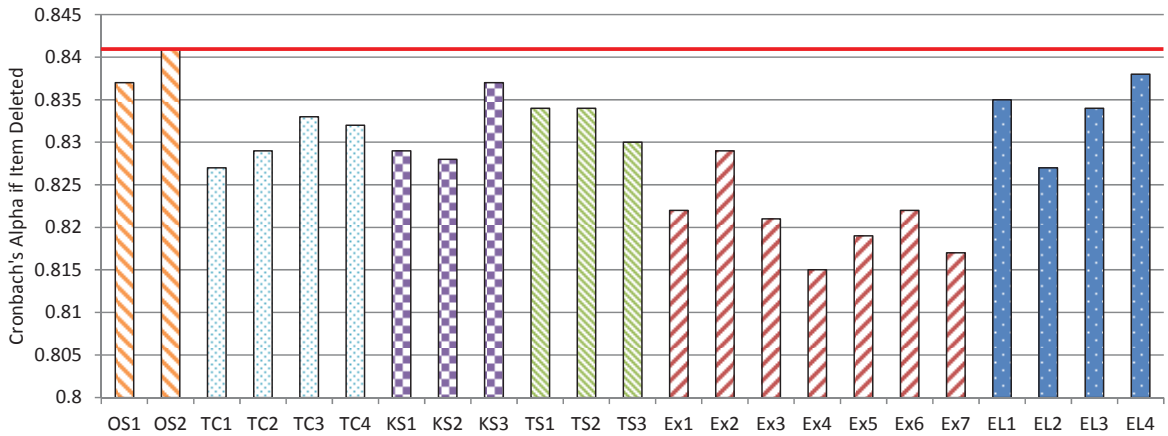

Figure 37: Cronbach's Alpha if Item Deleted with red horizontal line showing the standardised Cronbach's alpha

The results clearly show that Experience is the most reliable construct in the e-TAM questionnaire, where all are measuring the same construct from the EBM trainers. The next step is to use factor analysis to show the number of factors that can fit constructs of the questionnaire and then to examine their connection with their related components. There also is a way to prove the design of the e-TAM and the questionnaire by supporting the factors that were chosen in the model and the components that were chosen for them.

5.3 Factor analysis

The simplest meaning of factor analysis is; "a multivariate analysis technique to find out the correlation between the observed variables and latent variables" (Field, 2009), Section 3.7 has more detail on the methodology of factor analysis. This section describes the validation method of the constructs of the e-TAM model's factors that gave a designation to each question of the questionnaire from Oude Rengerink (2011).

Based on SPSS guidelines, Chenesy (2006) and Dancey (2002), this thesis considers 0.5 and above as an acceptable level of variance in the factor loading. Table 11 shows the variance of each component in the factors. Factors 1 to 4, which are Experience (Ex), Education Level (EL), Technology Support (TS) and Time Constraint (TC) respectively, are valid because of the high variance in their components. However, Factors 5 and 6, being Organisational Support (OS) and Knowledge Support (KS) respectively, are invalid. Section 5.5 discusses the reasons for their invalidity with consideration to the sample size. As previously discussed in Chapter 2, it is not possible to have a factor with fewer than three components hence, the factor of Organisational Structure is impossible to validate.

Question	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5	Factor 6
Ex6	0.904	0.061	0.029	-0.036	-0.074	0.031
Ex5	0.893	0.089	0.058	0.032	-0.029	-0.010
Ex7	0.869	0.016	0.182	0.016	-0.007	0.164
Ex4	0.863	0.084	0.211	0.123	0.101	0.019
Ex3	0.813	0.044	0.169	0.058	0.054	0.002
Ex1	0.757	-0.050	0.021	0.186	0.159	-0.043
OS1	0.400	-0.185	-0.053	0.130	-0.169	0.248
EL2	0.232	0.842	0.066	0.067	-0.015	0.008
EL1	0.015	0.835	-0.063	-0.066	0.169	0.106
EL3	-0.021	0.793	-0.007	0.118	0.000	0.100
EL4	-0.066	0.624	0.052	0.146	-0.051	-0.103
TS1	-0.052	-0.004	0.733	0.148	-0.088	0.415
TS3	0.046	0.002	0.614	0.192	0.239	0.007
Ex2	0.440	-0.074	0.556	-0.063	0.170	-0.347
KS2	0.104	0.088	0.515	0.230	0.356	-0.057
TS2	0.207	0.047	0.509	-0.166	-0.181	0.059
KS1	0.278	-0.051	0.361	0.129	0.250	0.133
TC1	0.188	-0.085	0.179	0.737	0.114	0.118
TC4	0.005	0.424	0.051	0.720	-0.166	-0.122
TC2	0.199	-0.019	0.206	0.616	0.118	-0.204
TC3	-0.030	0.379	-0.123	0.606	0.068	0.023
OS2	0.012	0.051	0.132	0.061	0.848	0.054
KS3	0.137	0.087	0.165	-0.131	0.095	0.621
Percentage Variance	21.7%	12.4%	9.3%	9.2%	5.3%	3.9%

Table 11: Factor loading with draw-out variables (dark grey shade)

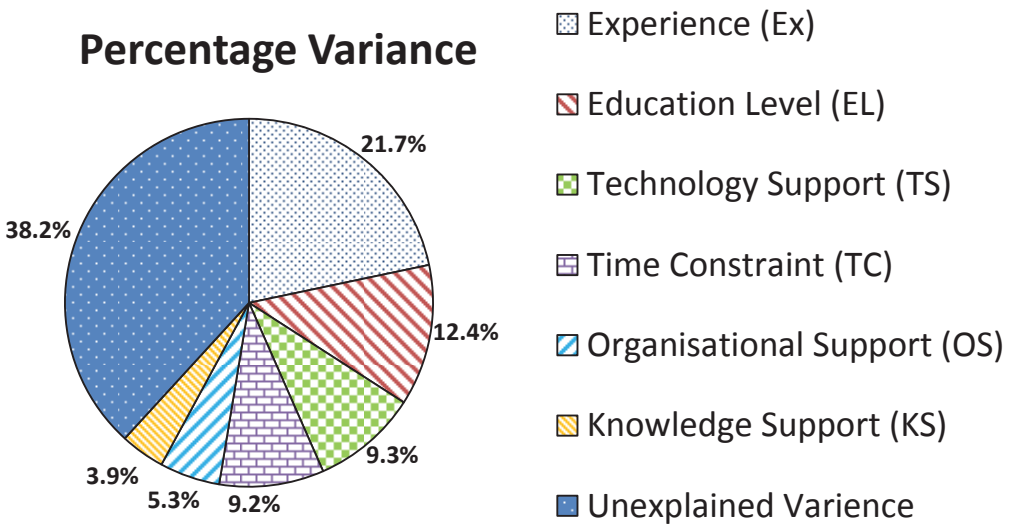

Figure 38: Percentage of variance explained

The factor analysis has shown that four out of six factors of the e-TAM are valid and have a high variance in their components. As shown in Figure 38, the factor with the highest variance is Experience that accounts for over a fifth of the total variance, which is significantly higher than all other factors. In order of decreasing percentage variance Education Level, Technology Support and Time Constraint all have medium explained variances. Altogether, the four factors cover 52.5% of the total variance explained.

Overall, Experience is the most reliable and the factor with the greatest explained variance. Depending on the results of the regression analysis, Experience could be found as the most influential factor. The next step is the regression analysis that attempts to fit the e-TAM with the data, which is a combination of independent and dependents variables.

5.4 Regression

As previously described in Section 3.9, multi-regression analysis involves the study of statistical correlation between dependent variables and one or more independent variables. This study has carried out a regression analysis to highlight the most influential factor of an

EBM trainer's approach to using the TTT-EBM e-course's application. This has created cross-comparable results of factors in the e-TAM model for the e-course and resulted in finding the strongest behavioural construct of the model.

Hypotheses	Dependent variables (DV)	Independent variables (IV)	Standardised regression coefficient (β)	Significant level
H1	Perceived Usefulness (PU)	Experience (Ex)	0.73	**P<0.001**
H2	Perceived Usefulness (PU)	Education Level (EL)	0.24	**P<0.01**
H3	Perceived Ease Of Use (PEOU)	Experience (Ex)	0.70	**P<0.001**
H4	Perceived Ease Of Use (PEOU)	Education Level (EL)	0.29	**P<0.05**
H5	Perceived Usefulness (PU)	Organisational Structure (OS)	0.56	**P<0.001**
H6	Perceived Usefulness (PU)	Time Constrain (TC)	0.37	**P<0.05**
H7	Perceived Ease Of Use (PEOU)	Organisational Structure (OS)	0.60	**P<0.001**
H8	Perceived Ease Of Use (PEOU)	Time Constrain (TC)	0.36	**P<0.05**
H9	Perceived Usefulness (PU)	Knowledge Support (KS)	0.82	**P<0.001**
H10	Perceived Usefulness (PU)	Technology Support (TS)	0.14	**Not significant**
H11	Perceived Ease Of Use (PEOU)	Knowledge Support (KS)	0.49	**P<0.01**
H12	Perceived Ease Of Use (PEOU)	Technology Support (TS)	0.48	**P<0.01**
H13	Behaviour Intention (BI)	Experience (Ex)	0.81	**P<0.001**
H14	Attitude Towards Use (ATU)	Experience (Ex)	0.81	**P<0.001**
H15	Attitude Towards Use (ATU)	Education Level (EL)	0.17	**Not significant**
H16	Behaviour Intention (BI)	Education Level (EL)	0.15	**Not significant**

Table 12: Regression result of e-TAM

The result of the external factors, after careful deliberation and taking into account the result of the hypothesis test, are shown in Table 12 and Figure 39. These are summarised based on

the conditional level of the standardised regression coefficient (β) that should be higher than 0.5, and significance level to indicate the most important predictors for the TTT-EBM e-learning project. As shown, most of the 16 hypotheses are statistically true since the value of P is less than or equal to 0.05 and regression coefficient (β) is between 0 and 1. The hypotheses were defined in Section 3.3.2.

- Statistically true hypotheses include: H1, H2, H3, H4, H5, H6, H7, H8, H9, H11, H12, H13 and H14

Some of the hypotheses were found to have a weaker significance level than the other factors. These hypotheses had an insignificant influence in the model and are of low consideration for the EBM trainers:

- Statistically insignificant hypotheses include: H10, H15 and H16

Shown in Section 5.3 was the factor analysis, which did not support hypotheses H5, H7, H9, and H11; Section 5.5 discusses the reasoning behind this in more detail. The result of the factor analysis of those unsupported factors shows they are uncorrelated with PU and PEOU. Even though the Knowledge Support had the most significant effect on PU as well as overall in the model, it was not loaded as a factor. Therefore, it has no effect on PU or PEOU, also Organisational Structure has no effect on PU or PEOU, which is shown in Figure 39 with dashed lines. As a result, Experience becomes the most significant predictor of EBM trainers' behavioural intentions overall in the model and for each factor.

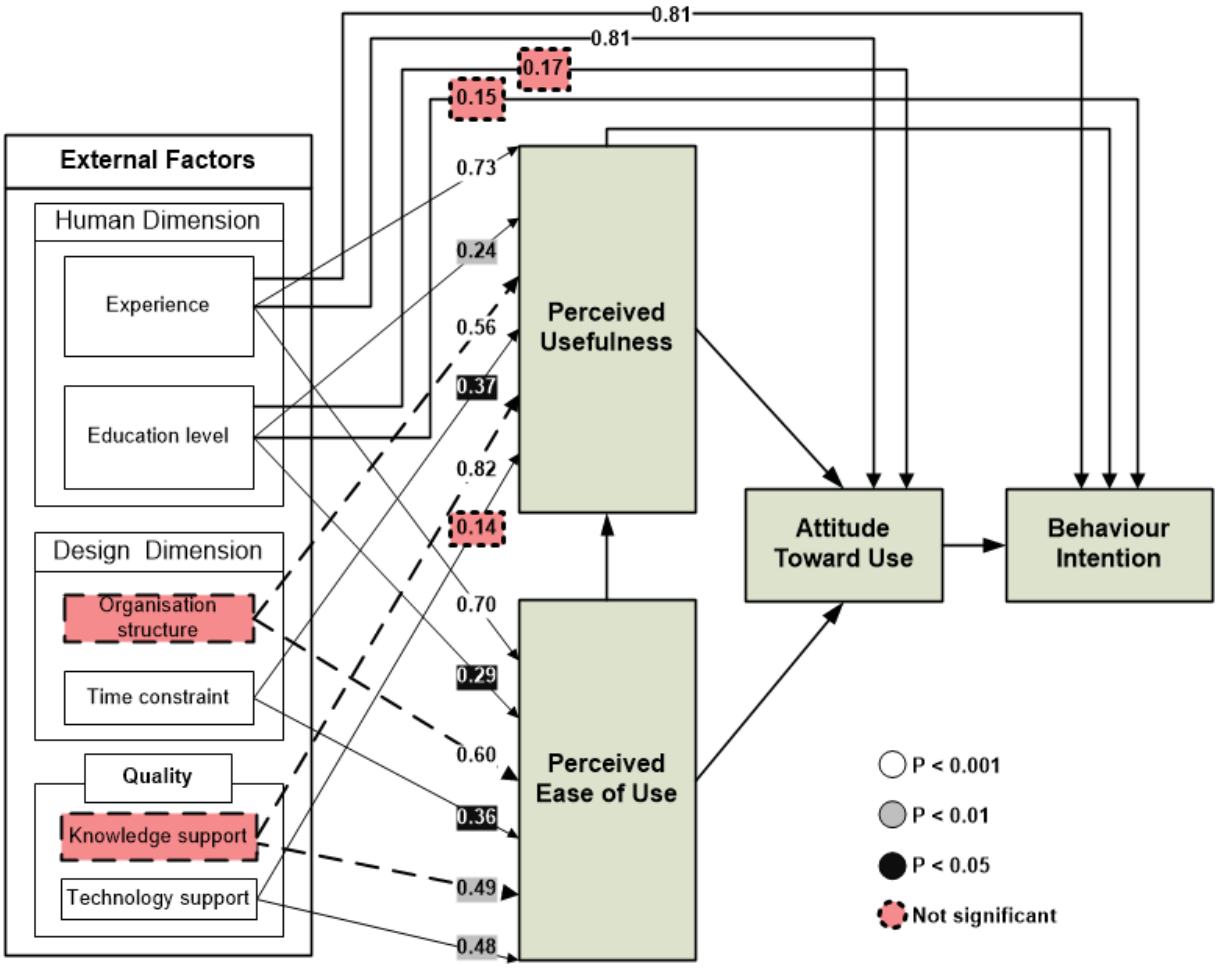

Figure 39: The e-TAM shows the weight of each factor on the other one with β coefficient.

5.5 Discussion

The e-TAM's ability to predict users' adoption of the TTT-EBM e-learning system was assessed using the three analyses of reliability, factor and regression. However, these analyses came across some unacceptable results, which limit the explained variance of some of the external factors. In this section, there is a deduction of five limitations, it then concludes with a final discussion of the results.

The initial limitation of the results was the sample size. The sample size is one of the parameters that potentially affected the correlation of the variables, as mentioned in Section 4.5. This limitation influences the reliability of the results and causes an assumption

of an uncertainty of the quality of the TTT-EBM e-learning curriculum's questionnaire from Oude Rengerink (2011).

The second limitation encountered, which is apparent in the reliability analysis, could be related to the case of the sample size. The factor analysis identified questions OS1, OS2, KS3, EL1 and EL2 as unreliable. Those questions had a bad correlation with the total score of the questionnaire. There is a significant point needing consideration regarding their reliability. These factors might have had a different reliability if the sample size were larger as discussed in Section 4.5 regarding the TAM questionnaire.

The third apparent limitation occurred in the factor analysis, since the analysis found some factors as invalid. The sample size could be the causality of this limitation because Organisational Structure and Knowledge Support had a medium to strong significance in the regression analysis, but did not load as factors. Organisational Structure had another limitation, as only having two relevant questions designated that are not enough to load it (Hinton, et al., 2004; Sapsford, et al., 2006; Kinnear & Gray, 2008; Field, 2009). There are three ways to deal with this: go back to the questionnaire and eliminate the specific questions with the limitation; increase the sample size; or continue based on there being no opportunity to reiterate the process. This study continued without reiteration because of the limitation of time in the project, although, it may be interesting as further work. The red dashed-line boxes and the dashed-line hypotheses in Figure 40 shows the areas affected by those limitations.

The fourth limitation occurred in the regression analysis, which gave an insignificant proof of hypotheses H10, H15 and H16. There are two reasons for this: The sample size might have had an effect on the results of the regression analysis. The second considers the user of the system

as the cause. The results of the regression analysis prove that Education Level for EBM trainers has a comparatively small effect in comparison with the other validated factors. In addition, the users found Technology Support as an insignificant factor to improve their jobs. These limitations are shown in red dashed-line boxes and the dashed-line hypotheses in Figure 40.

The fifth limitation, apparent in the design of the e-TAM, was the factors of Age and Gender. As discussed in Section 2.4 and 3.2.2, Age and Gender are important factors in e-learning, but because of the small sample size of this thesis, they were excluded from the design. To involve these two factors, it would be necessary to divide the sample size of Gender and Age analysis into different categories; however, this is unreasonable with a small sample size of 56.

Similar to the previous discussion in Section 4.5, the limitations associated with the questionnaire chosen from Oude Rengerink (2011) for the e-TAM are most likely linked to the sample size. As previously mentioned, other researchers had found that the sample size has a coherent effect on the mean and correlation coefficient. Presumably if the sample size were increased then the limitations would no longer be apparent, but to quantify the difference requires further work.

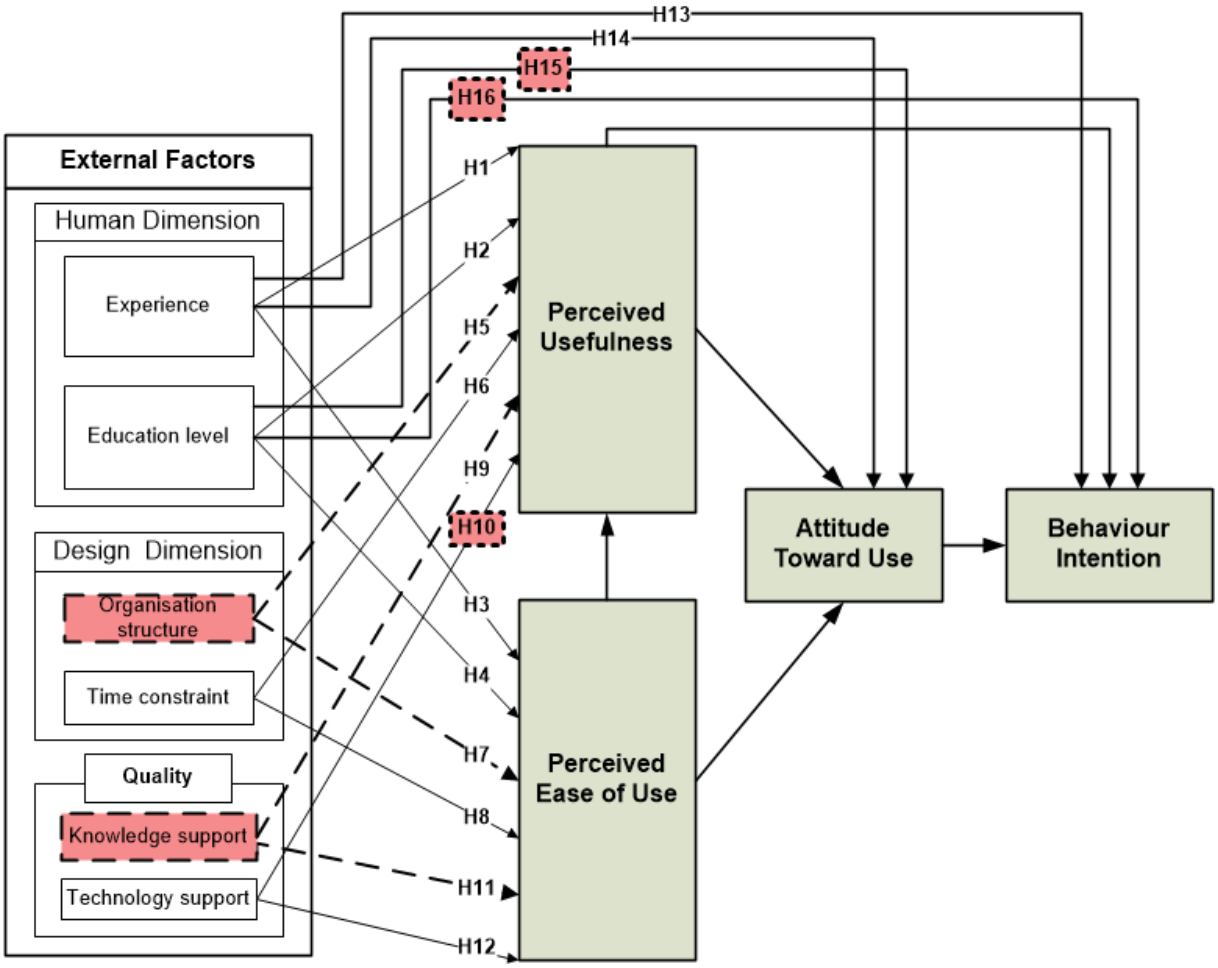

Figure 40: Showing the limitations with factors and hypotheses in red dashed-line boxes and with dashed-lines

The comparison of results from reliability, factor analysis and regression analysis showed that Experience is the most significant factor for adoption of the e-learning application. Figure 41 shows that Experience has an influence on the BI and ATU with exactly the same significant level of $P<0.0001$. Experience, with lesser magnitude of β, also has an influence on PU and PEOU. The level of influence between these two has a slight difference, however they both have the same significance level of $P<0.0001$. Figure 42 and Figure 43 show the influences the external factors have on PU and PEOU respectively.

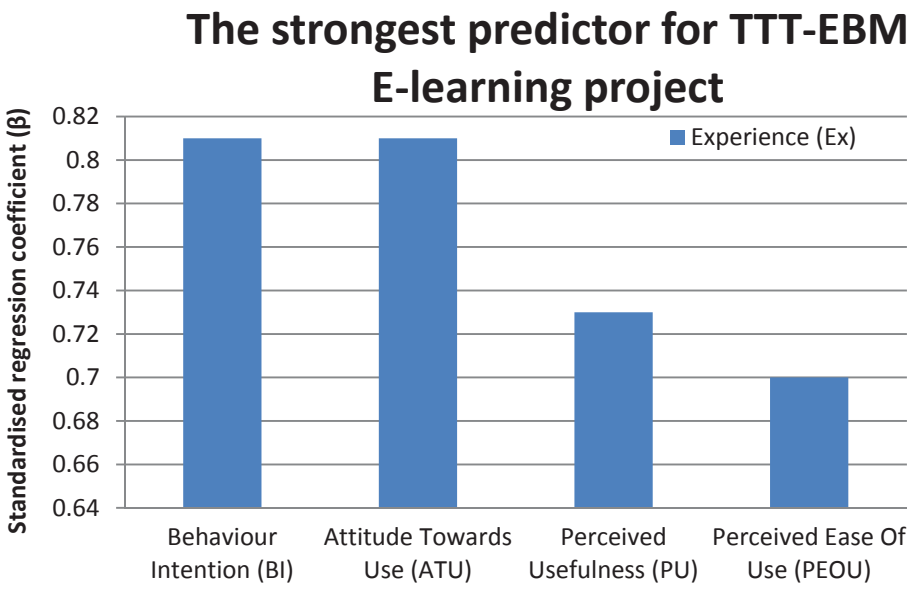

Figure 41: The results of Experience as the strongest predictor for TTT-EBM e-learning project

As mentioned in Section 5.1, this e-TAM model was designed specifically to draw out the important barriers for the adoption of the TTT-EBM e-learning application in clinical environments. The results and analysis of the e-TAM model has provided useful information on how the TTT-EBM project may improve. These results mean an improvement in an EBM trainer's ability and expertise of e-learning, EBM training systems or similar e-courses will increase their motivation and encourage their approach to using the e-course on the job.

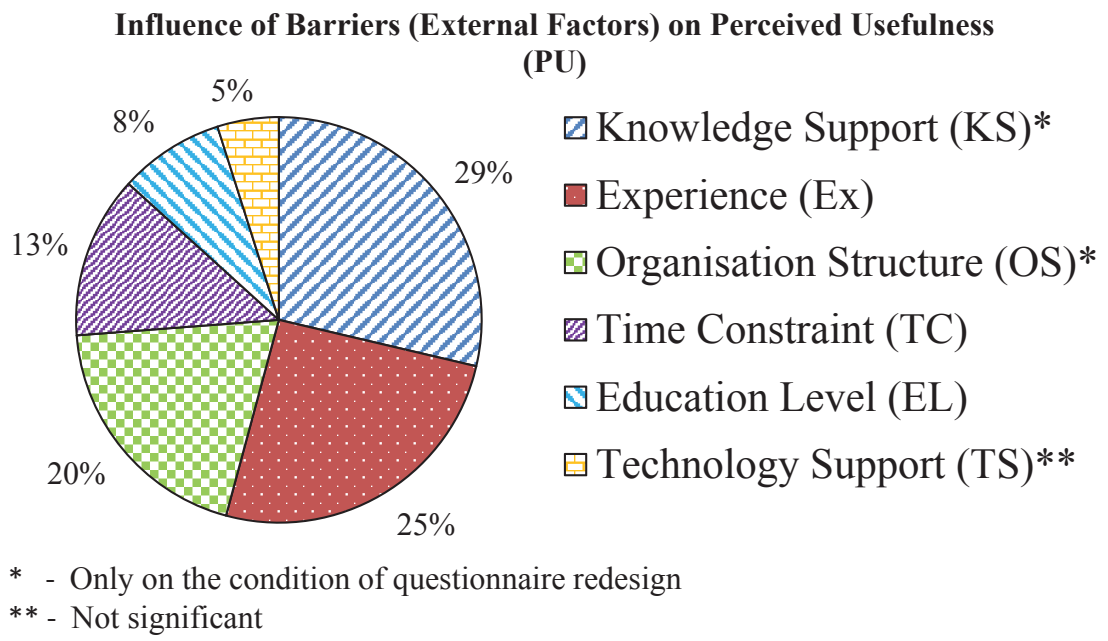

Figure 42: The demonstration of the relations and influence of external factors on perceived usefulness

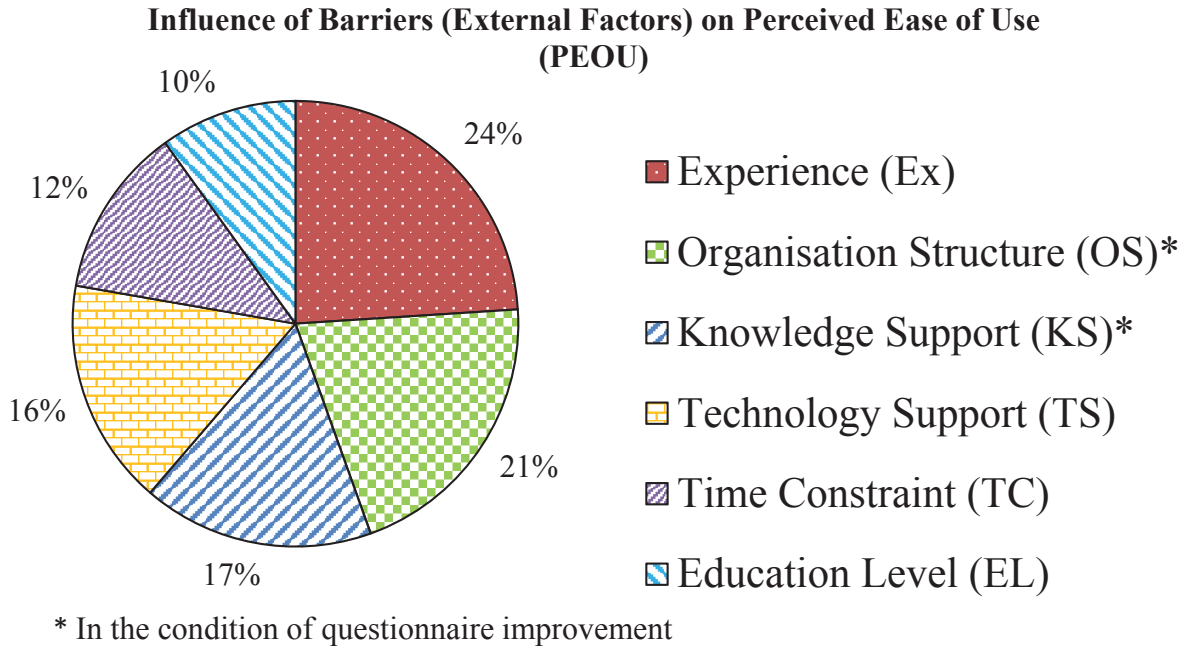

Figure 43: The demonstration of the relations and influence of external factors on perceived ease of use

5.6 **Summary**

This section has shown the steps required to calculate and analyse the results of the e-TAM model for the TTT-EBM project, which is the first e-learning course for teaching the trainers of EBM in medical practices or general clinical environments.

The results show the factor of Experience as the strongest predictor for a high level of user acceptance of this project. This factor has an impact on PU, PEOU, ATU and BI. From the results, there was a test of its reliability, which showed the amount of stability or confidence by calculating a Cronbach's Alpha coefficient and comparing the values of the questionnaire with a 0.3 or less cut-off point. The Cronbach's coefficient was high and indicated a good reliability overall, however some questions in the questionnaire were below the threshold. After that, this study used factor analysis to evaluate the correlation and variance of the external factors, which was done with a 0.5 or less cut-off point. Some of the factors were below the threshold and did not validate, which was explained to be related to the sample size. The final test was of regression analysis that involved a comparison of a dependent variable with one or more independent variables. The condition needs the significance level, P, to be less than 0.05 and the correlation coefficient (β) between 0 and 1. All apart from a few of the hypotheses met these conditions and were classified as statistically true. The questionnaire had a few limitations as the sample size was close to the recommended minimum, but overall was regarded as having good results of reliability, factor analysis and regression analysis.

The next chapter includes information relating to the possible further work from this thesis for researchers in a similar field of study.

6 CONCLUSION AND FURTHER WORK

The user acceptance of the TTT-EBM e-learning application project was assessed using a developed theoretical model, the e-TAM, which resulted in discovering that a user's experience is the most influential external factor to the user's perceived usefulness (PU), ease of use (PEOU), attitude toward use (ATU) and behavioural intention (BI) of the system. From the e-TAM the four factors of Experience, Education Level, Technology Support and Time Constraint explain 52.5% of the variance of a user's behavioural intention to work with the e-course, with Experience being the strongest predictor by explaining over a fifth of the total explained variance in user acceptance of the blended learning approach. This result means the greater amount of time EBM trainers spend interacting with the e-course's application, the more they accept it and the greater their motivation, ability and behavioural intention toward using the TTT-EBM e-learning application. The overall results of this study show the important user constructs to consider when developing online or computer-based learning systems.

This thesis also assessed the TAM's predictive ability of the user acceptance of the TTT-EBM e-learning application. The results from that analysis showed the users' ATU and PU of the system are the most influential factors of the TAM for a user's behavioural intention to use the e-learning system. ATU had the best predictive power overall but had the least explained variance, so PU was also selected based on it having the second strongest predictive power and the highest variance. This means that the user will most likely use the TTT-EBM e-learning application because of their positive belief to using it and its ability to help them in their work activity.

This thesis has assessed the applicability of the TAM and e-TAM by using statistical analysis techniques, namely reliability, factor analysis and regression, on results from questionnaires of the TTT-EBM e-learning curriculum. The techniques used in the analyses were derived from research involved with the statistical analysis of results in social sciences, where they have been acclaimed as useful analysis tools in assessing reliability, validation, factor analysis and regression analysis - see Chapter 3.

The e-TAM was developed from the TAM after a critical analysis of external factors that have been used by other researchers to assess the user acceptance of technology or their behavioural intention when using systems such as e-learning, EBM and other healthcare systems, see Section 2.4. These chosen external factors were grouped into human dimension, design dimension and quality, as explained in Section 3.2.2. This thesis gave each factor a direct hypothesis with the PEOU and PU factors of the TAM, where only the factors from the human dimension were given two additional hypothetical links each with ATU and BI. The work of this thesis, in developing and testing a model based on the TAM, resulted in a new validated model called the e-TAM. The e-TAM is able to assess systematically the user acceptance of technology in the context of the TTT-EBM e-course, but this statement is only valid considering the limitations from the results of the questionnaire analysis.

6.1 Proposed developments for TTT-EBM e-course

This study has emphasised the importance of improving the TTT-EBM e-course with involvement of Experience, ATU and PU of the system for EBM trainers to have a greater acceptance of the technology. The TTT-EBM project should design the e-course in a way that is suitable for the user's initial or assumed experience and focus on improving their experience

as the course progresses. This could be done is many ways such as making the interactions with the application similar to their everyday activities. Moreover, the TTT-EBM e-learning application may benefit from implementing a feedback mechanism in the system, which allows system improvement to support the variation of experiences among users.

6.2 Opportunities presented for new research

Other user-based projects may apply the findings of this thesis by focusing the design of their system to bring the user from the expected experience to a higher level of experience by decreasing the time it takes for a user to gain relevant experience. The e-TAM should be able to examine other e-learning systems, online learning applications and computer-based learning technologies. Further developments with the e-TAM could lead to its greater validity and predictive-power of a user's behavioural intention.

Technology acceptance modelling developers should weigh the factor of Education and its effect as a determinant of Experience because a user's aptitude, intelligence or knowledge may determine how quick a user gains experience with the system. However, this would also require a validated measurement of the user's intelligence rating (IQ) to see the influence of Education Level on Experience.

6.3 Considered further work for this study

The results of the analyses had limitations as some factors had a less than acceptable variance in their factor loading, their level of significance was below the threshold or their level of correlation was below the acceptable value. There were several limitations in the results of the analysis of the TAM questionnaire and the questionnaire from Oude Rengerink (2011),

which was chosen for the e-TAM. This thesis explained the limitations resulting from a relatively low sample size.

For further work, researchers could design new questionnaires in accordance with the TTT-EBM curriculum, the determinants of the TAM and external factors of the e-TAM. After, it would need to be completed by a larger sample size, where 100 has been recommended in Section 4.5 and 5.5. Alternatively, the same questionnaire could be used to gather results from more participants and the results added to the 56 participants who have already answered the questions to amount to the required sample size. This, after analysis, would allow a validation of the results with this study and clarify the sample size as the cause of the limitations.

On the other hand, the same questionnaires used in this thesis could be analysed using a different analysis technique to validate the results and to determine the root cause of the limitations. One example of a technique is using Structural Equation Modelling (SEM), which is different in the methodology of factor analysis. SEM uses confirmatory factor analysis, which is a statistical technique used to detect the structure of factors by considering their components (Suhr, 2006). Results from SEM would allow validation of this study's results.

The three methodologies stated above for validating the results of this study would provide further explanation of the limitations apparent in this study. This study leaves those methods as further work however, and assumes the sample size as the root cause based on similar findings of other literature such as Hinton, et al. (2004) and Field (2009). Apart from the apparent limitations, the analysis of the results contributed to similar research with TAM, and this study showed that e-TAM is a strong model in assessing the user adoption of technology.

7 REFERENCES

Abu-Shanab, E. A., 2011. *Education level as a technology adoption moderator.* Shanghai, IEEE Xplore Digital Library, pp. 324 - 328.

Ackoff, R. L., 1960. Unsuccessful Case Studies and Why. *Operation Research,* 8(2), pp. 259-263.

Ackoff, R. L., 1967. Management Misinformation Systems. *ManageInent Science,* 14(4), pp. B147-B156.

Ajzen, I., 1985. From intentions to actions: A theory of planned behavior. In: J. Kuhl & J. Beckmann, eds. *Action-control: From cognition to behavior.* Berlin, Heidelberg, New York, Tokyo: Springer-Verlag, pp. 11- 39.

Ajzen, I., 1991. The theory of planned behavior. *Organizational Behavior and Human Decision Processes,* 50(2), pp. 179-211.

Ajzen, I. & Cote, N. G., 2008. Attitudes and the prediction of behavior. In: W. D. Crano, R. Prislin, A. W. Kruglanski & J. P. Forgas, eds. *Attitudes and attitude change.* New York, NY: Psychology Press, pp. 289-311.

Ajzen, I. & Fishbein, M., 1980. *Understanding attitudes and predicting social behavior.* Englewood Cliffs: NJ, Prentice-Hall.

Ajzen, I. & Madden, T. J., 1986. Prediction of Goal-Directed Behavior: Attitudes, Intentions ,and Perceived Behavioral Control. *JOURNAL OF EXPERIMENTAL SOCIAL PSYCHOLOGY,* Volume 22, pp. 453-474.

Anon., n.d.

Arbaugh, J. B., 2004. Learning to learn online: A study of perceptual changes between multiple online course experiences. Volume 7, pp. 169-182.

Arbaugh, J. B. & Duray, R., 2002. Technological and structural characteristics, student learning and satisfaction with web-based courses: An exploratory study of two MBA programs. *Management Learning,* Issue 33, pp. 231-247.

Argyris, C., 1971. Management Information Systems: The Challenge to Rationality and Emotionality. Volume 17(6), pp. B275-B292.

Bagozzi, R. P., Davis, F. D. & Warshaw, P. R., 1992. Development and test of a theory of technological learning and usage. *Human Relations,* 45(7), pp. 659-686 .

Bailey, J. E. & Pearson, S. W., 1983. Development of a Tool For Measuring and Analyzing Computer User Satisfaction. *Management Science,* 29(5), pp. 530-545.

Bandura, A., 1986. *Social foundations of thought and action: A social cognitive theory.* Englewood Cliffs, NJ: Prentice-Hall .

BMJ Publishing, G. L., 2009. *Evidence-Based Medicine for Primary Care and Internal Medicine.* [Online] Available at: http://ebm.bmj.com/ [Accessed 10 May 2009].

Broderick, M. & Smaltz, D. H., 2003. E-Health Defined. *White Paper (Editorial and Research Team of E-Health SIG),* Volume 1, pp. 1 - 23.

Burgess, C., 2006. *Continuing Professional Development: Introduction to Research Statistics.* [Online] Available at: http://people.exeter.ac.uk/cnwburge/pages/CPD/cpdfactoranalysis.doc [Accessed 22 Feb 2009].

Byrne, B. M., 2010. *Structural Equation Modeling with AMOS basic concepts, applications, and programming.* 2nd ed. United States of America: Routledge Taylor & Francis Group.

Chang, P. V., 2004. The Validity of an Extended Technology Acceptance Model (TAM) for Predicting Intranet/Portal Usage.

Chau, P. Y. K., 1996. An empirical assessment of a modified technology acceptance model. Volume 13(2), p. 185–204.

Chau, P. Y. K. & Hu, P. J.-H., 2001. Information technology acceptance by individual professionals: a model comparison approach. *Decision Sciences ,* 32(4), p. 699–719.

Chau, P. Y. K. & Hu, P. J.-H., 2002. Investigating healthcare professionals' decisions to accept telemedicine technology: an empirical test of competing theories. *Information and Management,* 39(4), pp. 297-311.

Chesney, T., 2006. *An Acceptance Model for Useful and Fun.* Nottingham: Human Technology.

Child, D., 2006. *The Essentials of Factor Analysis.* 3rd ed. Leeds, UK: Continuum International Publishing Group.

Cohen, J., 1988. *Statistical power analysis for the behavioral sciences, 2nd edition.* Hillsdale: Lawrence Erlbaum.

Compeau, D. R. & Higgins, C. A., 1995. Computer self-efficacy: Development of a measure and initial test. *MIS Quarterly,* 19(2), p. 189–211.

Coomarasamy, A. & Khan, K. S., 2004. What is the evidence that postgraduate teaching in evidence based medicine changes anything? A systematic review. *BMJ: British Medical Journal,* 329(7473), pp. 1017-1019 .

Coppus, S. F. et al., 2007. A clinically integrated curriculum in Evidence-based Medicine for just-in-time learning through on-the-job training: The EU-EBM project. *BMC Medical Education ,* Volume 7, p. 47.

Cortina, J. M., 1993. What Is Coefficient Alpha? An Examination of Theory and Applications. *Journal of Applied Psychology,* 78(1), pp. 98-104.

Dancey, C. P. & Reidy, J., 2002. *Statistics Without Math for Psychology.* 2nd Edition ed. Harlow: Prentice Hall.

Davis, F. D., 1986. *A Technology Acceptance Model For Empirically Testing New End-User Information System: Theory and Results,* s.l.: Wayne State University.

Davis, F. D., 1989. Perceived usefulness, perceived ease of use, and user acceptance of information technology. 13(3), pp. 319-339.

Davis, F. D., 1993. User Acceptance Of Information Technology: System Characteristics, User Perceptions And Behavioral Impacts. *International Journal of Man-Machine Studies,* 38(3), pp. 415 - 428.

Davis, F. D., Bagozzi, R. P. & Warshaw, P. R., 1989. User acceptance of computer technology: a comparison of two theoretical models. *Management Science,* 35(8), pp. 982 - 1003.

Davis, G. B., 1974. *Management information systems : conceptual foundations, structure, and development.* New York: McGraw-Hill.

Davis, J. et al., 2007. Computer-based teaching is as good as face to face lecture-based teaching of evidence based medicine: a randomised controlled trial. *BMC Medical Education,* Volume 7, pp. 23-29.

Davis, J. et al., 2008. Computer-based teaching is as good as face to face lecture-based teaching of evidence based medicine: a randomised controlled trial. *Medical Teacher,* 30(3), pp. 302-307.

Dawes, J., 2008. Do Data Characteristics Change According to the number of scale points used? An experiment using 5-point, 7-point and 10-point scales. *International Journal of Market Research,* 50(1), pp. 61 - 77.

Dawes, M. et al., 2005. Sicily statement on evidence-based practice. *BMC Medical Education,* 5(1), pp. 1-7.

DeCoster, J., 2000. *Scale Construction Notes.* [Online] Available at: http://www.stat-help.com/notes.html [Accessed 2009].

Del Mar, C., Glasziou, P. & Mayer, D., 2004. Teaching evidence based medicine should be integrated into current clinical scenarios. *BMJ: British Medical Journal,* 329(7473), pp. 989-990 .

Diem, K. G., 2004. A Step-by-Step Guide to Developing Effective Questionnaires and Survey Procedures for Program Evaluation & Research. *RUTGERS COOPERATIVE RESEARCH & EXTENSION: Fact Sheet,* Volume FS995, pp. 1 - 6.

Dyer, C., 1995. *Beginning research in psychology: a practical guide to research methods and statistics.* s.l.:Blackwell.

Dyer, C., 2006. *Research in psychology: a practical guide to methods and statistics.* 1 ed. Malden, USA; Oxford, UK; Victoria, Australia: Blackwell Publishing.

EU-EBM, 2008. *Evidence Based Medicine Teaching the Trainers.* [Online] Available at: http://www.ebm-unity.org/ [Accessed 1 5 2009].

Eysenbach, G., 2001. What is e-health?. *Journal of Medical Internet Research,* 3(2), p. e20.

Field, A., 2009. *Discovering Statistics Using SPSS.* London: SAGE Publication Ltd.

Field, A., 2009. *Discovering Statistics Using SPSS, 3rd Ed.* London, California, New Delhi, Singapore: SAGE.

Fishbein, M. & Ajzen, I., 1975. *Belief, Attitude, Intention and Behavior: An Introduction to Theory and Research.* Reading, MA: Addison-Wesley.

Folorunso, O. & Ogunseye, S. O., 2008. Applying an enhanced technology acceptance model to knowledge management in agricultural extension services. Volume 7, pp. 31-45.

Gefen, D. & Straub, D. W., 1997. Gender differences in the perception and use of e-mail: an extension to the technology acceptance model. *MIS Quarterly,* 21(4), pp. 389-400.

Ginzberg, M. J., 1981. Early Diagnosis of MIS Implementation Failure: Promising Results and Unanswered Question. Volume 27(4), p. 459.

Goetzinger, L., Park, J., Lee, Y. J. & Rick, W., 2007. Value-driven consumer e-health information search behaviour. *International Journal of Pharmaceutical and Healthcare Marketing,* 1(2), p. 18.

Guilford, J. P., Christensen, P. R., Bond, N. A. J. & Sutton, M. A., 1954. A factor analysis study of human interests. *Psychological Monographs,* Volume 68(4), p. 38.

Hatala, R., Keitz, S. A., Wilson, M. C. & Guyatt, G., 2006. Beyond journal clubs. Moving toward an integrated evidence-based medicine curriculum. *J Gen Intern Med,* 21(5), p. 538–541.

Hatcher, L., 1994. *A Step-By-Step Approach to Using the Sas System for Factor Analysis and Structural Equation Modeling.* s.l.:SAS Institute.

Hinton, P. R., Brownlow, C., McMurray, I. & Cozens, B., 2004. *SPSS Explained.* East Sussex, UK: Taylor & Francis Ltd.

Hinton, P. R., Brownlow, C., McMurray, I. & Cozens, B., 2004. *Statistics explained, 2nd ed..* London and New York: Routledge.

Hofmann, D. W., 2002. Internet-based distance learning in higher education. Volume 62(1), p. 28–32.

Holden, R. J. & Karsh, B.-t., 2010. The Technology Acceptance Model: Its Past and its Future in Health Care. *J Biomed Inform,* 43(1)(159), p. 14.

IEEE, 2009. *IEEE Learning Technology Standards Committee IEEE LTSC Glossary.* [Online] Available at: http://ltsc.ieee.org

Igbaria, M., Zinatelli, P., Cragg, N. & Cavaye, L. M., 1997. Personal computing acceptance factors in small firms: a. Volume 21(2), p. 279–305.

Jasperson, J., Carter, P. E. & Zmud, R. W., 2005. A comprehensive conceptualization of post-adoptive behavior associated with information technology enabled work systems. *MIS Quarterly,* 29(3), pp. 525-557.

Jones, J., 2008. *The adoption of internet technology among general practioners in Kwazulu-Natal,* Durban : Unknown.

Kekkonen-Moneta, S. & Moneta, G. B., 2002. E-learning in Hong Kong: comparing learning outcomes in online multimedia and lecture versions of an introductory computing course. *British Journal of Education Technology,* 33(4), p. 423–433.

Khan, K. S. & Coomarasamy, A., 2006. A hierarchy of effective teaching and learning to acquire competence in evidenced-based medicine. *BMC Medical Education,* Volume 6, p. 59.

Kim, J. & Mueller, C. W., 1978. Factor Analysis: Statistical methods and practical issues. Volume 14.

Kinnear, P. R. & Gray, C. D., 2008. *SPSS 16 Made Simple.* Hove and New York: Psychology Press.

Koch, C., December. 1, 2004. When bad things happen to good projects. *CIO Magazine,* Volume 18, p. 50.

Koch, C., Jun, 15, 2004. Nike Rebounds-How (and Why) Nike Recovered from Its Supply Chain Disaster. *CIO Magazine,* Volume 17, p. 17.

Korenstein, D., Dunn, A. & McGinn, T., 2002. Mixing it up: integrating evidence-based medicine and patient care. *Association of American Medical Colleges (Acad Med),* 77(7), pp. 741-2.

Kripanont, N., 2007. *Examining a technology acceptance model of internet usage by academics within Thai business schools,* Melbourne, Australia: Victoria University.

Kulier, R., Gee, H. & Khan, K., 2008b. Five steps from evidence to effect: exercising clinical freedom to implement research findings. *BJOG,* Volume 115, p. 1197–1202.

Kulier, R. et al., 2008a. Harmonising Evidence-based medicine teaching: a study of the. *BMC Medical Education,* 27(8).

Lu, J., Yu , C.-s. & Liu, C., 2006. Gender and Age Differences in Individual Decisions about Wireless Mobile Data Services: A Report from China. *White Paper,* 1(1), pp. 1 - 19.

Mardikyan, S., Beşiroğlu, B. & Uzmaya, G., 2012. Behavioral Intention towards the Use of 3G Technology. *IBIMA Publishing Communications of the IBIMA,* Volume 2012, p. 10.

Masrom, M., 2007. *Technology Acceptance Model and E-learning.* Brunei, Universiti Brunei Darussalam.

Mathieson, K., 1991. Predicting user intentions: Comparing the technology acceptance model with the theory of planned behavior. *Information Systems Research,* 2(3), pp. 173-191 .

Miller, R. L., Acton, C., Fullerton, D. A. & Maltby, J., 2002. *SPSS For Social Scientists.* s.l.:Palgrave Macmillan.

Moon, J.-W. & Kim, Y.-G., 2001. Extending the TAM for a World-Wide-Web context. *Information & Management,* 38(4), pp. 217-230.

Moore, G. C. & Benbasat, I., 1991. Development of an Instrument to Measure the Perceptions of Adopting an Information Technology Innovation. *Information Systems Research,* 2(3), pp. 192-222.

Moore, G. C. & Benbasat, I., 1991. Development Of an Instrument To Measure the Perceptions of Adopting an InformationT echnology Innovation. *Information Systems Research,* Volume 2(3), pp. 192-222.

Morris, M. G. & Venkatesh, V., 2000. Age differences in technology adoption decisions: Implications for a changing work force. *Personnel Psychology,* Volume 53(2), pp. 375-403.

Morris, M., Venkatesh, V. & Ackerman, P., 2005. Gender and age differences in employee decisions about new technology: an extension to the theory of planned behavior. *IEEE Transactions on Engineering Management,* Volume 52(1), pp. 69- 84.

Muijs, D., 2004. *Doing Quantitative Research In Education with SPSS.* s.l.:SAGE Publications.

Mulaik, S., 1986. Factor analysis and Psychometrika: Major developments. Volume 51, pp. 23-33.

Ngai, E. W. T., Poon, J. K. L. & Chan, Y. H. C., 2007. Empirical examination of the adoption of WebCT using TAM. *Computers & Education,* 48(2), p. 250–267.

Nunnally, J. C., 1978. *Psychometric Theory.* New York: McGraw-Hill.

Ong, C.-S., Lai, J.-Y. & Wang, Y.-S., 2004. Factors affecting engineers' acceptance of asynchronous e-learning systems in high-tech companies. *Information and Management ,* 41(6), pp. 795 - 804 .

Oude Rengerink, K. et al., 2011. How can we teach EBM in clinical practice? An analysis of barriers to implementation of on-the-job EBM teaching and learning. *Med Teacher,* 33(3), pp. e125-e130.

Pahnila, S., 2006. *Assessing the usage of personalized web information systems.* Faculty of Science, Department of Information Processing Science, University of Oulu (Academic dissertation): Oulu University Press.

pearl, J., 2000. Causality: Models, reasoning, and inference. In: s.l.:Cambridge: Cambridge University Press.

Pedhazur, Elazar & Schmelkin, 1991. *Measurement, Design, and Analysis: An Integrated Approach.* Hillsdale: NJ: Lawrence Erlbaum Associates.

Piccoli, G., Ahmad, R. & Ives, B., 2001. Web-Based Virtual Learning Environments: A Research Framework and a Preliminary Assessment of Effectiveness in Basic IT Skills Training. *MIS Quarterly,* 25(4), pp. 401-426.

Pituch, K. A. & Lee, Y.-k., 2006. The influence of system characteristics on e-learning use. *Computers & Education ,* 47(2), pp. 222 - 244 .

Roca, J. C., Chiu, C. M. & Martinez, F. J., 2006. Understanding e-learning continuance intention: An extension of the Technology Acceptance Model. *International Journal of Human-Computer Studies,* 64(8), pp. 683-696 .

Rogers, E., 1995. *Diffusion of innovations.* 4 th ed. New York, NY: Free Press.

Rudner, Lawrence & William, 2001. *Reliability. ERIC Digest..* [Online] Available at: http://www.ericdigests.org/2002-2/reliability.htm [Accessed 12 May 2010].

Saadé, R. G. & Kira, D., 2009. Computer anxiety in e-Learning: The effect of computer self-efficacy. *Journal of Information Technology Education,* Volume 8.

Sapsford, Roger, Jupp & (Editors), V., 2006. *Data Collection and Analysis 2nd Edition.* London: Sage Publications.

Schaper, L. K. & Pervan, G. P., 2007. ICT and OTs: A model of information and communication technology acceptance and utilisation by occupational therapists. *International Journal of Medical Informatics ,* Volume 76, pp. 212 - 221.

Schuler, R. S., 1975. Sex, organizational level, and outcome importance: Where the differences are. *Personnel Psychology,* Volume 28(3), pp. 365-375.

Schumacker, R. E. & Lomax, R. G., 2004. *A Beginner's Guide to Structural Equation Modeling (Second Edition).* Mahwah, New Jersey: LAWRENCE ERLBAUM ASSOCIATES.

Sheppard, B. H., Hartwick, J. & Warshaw, P. R., 1988. The Theory of Reasoned Action: A Meta-Analysis of Past Research with Recommendations for Modifications and Future Research. *The Journal of Consumer Research,* 15(3), pp. 325-343.

Singh, G., O'Donoghue, J. & Worton, H., 2005. A Study Into The Effects Of eLearning On Higher Education. *Journal of University Teaching and Learning Practices,* 2(1), pp. 13-24.

Spearman, C., 1904. "General Intelligence," Objectively Determined and Measured. *The American Journal of Psychology,* April, 15(2), pp. 201 - 292.

Speier, C. & Venkatesh, V., 2002. The hidden minefields in the adoption of sales force automation technologies. *The Journal of Marketing,* 66(3), pp. 98-111.

Suhr, D., 2006. *Exploratory or Confirmatory Factor Analysis?.* San Francisco, California, s.n.

Sun, H. & Xiao, X., 2006. User acceptance of virtual technologies. In: *Encyclopedia of virtual communities and technologies.* USA: Idea Group Publishing, pp. 468-473.

Sun, H. & Zhang, P., 2006. The role of moderating factors in user technology acceptance. *INTERNATIONAL JOURNAL OF HUMAN-COMPUTER STUDIES ,* 64(2), pp. 53-78.

Sun, P. C. et al., 2006. What drives a successful e-Learning? An empirical investigation of the critical factors influencing learner satisfaction. *Computers & Education,* Volume 50(4), pp. 1183-1202.

Szajna, B., 1996. Empirical evaluation of the revised technology acceptance model. *Management Science,* Volume 42(1), pp. 85-92.

Taylor, S. & Todd, P. A., 1995. Understanding information technology usage: a test of competing models. *Information Systems Research ,* Volume 6(2), pp. 144-176.

Thangaratinam, S. et al., 2009. Teaching trainers to incorporate evidence-based medicine (EBM) teaching in clinical practice: the EU-EBM project. *BMC Medical Education,* 9(1), p. 59.

The University of Birmingham, 2012. *webLearn.* [Online] Available at: http://www.weblearn.bham.ac.uk/[Accessed 17 March 2012].

Thurstone, L. L., 1947. *Multiple-factor analysis; a development and expansion of The Vectors of Mind.* Chicago, IL, US: University of Chicago Press.

Venkatesh, V., 2000a. Determinants of perceived ease of use: Integrating perceived behavioral control, computer anxiety and enjoyment into the technology acceptance model. *Information Systems Research,* 11(4), p. 342–365.

Venkatesh, V., 2000c. Determinants of perceived ease of use: integrating control, intrinsic motivation, and emotion into the technology acceptance model. *Information System research,* Volume 11(4), pp. 342-365.

Venkatesh, V. & Agarwal, ,. R., 2006. Turning visitors into customers : A usability-centric perspective on purchase behavior in electronic channels. *Management science ,* 52(3), pp. 367-382 .

Venkatesh, V. & Bala, H., 2008. Technology Acceptance Model 3 and a Research Agenda on Interventions. Volume 39, pp. 273-315.

Venkatesh, V. & Davis, F. D., 1996. A model of the antecedents of perceived ease of use: Development and test. *Decision Sciences,* 27(3), p. 451.

Venkatesh, V. & Davis, F. D., 2000b. A theoretical extension of the technology acceptance model: Four longitudinal field studies. *Management Science,* Volume 46(2), pp. 186-204.

Venkatesh, V., Maruping, L. M. & Brown, S. A., 2006. Role of time in self-prediction of behavior. *Organizational Behavior and Human Decision Processes,* Volume 100(2), pp. 160-176.

Venkatesh, V., Morris, M. G. & Ackerman, P. L., 2000d. A longitudinal field investigation of gender differences in individual technology adoption decision making processes. *Organizational Behavior and Human Decision Processes,* Volume 83(1), pp. 33-60.

Venkatesh, V., Morris, M. G., Davis, G. B. & Davis, F. D., 2003. User acceptance of information technology: toward a unified view. *MIS Quarterly,* Volume 27(3), pp. 425-478.

Venkatesh, V., Morris, M. G., Sykes, T. A. & Ackerman, P. L., 2004. Individual reactions to new technologies in the workplace: The role of gender as a psychological construct. *Journal of Applied Social Psychology,* Volume 34(3), pp. 445-467.

Venkatesh, V. & Speier, C., 2002. The hidden minefields in the adoption of sales force automation technologies. *Journal of Marketing,* Volume 66, pp. 98-111.

Walker, J. T. & Madden, S., 2009. Factor Analysis, Path Analysis and Structural Equation Modelling, Chapter 14. In: *Statistics in Criminology and Criminal Justice: Analysis and Interpretation.* 3rd ed. s.l.:Jones & Bartlett Learning, pp. 325 - 328.

Webster, J. & Martocchio, J. J., 1992. Microcomputer playfulness: Development of a measure with workplace implications. *MIS Quarterly,* 16(2), p. 201–226.

Wilson, R., 1991. *Help! The art of computer technical support.* California: Peachpit Press.

Wood, M. J., Kerr, J. C. & Brink, P. J., 2005. Basic Steps In Planning Nursing Research. In: 6th ed. Sudbury: Jones & Bartlett Publishers, p. 85.

Wu, J.-H.et al., 2008. Testing the technology acceptance model for evaluating healthcare professionals' intention to use an adverse event reporting system. Volume 20(2), pp. 123-129.

Zanrei, G., 2009. *EU EBM Unity Course Training the Trainers across the Healthcare Sector: Learner's Handbook.* s.l.:eu-emb ttt.

Zhang, S., Zhao, J. & Tan, W., 2008. Extending TAM for Online Learning Systems: An Intrinsic Motivation Perspective. *Tsinghua Science and Technology,* 13(3), pp. 312 - 317.

8 APPENDIX

8.1 Davis' Explanation of the Fishbein Model

The design of Davis' derived Technology Acceptance Model (TAM) is based on the theories of TRA. This section covers the explanation Davis gave of the Fishbein model, followed by an introduction to the TAM. Davis (1986) analysed the strong and weak points of the Fishbein model, more information on the criticisms of the Fishbein model in Section 2.3.1.5. He emphasised its strong ability to assess and predict a user's behaviour with paradigms of belief, evaluation, attitude, normative belief, motivation, and subjective norm (Davis, 1986). However, he criticised its limited ability to work specifically with the voluntary action of a user "The Fishbein model views A_O as an external variable" (Davis, 1986), where A_O is a person's attitude toward the object, emphasising that it specifically works with the behavioural intention of their voluntary action. On that basis, Davis continued to clarify the theories of how the user's behaviour is affected by the system characteristics and how system characteristics have an effect on user behaviour, attitude and intention.

The Fishbein model can be represented by a set of three equations, as shown below. Equation 8-1 represents the intention of the user to behave with a certain action $\mathrm{BI_{act}}$. The effect of a user's behavioural intention is dependent on their attitude towards their behaviour of carrying out a voluntary action including how people who are considered important to the user in their society can influence the behavioural action of the user. The term $\mathrm{BI_{act}}$ has previously been described in other works, however this was defined as BI and this shows the probability of a user's behaviour in a particular way (Davis, 1986).

$$B \approx BI_{act} = W_1 A_{act} + W_2 SN_{act} \qquad \text{Equation 8-1}$$

Equation 8-1: Intention to perform a given behaviour (Davis, 1986)

where:

- $B = \text{behaviour}$
- $BI_{act} = \text{behavioural intention regarding a behaviour}$
- $A_{act} = \text{attitude toward a behaviour}$
- $SN_{act} = \text{subjective norm regarding a behaviour}$
- $W_1, W_2 = \text{importantance weights (estimate via multi regression)}$

Equation 8-2 concerns the attitude of the user towards a given behaviour, which depends on the belief that carrying out behaviour will result in consequence i (b_i) and the evaluation of consequence i (e_i). This equation defines the relationship between the belief and the attitude of the user (Davis, 1986).

$$A_{act} = \sum i = 1, n\ b_i e_i \qquad \text{Equation 8-2}$$

Equation 8-2: Individual's attitude toward a given behaviour (Davis, 1986)

where:

- $n = \text{number of salient beliefs}$

Fishbein and Ajzen (1975) made the relation between beliefs and attitude clear as being a theoretical idea that a person's belief about an item is directly related to their attitude towards that same item.

Equation 8-3 describes the expectation of the user. It is influenced by how the user understands the expected procedure, what they expect to do and their incentives to follow

the procedure (Fishbein & Ajzen, 1975). This equation can be affected by salient beliefs (Davis, 1986).

$$SN_{act} = \sum j = 1, m\ nb_j mc_j \qquad \text{Equation 8-3}$$

Equation 8-3: Individual's subjective norm (Davis, 1986)

where:

- $nb_j =$ normative belief that referent j wants a subject to perform a behaviour
- $mc_j =$ motivation to comply with referent j
- $m =$ number of salient referents

8.5 Glossary

- **Attitude**: "favourable or unfavourable evaluation of the behaviour" (Ajzen & Cote, 2008).
- **Behavioural intention**: "measuring of the strength of his or her intention to perform a specified behaviour" (Fishbein & Ajzen, 1975).
- **Computer anxiety**: The degree of "an individual's apprehension, or even fear, when she/he is faced with the possibility of using computers" (Venkatesh, 2000a).
- **Computer playfulness**: the degree of "cognitive spontaneity in microcomputer interactions" (Webster & Martocchio, 1992).
- **Computer self-efficacy**: The degree to which an individual believes that he or she has the ability to perform a specific task or job using the computer (Compeau & Higgins, 1995)
- **Image**: "The degree to which use of an innovation is perceived to enhance one's image or status in one's social system" (Moore & Benbasat, 1991).
- **Job relevance**: "define as an individual's perception regarding the degree to which the target system is applicable to his or her job. In other words, job relevance is a function of the importance within one's job of the set of tasks the system is capable of supporting" (Venkatesh & Davis, 2000b).
- **Objective usability**: A "comparison of systems based on the actual level (rather than perceptions) of effort required to completing specific tasks" (Venkatesh, 2000a)
- **Output quality**: "The degree to which an individual believes that the system performs his or her job tasks well" (Venkatesh & Davis, 2000b) .
- **Performance expectancy**: "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).
- **Perceived ease of use**: "degree to which a person believes that using a particular system would be free of effort" (Davis, 1989).
- **Perceived enjoyment**: The extent to which "the activity of using a specific system is perceived to be enjoyable in its own right, aside from any performance consequences resulting from system use" (Venkatesh, 2000a).
- **Perceived usefulness**: "degree to which a person believes that using a particular system would enhance his or her job performance" (pearl, 2000).
- **Perception of external control**: "The degree to which an individual believes that organizational and technical resources exist to support the use of the system" (Venkatesh, et al., 2003).
- **Result demonstrability (Result)**: "the tangibility of the results of using the innovation, including their observability and communicability" (Moore & Benbasat, 1991).
- **Subjective norm**: "perceived social pressure to perform or not perform the behaviour" (Ajzen & Cote, 2008).
- **Voluntariness (of use)**: "the degree to which use of the innovation is perceived as being voluntary or of free will" (Moore & Benbasat, 1991)

8.6 Table of Acronyms

Definition	Acronym
Attitude	A
Attitude Toward Use	ATU
Behavioural Intention	BI
Corrected Item-Total Correlation	CITC
Correlation Coefficient	r-value
Cronbach's Alpha if Item Deleted	CAIID
Dependent Variable	DV
Education Level	EL
Evidence-based medicine	EBM
Experience	Ex
Extended Technology Acceptance Model	e-TAM
Independent Variable	IV
Information and Communication Technology	ICT
Information Technology	IT
Knowledge Support	KS
Organisational Structure	OS
Perceived Ease of Use	PEOU
Perceived Usefulness	PU
Significance Level of the Hypothesis	P value
Standardised Regression Coefficient	β
Structural Equation Modelling	SEM
Subjective Norm	SN
Teaching the Trainers EBM	TTT-EBM
Technology Acceptance Model	TAM
Technology Acceptance Model 2	TAM2
Technology Acceptance Model 3	TAM3
Technology Support	TS
Theory of Planned Behaviour	TPB
Theory of Reasoned Action	TRA
Time Constraint	TC
Unified Theory of Acceptance and Use of Technology	UTAUT