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A Comparison of Alternative Technology Adoption Models: The Adoption of a CASE tool at a University

A Masters Dissertation

Presented to
The University of Cape Town
Department of Information Systems



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Master of Commerce Degree in Information Systems
(by coursework and dissertation)

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Abstract

In a field such as that of Information Systems the emergence of new technologies is one of the only constants. It is therefore necessary, indeed vital, to be able to measure, as well as anticipate, the adoption and diffusion of these new technologies into organisations. For this purpose adoption models came to the fore. Such models include the Technology Acceptance Model (TAM) (Davis, 1989), the Technology Acceptance Model 2 (TAM2) (Venkatesh & Davis, 2000), the Decomposed Theory of Planned Behaviour (DTPB) (Taylor & Todd, 1995b), and the Perceived Characteristics of Innovating model (PCI) (Moore & Benbasat, 1991). Adoption models test the perceptions and attitudes of potential and actual adopters of a new technology. Although all of the adoption models test adoption of a new technology, each tests different aspects of this adoption. Through the comparison of the four adoption models mentioned above, this study determines which constructs mostly strongly explain the adoption of a CASE tool by university students. These constructs are then combined to form a new technology adoption model, the Perceived Characteristics of Technology Adoption (PCTA), which is tested and found to explain a significant degree of variance in the context of CASE tool adoption amongst students at a university.

Key Words

Technology adoption models; CASE tools; TAM; TAM2; DTPB; PCI; model comparison

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University of Cape Town

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1. Introduction

This section introduces the topic of this study by explaining its context in the field of information systems, as well as its history. The research topic is broken down into its individual ideas and these ideas are briefly explained. The research hypotheses and the necessity for the research are also described.

1.1 Introduction

Although academia and industry are usually quite separate, this study looks to bring them together through testing academic theory for actual use in practice, in this instance using technology adoption models to test the adoption of a CASE tool for use in systems development.

Adoption models have a rich heritage stemming from the fields of psychology, sociology and, to a lesser extent, engineering. These models help to measure how people adopt new processes and technologies into their daily behaviour. The field of information systems incorporated and expanded on these models when a new phenomenon occurred in organisations in the late eighties. This new phenomenon emerged during the mass implementation of information systems for use by the majority of employees in order to improve productivity. This phenomenon followed the argument that in order for new technologies to increase productivity, they needed to be accepted by the users. However, when the information systems were implemented, they were not fully accepted and the scale of productivity increases that may have been expected were not seen (Davis, 1989;

Davis, Bagozzi & Warsaw, 1989; Mathieson, Peacock & Chin, 2001). Adoption models came into play to answer why the new technologies were not being accepted.

Information systems adoption has been approached from three main fronts, namely information systems implementation (Kwon & Zmud, 1987), innovation diffusion (Brancheau & Wetherbe, 1990; Rogers, 1995), and technology acceptance (Davis, 1989; Davis, Bagozzi & Warsaw, 1989). This study focuses on technology acceptance as sound models exist that have been previously tested and retested to assure validity and reliability.

There are various different ways of measuring information system success, the two main ones being to measure system effectiveness and system usage. Agarwal and Prasad (1999) state that system utilisation is crucial to gaining the benefits from the system, i.e. system success. Technology adoption models measure system usage through determining the users' intentions and behaviours towards the system. These intentions and behaviours are gleaned from the users' attitudes towards the system. Al-Gahtani and King (1999) researched system usage and user satisfaction and found that system usage was a better predictor of technology acceptance, as it is a more clearly defined measure. Igbaria, et al. (1997) lent support to this finding through reporting that the primary indicator of technology acceptance is system usage. Thus this study will determine the success of the adoption of a CASE tool by determining its usage.

CASE tools are proving to be a useful learning tool at the University of Cape Town to teach students about the systems development life cycle and about how systems are

developed in the business world. The students' involvement with CASE tools is allowing them to build experience with CASE software, which they will be able to use when they enter the industry after graduating. The CASE tool implementation with which this study is concerned is Rational Rose. Rational Rose is an advanced CASE tool that contains components of both upper and lower CASE. Rational Rose is regarded as one of the CASE industry leaders, because one of the original developers of the Unified Modelling Language (UML) specification, Grady Booch, helped develop Rational Rose, and Rational Rose has held above a 30% share of the CASE tool market over the past few years (www.rational.com). The 3rd year student participants used mostly the upper CASE components of the CASE tool, while the honours year student participants used both the upper and lower CASE components.

In a recent study Al-Gahtani (2001) found that very few Technology Acceptance Model (TAM) studies were undertaken outside of North America. Switzerland and Japan are two other countries where major TAM studies have been undertaken. Straub, Keil and Brenner (1997) argue that TAM may not hold equally well across different cultures, which they found in Japan where TAM was not supported. This study will put this argument to the test as there has been no previous major TAM study conducted in South Africa, which is remote from North America both in distance and culture.

1.2 Research Topic

A Comparison of Alternative Technology Adoption Models: The Adoption of a CASE tool at a University.

Comparison: This study compares four technology adoption models in order to obtain a broader picture of a university adoption scenario in a CASE tool context. A comparison of adoption models is advised as each adoption model uses a slightly different set of constructs to measure adoption. By comparing a collection of adoption models a researcher is able to get a better view of the full adoption picture, as more constructs that affect the adoption process can be measured. Further, using more than one adoption model allows a researcher to have a higher level of confidence in their data, as the data was obtained from more than one stand-point.

Alternative: Technology adoption models exist in various forms; some are technology based (Information Engineering model; Finlay & Mitchell, 1994) while others are psychologically based (Concerns-Based Adoption Model; Hord, et al., 1987), and some have few constructs (Technology Adoption Model; Davis, 1989) while others have many constructs (Decomposed Theory of Planned Behaviour; Taylor & Todd, 1995b). Alternative technology adoption models allow researchers to measure various aspects of an adoption scenario, from usefulness to self-efficacy to resource facilitating conditions. These different aspects allow researchers to see a full picture of the situation by measuring various different adoption constructs.

Technology Adoption Models: Technology adoption models measure the rate or level of adoption. The adoption is measured by asking users for their perceptions of various issues. The answers to these questions, usually measured on a Lickert scale, allow researchers to gauge the rate and level of adoption by measuring the strength of

associations between constructs in the model, usually done by statistical processes such as partial least squares analysis. Adoption models are made up of constructs designed to measure the perceptions of adopters and potential adopters in order to determine their future behaviour, which is believed to be influenced by their perceptions.

CASE tool: The Computer-Aided Software Engineering (CASE) tool used in this study is Rational Rose, which is among the top CASE tools available. The author found few adoption studies of a CASE tool and no adoption model comparisons conducted with a CASE tool. This is unfortunate as it is a good technology to measure the adoption of, as a CASE tool is a complex piece of software with a complex use process. This complexity ensures that participants in its adoption will encounter difficulties and triumphs that will remain memorable when they complete questionnaires about the adoption process. This should have allowed the participants in this study to answer the questionnaires with more vigour, thus providing good data for this study.

University: This study took place at the University of Cape Town (UCT) in the information systems department, using information systems students as participants. This clarification is important as results of studies done in universities and the business world tend to differ. These differences, applicable to this study, include differences in consequences of actions, chain of command differences and differences in the level of responsibilities. However, the fact that this study was undertaken in a university with students as participants shouldn't detract from the value of the research as many of the earlier technology adoption studies were undertaken in universities with students as participants, including Davis's (1989) Technology Acceptance Model study.

This study will make use of four technology adoption models; these are the Technology Adoption Model (TAM) (Davis, 1989); TAM2 (Venkatesh & Davis, 2000); the Decomposed Theory of Planned Behaviour (DTPB) (Taylor & Todd, 1995b); and the Perceived Characteristics of Innovating model (PCI) (Moore & Benbasat, 1991). These four models can be considered as the leading technology adoption models as they are the adoption models that are used most in published research papers.

1.3 Research Hypotheses

There are five main hypotheses in this study; the first four relate to retesting the four adoption models compared in this study and the fifth relates to the success of the CASE tool adoption. The five main hypotheses are listed below.

H1: This test of the Technology Acceptance Model is in concordance with the results obtained in the original study.

H2: This test of the Technology Acceptance Model 2 is in concordance with the results obtained in the original study.

H3: This test of the Decomposed Theory of Planned Behaviour model is in concordance with the results obtained in the original study.

H4: This test of the Perceived Characteristics of Innovating model is in concordance with the results obtained in the original study.

H5: The level of adoption of Rational Rose by UCT students is high.

1.4 Necessity for Research

The state of adoption theory in the field of information systems is fractured and in need of consolidation. It is thus necessary for present adoption studies to validate past studies and consolidate the best segments into a strong central theory. This study and comparison of technology adoption models stands as another step toward unifying technology adoption model research. In addition, this study tests existing technology adoption models in order to validate them, thus building a strong foundation for the technology adoption body of knowledge.

This study adds to the technology adoption body of knowledge by testing technology adoption models in the under-researched context of CASE tools. Further, the author has found no studies that have compared adoption models in a CASE tool context.

South Africa lacks studies in the area of technology adoption and this study is the first of its kind in South Africa. This is important as South Africa is attempting to make a name for itself in the global research arena; so it needs to conduct studies in all fields in order to develop a research tradition. The University of Cape Town, as a main contributor to South Africa's research effort, also benefits from studies that are conducted to fill gaps in the body of knowledge, such as this study.

Finally, technology adoption research is conducted in order to help the business world with the adoption of new innovations. Many technology adoption models exist, and each caters best for a different adoption context. Therefore it is important for studies to be conducted in different technology contexts with different adoption models. These studies

help business people to select which adoption models they should use for measuring their technology adoption context; this study is mainly for use in a CASE tool context.

1.5 History in Context

Gabriel Tarde began his diffusion observations in the early 1900's and began an anthropological research in diffusion through studying the adoption of new innovations by indigenous tribes (Rogers, 1995). By the 1920's an anthropological research tradition in diffusion had been formed. The field of sociology picked up on this research tradition and began studying imitation and adoption behaviour in individuals in the 1940's. The 1960's saw an explosion of diffusion investigations in Latin America, Africa and Asia. The research tradition of diffusion and adoption spread to the fields of engineering and psychology; and these two fields, along with that of sociology, became the main contributors to the body of knowledge until the late 1980's. The late 1980's brought the addition of the field of information systems to this research tradition with Davis's (1989) Technology Acceptance Model (TAM). The 1990's heralded a split between diffusion and adoption models, where several of each abounds. Rogers (1995) became a proponent of diffusion models while Davis (1989) became a proponent of adoption models. According to Rogers (1995) diffusionism was originally defined as "*...the point of view in anthropology that explained social change in a given society as a result of the introduction of innovations from another society*" (p. 41).

Each of the fields involved in the evolution of the diffusion and adoption research tradition added their own points of view. The field of anthropology laid a foundation for the research tradition. The fields of sociology and psychology focused mainly on the

human side of adoption and diffusion, measuring things such as attitudes, behaviours and perceptions. This culminated in models such as the Theory of Reasoned Action (TRA) (Fishbein & Ajzen, 1975); the Theory of Planned Behaviour (TPB) (Ajzen, 1991); the Concerns-Based Adoption Model (CBAM) (Hord, et al, 1987); and the Cognitive, Affective factors and Usage model (Compeau & Higgins, 1995). The field of engineering focused mainly upon the technology side of adoption and diffusion, measuring things such as facilitating conditions and tasks. This culminated in models such as the Information Engineering model (Finlay & Mitchell, 1994). Finally the field of information systems brought the human and technology sides together to measure the whole effect of adoption and diffusion situations. This culminated in models such as the Technology Adoption Model (TAM) (Davis, 1989); TAM2 (Venkatesh & Davis, 2000); the Decomposed Theory of Planned Behaviour (DTPB) (Taylor & Todd, 1995b); and the Perceived Characteristics of Innovating model (PCI) (Moore & Benbasat, 1991).

Although various fields were involved in the evolution of the adoption and diffusion research tradition, most studies followed the same methodology. Studies were usually strictly quantitative; relying solely upon statistics. The data was collected from users and potential users via questionnaires and surveys. These instruments contained multiple questions to measure each construct and were tested and retested in an attempt to ensure high reliability and validity. Even today this methodology is still used in the majority of adoption and diffusion studies. This study will make use of this well tested and successful methodology. The qualitative methodology is another methodology that has come to the fore. The qualitative studies, such as actor network theory and due process (Latour, 1987), use focus groups and interviews to immerse the researchers in the

situation, so that the researchers can use their expertise to provide solutions to any possible problems with adoption. Although these theories may sometimes contend with one another, it is possible for the two theories to merge successfully into one study, which may in fact yield richer and more explanatory results.

Another contention that has appeared is between the technology-oriented and person-oriented adoption theories. The technology-oriented adoption theories focus mainly on the technology or new innovation that is to be or has been adopted. These theories make use of constructs such as ease of use and usefulness, and examples of models include the technology acceptance model (Davis, 1989) and the information engineering model (Finlay & Mitchell, 1994). Proponents of this theory argue that it is the technology itself that is the most important variable in adoption behaviour. Proponents of person-oriented theories, on the other hand, argue that it is the individual that is the most important variable in adoption behaviour. Person-oriented adoption theories focus mainly upon the individuals potentially and actually adopting a new technology or innovation. These theories make use of constructs such as subjective norm and self-efficacy, and examples of models include the concerns-based adoption model (Hord, et al., 1987) and the model of personal computer utilisation (Thompson, Higgins & Howell, 1991). This rift has been breached though, with various studies of theories that contain both technology- and person-oriented constructs, examples of these include the decomposed theory of planned behaviour (Taylor & Todd, 1995b) and TAM2 (Venkatesh & Davis, 2000).

The stakeholders of this study are managers, systems designers and organisations. These stakeholders can make use of this study in predicting the adoption and diffusion of a new

innovation. Managers and systems designers will be able to use the adoption measurements to determine how best to improve the rate and level of adoption amongst CASE tool users. Organisations can use the adoption measurements to determine the success of the introduction of a new innovation, hereby determining their return on investment.

University of Cape Town

2. Literature Survey

“A system that does not help people perform their jobs is not likely to be received favourably in spite of careful implementations efforts” (Robey, 1979, p. 537).

2.1 Introduction

The field of Information Systems (IS) deals largely with change, due to the fact that technology plays a large part in IS and technology is ever-changing. It therefore follows that adoption of technology should be an important aspect of IS. The IS field has addressed this aspect by borrowing and building technology adoption models. Such adoption models include the Theory of Reasoned Action (TRA) (Fishbein & Ajzen, 1975); the Theory of Planned Behaviour (TPB) (Ajzen, 1991); the Decomposed Theory of Planned Behaviour (DTPB) (Taylor & Todd, 1995b); the Technology Adoption Model (TAM) (Davis, 1989); TAM2 (Venkatesh & Davis, 2000); the Perceived Characteristics of Innovating model (PCI) (Moore & Benbasat, 1991); the Motivational Model (MM) (Vallerand, 1997); the Model of Personal Computer Utilisation (MPCU) (Thompson, Higgins & Howell, 1991); Concerns-Based Adoption Model (CBAM) (Hord, et al., 1987); Information Engineering model (Finlay & Mitchell, 1994); and others.

However, due to the existence of multiple adoption models from the fields of psychology, engineering and IS, each model measures different aspects of adoption and each model works best in its own context. It is therefore advisable that an adoption situation should be tested by various adoption models simultaneously in order to derive the true analysis of the situation (Venkatesh & Brown, 2002). Unfortunately this is seldom done; only a

few studies were found by this study that analysed technology adoption situations with more than one adoption model. These included Davis (1989); Mathieson (1991); Taylor and Todd (1995b); Chau and Hu (2001); Plouffe, Hulland and Vandenbosch (2001); Venkatesh and Brown (2002); Riemenschneider, Hardgrave and Davis (2002); and Venkatesh et al. (2003). Of these studies only three compared more than three adoption models, namely Venkatesh and Brown (2002); Riemenschneider, Hardgrave and Davis (2002); and Venkatesh et al. (2003). This is a clear indication that there is a gap in the IS research body of knowledge that needs to be filled.

2.2 Early Adoption Models

According to Nelson and Shaw (2001), the study of technology adoption models is gaining popularity in IS research. This popularity stems from benefits gained in this line of study by “*Academicians, business managers, IT managers and other commercial organizations...*” (Nelson & Shaw, 2001). Nelson and Shaw (2001) suggest that reasons for these benefits include:

- Predicting the use of a system prior to a costly development process
- Insight into system features and functionality to incorporate in a system
- Results applicable across multiple types of technology
- Possible solutions to increasing the use of an information system
- Findings that are particularly relevant to an industry standard setting organization.

Adoption models, not to be confused with their diffusion forefathers, originated within the field of psychology with models such as the Theory of Reasoned Action (TRA)

(Fishbein & Ajzen, 1975), as shown in Figure 1, and the Theory of Planned Behaviour (TPB) (Ajzen, 1985), as shown in Figure 2. TRA's main variables are *attitude toward behaviour* and *subjective norm*. Attitude toward behaviour is defined as "...an individual's positive or negative feelings (evaluative affect) about performing the target behavior" (Fishbein & Ajzen, 1975, p. 216). Subjective norm is defined as "...the person's perception that most people who are important to him think he should or should not perform the behavior in question" (Fishbein & Ajzen, 1975, p. 302).

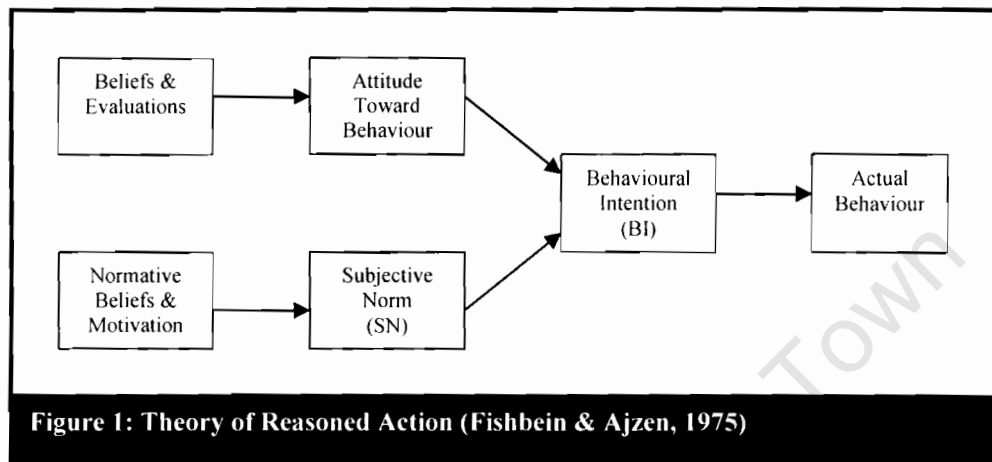


Figure 1: Theory of Reasoned Action (Fishbein & Ajzen, 1975)

TPB's main variables include TRA's *attitude toward behaviour* and *subjective norm*, as well as *perceived behavioural control*. Perceived behavioural control "...refers to the perceived ease or difficulty of performing the behaviour..." (Ajzen, 1991, p. 188).

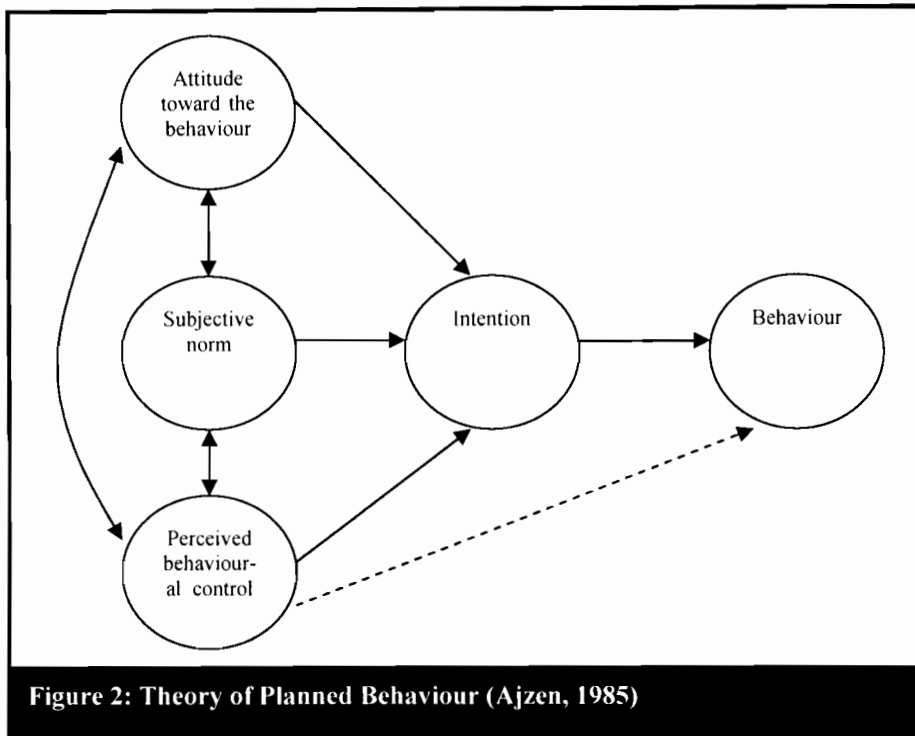


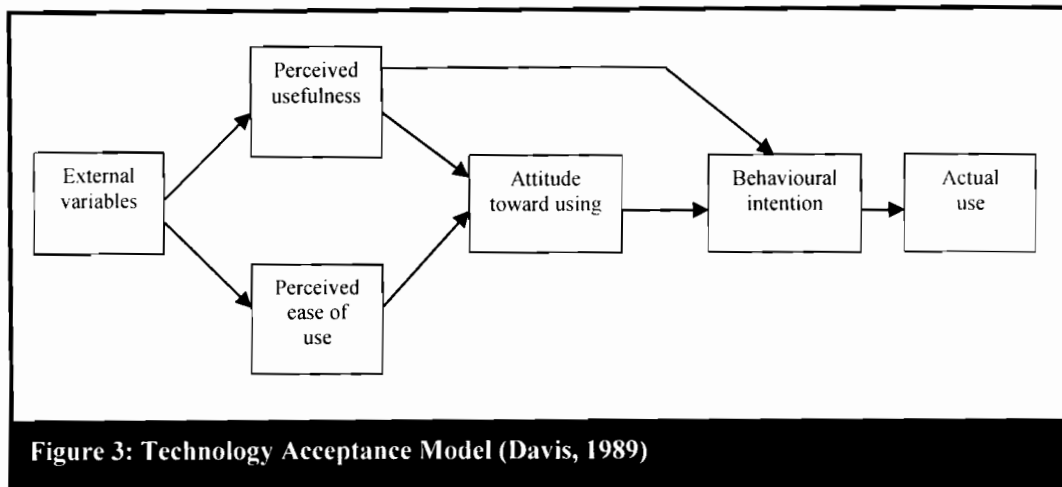
Figure 2: Theory of Planned Behaviour (Ajzen, 1985)

These two adoption models from the field of psychology were developed to measure the actions and behaviours of individuals so that their future actions and behaviours could be determined. This proves useful in psychology as aberrant behaviours can be measured, the causes found, by measuring how much each construct in the model contributes to the behaviour, and these causes treated, by treating the areas most affected as clarified by the constructs from the model, so that the behaviour can be stopped.

2.3 Technology Acceptance Model

The TRA and TPB adoption models were originally used in the field of IS to predict and assess adoption of new technologies. However it was found that the affect of the technology itself on the users was not being taken into account, so technology adoption models emerged in the IS field. These models build on from the original psychology

adoption models and include the affect of technology. Davis (1989) was one of the first on this front with his Technology Acceptance Model (TAM), shown in Figure 3.



The TAM model builds onto the TRA model by including the constructs of *perceived ease of use* and *perceived usefulness*. These constructs measure the affect that a technology's ease of use and usefulness for the user have on the user's willingness to adopt the technology into their everyday use. Perceived usefulness measures "...the degree to which a person believes that using a particular system would enhance his or her job performance" (Davis, 1989, p. 320), while perceived ease of use measures "...the degree to which a person believes that using a particular system would be free of effort" (Davis, 1989, p. 320).

Segars and Grover (1993) tested Davis's perceived usefulness and perceived ease of use scales and found them to be both valid and reliable. Although in further structural equation testing, Segars and Grover (1993) found that there were inconsistencies "...regarding the strength of causal influence of Davis's constructs on usage". This

means that the relationships between the perceived usefulness and perceived ease of use constructs and the usage construct may contain more complexities than originally thought by Davis. In order to eliminate this possibility, Segars and Grover (1993) suggest that the model should be rigorously tested. To date this has been done through various studies that have either retested the original model in different technology contexts or tested the model with added constructs in different technology contexts. Adams, Nelson and Todd (1992), Hendrickson, Massey and Cronan (1993), and Mathieson (1991) are examples of studies that have tested and validated the perceived usefulness and perceived ease of use scales. Hendrickson, Massey and Cronan (1993) found that the TAM model's scales of the perceived ease of use and perceived usefulness constructs demonstrate a high degree of test-retest reliability.

Many technology adoption studies have found perceived usefulness to have a positive affect on system usage, including Adams, Nelson and Todd (1992), Al-Gahtani and King (1999), Davis (1989; 1993), Davis, Bagozzi and Warsaw (1989), Doll, Hendrickson and Deng (1998), Straub, Limayem and Karahanna-Evaristo (1995), Szajna (1996), and Thompson, Higgins and Howell (1991). Perceived usefulness is in turn affected by perceived ease of use (Adams, Nelson and Todd, 1992; Davis, 1989; Davis, Bagozzi & Warsaw, 1989; Goodwin, 1987). This affect has been found to be a strong one (Davis, 1993; Davis, Bagozzi & Warsaw, 1989; Igbaria, et al., 1997).

After analysing eleven different TAM studies, Nelson and Shaw (2001) found that perceived usefulness was by far “...*the most common direct determinant of BI* [behavioural intention]”. The eleven studies although ranging in technologies, from the

World Wide Web to graphics software, still came to the same conclusion – perceived usefulness is a direct determinant of behavioural intention. Thus this lends support to the TAM model's external validity and generalisability.

However, in many studies perceived ease of use has been found to be substantially less significant in predicting usage than perceived usefulness, including Davis's original 1989 study where one of the most significant findings was that the 'usefulness – usage' relationship was stronger than the 'ease of use – usage' relationship. However, perceived ease of use is highly significant in the initial decision to use a technology (Adams, Nelson & Todd, 1992; Davis, Bagozzi & Warsaw, 1989; Moore & Benbasat, 1991), hence before perceived usefulness plays a part in the intention to adopt.

Venkatesh (1999) states that a great challenge for IS researchers and practitioners has been creating user intentions to adopt new technologies. In his study, Venkatesh (1999) found that using intrinsic motivators during training helped to create favourable user reactions to the new technology. Iivari and Maansaari (1997) define an intrinsic motivator, in this context, to be a technology that is "*enjoyable and fun*" to use; while an extrinsic motivator is "*useful and beneficial*". Thus in TAM, perceived ease of use is intrinsic motivation and perceived usefulness is extrinsic motivation.

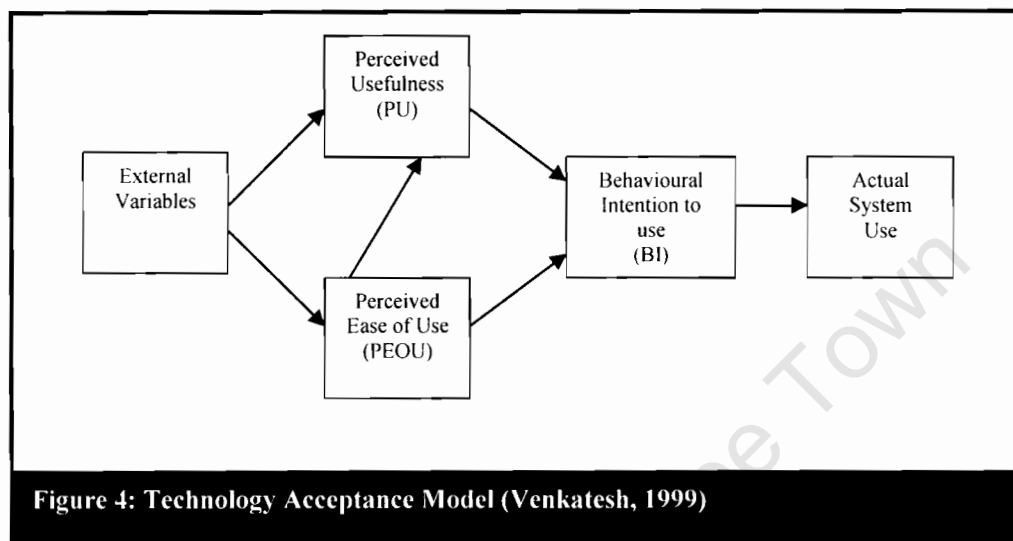
Gefen and Straub (2000) hypothesize that perceived ease of use will affect technology adoption only when technology provides the main service or product, i.e. when technology is the "*central component of the process*". Venkatesh (1999) explains further that perceived ease of use is a process expectancy and perceived usefulness an outcome

expectancy. This implies that perceived ease of use is directly significant only until the user is able to competently use the new technology, while perceived usefulness is always directly significant. Thus perceived ease of use affects adoption strongly in initial acceptance. So it follows that taking cognizance of perceived ease of use in the training stage is beneficial to increasing the rate of adoption (Nelson, Kattan & Cheney, 1991).

Perceived ease of use acts both directly and indirectly through perceived usefulness as “*the easier a technology is to use, the more useful it can be*” (Venkatesh, 1999). Goodwin (1987, as cited in Igarria, et al., 1997) concurs: “...*the effective functionality of a system (perceived usefulness) depends on its usability (perceived ease of use)*”. With time and experience perceived ease of use affects adoption indirectly through perceived usefulness (Davis, Bagozzi & Warsaw, 1989; Szajna, 1996). Mathieson (1991) and Szajna (1996) found that over time perceived ease of use accounted for a significant portion of variance in perceived usefulness. This indirect affect of perceived ease of use is sometimes shown in the TAM model by a relationship between perceived ease of use and perceived usefulness. As perceived ease of use is strongly affected by experience, Davis and Venkatesh (1996) have stated that it embodies the construct of self-efficacy – which is viewed as a separate construct in some of the other adoption models.

One of the TAM model’s great strengths is that it works well in varying technological and organisational contexts (Subramanian, 1994). This is due to its robustness and the high internal validity of its constructs; the Cronbach alpha for perceived usefulness and perceived ease of use both exceeded 0.90 in the original study (Davis, 1989). The versatility of TAM has been shown through various studies including e-mail and graphics

(Davis, 1989), spreadsheets (Mathieson, 1991), voice-mail and word processors (Adams, Nelson & Todd, 1992; Chin & Todd, 1995), database management systems (Szajna, 1994), group support systems (Chin & Gopal, 1995), adaptive technology for the physically challenged (Goette, 1995), negotiation support systems (Lim, Gan & Chang, 2002), mobile commerce (Saljoughi, 2002), eGovernment (Gefen, et al., 2002), and the world wide web (Lucy & VanLengen, 2002). Through the TAM model's various studies it has evolved slightly into the model illustrated below in Figure 4, which this study uses.



To increase the TAM model's robustness and generalisability, Davis (1989) included the construct of external variables to the model. This construct can be used to model environmental variables that are prominent to the adoption of the technology under study. Various studies have included external variables such as extrinsic and intrinsic motivators (Davis, Bagozzi & Warsaw, 1992; Igarria, Iivari & Maragahh, 1995), task-to-technology fit (Keil, Beranek & Konsynski, 1995; Satzinger & Olfman, 1995), prior experience

(Taylor & Todd, 1995a), and computer self-efficacy (Compeau & Higgins, 1995; Igbaria & Iivari, 1995).

The TAM model is still used today as the main technology adoption model in the IS field, however the model only gives a superficial view of the situation; it lacks the richness that some of the other adoption models give. Davis acknowledges this and explains that TAM sacrifices some richness for parsimony, as parsimony allows the model to be easier to use; and thus used more in practice. Thompson (1998) supports this view and adds that not only is TAM parsimonious and easy to understand, but “...provides reasonable explanatory value under a variety of conditions”.

A notable exclusion from the TAM model has been the subjective norm construct. Subjective norm refers to “...the person's perception that most people who are important to him think he should or should not perform the behavior in question” (Fishbein & Ajzen 1975, p. 302). Davis (1989) excluded the subjective norm construct in his original study due to “measurement problems”. Since then the construct has been added to the TAM model in various studies, however the empirical evidence of its role has been mixed. Many studies have proven empirically that subjective norms directly influence behavioural intention towards the adoption of a new technology (Ajzen, 1991; Chang & Cheung, 2001; Karahanna, Straub & Chervany, 1999; Kwon & Chidambaram, 2000; Lau, Yen & Chau, 2001; Limayem, Khalifa & Frini, 2000; Morris & Dillon, 1997; Randolph, 1999; Segars & Grover, 1993; Venkatesh, 2000; Xia & Lee, 2000). Mathieson (1991), Taylor and Todd (1995a), Thompson (1998), and Malhotra and Galletta (1999) successfully operationalised the construct, and Igbaria, Iivari and Maragahh (1995) and

Igbaria and Iivari (1995) found some support for it. On the other hand, Adams, Nelson and Todd (1992) and Szajna (1994; 1996) omitted the construct completely, while Davis, Bagozzi and Warsaw (1989), Hartwick and Barki (1994), Mathieson (1991), and Taylor and Todd (1995b) found the construct to be non-significant. Sheppard, Hartwick and Warsaw (1988) found subjective norm to be the weakest predictor of behavioural intention.

One of the reasons for the mixed findings may be that subjective norm tends to only have a significant effect in voluntary adoption settings, and then only in the early stages of adoption (Hartwick & Barki, 1994). Venkatesh and Davis (2000) showed that the direct effect of subjective norm is significantly moderated by voluntariness when the adoption context is a non-mandatory one. The construct has the strongest influence in the early stages of adoption and that influence diminishes over time as the users gain experience (Venkatesh & Morris, 2000). Lopez and Manson (1997) add that the subjective norm must be used in the early stages of adoption to improve the perceived usefulness of the new technology.

Another reason for this mixed result has been explained by Conner and Armitage (1998), Davis, Bagozzi and Warsaw (1989), and Lee, Lee and Lee (2001) as being caused by problems with its measurement, and failure to consider all of the relevant social factors. And finally Mao and Palvia (2001) and Taylor and Todd (1995b) explain the mixed result to be caused by the fact that the studies that found subjective norm to be insignificant involved student subjects, who have no real consequences resulting from their adoption behaviour.

2.4 Technology Acceptance Model 2

There are other researchers, such as Agarwal and Prasad (1997), Lucas and Spitler (1999), and Szajna (1996) that also have the view that TAM should include other constructs in order to better explain the adoption intention. To increase the richness that TAM gives, Davis partnered with Venkatesh to develop the Technology Acceptance Model 2 (TAM2) (Venkatesh & Davis, 2000). TAM2 adds richness to the analysis of an adoption situation by adding social influence processes and cognitive instrumental processes (Venkatesh & Davis, 2000). The constructs contained in the social influence processes are *subjective norm*, *voluntariness*, and *image*, while those contained in the cognitive instrumental processes are *job relevance*, *output quality*, and *result demonstrability*. Subjective norm, from TRA, was brought into TAM (to be called TAM2) after it was realised that it was an important variable in adoption analysis. Voluntariness was also included so that voluntary and mandatory adoption of a new technology could be measured by the TAM2 model, as shown in Figure 5.

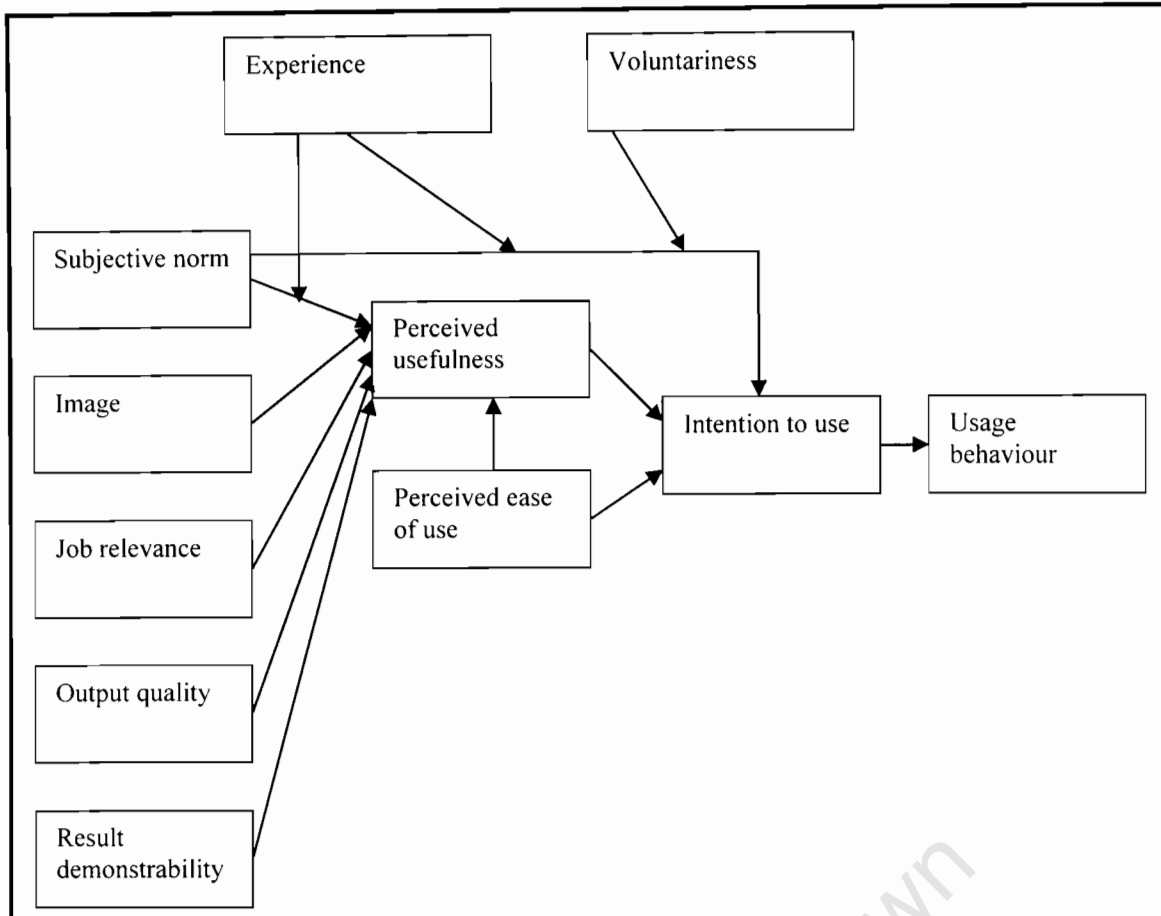


Figure 5: Technology Acceptance Model 2 (Venkatesh & Davis, 2000)

The usefulness of a system is often most easily seen through the results that the system produces. However, it is possible for a system to be effective without producing distinct results. This situation hampers the adoption process as the potential users are unable to see the results and thus unable to gauge the usefulness of the system. Venkatesh and Davis (2000) came across this situation and incorporated a construct that would measure it in their TAM2 model. This construct they called *result demonstrability*. In the TAM2 model, Venkatesh and Davis (2000) placed the result demonstrability construct as a determinant of perceived usefulness.

Venkatesh and Davis (2000) encountered another situation that could affect technology adoption and developed a TAM2 construct for it called *image*. The image construct would come into effect when adopting a technology could affect the attainment of group goals. Venkatesh and Davis (2000) argued that the greater the image, the greater the support from the group; thus through greater group membership, group goals could be attained. This attainment of group goals tends to lead to greater productivity and performance of the organization as a whole.

Job relevance was added as a construct by Venkatesh and Davis (2000) to measure the direct effect a new technology would have on the user's job tasks. This construct is a direct determinant of perceived usefulness. The job relevance construct was inspired by the task-technology fit models of Keil, Beranek and Konsynski (1995) and Satzinger and Olfman (1995).

Output quality was added as a construct by Venkatesh and Davis (2000) to measure the effect a new technology would have on the user's output. This construct fills the gap between result demonstrability and job relevance, as it measures the effect a new technology will have on the results produced by the user's job. The output quality construct is a direct determinant of perceived usefulness in the TAM2 model.

Experience was another construct that was added because it was found to be a significant predictor of the intention to adopt a technology. Computer self-efficacy falls within the realm of the experience construct.

Harrison and Rainer (1992) and Igbaria and Iivari (1995) support the idea that the more experience with computers a user has, the higher their computer self-efficacy. However, Handzic and Low (1999) report that there has been mixed findings on the impact of experience on perceptions, attitudes or behaviour towards technology.

Bandura (1986) defines self-efficacy as, “*People’s judgements of their capabilities to organise and execute courses of action required to attain designated types of performances. It is concerned not with the skills one has but with judgements of what one can do with whatever skills one possesses*” (p. 391).

Compeau and Higgins (1995) define computer self-efficacy as, “*...an individual’s perceptions of his/her ability to use computer (software) in the accomplishment of a task*” (p. 191).

Compeau and Higgins (1991) suggest that self-efficacy is affected by the three main factors of prior experience, environmental characteristics and observational learning. Observational learning is made up of encouragement by other users, other users’ actual use and organisational support (Compeau & Higgins, 1991). Of the three main factors however, prior experience has undoubtedly the strongest influence on self-efficacy (Bandura, 1977; 1982). Although it is clear that self-efficacy is affected by training, it should also be noted that the motivation to attend training is affected by the level of self-efficacy. Computer self-efficacy has been empirically shown to affect a person’s motivation to take part in computer training and adopt a new computer technology

(Compeau & Higgins, 1995; Compeau, Higgins & Huff, 1999; Webster & Martocchio, 1993; Yi & Davis, 2001).

Venkatesh and Davis (1994), from analysing past research in both the IS and social psychology fields, found that both perceived ease of use and computer self-efficacy are important and significant factors affecting perceptions about adopting new technologies and innovations.

Davis (1989) based the construct of perceived ease of use, used in the TAM model, on the theory of self-efficacy (Venkatesh & Davis, 1994). This was supported by Hill, Smith and Mann's (1987) research that operationalised self-efficacy in a similar way to perceived ease of use.

Over the years various studies have demonstrated different roles for the computer self-efficacy construct: Compeau and Higgins (1995) found it to be a significant determinant of usage; Hill, Smith and Mann (1987) found it to be a significant determinant of behavioural intention; Taylor and Todd (1995b) found it to be a significant determinant of perceived behavioural control, which is a determinant of behavioural intention and usage; and Venkatesh and Davis (1994) found it to be a significant determinant of perceived ease of use, which is a determinant of perceived usefulness and behavioural intention.

Venkatesh and Davis (1996) modeled computer self-efficacy as an antecedent of perceived ease of use based on Compeau and Higgins's (1995) computer self-efficacy

scale. The reason behind this was that a person will use their perception of their own computer abilities to judge the ease of use of a new software or technology. Also, the higher a person's computer self-efficacy, the greater their knowledge gained from prior experience, and thus the easier the new software or technology is to use (Dishaw, Strong & Bandy, 2002).

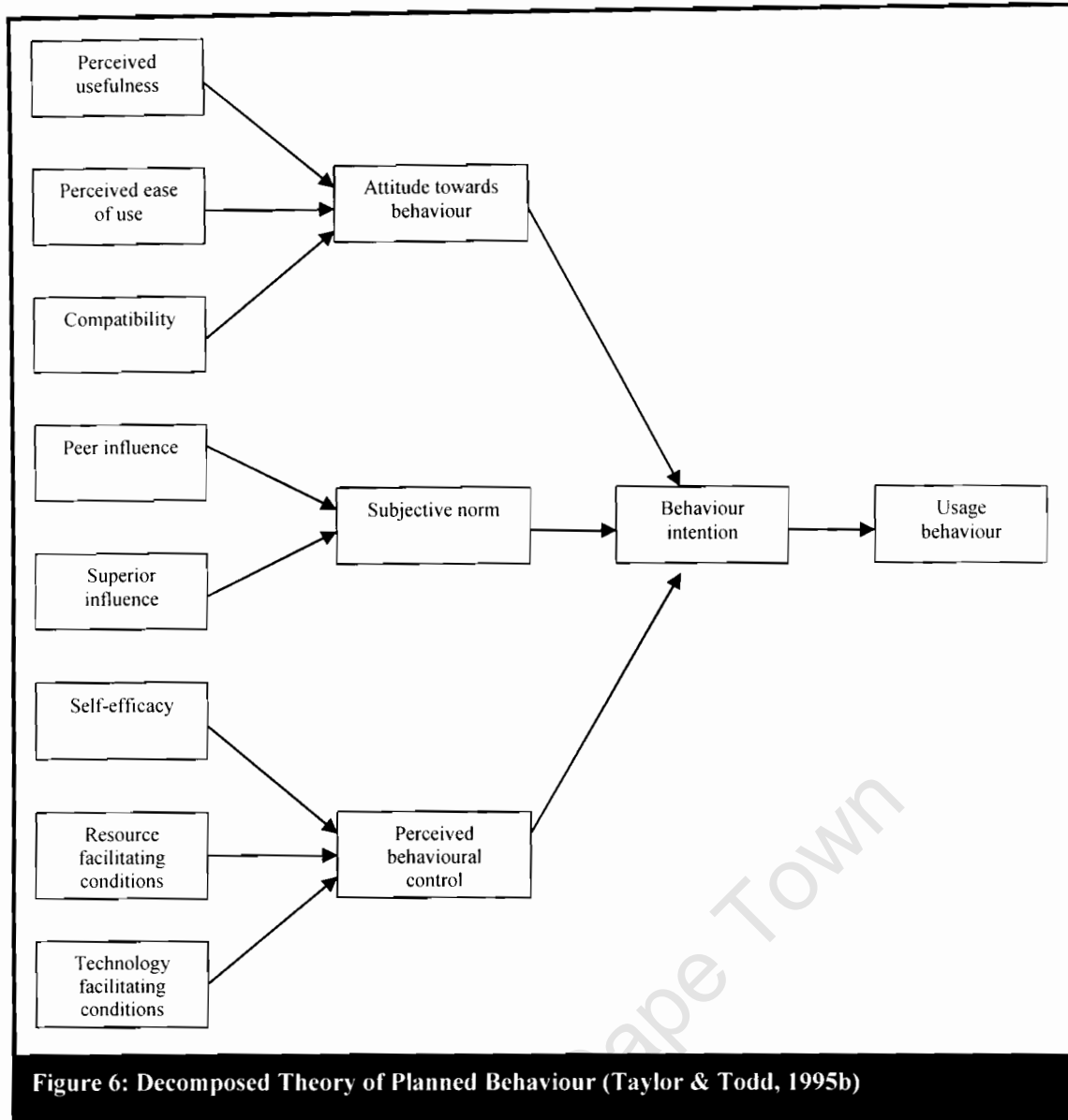
Many studies have demonstrated a strong relationship between computer self-efficacy and individual reactions to adopting computer technology (Compeau & Higgins, 1995; Hill, Smith & Mann, 1987; Kelley, Compeau & Higgins, 1999; Taylor & Todd, 1995a; Venkatesh & Davis, 1996). This could be due to the users feeling more at ease using computers and are more confident that they will be able to complete the required tasks with computers. Gravill, Compeau and Marcolin (2002) suggest that computer self-efficacy plays a major role in a person's ability of self-assessment; the better their ability of self-assessment, the more aware they are of their capabilities and thus the more confident and open to adoption. Computer self-efficacy can be measured and each person has a certain range of computer self-efficacy. If a new system or technology falls within that range then it is accepted, but if it falls outside of that range then it is likely to be rejected (Venkatesh & Davis, 1996). Therefore, it is the task of managers to increase the computer self-efficacy of users, so that they will be more likely to adopt new systems and technologies.

Compeau, Higgins & Huff (1999) add that adoption is not just about persuading people to use a new technology, but rather it is about training and encouraging the adopters to

ensure that they have the requisite skills and confidence, i.e. a high computer self-efficacy, to adopt the new technology successfully.

2.5 Decomposed Theory of Planned Behaviour

Taylor and Todd (1995b) followed in Davis's footsteps, but instead of using the theory of reasoned action as a base they used the theory of planned behaviour. By dividing up the three main constructs of the TPB model to further explain them, Taylor and Todd (1995b) developed the richer Decomposed Theory of Planned Behaviour (DTPB), as shown in Figure 6. In DTPB attitude toward behaviour is divided into *perceived usefulness*, *perceived ease of use* and *compatibility*; subjective norm is divided into *peer influence* and *superior's influence*; while perceived behavioural control is divided into *self-efficacy*, *resource facilitating conditions* and *technology facilitating conditions*. Compatibility "... is the degree to which the innovation fits with the potential adopter's existing values, previous experience and current needs" (Rogers, 1995, as quoted in Taylor & Todd, 1995b, p. 152). Self-efficacy is "...an individual's self-confidence in his/her ability to perform a behaviour" (Taylor & Todd, 1995b, p 150). Resource and technology facilitating conditions refer to the availability of money, time and technology in order to make use of the new innovation.



The perceived behavioural control (PBC) construct was developed by Ajzen (1985) to better explain intention and behaviour in mandatory adoption situations. Ajzen (1985; 1991) included this construct in his TPB model. Unfortunately not many studies have been conducted that utilised the TPB model, exceptions include Mathieson (1991) and Taylor and Todd (1995b), so it is unclear whether the perceived behavioural control construct can explain mandatory adoption better than the TRA and TAM models. In a

study that Rawstorne, Jayasuriya and Caputi (2000) conducted, they found no evidence that the perceived behavioural control construct in the TPB model explained more variance than the TRA or TAM models in volitional or mandatory adoption situations. On the other hand, Pedersen and Nysveen (2002) found that the perceived behavioural control construct increased the explanatory power of the TPB model. Perceived behavioural control and perceived ease of use have a somewhat tenuous link in that if a new technology is perceived as easy to use, then perceived behavioural control will be high (Choi, et al., 2003; Davis, 1989; Karahanna, Straub & Chervany, 1999; Morris & Dillon, 1997; Segars & Grover, 1993; Venkatesh, 2000).

The DTPB model's great advantage comes from the fact that it is decomposed into several constructs for each of the core belief structures, namely attitudinal, normative and control beliefs. Because the belief structures are decomposed into several constructs, the adoption intentions can be mapped to their sources with more ease. Thus the relationships between cause and effect (source of influence and adoption intention) can be more clearly seen and understood (Lau, Yen & Chau, 2001). Further, because each construct only measures a certain aspect of a belief structure, the measurement model of the set of beliefs becomes more stable and thus more generalisable over a variety of different contexts. Taylor and Todd (1995b) suggest that this overcomes some of the "*disadvantages in operationalisation*" that some authors (Berger, 1993 as cited in Taylor & Todd, 1995b; Mathieson, 1991) have found in other adoption models.

By decomposing each belief structure into several constructs, the model becomes more manageable in a practical sense. The users of the model can identify which adoption

factors to concentrate on in order to improve the rate and level of adoption. These adoption factors can be addressed in the design and implementation phases of new technologies and systems. This makes the DTPB model more attractive to managers and systems designers, and thus a more practical model in industry (Taylor & Todd, 1995b).

However, because the belief structures are divided into several constructs, the DTPB model is more complex. This increased complexity makes the DTPB model more difficult to use than a parsimonious model such as TAM, which in turn can make DTPB a less attractive choice for practical use. On the other hand, researchers should relish the prospect of using the DTPB model as it gives a more complete picture of the adoption situation than the parsimonious TAM model. Thus it is clear that for just predictions of usage a parsimonious model, such as TAM, is preferable. While in situations where an understanding of the causality of intentions, or lack thereof, is necessary, the DTPB model is preferable, as evidenced by Pedersen (2002) and Wungwanitchakorn (2002).

In a study by Brown, et al. (2002), the TAM, TPB and DTPB models were compared and DTPB was found to explain the most variance through providing the greatest detail. Another of the important findings of this study was that compatibility predicted satisfaction better than perceived usefulness predicted satisfaction when independently considered. Other studies that confirm that compatibility is a better predictor than perceived usefulness are Karahanna, Straub and Chervany (1999) and Staples, Wong and Seddon (2002).

2.6 Perceived Characteristics of Innovating

Rogers's (1983) diffusion of innovations theory is one of the most popular and most cited reviews of perceived characteristics literature. Rogers (1983) reviewed thousands of innovation studies and identified some characteristics that affected the rate of innovation diffusion. He identified five perceived characteristics of innovating (PCI), namely *relative advantage*, *compatibility*, *trialability*, *complexity* and *observability*. Moore and Benbasat (1991) looked at Rogers' diffusion of innovations theory and developed their own adoption model, the Perceived Characteristics of Innovating (PCI), containing 8 key constructs that they tested on individuals adopting personal work stations.

The number of constructs in PCI is substantially more than that in TAM or TPB, but Plouffe, Hulland and Vandenbosch (2001) found that PCI explained a higher proportion of variance than TAM or TPB; PCI explained about 12% more variance in adoption intention. They explain that this may be because a model that captures more richness is better able to explain adoption behaviour in different contexts. Plouffe, Hulland and Vandenbosch (2001) continue further to state "*IS researchers often cite or discuss Moore & Benbasat's PCI constructs as valid and reliable candidates for modelling various technology adoption decisions*", however researchers seldom use the model. The few studies that have used the model include Agarwal and Prasad (1997; 1998), Gagliardi and Compeau (1995), Karahanna, Straub and Chervany (1999), Lowry (2002), Moore and Benbasat (1994), Riemenschneider, Hardgrave and Davis (2002), and Venkatesh and Brown (2002). Plouffe, Hulland and Vandenbosch (2001) conclude that researchers should pay more attention towards PCI as, although it is not as parsimonious as TAM, it is more robust and captures more richness than TRA, TPB and TAM.

The PCI model takes four constructs from Rogers (1983), namely *relative advantage*, *compatibility*, *trialability*, and *complexity*, and adds four more, namely *visibility*, *image*, *result demonstrability*, and *voluntariness*. *Complexity* was renamed to *ease of use* in order to make PCI consistent with other technology adoption models. Observability was split into two different constructs, namely visibility and result demonstrability, as Moore and Benbasat (1991) felt that observability was too complex because it was “...*tapping two distinctly different constructs*”. Although image first appeared in PCI as a separate construct, it was considered previously to be a component of the perceived usefulness / relative advantage construct by Davis (1989), Davis, Bagozzi and Warsaw (1989) and Rogers (1983).

PCI and TAM2 are the only adoption models to contain the construct of voluntariness, which Moore and Benbasat (1991) found to have an evident effect on usage. Although voluntariness appears to be a simple Boolean construct, this is not the case. Voluntariness should actually read ‘perceived voluntariness’ because although adoption may not be mandatory, some adopters may feel a degree of influence or pressure to adopt. It follows therefore that it is not the actual voluntariness that will cause a potential adopter to adopt but rather their perception of the voluntariness (Moore & Benbasat, 1991). However, Agarwal, Prasad and Zanino (1996) found that the intention to adopt was only weakly dependent upon perceived voluntariness.

Lowry (2002) and Moore and Benbasat (1991) found through factor analysis that relative advantage and compatibility are not mutually exclusive constructs. Components of the

two constructs interrelate to the point of there being no need for the constructs to be separate. Moore and Benbasat (1991) suggest that the reason for this lies in the fact that if a technology is not compatible with the adopter's job, then it is unlikely that the technology will impart any advantages to the adopter. However, Moore and Benbasat (1991) tested the differences between the constructs with adopters and non-adopters and found those differences to be significant, thus the two separate constructs were maintained.

Agarwal and Prasad (1997) found that relative advantage and result demonstrability are important predictors of technology adoption, so it is important for managers to bring a new technology's benefits to light through persuasion and practical initiatives. Zmud (1983) suggests that training, seminars, newsletters and opinion leaders are good initiatives to highlight a new technology's benefits. Although talking about a new technology's benefits is a good initial step, actual practical experience within the desired environmental context, called initial use, is a necessary step in forming a potential adopter's perceptions about a new technology (Barki & Hartwick, 1989). Initial use affects more than just relative advantage and result demonstrability, but also the perceived innovation characteristics of compatibility, visibility, trialability and voluntariness.

In a study by Lowry (2002) it was found that in a management system context relative advantage, result demonstrability and visibility were the best predictors of adoption variance, while ease of use, trialability and image were the weakest. Lowry's (2002) study also found that relative advantage was a more significant predictor of adoption

variance than ease of use, which is in line with Davis's (1989) findings for perceived usefulness and perceived ease of use.

2.7 Adoption Model Comparisons

Due to the fact that there are different adoption models that measure different aspects of adoption, and were developed in different fields; Venkatesh and Brown (2002) suggest that comparison studies of the different models should be undertaken. However, thus far very few comparison studies have been undertaken, namely Davis (1989), Mathieson (1991), Taylor and Todd (1995b), Chau and Hu (2001), Plouffe, Hulland and Vandebosch (2001), Venkatesh and Brown (2002), Riemenschneider, Hardgrave and Davis (2002), and Venkatesh, et al. (2003). Table 1 shows the models that each study has compared, as well as their contexts and findings.

According to Venkatesh and Brown (2002) the better an adoption model can generalize to new situations, the more robust it is considered to be. Therefore it is important to test existing adoption models in new settings and contexts in order to determine their robustness. This can be achieved through model comparison, which this study intends to do. If the adoption models are supported then they gain further empirical evidence of their robustness, however if they are not strongly supported the models do not get a 'black mark' next to their names. Instead if weaknesses are found or strong support is lacking, this empirical evidence can be used to help define the model's boundaries and support researchers in extending or modifying the model to make it more generalisable, say Venkatesh and Brown (2002).

| Study | Models Compared | Context | Findings |
|---|---|--|--|
| Davis (1989) | TRA, TAM | PROFS email, XEDIT file editor, Chart-Master and Pendraw | TAM superior to TRA in explaining variance. |
| Mathieson (1991) | TPB, TAM | An information system (including spreadsheets) | TAM explained more variance than TPB. TPB delivered more specific acceptance information than TAM. |
| Taylor & Todd (1995b) | TPB, TAM, DTPB | Computer resource centre | Superiority of DTPB over TAM and TPB. |
| Chau & Hu (2001) | TPB, TAM, DTPB | Telemedicine technology | Limitations of TAM and TPB in explaining telemedicine technology. Slight superiority of DTPB over TAM and TPB. |
| Plouffe, Hulland & Vandenbosch (2001) | TAM, PCI | Smart card-based payment system | Superiority of PCI over TAM. |
| Venkatesh & Brown (2002) | TRA, TPB, TAM, DTPB, MM, Innovation Diffusion Theory (IDT) | Personal Computing | Superiority of TPB and DTPB. |
| Riemenschneider, Hardgrave & Davis (2002) | TAM, TAM2, PCI, TPB, MPCU | Software developer acceptance of methodologies | Extension of the boundaries of the models to include methodologies. |
| Venkatesh, et al. (2003) | TRA, TPB, TAM, Social Cognitive Theory (SCT), DTPB, IDT, MM, MPCU | New technology in the workplace | Development of a unified model of technology acceptance and use. |

Table 1: Studies comparing different adoption models

2.8 Adoption Models in Practice

Organisations invest in information systems to increase productivity, effectiveness, quality and many other attributes. However, for this to occur it is necessary for the employees to use the new information systems. Thus it is important for managers and

system designers to be able to predict and measure system use (Lucas & Spitler, 1999). Adoption models are the enablers for this to occur. Thus managers that can predict and influence technology use can gain more benefits from IS than those managers that ignore the issue.

Organisations also make use of information systems to achieve returns on investment. Organisations that have managers that are able to understand, predict and influence technology use are in a better position to increase their returns on investment (Lucas & Spitler, 1999). A further advantage to organisations of managers with adoption knowledge is that the new systems can be tested on a trial basis and user reactions assessed before making costly purchase decisions (Davis, Bagozzi & Warsaw, 1989). This reduces return on investment risk by weeding out systems that are doomed to be rejected by users (Doll, Hendrickson & Deng, 1998).

Doll, Hendrickson and Deng's (1998) study found that users can form usefulness and ease of use beliefs about a new system after only a brief exposure. This study therefore lends support to TAM for use in pre-purchase decisions. Doll, Hendrickson and Deng (1998) claim that novice and experienced users can form usefulness and ease of use beliefs about a system equally well, so managers need not only rely on expert users.

According to Al-Gahtani (1998) managers and systems designers will be able to better design and implement systems and system measurements if they understand user perceptions and attitudes towards that type of system and its environment. This understanding can be attained through the use of adoption models.

According to Agarwal and Prasad (1997) many researchers of adoption models turned to independent variables that included perceived innovation characteristics. Agarwal and Prasad (1997) tested this belief and found that perceived innovation characteristics, such as relative advantage, compatibility, trialability, complexity and observability, do indeed explain acceptance behaviour, further that this acceptance behaviour can be influenced by external pressures, and finally that user perceptions explain a substantial amount of the variance in current and future use intentions. This is an important finding as it means that managers are able to influence their employees' perceptions about adopting a new technology. All of the adoption models in this study make use of constructs containing perceived innovation characteristics.

Not all perceived innovation characteristics influence technology adoption in every context, so it is important for managers to pinpoint the innovation characteristics that are important for their particular technology context and concentrate on those, suggest Agarwal and Prasad (1997). Thus an organisation's limited resources will be effectively allocated.

Agarwal and Prasad (1997) suggest that because all of the technology adoption models are based on the same set of perceived innovation characteristics, it is important for the Information Systems research community to agree upon "...a stable set of perceptions that have theoretical and practical merit" (Agarwal & Prasad, 1997, p. 576).

2.9 CASE Tools

Computer-Aided Software Engineering (CASE) is defined by Hyper Dictionary as “*a technique for using computers to help with one or more phases of the software life-cycle... [that] involves software tools*” (www.hyperdictionary.com). CASE is a term that came to the fore in the late 1980’s. And, although it became a buzz word in the Information Systems industry, just like CRM (Customer Relations Management) and ERP (Enterprise Resource Planning), it is not a methodology in itself. Rather CASE is a way of implementing a methodology that will help an organisation to plan, analyse, design and develop systems more effectively and efficiently (Gibson, Snyder & Rainer, 1989). Jankowski (1997) suggests that the role of a CASE tool is “*...to serve as a methodology companion*”.

CASE tools became popular within the Information Systems industry in the late 1980’s and early 1990’s (Banker & Kauffman, 1991; Flatscher, 1993; Orlikowski, 1993). Reasons for this include faster development cycles and standardised documentation (Flatscher, 1993); decreasing the maintenance burden of in-house created software (Orlikowski, 1993); and enhancing effectiveness, efficiency and quality through software reuse and a standardised, consistent picture of data (Banker & Kauffman, 1991; Finlay & Mitchell, 1994).

Case (1985), Freedman (1986) and Stamps (1987), as cited in Orlikowski (1989), suggest further advantages of CASE tools including responsiveness to change of requirements, decreased loss of knowledge due to staff turnover, ability to solve large, complex problems, increased development productivity and decreased development time. These

advantages are due to the functionality provided by CASE tools; however, each CASE tool tends to provide its own subset of functionality. Orlikowski (1989) suggests that a good CASE tool should provide at least the following functionality:

- screen and report design aids
- text and diagram editors
- data modeling tools
- data dictionaries
- code generators
- testing and debugging tools

And Gibson, Snyder and Rainer (1989) add:

- storing, reviewing and updating how business systems function
- reengineering tools

Because of the wide use of CASE tools, it is important for students to have exposure to them in order to improve their competitive advantage. Organisations will also benefit from the students' CASE tool experience as they will be able to recruit graduates capable of using CASE tools with minimal training.

Although minimising training appears to be one of the advantages of CASE tools, due to the automation of systems development tasks, this is definitely not the situation. The computer industry's sales and marketing departments have led us to believe that automation of tasks leads to a lesser need of staff training; however with CASE tools this is definitely not the situation. CASE tools require the users to have more training to gain greater skills and rigour, which are needed to properly analyse and design systems in

modelling languages (Albizuri-Romero, 2000; Iivari, 1996). These skills and rigour can be learnt by students, thereby making them more attractive graduate recruits. Thus this is another reason why it is important for students to have exposure to CASE tools.

CASE tools can be divided into three categories, namely upper CASE, lower CASE, and integrated CASE (iCASE). Upper CASE provides support for the earlier stages of the systems development life cycle, i.e. analysis and design. This support is mainly through visual modelling, using languages such as the Unified Modelling Language (UML). Lower CASE provides support for the later stages of the systems development life cycle, i.e. building and maintenance. This support is chiefly through code generation and testing. Integrated CASE provides support for the whole systems development life cycle, from analysis to testing (DuPlessis, 1993), and focuses on integration via a central repository. Examples of leading integrated CASE tools are Enterprise Architect, AllFusion Suite and Rational Rose, the CASE tool with which this study is concerned. This study tests the adoption, via four adoption models, of Rational Rose amongst students.

2.10 Choice of Models

The four adoption models that are compared in this study are:

- Technology Acceptance Model (TAM) (Davis, 1989)
- Technology Acceptance Model 2 (Venkatesh & Davis, 2000)
- Decomposed Theory of Planned Behaviour (DTPB) (Taylor & Todd, 1995b)
- Perceived Characteristics of Innovating (PCI) (Moore & Benbasat, 1991)

These four models were selected mainly because they are the four technology adoption models that are most cited in the literature; a fifth is also heavily cited, the theory of planned behaviour (Ajzen, 1991), but it is just a simpler version of the DTPB. A further reason for their selection is that the TAM2, DTPB and PCI models address both the human and technical sides of technology adoption; however the constructs used differ somewhat between models. The importance of addressing both the human and technical sides of adoption stems from the desire to gain a complete picture of the situation. If both sides of the adoption can be measured and understood, then both the human and technical issues can be predicted and addressed if necessary.

TAM was chosen because it represents the technology adoption model most cited in the literature and most used by researchers to measure and predict technology adoption. Through its abundant use the TAM model has been proven reliable and valid, so it can be considered the control model, i.e. if the TAM model is not supported in this study, then the data collection technique or research sample may be suspect and the methodology for the study may have to be redesigned.

2.11 Objectives

1. *To empirically compare the four adoption models:* A comparison of the four adoption models to determine the constructs that are most prevalent to the context of the adoption of a CASE tool at a university.

2. *To empirically test each adoption model:* Individual tests of the validity and reliability of each of the adoption models via comparisons between this study's data and the original studies.
3. *To gauge the level of adoption of the CASE tool:* An estimation of the level of adoption of the CASE tool amongst the student participants in this study.

This research aims not only to compare the different adoption models and their usefulness in this adoption context, but also to analyse the adoption of Rational Rose as a CASE tool in the systems development process of 3rd and honours year IS students at UCT. The analysis of the CASE tool adoption should be complete due to the fact that four different adoption models are being used and that each model measures different aspects of technology adoption. The four models that are used in this research have proven to be strong, accurate and reliable adoption models in the literature. The four models are the Technology Adoption Model (TAM) (Davis, 1989); TAM2 (Venkatesh & Davis, 2000); the Decomposed Theory of Planned Behaviour (DTPB) (Taylor & Todd, 1995b); and the Perceived Characteristics of Innovating model (PCI) (Moore & Benbasat, 1991).

From the analysis of the CASE tool adoption, a comparison of the different adoption models can be made and their strengths, in this context, highlighted. From this comparison a new technology adoption model can be built from the strong aspects of each of the tested models. This new adoption model should give the most generalisable measurement of adoption in this context – the adoption of a CASE tool by students.

Adams, Nelson and Todd (1992) advocate the replication of adoption studies in order to build on the limited number of existing studies. This study will replicate the studies of the four models in a CASE tool context, and then analyse the results. A main hypothesis for the success of the replication of each original study has been formed; these include hypotheses H1, H2, H3 and H4. In order to analyse the four different adoption models their individual hypotheses will be tested. The strength of support for the hypotheses will determine the strength of the adoption models in this context. The hypotheses for the individual adoption models will be taken from the original studies for which they were developed, thus ensuring that the choice of the hypotheses used does not impact the outcome of this research. These sub-hypotheses fall under the main hypothesis for each model; for example the TAM model's sub-hypotheses, H1a, H1b, H1c and H1d, fall under the main hypothesis of H1.

This research also highlights the constructs that most strongly affect the adoption of CASE tools by students in a voluntary use environment. These constructs will help lecturers to more effectively structure a curriculum that is conducive to the adoption of CASE tools. This course of action is strongly supported by Lin, et al. (2001), who suggests that the constructs from different adoption models, when combined, may provide a more detailed explanation of adoption behaviour than an individual adoption model.

Finally, hypothesis H5 was formed so that this study can determine if the level of adoption of the Rational Rose CASE tool, by the information systems students at UCT, can be considered high.

2.12 Research Hypotheses

H1: This test of the Technology Acceptance Model is in concordance with the results obtained in the original study.

There will be a positive relationship between:

H1a: *Perceived Ease of Use* and *Perceived Usefulness*.

H1b: *Perceived Ease of Use* and *Behavioural Intention* to use the system.

H1c: *Perceived Usefulness* and *Behavioural Intention* to use the system.

H1d: *Behavioural Intention* to use the system and *Actual Use*.

H2: This test of Technology Acceptance Model 2 is in concordance with the results obtained in the original study.

There will be a positive relationship between:

H2a: *Perceived Usefulness* and *Intention To Use* the system.

H2b: *Perceived Ease of Use* and *Intention To Use* the system.

H2c: *Perceived Ease of Use* and *Perceived Usefulness*.

H2d: *Voluntariness* and *Intention To Use* the system.

H2e: *Subjective Norm* and *Intention To Use* the system.

H2f: *Subjective Norm* and *Perceived Usefulness*.

H2g: *Image* and *Perceived Usefulness*.

H2h: *Job Relevance* and *Perceived Usefulness*.

H2i: *Output Quality and Perceived Usefulness.*

H2j: *Result Demonstrability and Perceived Usefulness.*

H3: This test of the Decomposed Theory of Planned Behaviour model is in concordance with the results obtained in the original study.

There will be a positive relationship between:

H3a: *Perceived Usefulness and Attitude Towards Behaviour.*

H3b: *Perceived Ease of Use and Attitude Towards Behaviour.*

H3c: *Compatibility and Attitude Towards Behaviour.*

H3d: *Peer Influence and Subjective Norm.*

H3e: *Superior Influence and Subjective Norm.*

H3f: *Self-efficacy and Perceived Behavioural Control.*

H3g: *Resource Facilitating Conditions and Perceived Behavioural Control.*

H3h: *Technology Facilitating Conditions and Perceived Behavioural Control.*

H3i: *Attitude Towards Behaviour and Behavioural Intention.*

H3j: *Subjective Norm and Behavioural Intention.*

H3k: *Perceived Behavioural Control and Behavioural Intention.*

Because there were no specific hypotheses in the original Moore and Benbasat (1991) study, the Perceived Characteristics of Innovating model's hypotheses are structured in a similar way to the other models' hypotheses in this study.

H4: This test of the Perceived Characteristics of Innovating model is in concordance with the results obtained in the original study.

There will be a positive relationship between:

H4a: *Relative Advantage* and *Intention To Adopt* the system.

H4b: *Ease of Use* and *Intention To Adopt* the system.

H4c: *Compatibility* and *Intention To Adopt* the system.

H4d: *Image* and *Intention To Adopt* the system.

H4e: *Result Demonstrability* and *Intention To Adopt* the system.

H4f: *Visibility* and *Intention To Adopt* the system.

H4g: *Trialability* and *Intention To Adopt* the system.

H4h: *Voluntariness* and *Intention To Adopt* the system.

H5: The level of adoption of Rational Rose by UCT students is high.

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3. Methodology

This section reviews the methodology used in this study through stating the type of study, the data sample, the data collection and capture techniques, and the data integrity. This section also explores the possibility of generalising the results, explain the role of data, and determine the level of confidence of the data. The data collection instrument's construction and validity is also addressed.

3.1 Introduction

The information systems field makes use of models that it has developed as well as models from the field of psychology, but both are relevant as they deal with the way that individuals behave when confronted by technology. Many adoption models have been developed in the psychology and information systems fields, and most are quantitative in nature. The quantitative majority include the Theory of Reasoned Action (TRA) (Fishbein & Ajzen, 1975); the Theory of Planned Behaviour (TPB) (Ajzen, 1991); the Technology Adoption Model (TAM) (Davis, 1989); TAM2 (Venkatesh & Davis, 2000); the Decomposed Theory of Planned Behaviour (DTPB) (Taylor & Todd, 1995b); the Perceived Characteristics of Innovating model (PCI) (Moore & Benbasat, 1991); the Motivational Model (MM) (Vallerand, 1997); the Model of Personal Computer Utilisation (MPCU) (Thompson, Higgins & Howell, 1991); Concerns-Based Adoption Model (CBAM) (Hord, et al., 1987); and the Cognitive, Affective factors and Usage model (Compeau & Higgins, 1995). The qualitative technology adoption models include the Actor Network Theory (ANT) and Due Process (Latour, 1987; 1993). It is clear

therefore that the strongest and most widely supported technology adoption theories are of a quantitative nature, thus this study will follow a quantitative methodology.

Three of the studies tested in this paper, TAM, DTPB and PCI, have been tested and retested over a period of a decade, while the fourth, TAM2, although it has only been in existence for a few years, is based on heavily tested constructs. The data collection instruments that these studies use have also been extensively tested and validated through various studies over the years (Davis, 1989; Chau and Hu, 2001; Mathieson, 1991; Moore & Benbasat, 1991; Plouffe, Hulland and Vandenbosch, 2001; Riemenschneider, Hardgrave and Davis, 2002; Taylor & Todd, 1995b; Venkatesh and Brown, 2001; 2002; Venkatesh & Davis, 2000; Venkatesh, et al., 2003). Thus well established, quantitative, reliable and valid instruments are available to measure technology adoption. This study makes use of these four instruments to measure the adoption of a CASE tool, Rational Rose, amongst students. The four adoption models that are used for this paper are the Technology Adoption Model (TAM) (Davis, 1989), TAM2 (Venkatesh & Davis, 2000), the Decomposed Theory of Planned Behaviour (DTPB) (Taylor & Todd, 1995b), and the Perceived Characteristics of Innovating model (PCI) (Moore & Benbasat, 1991). The students used as subjects in the data collection for this research are discussed in more detail in following sections of this paper.

The generalisability of this study may be in question due to the fact that only student participants were used; however Xia and Lee (2000) believe that this does not necessarily have to be the case. Many of the technology adoption theories were created and validated using students as subjects. If the student participants were users of the new technology, if

the new technology was relevant and instrumental in their projects, and if the adoption process involved was similar to a real-world technology adoption situation, then the study can be considered generalisable. This study fits all three of the criteria, so can be considered generalisable, according to Xia and Lee (2000).

Straub, Keil and Brenner (1997) argue that TAM may not hold equally well across different cultures, which they found in Japan where TAM was not supported, and Switzerland where TAM was only moderately supported. This is a good argument to the possibility of this study not being generalisable to all cultures. As this study is undertaken in a South African context, which is a multi-cultural context, this argument should be borne in mind.

This study collates four existing technology adoption instruments into one questionnaire, which is the sole source of data for this study. The data that this questionnaire collected consists of primary data in the form of mental constructs, i.e. beliefs, attitudes and opinions. The reason for this comes from the field of psychology, where adoption models were born, which follows that beliefs and intentions relate strongly to behaviour. And the only way to predict future behaviour is to look at the patterns of behaviour formed in the past. Past behaviour forms our beliefs, attitudes and opinions, thus the questionnaire collected the beliefs, attitudes and opinions of the research subjects in order to determine their future adoption behaviours in relation to adopting the CASE tool, or not.

The role of data in this study is extremely important as the adoption theory relies solely on the data collected from the research subjects. The strengths and associations of the constructs of the models rely solely upon this data, and the conclusions of this study rely solely upon the strengths and associations of the constructs of the models. It is clear therefore that collecting the correct data is paramount to the success of this study. Thus problems that were taken into account include sampling problems, which is discussed below in sampling methods; observer errors – asking the wrong questions – which should have been neutralised due to the questionnaire being fully adopted from well established instruments; and recording errors, which is discussed below in data collection techniques.

This paper concentrates on theory testing – the testing of four existing technology adoption theories – and theory comparison. Through these two techniques this research should be able to pinpoint the strongest constructs in the technology adoption body of knowledge that apply to a CASE tool adoption context. Further this research identifies limitations of some of the technology adoption models tested, and this will help researchers to change or extend these models for the better in the future. Chau and Hu (2002) advocate this research methodology as it “*follows replication logic*” and thus builds onto the existing body of knowledge in an effective and productive manner. Compeau and Higgins (1995) add to the benefits of this methodology by reminding us that validity cannot be established in only one study, instead “...*validation of measures is an ongoing process*” that must be carried out over many studies in similar and different contexts. This study is the first to compare different adoption models in a CASE tool context. Further, this study is the first major adoption tool research in South Africa, to

the author's knowledge, which was established through much research and interviewing of academics.

Different technology adoption scenarios tend to affect the success of the different variables of adoption models in predicting adoption. Thus adoption model comparative studies should be carried out in all major technology adoption scenarios to help future adopters in these same scenarios select a model that will most accurately predict the adoption in their context. So it is important for a study, such as this, to be conducted in the CASE tool context and the results to be added to the technology adoption body of knowledge.

3.2 Sampling Methods

The participants in the study are 3rd and honours years (4th year) Information Systems (IS) students at the University of Cape Town (UCT). The students were invited to attend Rational Rose workshops, which formally introduced the CASE tool to them for the first time. These Rational Rose workshops were held for the first time as UCT only attained seed licenses for Rational Rose in 2003, the year the data for this study was collected. An estimated 130 students attended the workshops, thus the sample frame is 130 students. Of these 130 students 100 participated in answering the questionnaire, thus the research sample size is 100 students.

These 100 students effectively represent a random sample of IS students with only two things in common: they are completing an IS degree at UCT and they attended the Rational Rose workshop. The representativeness of this sample is sufficient for the

purpose of this study, namely to measure the level of adoption of a CASE tool amongst students, as the research sample makes up a high percentage of the sampling frame and individual subjects were chosen at random. The layout of the data collection instrument to be used also ensures representativeness, as only closed questions are asked, thus each respondent has the same set of options available to them when choosing answers to the questions. Because of the high level of representativeness in the data for this study, it is rational to assume that the data represents all of the data points not present, thus the data can be generalised for the context of CASE tool adoption amongst IS students.

The level of confidence of the data should be high as the research sample was chosen at random, thus ensuring random variation of biases. Further, the size of the research sample is large enough to perform meaningful statistics on the data. Also, the size of the research sample is inline with the size of the samples used in the original adoption studies. The data should also have a high generalisability as the research sample is very close to the sample frame, i.e. the research sample is 100 students, while the sample frame is an estimated 130 students.

The level of aggregation and sample size are not issues in this study, since adoption at an individual level is measured – the students worked on an individual basis - and the research sample closely represents the actual sample (the research sample is almost the same size as the sampling frame).

There were no ethical issues encountered in this research as there was no need to ask sensitive questions or obtain confidential information relating to the study participants.

3.3 Data Collection Techniques

This study is a comparison of four previous studies done on technology adoption models. All four of these previous studies used questionnaires as their main technique of data collection. As this study is a comparison of the previous studies, a replication of each study needs to be conducted first. In order to replicate these studies it is necessary to use the same data collection technique as the original studies used. In all four cases the questionnaire data collection technique was originally used, so this study makes exclusive use of the questionnaire data collection technique.

Instrument Construction

The questionnaires from the original studies were adapted and combined to form one questionnaire applicable to the context of students adopting a CASE tool, namely Rational Rose. The process of the questionnaire construction details as follows:

- The four original questionnaires were combined into one questionnaire
- Duplicate questions were dropped from the new questionnaire
- The wording of the questions was adapted to fit this study's context
- A seven point Lickert scale was added for the answering of the questions
- A focus group of experts studied the questionnaire and suggested minor changes
- The minor changes were made and the questionnaire layout was formatted to ease the participants' process of answering

Instrument Validity

The questionnaires collected data that is retrospective, subjective, researcher-driven and empirical. The data is retrospective because the questionnaires forced the respondents to think back to when they participated in the Rational Rose workshop and when they had used the Rational Rose CASE tool. The respondents gave subjective answers to the questions that are researcher-driven, as the researcher created the stimulus via the question asked. The data collected is purely empirical and quantitative as all the questions were closed questions.

The interpretation of the respondents' answers should be free of misunderstanding, since the questions are adapted from the original studies, which are tried and tested. The constructs of the models are conceptualised well and the questions that apply to these constructs relate well, as can be seen by the strong Cronbach alpha tests. The Cronbach alpha tests are used to determine the strength of the constructs' conceptualisation and validity (Cronbach, 1951). The 7 point Lickert scale is also adequate and appropriate to this questionnaire as it has been used in the original studies, which were found to be valid and reliable.

There is no room for interpretation (or misinterpretation) as the questions were all answered by the checking of a box, no freehand writing was required. This limits the study to only quantitative, empirical data, but this is inline with the original studies that are being replicated.

3.4 Data Collection, Capture and Integrity

The Rational Rose training course, where the students were initially introduced to the CASE tool, took place in April. The questionnaires for this study were handed out and completed in July. These questionnaires were delivered by hand to the IS 3rd and honours years students. This data collection took place over two days. The questionnaires were completed immediately by the students in class. The questionnaires took an average of ten minutes to complete. The questionnaires contained no identification of the respondent, except for their level of study – 3rd or honours year. No demographic information was collected and no incentives were attached to the completion of the instrument. Once completed the questionnaires were allocated unique identifying numbers and captured into Microsoft Excel XP. There were no problems with the capturing of the information as the questionnaires were answered by checking boxes, thus no handwriting recognition was required. The questionnaire layout is based on a 7 point Lickert scale, 1 being “*strongly disagree*”, 4 being “*neutral*”, and 7 being “*strongly agree*”. The answers were captured as such (i.e. the number representing the scale of answer) in MS Excel, with one row for each completed questionnaire.

Once the captured data had been entered, the MS Excel spreadsheet was password protected and then compressed into a Winzip file, which was also password protected. This zip file was replicated and kept in four mutually exclusive, secure locations to ensure no loss of data through unforeseen circumstances.

3.5 Data Analysis

The captured data in the MS Excel spreadsheet was imported into Statistica 6 in order to be analysed. This imported method had been tried and tested, so no data loss or corruption was anticipated: none occurred.

Various statistical tests were performed, including Cronbach alpha, to determine the reliability of each variable; regression, to obtain the beta (β) and R^2 coefficients for each hypothesis, where the beta coefficient shows the strength of association between the constructs in the hypothesis and the R^2 coefficient shows the amount of variance explained by the hypothesis; and correlation, mean and standard deviation testing, to give a full picture of the data set. The tests performed mirrored the tests undertaken in the original adoption model studies.

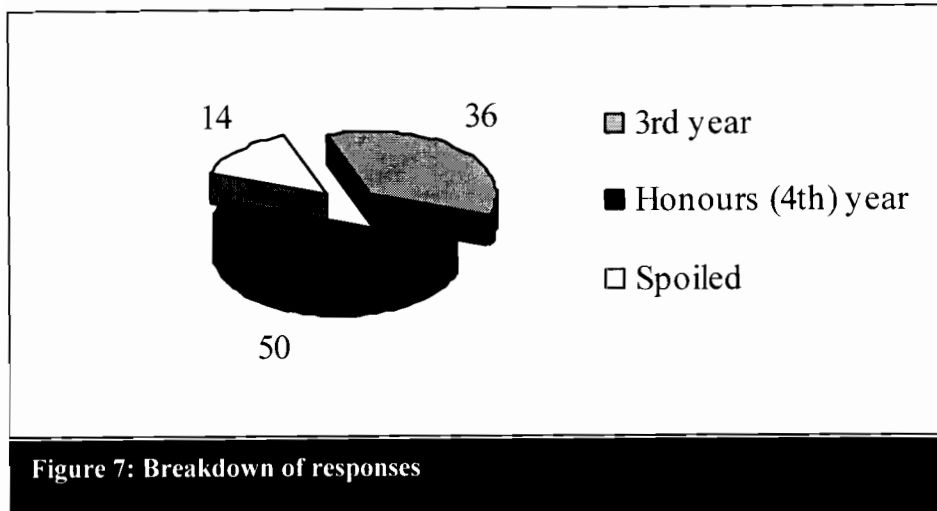
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4. Analysis

This section shows the analysis of the demographics of the participants, the analysis of each adoption model and its comparison to the original study, the test of the level of adoption of the CASE tool by the students, and the construction of a new model. The demographics section shows the breakdown of the responses and the respondents' backgrounds in using a CASE tool. The adoption models are analysed in detail and these findings are compared with those contained in the original studies. The level of adoption of the CASE tool by students is determined through the analysis of various constructs contained within the adoption models. Finally, a new adoption model is constructed that aims to predict adoption in a CASE tool context better than the four adoption models tested.

4.1 Demographics

The respondents to this study were 3rd and honours (4th) year information systems students from the University of Cape Town (UCT). 100 surveys were taken, and of these 14 were spoiled. The spoiled surveys consisted wholly of questionnaires that contained unanswered questions. The remaining 86 were split between the 3rd year students, with 36 responses, and honours year students, with 50 responses. A pie chart showing this breakdown of responses is shown in figure 7.



No specific demographics, such as gender, race or age, were asked as they had no specific significance to the study, but would have resulted in ethical implications. However, some general questions about the respondent's background in the CASE tool context were asked; these can be seen in section 1 of the questionnaire.

When asked if they had used Rational Rose before the training course, 8 respondents replied that they had, while 78 replied that they had not. This bode well for the study as the training course could be safely considered as the first contact with Rational Rose that the participants in the study had had. This resulted in more significant answers to the adoption of the CASE tool.

When asked if they had done visual modelling before the Rational Rose training course, 67 replied that they had, while 19 replied that they had not. And when asked if they had used a CASE tool besides Rational Rose, 53 replied that they had, while 33 replied that they had not. This was promising for the study as the majority of participants in the study understood the concepts involved in using a CASE tool, so just the adoption of the

technology could be measured without the influence of the conceptual components of CASE.

4.2 Technology Acceptance Model

Table 2 shows the correlations and descriptive statistics of the TAM model's constructs. Reliability of the constructs was tested with Cronbach alpha, where a construct is considered reliable if the alpha is at least 0.70 (Heilman & White, 2001). The four major TAM constructs have alphas exceeding 0.82, which bodes well for the reliability of the model; the fifth construct, actual use, only has an alpha of -0.93 however. The possible reason for this low alpha coefficient lies within the context of this study. Although students may have a promising attitude towards using the CASE tool, the actual use of the CASE tool is limited to their systems development project, which is only one component of their studies. A more likely reason for the negative alpha is that the student participants may have incorrectly answered one of the questions relating to the actual use construct, i.e. question 24a. Question 24a is reversed on the Lickert scale with 1 being very high and 7 being very low.

The original study (Davis, 1989) had alpha coefficients of 0.97 for perceived usefulness and 0.91 for perceived ease of use. These high alphas lead to the conclusion of the TAM model having a high reliability, which has been proven in various tests and retests of the TAM model including the test of the TAM model in this study. The alphas of the TAM model's perceived usefulness and perceived ease of use constructs in this study are 0.93 and 0.94 respectively.

| | 1 | 2 | 3 | 4 | 5 |
|--------------------------|----------|----------|----------|----------|-----------|
| 1. Perceived ease of use | 1.00 | 0.45* | 0.40* | -0.55* | -0.07 |
| 2. Perceived usefulness | 0.45* | 1.00 | 0.34* | -0.43* | -0.09 |
| 3. Behavioural intention | 0.40* | 0.34* | 1.00 | -0.33* | -0.18 |
| 4. Attitude towards use | -0.55* | -0.43* | -0.33* | 1.00 | 0.10 |
| 5. Actual use | -0.07 | -0.09 | -0.18 | 0.10 | 1.00 |
| Mean | 23.90700 | 24.44190 | 8.74419 | 5.06977 | 8.77907 |
| Std. dev. | 6.93097 | 6.85927 | 5.25623 | 1.40412 | 1.35821 |
| Cronbach alpha | 0.936476 | 0.934406 | 0.949703 | 0.827459 | -0.926400 |

Table 2: Correlations and descriptive statistics of TAM

*Marked correlations are significant at $p < .05$

The support for the TAM hypotheses is shown in table 3. The beta (β) and R^2 coefficients are included in table 3, where the beta coefficient shows the strength of association between the constructs in the hypothesis and the R^2 coefficient shows the amount of variance explained by the hypothesis. Only hypothesis 1d is not supported for the TAM model in this study. Hypothesis 1d relates to the relationship between behavioural intention to use the system and actual use of the system (refer to page 47). This negative beta may have been caused by the phenomenon mentioned above about the reversal of the Lickert scale for question 24a. Hypothesis 1d has a negative and non-significant beta, which leads the hypothesis to be unsupported. The other three hypotheses, 1a, 1b and 1c, are strongly supported with positive and significant betas.

Even though only three of the four hypotheses are supported for the TAM model, the main hypothesis, hypothesis 1, is deemed supported as the unsupported hypothesis 1d is controversial due to the phenomenon related to the participants answering question 24a incorrectly.

| Hypothesis | Beta (β) | R ² | Supported |
|--|------------------|----------------|-----------|
| Perceived ease of use -> Perceived usefulness | 0.448287* | 0.20096141 | Yes |
| Perceived ease of use -> Behavioural intention | 0.395256* | 0.15622708 | Yes |
| Perceived usefulness -> Behavioural intention | 0.335029* | 0.11224417 | Yes |
| Behavioural intention -> Actual use | -0.179395 | 0.03218259 | No |

Table 3: Beta and R² hypothesis testing for TAM

*Marked Betas are significant

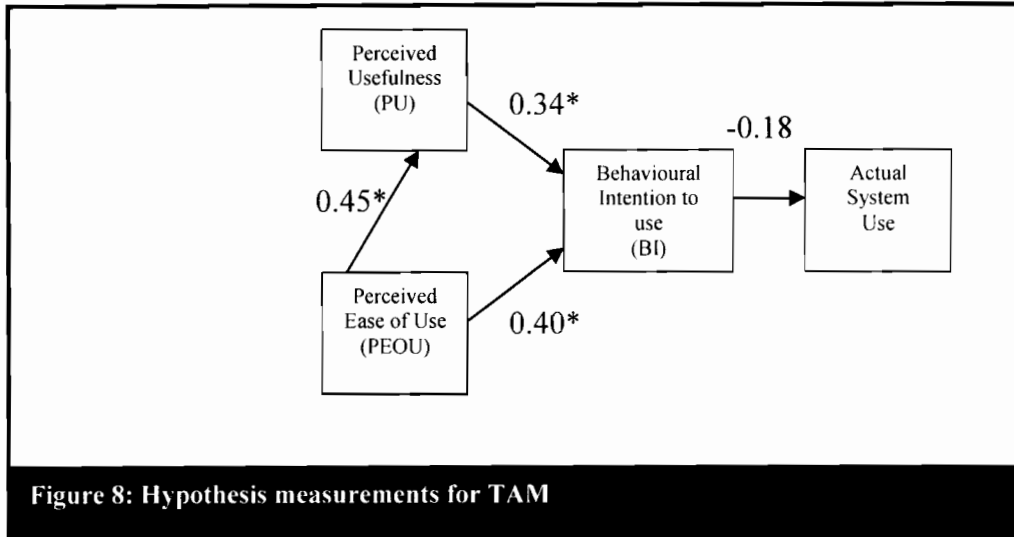
Figure 8 shows the strengths of the relationships between the constructs in the TAM model. Only one relationship is not positive and significant in the TAM model below, namely that between behavioural intention to use and actual system use. This relationship is both negative and non-significant. This negative beta may have been caused by the phenomenon mentioned above about the reversal of the Lickert scale for question 24a. There are two possible alternative reasons for this poor relationship in addition to the question 24a phenomenon; the first is that the students were behaving as if they were going to adopt the CASE tool by using it for their systems development projects, but then did not continue to adopt the CASE tool on a permanent basis after their systems development projects were complete. This is a highly likely scenario as the CASE tool would only be useful to the students in their systems development projects, but in no other areas of their studies. The TAM model is unlikely to measure this scenario accurately as it is mainly used to measure adoption of a technology that will be used often, such as a technology that is fundamental to an employee's job tasks.

The second reason for the poor relationship is that the students worked in teams to complete their systems development projects, and thus between four and six students would be using the CASE tool simultaneously to complete the tasks needed to be performed in the CASE tool. This may have resulted in a project task usually taking five

hours to complete in the CASE tool only taking one hour, since each student simultaneously works for one hour with the CASE tool and thus completes four to six man-hours of work. This decomposition of tasks amongst the team members may have resulted in each student only performing an hour of work with the CASE tool per week, and thus resulting in the weak relationship between behavioural intention to use and actual system use.

The strongest relationship was between perceived ease of use and perceived usefulness, with a beta of 0.45. Although this is in line with one of the main findings of the original study (Davis, 1989), that there is a strong relationship between perceived ease of use and perceived usefulness, it was not the strongest relationship in the original study. The strongest relationship in the original study was between perceived usefulness and behavioural intention to use with a beta of 0.75.

In this study, unlike in the original TAM study, the relationship between perceived ease of use and behavioural intention to use is stronger than the relationship between perceived usefulness and behavioural intention to use. The reason for this is suggested by Chau (1996) who found that ease of use was the largest predictor of CASE acceptance. The original TAM study did not measure the adoption of a CASE tool so this finding would not have occurred to Davis (1989).



*Marked hypotheses are significant

4.3 Technology Acceptance Model 2

Table 4 shows the correlations and descriptive statistics of the DTPB model's constructs. Cronbach alpha was used to test the reliability of the constructs, where a construct is considered reliable if the alpha is at least 0.70 (Heilman & White, 2001). Only one construct is unreliable, namely result demonstrability with 0.32, while all of the other constructs have alphas of at least 0.81. A possible reason for the result demonstrability construct's poor reliability is that the student participants may have answered a question relating to the result demonstrability construct incorrectly. Question 7d has a reversed Likert scale with 1 being very high and 7 being very low. This phenomenon was also encountered in question 24a as explained above. Another possible reason for the poor reliability is that the students were not very interested in the results of the CASE tool, as long as it could perform the basic tasks they required of it, as they were only to use it for the duration of their systems development projects and not necessarily in their careers.

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|----------------------------------|----------|----------|----------|----------|----------|----------|----------|----------|----------|
| 1. Perceived ease of use | 1.00 | 0.37* | 0.14 | 0.35* | 0.17 | 0.50* | 0.16 | 0.21 | 0.51* |
| 2. Perceived usefulness | 0.37* | 1.00 | 0.25* | 0.51* | 0.01 | 0.48* | 0.30* | 0.31* | 0.52* |
| 3. Image | 0.14 | 0.25* | 1.00 | 0.20 | -0.36* | 0.33* | 0.53* | 0.40* | 0.26* |
| 4. Result demonstrability | 0.35* | 0.51* | 0.20 | 1.00 | 0.13 | 0.36* | -0.01 | 0.13 | 0.46* |
| 5. Voluntariness | 0.17 | 0.01 | -0.36* | 0.13 | 1.00 | 0.02 | -0.44* | -0.15 | 0.16 |
| 6. Intention to use | 0.50* | 0.48* | 0.33* | 0.36* | 0.02 | 1.00 | 0.32* | 0.44* | 0.57* |
| 7. Subjective norm | 0.16 | 0.30* | 0.53* | -0.01 | -0.44* | 0.32* | 1.00 | 0.63* | 0.30* |
| 8. Job relevance | 0.21 | 0.31* | 0.40* | 0.13 | -0.15 | 0.44* | 0.63* | 1.00 | 0.46* |
| 9. Output quality | 0.51* | 0.52* | 0.26* | 0.46* | 0.16 | 0.57* | 0.30* | 0.46* | 1.00 |
| Mean | 16.05810 | 16.44190 | 8.58140 | 15.45350 | 17.11630 | 7.81395 | 5.96511 | 6.39534 | 8.18604 |
| Std. dev. | 4.74863 | 4.62882 | 3.93316 | 3.46972 | 3.88790 | 3.41454 | 2.90009 | 3.07276 | 2.67235 |
| Cronbach alpha | 0.914730 | 0.919314 | 0.873678 | 0.318830 | 0.805359 | 0.917304 | 0.893154 | 0.811243 | 0.825224 |

Table 4: Correlations and descriptive statistics of TAM2

*Marked correlations are significant at $p < .05$

The original study's (Venkatesh & Davis, 2000) constructs had alpha coefficients in excess of 0.88; the highest being perceived usefulness and perceived ease of use that each had alphas of 0.93. This study's highest TAM2 constructs are perceived usefulness with 0.92, intention to use with 0.92 and perceived ease of use with 0.91.

The support for the TAM2 hypotheses is shown in table 5. The beta (β) and R^2 coefficients are included in table 5, where the beta coefficient shows the strength of association between the constructs in the hypothesis and the R^2 coefficient shows the amount of variance explained by the hypothesis. In this study all of the TAM2 hypotheses are supported, and this shows TAM2 to be a good model to use in this context. All of the beta coefficients are positive and only one is not significant, namely that of hypothesis 2d. Hypothesis 2d relates to the relationship between voluntariness and intention to use the system. The fact that all of the hypotheses are supported leads to the conclusion that the main hypothesis for TAM2, hypothesis 2, is also supported.

| Hypothesis | Beta (β) | R^2 | Supported |
|--|------------------|------------|-----------|
| Perceived usefulness -> Intention to use | 0.480159* | 0.23055241 | Yes |
| Perceived ease of use -> Intention to use | 0.499868* | 0.24986786 | Yes |
| Perceived ease of use -> Perceived usefulness | 0.368127* | 0.13551784 | Yes |
| Voluntariness -> Intention to use | 0.209827 | 0.14092033 | Yes |
| Subjective norm -> Intention to use | 0.324864* | 0.10553674 | Yes |
| Subjective norm -> Perceived usefulness | 0.295630* | 0.08739694 | Yes |
| Image -> Perceived usefulness | 0.251313* | 0.06315808 | Yes |
| Job relevance -> Perceived usefulness | 0.313469* | 0.09826271 | Yes |
| Output quality -> Perceived usefulness | 0.518273* | 0.26860656 | Yes |
| Result demonstrability -> Perceived usefulness | 0.509659* | 0.25975233 | Yes |

Table 5: Beta and R^2 hypothesis testing for TAM2

*Marked Betas are significant

Figure 9 shows the strengths of associations between the constructs in the TAM2 model. As can be seen all of the relationships are significant except for that between voluntariness and intention to use. The possible reason for the lack of significance is two-fold; firstly since the adoption was completely voluntary in this study, the construct did not play a significant role in explaining the intention to use. Secondly, the voluntariness construct only has an indirect relationship with the intention to use construct as voluntariness acts only as a moderating effect on the relationship between the subjective norm and intention to use constructs.

The strongest relationships are between output quality and perceived usefulness with a beta of 0.52, result demonstrability and perceived usefulness with a beta of 0.51, perceived ease of use and intention to use with a beta of 0.50, and perceived usefulness and intention to use with a beta of 0.48. The original study's strong relationships included that between perceived usefulness and intention to use with a beta of 0.55 and that between subjective norm and perceived usefulness with a beta of 0.47.

The somewhat weak relationship between subjective norm and intention to use, with a beta of 0.32, is explained by Venkatesh and Davis (2000) as being a result of the voluntary context of this study; "...where usage was voluntary... subjective norm had no direct effect on intention" (Venkatesh & Davis, 2000).

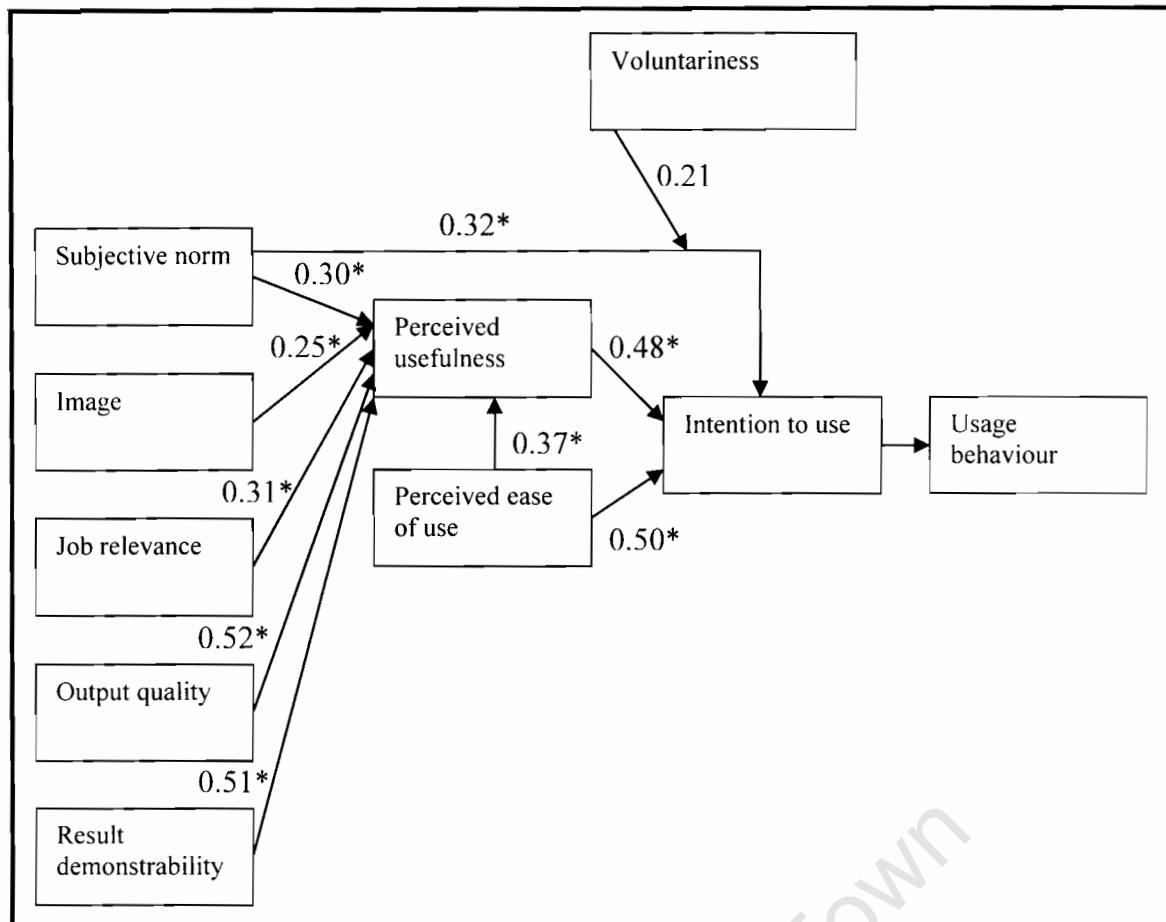


Figure 9: Hypothesis measurements for TAM2

*Marked hypotheses are significant

4.4 Decomposed Theory of Planned Behaviour

Table 6 shows the correlations and descriptive statistics of the DTPB model's constructs. Reliability of the constructs was tested with Cronbach alpha, where a reliable construct has an alpha of at least 0.70 (Heilman & White, 2001). As can be seen only two constructs are not considered reliable, namely superior influence with 0.12 and technology facilitating conditions with 0.52. The unreliability of the superior influence construct is almost certainly caused by the fact that it is a non-issue in this study. The reason for this is that the student adopters' superiors, i.e. lecturers, were not involved in

the CASE tool adoption or use. The technology facilitating conditions also did not play a major role in this study as the CASE tool was widely available for use in the computer labs that the students usually frequented, and the computers had adequate hardware for the CASE tool to run efficiently.

The original study's (Taylor & Todd, 1995b) constructs all proved reliable except for perceived usefulness with 0.68 and resource facilitating conditions with 0.50. The original study's constructs with alphas over 0.90 included behavioural intention with 0.91 and peer influence with 0.92. This study's DTPB constructs with alphas over 0.90 include perceived ease of use with 0.94, perceived usefulness with 0.93, peer influence with 0.92, self-efficacy with 0.90, and behavioural intention with 0.95.

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| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
|---|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|
| 1. Perceived ease of use | 1.00 | 0.45* | 0.38* | 0.23* | 0.31* | 0.27* | 0.62* | -0.05 | 0.13 | 0.66* | 0.40* | -0.55* |
| 2. Perceived usefulness | 0.45* | 1.00 | 0.63* | 0.25* | 0.35* | 0.16 | 0.40* | -0.14 | 0.34* | 0.46* | 0.34* | -0.43* |
| 3. Compatibility | 0.38* | 0.63* | 1.00 | 0.29* | 0.39* | 0.02 | 0.30* | -0.16 | 0.09 | 0.40* | 0.47* | -0.32* |
| 4. Subjective norm | 0.23* | 0.25* | 0.29* | 1.00 | 0.54* | 0.16 | 0.22* | 0.04 | 0.18 | 0.15 | 0.43* | -0.19 |
| 5. Peer influences | 0.31* | 0.35* | 0.39* | 0.54* | 1.00 | 0.31* | 0.31* | -0.10 | 0.27* | 0.19 | 0.41* | -0.25* |
| 6. Superior influences | 0.27* | 0.16 | 0.02 | 0.16 | 0.31* | 1.00 | 0.34* | -0.01 | 0.13 | 0.27* | 0.02 | -0.12 |
| 7. Self-efficacy | 0.62* | 0.40* | 0.30* | 0.22* | 0.31* | 0.34* | 1.00 | -0.08 | 0.21 | 0.73* | 0.50* | -0.38* |
| 8. Facilitating conditions: Technology | -0.05 | -0.14 | -0.16 | 0.04 | -0.10 | -0.01 | -0.08 | 1.00 | 0.04 | -0.18 | -0.13 | 0.23* |
| 9. Facilitating conditions: Resources | 0.13 | 0.34* | 0.09 | 0.18 | 0.27* | 0.13 | 0.21 | 0.04 | 1.00 | 0.07 | 0.15 | -0.03 |
| 10. Perceived behavioural control | 0.66* | 0.46* | 0.40* | 0.15 | 0.19 | 0.27* | 0.73* | -0.18 | 0.07 | 1.00 | 0.48* | -0.56* |
| 11. Behavioural intention | 0.40* | 0.34* | 0.47* | 0.43* | 0.41* | 0.02 | 0.50* | -0.13 | 0.15 | 0.48* | 1.00 | -0.33* |
| 12. Attitude towards behaviour | -0.55* | -0.43* | -0.32* | -0.19 | -0.25* | -0.12 | -0.38* | 0.23* | -0.03 | -0.56* | -0.33* | 1.00 |
| Mean | 23.90700 | 24.44190 | 10.68600 | 5.96511 | 5.80232 | 8.90697 | 11.86050 | 10.25580 | 11.77910 | 12.46510 | 8.74419 | 5.06977 |
| Std. dev. | 6.93097 | 6.85927 | 3.27652 | 2.90009 | 2.70868 | 2.31429 | 4.61242 | 3.30841 | 4.59002 | 3.72179 | 5.25623 | 1.40412 |
| Cronbach alpha | 0.936476 | 0.934406 | 0.834206 | 0.893154 | 0.924804 | 0.122293 | 0.903090 | 0.518210 | 0.888377 | 0.746237 | 0.949703 | 0.827459 |

Table 6: Correlations and descriptive statistics of DTPB*Marked correlations are significant at $p < .05$

The support for the DTPB hypotheses is shown in table 7 below. The beta (β) and R^2 coefficients are included in table 7, where the beta coefficient shows the strength of association between the constructs in the hypothesis and the R^2 coefficient shows the amount of variance explained by the hypothesis.

In this study the DTPB hypotheses are not all supported, as in the original DTPB study where all were supported except for H3h: there will be a positive relationship between technology facilitating conditions and perceived behavioural control. In this study it appears that neither hypotheses 3a, 3b nor 3c are supported as perceived usefulness, perceived ease of use and compatibility all have negative relationships with attitude towards behaviour. However, this stems from the fact that the attitude towards behaviour construct is measured negatively (question 23 in the questionnaire); i.e. that a low number is a positive response and a high number is a negative response in the questionnaire – 1 is positive and 2 is negative, while the rest of the questions in the questionnaire are measured with a low number as a negative response and a high number as a positive response. Thus there is also a negative relationship between attitude towards behaviour and behavioural intention, which is hypothesis 3i and is not supported either.

So, although hypotheses 3a, 3b, 3c and 3i are negative, the hypotheses are considered supported. Hypotheses 3d and 3e are both supported as peer influence and superior influence both have positive relationships with subjective norm, which in turn has a positive relationship with behavioural intention, thus hypothesis 3j is supported as well. Hypotheses 3f and 3g are supported while hypothesis 3h is not; this is because self-

efficacy and resource facilitating conditions have positive relationships with perceived behavioural control while technology facilitating conditions has a negative relationship with perceived behavioural control. Perceived behavioural control has a positive relationship with behavioural intention, thus hypothesis 3k is supported.

The main hypothesis 3 is supported as the results of the test of DTPB in this study are in line with the results of the original DTPB study.

| Hypothesis | Beta (β) | R ² | Supported |
|---|------------------|----------------|-----------|
| Perceived usefulness -> Attitude towards behaviour | -0.429548* | 0.18451181 | Yes |
| Perceived ease of use -> Attitude towards behaviour | -0.554202* | 0.30713983 | Yes |
| Compatibility -> Attitude towards behaviour | -0.322505* | 0.10400939 | Yes |
| Peer influence -> Subjective norm | 0.538268* | 0.28973229 | Yes |
| Superior influence -> Subjective norm | 0.159022 | 0.02528815 | Yes |
| Self-efficacy -> Perceived behavioural control | 0.727535* | 0.52930702 | Yes |
| Resource facilitating conditions -> Perceived behavioural control | 0.074265 | 0.00551528 | Yes |
| Technology facilitating conditions -> Perceived behavioural control | -0.182714 | 0.03338448 | No |
| Attitude towards behaviour -> Behavioural intention | -0.329117* | 0.10831801 | Yes |
| Subjective norm -> Behavioural intention | 0.428519* | 0.18362866 | Yes |
| Perceived behavioural control -> Behavioural intention | 0.477643* | 0.22814247 | Yes |

Table 7: Beta and R² hypothesis testing for DTPB

*Marked Betas are significant

As can be seen in figure 10, attitude towards behaviour did not seem to influence the adopters' behavioural intention to adopt the CASE tool, but actually did. The relationship is negative as the attitude towards behaviour construct is measured negatively as opposed to the behavioural intention construct which is measured

positively; as explained above. The Subjective norm and perceived behavioural control constructs influence the behavioural intention constructs significantly. It is explained above why attitude towards behaviour does not positively support the behavioural intention, and it is clear that the negative associations precipitate through the decomposition of constructs; perceived usefulness, perceived ease of use and compatibility have significantly negative associations with attitude towards behaviour.

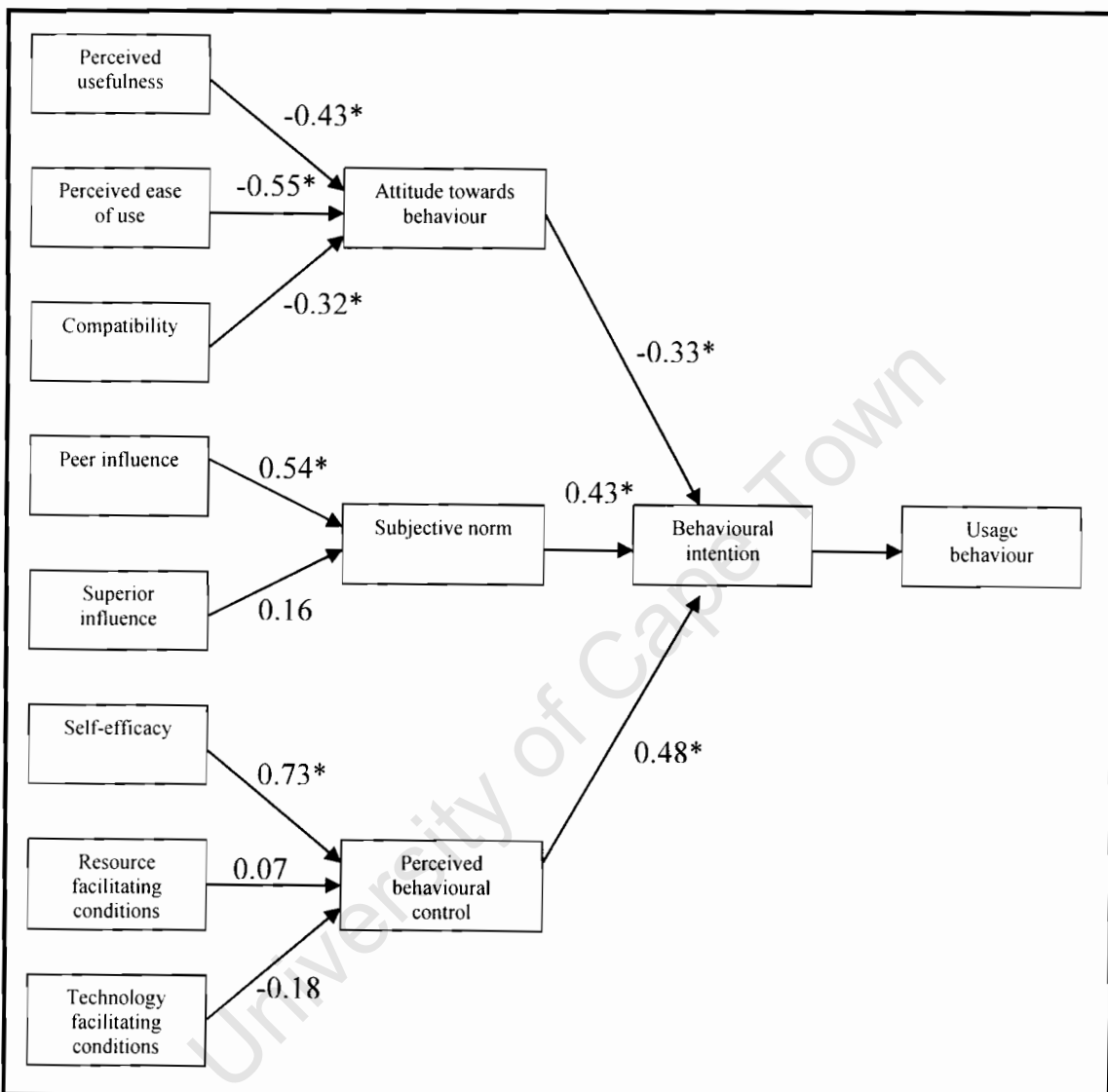


Figure 10: Hypothesis measurements for DTPB

*Marked hypotheses are significant

Peer and superior influence both relate positively to subjective norm, but only peer influence does so significantly. This suggests that the student adopters were influenced in their decision to adopt by their fellow students, but not by their lecturers. This is not a surprising finding as the students were under no pressure from lecturers to adopt the CASE tool. Further, the students were only to make use of the CASE tool in their systems development projects, of which the lecturers were not a part.

Perceived behavioural control is positively and significantly influenced by self-efficacy, which indicates that the students' confidence in their computing abilities played a part in whether they adopted the CASE tool or not. This finding was expected as CASE tools are complex software packages and thus have a steep learning curve associated with them. As is explained in the literature survey above, the higher an adopter's self-efficacy the more likely they are to adopt a complex or difficult to understand innovation or technology. Resource and technology facilitating conditions do not have significant affects of perceived behavioural control. This is due to the fact that the CASE tool was widely available for use in the computer labs that the students usually frequented, and the computers had adequate hardware for the CASE tool to run efficiently.

4.5 Perceived Characteristics of Innovating

A model was not constructed or the strength of associations measured in the original study, so the analysis of the PCI model is conducted in the same fashion as the other adoption models in this study. However, Cronbach alpha tests were carried out in the original study so can be compared with those in this study, where a construct is

considered reliable if the alpha is at least 0.70 (Heilman & White, 2001). In table 8 it can be seen that only three constructs proved to be unreliable in this context, namely visibility with -1.33, voluntariness with 0.59 and intention to adopt with 0.09. The wayward alpha coefficient for the visibility construct was clearly a case of the respondents misunderstanding the questions pertaining to the construct in the questionnaire, which are questions 8a and 8b. The voluntariness construct has a poor reliability in this context as the CASE tool adoption was purely voluntary, and thus the construct was unnecessary.

The intention to adopt construct is measured by four questions in the questionnaire, however two of these questions do not strictly apply in this context, namely question 11b about permanently adopting Rational Rose, which is an unlikely situation since the CASE tool would only be used by the students in their systems development project that is only one component of their courses, and question 11e about recommending Rational Rose to their fellow students, which is also an unlikely situation as there is a lot of competition around obtaining the best mark for the systems development project. As half of the questions measuring the intention to adopt construct do not apply in this context, the construct was not accurately portrayed and thus the reliability of it is low.

In the original study (Moore & Benbasat, 1991) all of the constructs proved reliable, though trialability was on the borderline with an alpha of 0.71. The only construct with an alpha over 0.90 was relative advantage with 0.90. In this study however, there are two PCI constructs with high alphas, namely ease of use with 0.91 and relative advantage with 0.90.

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|----------------------------------|----------|----------|----------|----------|----------|-----------|----------|----------|----------|
| 1. Ease of use | 1.00 | 0.44* | 0.35* | 0.14 | 0.39* | 0.06 | 0.41* | 0.21 | 0.30* |
| 2. Relative advantage | 0.44* | 1.00 | 0.66* | 0.26* | 0.53* | 0.04 | 0.40* | 0.03 | 0.52* |
| 3. Compatibility | 0.35* | 0.66* | 1.00 | 0.32* | 0.36* | 0.20 | 0.31* | 0.00 | 0.41* |
| 4. Image | 0.14 | 0.26* | 0.32* | 1.00 | 0.17 | 0.00 | 0.10 | -0.32* | 0.39* |
| 5. Result demonstrability | 0.39* | 0.53* | 0.36* | 0.17 | 1.00 | 0.26* | 0.53* | 0.13 | 0.38* |
| 6. Visibility | 0.06 | 0.04 | 0.20 | 0.00 | 0.26* | 1.00 | 0.34* | 0.11 | 0.24* |
| 7. Trialability | 0.41* | 0.40* | 0.31* | 0.10 | 0.53* | 0.34* | 1.00 | 0.29* | 0.22* |
| 8. Voluntariness | 0.21 | 0.03 | 0.00 | -0.32* | 0.13 | 0.11 | 0.29* | 1.00 | -0.21 |
| 9. Intention to adopt | 0.30* | 0.52* | 0.41* | 0.39* | 0.38* | 0.24* | 0.22* | -0.21 | 1.00 |
| Mean | 16.05810 | 19.96510 | 10.68600 | 8.58140 | 11.90700 | 7.23255 | 6.72093 | 11.22093 | 13.39530 |
| Std. dev. | 4.74863 | 5.44804 | 3.27652 | 3.93316 | 3.96938 | 1.97439 | 3.13482 | 2.62746 | 3.39993 |
| Cronbach alpha | 0.914730 | 0.897064 | 0.834206 | 0.873678 | 0.833247 | -1.326923 | 0.756000 | 0.585753 | 0.091077 |

Table 8: Correlations and descriptive statistics of PCI

*Marked correlations are significant at $p < .05$

The support for the PCI hypotheses is shown in table 9. The beta (β) and R^2 coefficients are included in table 9, where the beta coefficient shows the strength of association between the constructs in the hypothesis and the R^2 coefficient shows the amount of variance explained by the hypothesis. The original study did not have any hypothesis testing, but it appears that the model was and still is sound, as only one hypothesis is not supported by this study, namely hypothesis 4h where the relationship between voluntariness and intention to adopt the system is tested. In this study the relationship proved to be negative, but this is caused by the fact that the adoption of Rational Rose was completely voluntary, so any measurement of the construct would prove nonsensical.

| Hypothesis | Beta (β) | R^2 | Supported |
|--|------------------|------------|-----------|
| Relative advantage -> Intention to adopt | 0.522841* | 0.27336223 | Yes |
| Ease of use -> Intention to adopt | 0.300966* | 0.09058046 | Yes |
| Compatibility -> Intention to adopt | 0.406249* | 0.16503818 | Yes |
| Image -> Intention to adopt | 0.387304* | 0.15000418 | Yes |
| Result demonstrability -> Intention to adopt | 0.381966* | 0.14589795 | Yes |
| Visibility -> Intention to adopt | 0.243772* | 0.0594247 | Yes |
| Trialability -> Intention to adopt | 0.219096* | 0.04800298 | Yes |
| Voluntariness -> Intention to adopt | -0.208755 | 0.04357849 | No |

Table 9: Beta and R^2 hypothesis testing for PCI

*Marked Betas are significant

The other hypotheses are all soundly supported with each bearing a significant positive beta coefficient. The sound support for all of the hypotheses, except for the one containing voluntariness, leads to the main hypothesis 4 being supported. Thus the PCI model proves to be reliable and valid in the context of this study.

As can be seen in figure 11, seven of the eight associations are positive and significant. The only association that is negative is between voluntariness and intention to adopt. The reason for this is that the CASE tool adoption was completely voluntary, thus the voluntariness construct was unnecessary, as was expected. Further the expectation that the relationship between voluntariness and intention to adopt was non-significant, as the perception of voluntariness played no role in the intention to adopt the CASE tool, was proven correct.

The strongest relationship is between relative advantage and intention to adopt, with a beta coefficient of 0.52. This was expected as the original study (Moore & Benbasat, 1991) implied that this would be the case. The weakest relationship is between trialability and intention to adopt, with a beta coefficient of 0.22, though this relationship is still significant. The reason for the weak relationship may lie in the fact that the trialability construct is best suited for mandatory adoption contexts, while the context in this study was voluntary.

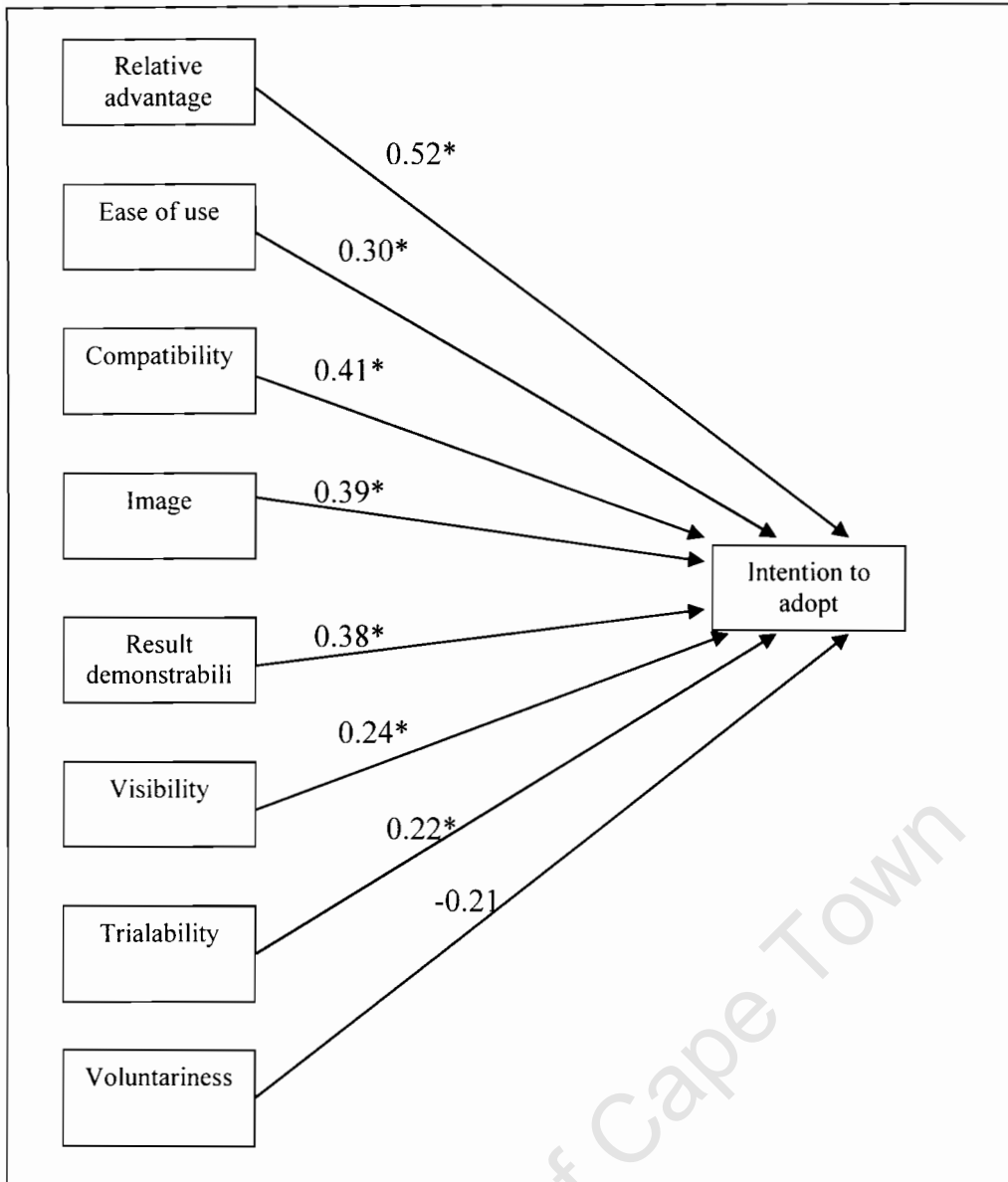


Figure 11: Hypothesis measurements for PCI

*Marked hypotheses are significant

4.6 Summary of Adoption Models

Of the four adoption models tested in this study, all are supported, namely TAM, TAM2, DTPB and PCI. It is clear therefore that any of the models are appropriate to use when testing a technology adoption in this context. The R^2 coefficient shows the amount of

variance explained by the construct, as can be seen in table 10, DTPB explains the most variance of the four adoption models, with PCI and TAM2 close behind. The more variance that an adoption model explains, the more desirable is the model to use as it will give a clearer picture of the adoption situation. But since TAM2, DTPB and PCI each explain a large portion of variance, it is suggested that a new hybrid model may be the best adoption model for this context. This new model should explain the most variance as well as be supported through strong relationships between its constructs. This new model is developed and tested below.

| TAM | R² |
|-------------------------------|----------------------|
| Behavioural intention | 19% |
| Perceived usefulness | 20% |
| TAM2 | |
| Intention to use | 38% |
| Perceived usefulness | 41% |
| DTPB | |
| Behavioural intention | 36% |
| Attitude | 35% |
| Subjective norm | 29% |
| Perceived behavioural control | 55% |
| PCI | |
| Intention to adopt | 44% |

Table 10: Explained variance by adoption model

4.7 The Adoption of Rational Rose by UCT Students

The final hypothesis, hypothesis 5, deals with whether the level of adoption of Rational Rose by UCT students was high or not. As can be seen in table 11, all of the usage questions were answered neutrally or slightly negatively. This should lead to the conclusion that the level of adoption was low. However, since the students were only to

make use of the CASE tool for their systems development projects, the level of adoption of the CASE tool for the systems development projects should be measured. This measurement was conducted in questions 24a, 24b and 24c, as seen in table 11. But even from the answers to these questions it is clear that the CASE tool was infrequently used; with the frequency of use being quite infrequent, the amount of use per week being less than once, and the hours of use per week being less than one hour. So from this it can be concluded that the level of adoption of Rational Rose was not high in either the short or long term amongst students at UCT.

| Question | Answer | Mean |
|-----------------------------|---------------------------|----------|
| 11) Intention to adopt | Slightly disagree | 3.348837 |
| 12) Intention to use | Neutral | 3.906977 |
| 22) Behavioural intention | Slightly disagree | 2.914729 |
| 24a) Frequency of use | Quite infrequently | 5.988372 |
| 24b) Amount of use per week | Less than once per week | 1.546512 |
| 24c) Hours of use per week | Less than 1 hour per week | 1.244186 |

Table 11: Success of adoption

4.8 The New Model

The new model is a hybrid of the three strongest models that this study tested in this context, namely the TAM2, DTPB and PCI models. The new hybrid model is dubbed a name formed from the hybrid of two of its predecessors' names: the Perceived Characteristics of Technology Acceptance (PCTA). The TAM2 model was taken as a base, but the voluntariness construct was dropped, since it did not play a role in the context as its beta was not significant. The PCI constructs of relative advantage, ease of use, compatibility, image, result demonstrability, visibility, and trialability were added to

the model; voluntariness was left out as it did not apply to the context as its beta was not significant. The relative advantage construct overlapped with the perceived usefulness construct, and the ease of use, image and result demonstrability constructs were already contained in the TAM2 model. So with the TAM2 model as a base, the constructs of compatibility, trialability and visibility were added. The visibility construct had proven to be significant in the PCI model, but its beta was not significant in the new model, so it was dropped from the model after a regression analysis of the new model.

The compatibility construct was added to the model as an antecedent to perceived usefulness, and the trialability construct was added as an antecedent to perceived ease of use. This was done because the trialability construct proved to be more strongly associated with perceived ease of use than perceived usefulness. The DTPB constructs of perceived usefulness, perceived ease of use, compatibility and subjective norm can be seen in the model, while the DTPB constructs of peer influence and self-efficacy are substituted with the PCTA constructs of image and trialability. The PCTA model can be seen in figure 12.

Table 12 shows the correlations and descriptive statistics of the PCTA model's constructs. Reliability of the constructs was tested with Cronbach alpha, where a construct is considered reliable if the alpha is at least 0.70 (Heilman & White, 2001). All the constructs have alphas that exceed 0.81 except result demonstrability and trialability, though trialability is acceptable at 0.76. Result demonstrability has an alpha of 0.32. A possible reason for the low alpha of the result demonstrability construct is that the

students participants may have answered a question relating to the construct, question 7d, incorrectly. Question 7d has a reversed Lickert scale and it is likely that the respondents may not have noticed this and answered the question incorrectly. Another possible reason for the construct's low reliability is that the students were not very interested in the results of the CASE tool, as long as it could perform the basic tasks they required of it, as they were only to use it for the duration of their systems development projects and not necessarily in their careers. The constructs with the highest reliability included perceived usefulness with a beta of 0.92, intention to use with a beta of 0.92, and perceived ease of use with a beta of 0.91.

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| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|----------------------------------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|
| 1. Perceived usefulness | 1.00 | 0.37* | 0.30* | 0.61* | 0.25* | 0.31* | 0.52* | 0.51* | 0.37* | 0.48* |
| 2. Perceived ease of use | 0.37* | 1.00 | 0.16 | 0.35* | 0.14 | 0.21 | 0.51* | 0.35* | 0.41* | 0.50* |
| 3. Subjective norm | 0.30* | 0.16 | 1.00 | 0.29* | 0.53* | 0.63* | 0.30* | -0.01 | 0.00 | 0.32* |
| 4. Compatibility | 0.61* | 0.35* | 0.29* | 1.00 | 0.32* | 0.38* | 0.39* | 0.37* | 0.31* | 0.45* |
| 5. Image | 0.25* | 0.14 | 0.53* | 0.32* | 1.00 | 0.40* | 0.26* | 0.20 | 0.10 | 0.33* |
| 6. Job relevance | 0.31* | 0.21 | 0.63* | 0.38* | 0.40* | 1.00 | 0.46* | 0.13 | 0.11 | 0.44* |
| 7. Output quality | 0.52* | 0.51* | 0.30* | 0.39* | 0.26* | 0.46* | 1.00 | 0.46* | 0.36* | 0.57* |
| 8. Result demonstrability | 0.51* | 0.35* | -0.01 | 0.37* | 0.20 | 0.13 | 0.46* | 1.00 | 0.44* | 0.36* |
| 9. Trialability | 0.37* | 0.41* | 0.00 | 0.31* | 0.10 | 0.11 | 0.36* | 0.44* | 1.00 | 0.39* |
| 10. Intention to use | 0.48* | 0.50* | 0.32* | 0.45* | 0.33* | 0.44* | 0.57* | 0.36* | 0.39* | 1.00 |
| Mean | 16.44190 | 16.05810 | 5.96511 | 10.68600 | 8.58140 | 6.39534 | 8.18604 | 15.45350 | 6.72093 | 7.81395 |
| Std. dev. | 4.62882 | 4.74863 | 2.90009 | 3.27652 | 3.93316 | 3.07276 | 2.67235 | 3.46972 | 3.13482 | 3.41454 |
| Cronbach alpha | 0.919314 | 0.914730 | 0.893154 | 0.834206 | 0.873678 | 0.811243 | 0.825224 | 0.318830 | 0.756000 | 0.917304 |

Table 12: Correlations and descriptive statistics of PCTA

*Marked correlations are significant at $p < .05$

The support for the PCTA model's associations is shown in table 13. The beta (β) and R^2 coefficients are included in table 13, where the beta coefficient shows the strength of relationship between the constructs in the association and the R^2 coefficient shows the amount of variance explained by the association. The beta coefficients are positive and significant for all of the associations, which prove PCTA to be a strong predictor of variance in the context of CASE tool adoption amongst students.

| Association | Beta (β) | R^2 |
|--|------------------|------------|
| Perceived usefulness -> Intention to use | 0.480159* | 0.23055241 |
| Perceived ease of use -> Intention to use | 0.499868* | 0.24986786 |
| Perceived ease of use -> Perceived usefulness | 0.368127* | 0.13551784 |
| Subjective norm -> Intention to use | 0.324864* | 0.10553674 |
| Subjective norm -> Perceived usefulness | 0.295630* | 0.08739694 |
| Compatibility -> Perceived usefulness | 0.608101* | 0.36978648 |
| Image -> Perceived usefulness | 0.251313* | 0.06315808 |
| Job relevance -> Perceived usefulness | 0.313469* | 0.09826271 |
| Output quality -> Perceived usefulness | 0.518273* | 0.26860656 |
| Result demonstrability -> Perceived usefulness | 0.509659* | 0.25975233 |
| Trialability -> Perceived ease of use | 0.406534* | 0.16527004 |

Table 13: Beta and R^2 association testing for PCTA

*Marked Betas are significant

As can be seen in figure 12, all of the associations are positive and significant. The strongest associations include those between compatibility and perceived usefulness ($\beta = 0.61$), output quality and perceived usefulness ($\beta = 0.52$), result demonstrability and perceived usefulness ($\beta = 0.51$), and perceived ease of use and intention to use ($\beta = 0.50$). In their study on the use of CASE tools, Iivari and Maansaari (1997) found that the subjective norm construct was the primary usage determinant; however in this study subjective norm is a fairly weak determinant of intention to use in PCTA. In his study

Chau (1996) found that perceived ease of use was the largest predictor of CASE acceptance. The PCTA model in this study supports this finding, as perceived ease of use is a chief determinant of intention to use.

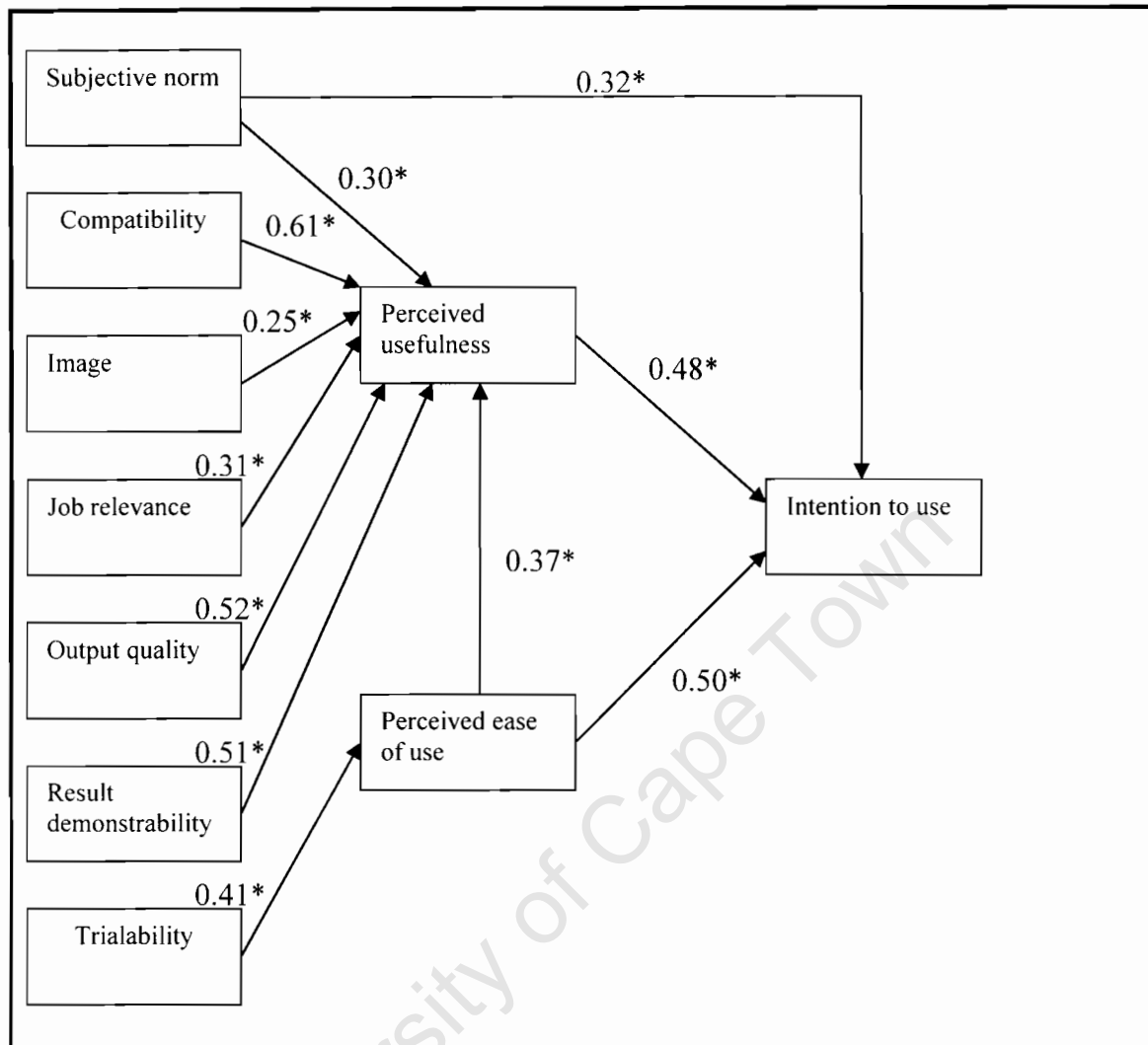


Figure 12: Association measurements for PCTA

*Marked hypotheses are significant

The R^2 coefficient shows the amount of variance explained by the construct; table 14 shows the variance explained by PCTA. As is evident, intention to use explains 38% of the variance, perceived usefulness shows an impressive 53% of variance, while perceived

ease of use shows a paltry 17% of variance. The joining of the supported models of TAM2, DTPB and PCI appears to have paid off, as the new model explains more variance than either TAM2 or PCI did alone. PCTA also rivals DTPB with the amount of variance explained.

| PCTA | R² |
|-----------------------|----------------------|
| Intention to use | 38% |
| Perceived usefulness | 53% |
| Perceived ease of use | 17% |

Table 14: Explained variance by PCTA

Table 15 below shows the variance explained by the four adoption models tested in this study.

| TAM | R² |
|-------------------------------|----------------------|
| Behavioural intention | 19% |
| Perceived usefulness | 20% |
| TAM2 | |
| Intention to use | 38% |
| Perceived usefulness | 41% |
| DTPB | |
| Behavioural intention | 36% |
| Attitude | 35% |
| Subjective norm | 29% |
| Perceived behavioural control | 55% |
| PCI | |
| Intention to adopt | 44% |

Table 15: Explained variance by adoption model

5. Conclusions

This section reviews the objectives, reports on the major findings, and states the implications of this study. The limitations and recommendations for future research are also included.

5.1 Summary of Findings

There were three main objectives for this study:

- To compare the four technology adoption models empirically and determine those constructs most prevalent to the context of the adoption of a CASE tool at a university.
- To conduct reliability and validity tests for each individual adoption model via comparisons between the data of this study and the data of the original studies.
- To determine the level of adoption of the CASE tool amongst the student participants in this study.

The first objective is the major objective of this study and in pursuing it a new technology adoption model was developed, the Perceived Characteristics of Technology Acceptance (PCTA), which rivals the other four adoption models with the amount of variance it explains. It was found that the most prevalent constructs affecting this study's context are perceived usefulness, perceived ease of use, compatibility, output quality, and result demonstrability. Of these constructs, perceived usefulness and perceived ease of use are

associated with the intention to use to technology, while compatibility, output quality and result demonstrability are associated with perceived usefulness.

The second objective is divided into the first four hypotheses of this study.

Hypothesis H1 is supported as this study's test of the TAM model is in concordance with that of the original study. The TAM model's construct of behavioural intention explains 19% of variance and the construct of perceived usefulness explains 20% of variance.

This study's test of TAM2 is in concordance with the original TAM2 study and thus hypothesis H2 is supported. All of hypothesis H2's sub-hypotheses are supported with positive and significant betas except for that regarding volutariness. The intention to use construct explains 38% of variance and the perceived usefulness construct explains 41% of variance.

Hypothesis H3, a test of the DTPB model, is supported, although sub-hypothesis H3h is not as technology facilitating conditions, which this sub-hypothesis regards, was a non-issue in this study. The DTPB model's constructs explain variances between 29% and 55%.

The test of the PCI model resulted in the support of its hypothesis H4. The PCI construct of volutariness, sub-hypothesis H4h, is not supported however, and a possible reason for this is that the adoption of the CASE tool was completely voluntary. The PCI model has an explained variance of 44%.

The third objective is tested with hypothesis H5, where the level of adoption of Rational Rose is tested. It was found that hypothesis H5 is not supported as the student participants used the CASE tool quite infrequently, for an average of less than an hour per week. The student participants also responded that they did not intend to adopt the CASE tool and were neutral as to whether they would use the tool again in the future.

The findings of this study result in certain implications for universities that intend helping students to adopt CASE tools. These implications stem from the constructs of the adoption models that showed prevalence, including perceived usefulness, perceived ease of use, compatibility, output quality and result demonstrability. University lecturers can increase the level of adoption of a CASE tool amongst students by addressing these constructs. It is necessary to address these constructs comprehensively if the adoption context is voluntary. Table 16 below illustrates some examples of how this can be done.

| Construct | Measures to Increase Level of Adoption |
|-----------------------|--|
| Perceived usefulness | <ul style="list-style-type: none"> • Demonstrate how the CASE tool can satisfy the systems development life cycle needs of the students via the application of a pilot system • Highlight the advantages of using a CASE tool • Indicate, via a live demonstration, the areas of the students' studies where the use of a CASE tool would be beneficial |
| Perceived ease of use | <ul style="list-style-type: none"> • Increase CASE tool training time • Conduct CASE tool practice / trial use workshops |
| Compatibility | <ul style="list-style-type: none"> • Demonstrate how the CASE tool is compatible with the students' work tasks, i.e. show how these tasks can be completed with the CASE tool • Run a pilot project, that is similar to the students' coursework needs, using the CASE tool |
| Output quality | <ul style="list-style-type: none"> • Illustrate the quality of the CASE tool's output with live demonstrations • Show the students physical evidence of the CASE tool's outputs (e.g. printed diagrams, code generation) |

| Construct | Measures to Increase Level of Adoption |
|------------------------|---|
| Result demonstrability | <ul style="list-style-type: none"> • Demonstrate clearly the results that can be achieved with the CASE tool by running a live demonstration • Lead the students through the systems development life cycle using the CASE tool |

Table 16: Increasing the level of adoption through prevalent constructs

There are also implications for the researchers in the technology adoption area regarding the four adoption models tested in this study. The fact that all four adoption models tested proved to be in concordance with their original studies suggests that these models are indeed valid and should be used to test individual technology adoption. This validation stems from the concordance between the results of the original studies and of this study even though the contexts are completely different. The reliability of the individual models' constructs was also proved through the strong Cronbach alpha coefficients obtained. These strong reliability and validity findings confirm to researchers that the adoption models do have a place in technology adoption research, as well as in a CASE tool adoption context.

5.2 Limitations of Study

Due to the specific context of this study, the adoption of a CASE tool by students, the study is somewhat limited in its generalisability. However, CASE tools are prolific in the information system industry, so this study should help contribute to the adoption and management of them. However, since this study was conducted with students as participants, it is doubtful whether the results can be generalised to the information systems industry. The reason for this is that students tend not to have long-term

consequences for their actions, as they have not yet embarked on their careers. Though this being said, the students that participated in this study were all close to graduating and therefore were likely to be more career-minded.

This study made use of 100 student participants; which although significant number and close to the sample frame, is a small sample to base a theory upon. The confidence of generalisability will increase as the sample size increases. Also, this study was conducted at only one university. If more universities could be involved in an extension of this study then the results could be generalised with more confidence.

Finally, this study was conducted in South Africa and is the first of its kind, to the author's knowledge, in the country. Without more studies in the technology adoption area, it is unclear what effect the multi-cultural society has on the validity of the adoption models. The results from a study by Straub, Keil and Brenner (1997) suggested that adoption models, such as TAM, do not hold equally well across cultures. Until this issue has been researched and conclusions have been drawn, the generalisability of this study is limited.

5.3 Recommendations for Future Research

Due to the specific context of this study it is important for this study to be replicated in different contexts in order for it to gain generalisability. Comparisons of adoption models are conducted in order to test the validity and reliability of the models, as well as to guide practitioners to use the best adoption model in their adoption context.

This study can also be extended by either using information systems employees as participants instead of students or by using a larger sample of students from different universities around South Africa. These extensions will help give credence to the results obtained in this study.

A retest of this study with a similar sample size of students may help to give the new hybrid model developed in this study, the PCTA, reliability and validity. If the same result is obtained then it is clear that the PCTA model does apply to this context, and future use of it is advocated.

Finally, more adoption studies should be conducted in South Africa in order to establish the effect of a multi-cultural society on the adoption of a technology. If there is an effect that invalidates the present adoption models then new adoption models need to be constructed.

The study of technology adoption models in South Africa needs to get more attention from researchers. This area of research is an important one that needs to be addressed, as South Africa will be increasingly adopting more new technologies in the near future.

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Appendix A: Questionnaire

If you, in any way, object to the ethical implications of answering any of the questions contained within this questionnaire, please do not feel obligated to answer them. However, it is encouraged that you answer all of the questions honestly, as this questionnaire is being used in the rigorous research for an Information Systems Master's dissertation.

Please circle the IS course in which you are registered: **INF313H** **INF414W**

Please mark YES or NO to answer each of the following questions:

| | | | | |
|---|----|---|-----|----|
| 1 | a) | Did you attend the Rational Rose training course held during May 2003? | Yes | No |
| | b) | Had you used Rational Rose before the training course? | Yes | No |
| | c) | Had you done visual modelling before the Rational Rose training course? | Yes | No |
| | d) | Have you used a CASE tool besides Rational Rose? | Yes | No |

Please mark the number that reflects your desired answer for each statement:

[Key: 1 = strongly disagree; 4 = neutral; 7 = strongly agree]

| | | | | | | | | | |
|---|----|--|---|---|---|---|---|---|---|
| 2 | a) | Learning to operate Rational Rose is easy for me | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| | b) | I find it easy to get Rational Rose to do what I want it to do | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| | c) | My interaction with Rational Rose is clear and understandable | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| | d) | I find Rational Rose to be flexible to interact with | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| | e) | It is easy for me to become skilful at using Rational Rose | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| | f) | I find Rational Rose easy to use | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 3 | a) | Using Rational Rose in my project would enable me to accomplish tasks more quickly | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| | b) | Using Rational Rose would improve my project performance | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| | c) | Using Rational Rose in my project would increase my productivity | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| | d) | Using Rational Rose would enhance my effectiveness on the project | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| | e) | Using Rational Rose would make it easier to do my project | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| | f) | I would find Rational Rose useful in my project | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 4 | a) | Using Rational Rose improves the quality of the work I do for my project | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| | b) | Using Rational Rose gives me greater control over the work for my project | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 5 | a) | Using Rational Rose is compatible with all aspects of my project | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| | b) | I think that using Rational Rose fits well with the way I like to work | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| | c) | Using Rational Rose fits into my work style | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 6 | a) | Students who use Rational Rose have more prestige than those who do not | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| | b) | Students who use Rational Rose have a higher profile than those who do not | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| | c) | Having Rational Rose is a status symbol among the students in my course | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 7 | a) | I would have no difficulty telling others about the results of using Rational Rose | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| | b) | I can communicate to others the consequences of using Rational Rose | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| | c) | The results of using Rational Rose are apparent to me | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| | d) | I will have difficulty explaining why using Rational Rose may or may not be beneficial | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 8 | a) | In my course, I see many students using Rational Rose | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| | b) | Rational Rose is not very visible in my course | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 9 | a) | Before deciding whether to use Rational Rose, I was able to properly try it out | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| | b) | I was able to use Rational Rose on a trial basis long enough to see what it could do | 1 | 2 | 3 | 4 | 5 | 6 | 7 |

| | | | | | | | | | |
|----|----|---|---|---|---|---|---|---|---|
| 10 | a) | My use of Rational Rose was (is) voluntary | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| | b) | I'm not required to use Rational Rose | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| | c) | Although it might be helpful, using Rational Rose is certainly not compulsory for my project | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 11 | a) | Once the trial period was over, I was interested in continuing to use Rational Rose in my project | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| | b) | Once the trial period was over, I arranged to permanently adopt Rational Rose as soon as possible | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| | c) | Once the trial period was over, I didn't see much need to continue to use Rational Rose in my project | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| | d) | Once the trial period was over, I recommended that my fellow students use Rational Rose | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 12 | a) | Assuming I have access to Rational Rose, I intend to use it | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| | b) | Given that I have access to Rational Rose, I predict that I will use it | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 13 | a) | People who influence my behaviour think I should use Rational Rose | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| | b) | People who are important to me think I should use Rational Rose | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 14 | a) | In my project, usage of Rational Rose is important | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| | b) | In my project, usage of Rational Rose is relevant | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 15 | a) | The quality of the output I get from Rational Rose is high | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| | b) | I have no problem with the quality of Rational Rose's output | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 16 | a) | My friends think that I should use Rational Rose | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| | b) | My fellow students think that I should use Rational Rose | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 17 | a) | My lecturers think that I should use Rational Rose | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| | b) | I will use Rational Rose if my lecturers require it | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 18 | a) | I feel comfortable using Rational Rose on my own | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| | b) | If I wanted to, I could easily operate Rational Rose on my own | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| | c) | I am able to use Rational Rose even if there is no one around to show me how to use it | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 19 | a) | Rational Rose is not compatible with the hardware I use | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| | b) | Rational Rose is not compatible with the other applications I use | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| | c) | I have trouble transferring my work between Rational Rose and other applications I use | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 20 | a) | There are not enough computers with Rational Rose for everyone to use | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| | b) | I am not able to use a computer with Rational Rose when I need to | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| | c) | It is too difficult for me to find a computer with Rational Rose when I need to use it | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 21 | a) | I am able to use Rational Rose | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| | b) | Using Rational Rose is entirely within my control | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| | c) | I have the resources <i>and</i> the knowledge <i>and</i> the ability to make use of Rational Rose | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 22 | a) | I intend to use Rational Rose this year | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| | b) | I intend to use Rational Rose in my project this year | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| | c) | I intend to use Rational Rose frequently this year | 1 | 2 | 3 | 4 | 5 | 6 | 7 |

Please mark the word that most accurately fills the blank in each statement:

| | | | | |
|----|----|---|----------|------------|
| 23 | a) | Using Rational Rose is a _____ idea | good | bad |
| | b) | Using Rational Rose is a _____ idea | wise | foolish |
| | c) | I _____ the idea of using Rational Rose | like | dislike |
| | d) | Using Rational Rose is _____ | pleasant | unpleasant |

Please mark the block that reflects your answer to each question:

| | | | | | | | | | |
|----|----|---|--------------------|-----------------------|-------------------|---------------------|----------------------|------------------|----------------------|
| 24 | a) | How frequently do you believe you use Rational Rose? | extremely frequent | Quite frequent | Slightly frequent | neither | Slightly infrequent | Quite infrequent | extremely infrequent |
| | b) | How many times do you believe you use Rational Rose per week? | not at all | less than once a week | about once a week | 2 or 3 times a week | several times a week | about once a day | several times a day |
| | c) | How many hours do you believe you use Rational Rose every week? | less than 1hr | between 1-5hrs | between 5-10hrs | between 10-15hrs | between 15-20hrs | between 20-25hrs | more than 25hrs |

University of Cape Town

Appendix B: Construct Reference

The table below gives reference to the constructs measured by each question in the questionnaire.

| Question | Construct |
|----------|---|
| 1 | Demographics |
| 2 | Perceived ease of use |
| 3 | Perceived usefulness / Relative advantage |
| 4 | Relative advantage |
| 5 | Compatibility |
| 6 | Image |
| 7 | Result demonstrability |
| 8 | Visibility |
| 9 | Trialability |
| 10 | Voluntariness |
| 11 | Intention to adopt |
| 12 | Intention to use |
| 13 | Subjective norm |
| 14 | Job relevance |
| 15 | Output quality |
| 16 | Peer influences |
| 17 | Superior influences |
| 18 | Efficacy |
| 19 | Facilitating conditions - Technology |
| 20 | Facilitating conditions - Resources |
| 21 | Perceived behavioural control |
| 22 | Behavioural intention |
| 23 | Attitude |
| 24 | Actual use |