The use and effectiveness of information system development methodologies in health information systems

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SOLI DEO GLORIA

Abstract

The main focus of this study is the identification of factors influencing the use and effectiveness of information system development methodologies (i.e., systems development methodologies) in health information systems. In essence, it can be viewed as exploratory research, utilizing a conceptual research model to investigate the relationships among the hypothesised factors. More specifically, classified as behavioural science, it combines two theoretical models, namely the Unified Theory of Acceptance and Use of Technology and the Expectancy Disconfirmation Theory. The main aim of behavioural science in information systems is to assist practitioners (i.e., social actors) in improving business processes and competitiveness, thus the effective use of information systems. A wider view of behavioural science incorporates other social actors (e.g., end users) and organisational actors (e.g., executives). In health information systems, the effective use of information systems is especially relevant. Health information systems are vital in the area of health care, since only by having access to pertinent health information, can the correct decisions relating to diagnostics and curative procedures be made. The use of systems development methodologies in health information systems development is therefore crucial, since they can make the development process more effective, while improving software quality.

By empirically evaluating the conceptual research model, utilizing a survey as the main research method and structural equation modelling as the main statistical technique, meaningful results were obtained. Focussing on the factors influencing the individual's behavioural intent, it was found that the compatibility of systems development methodologies to the developer's pre-existing software development style is vital. Furthermore, performance expectancy, self-efficacy, organisational culture, policies, customer influence, voluntariness and facilitating conditions, all directly influenced the use of systems development methodologies, with policies and customer influence playing a significant role, especially in relation to health information systems. No significant direct effects or indirect effects could be established for the factors effort expectancy, personal innovativeness and social influence. It appears that individuals working in the health care software development discipline are more autonomous, less influenced by others. Also, the lack of support for the factor effort expectancy may indicate that systems development methodologies have entered a mature state, with less concern on the effort required for use. Furthermore, with regard to effectiveness and the continued use of information systems methodologies, satisfaction had a significant direct effect, with confirmation having a significant indirect effect.

Keywords: behavioural science; conceptual research model; direct effect; exploratory research; Expectancy Disconfirmation Theory; indirect effect; Unified Theory of Acceptance and Use of Technology; structural equation modelling; survey; systems development methodologies.

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Chapter 1 : Introduction

1.1 Introduction

This chapter provides an introduction to the study, starting with a background to its underlying elements. Thereafter, research in information systems and the specific aspects of ontology, epistemology and methodology are considered, thereby identifying the intrinsic research paradigm, namely positivism. This is followed by an overview of the purpose of this study, its significance and the specific research questions identified. Special consideration is given to Structural Equation Modelling (SEM), the fundamental statistical method used. A summary of SEM advantages, resulting in it being used as the primary data analysis method, is provided. In conclusion, principle terms used are defined, as well as the study's structure, outlining each of the research phases and its relevant chapters.

interpretation of findings and its use of these findings in extending theory or developing new theory) and relevant (i.e., demonstrating a meaningfulness regarding its application to the significant problems and opportunities being faced by today's organizations and their members)".

In the context of theories, it is important to note that information systems are a diverse discipline, with many scholars having their foundation in other research fields. It is therefore natural that different views on the nature of theory exist in the field of IS (Lee, 1999b). It is, however, essential that IS researchers develop unique IS theories in a world where knowledge regarding physical systems, human behaviour and IS designed information technology artifacts (e.g., SDMs) meet. Based on this, and considering that this research is mainly a behavioural study focusing on factors influencing the use and effectiveness of SDMs, as well as the rigor required for valid research, it was decided to employ the Unified Theory of Acceptance and Use of Technology (UTAUT) as this study's core theory. The UTAUT was developed and empirically tested by Venkatesh *et al.* (2003), regarded as a theory developed distinctively in the IS discipline.

The acceptance and use of information technology is an issue that has received wide attention. Successful investment in Information Technology (IT) can lead to enhanced productivity, while failed systems can lead to undesirable consequences, including financial loss and general user dissatisfaction. This attention to acceptance and use has resulted in a number of different theoretical models, not only in the discipline of information systems, but also in psychology and sociology, where general acceptance and use theories are also relevant. Venkatesh *et al.* (2003) therefore postulated the need for a review and synthesis of the major theoretical models, thereby progressing toward a unified view of user acceptance in IT. As a result, the authors combined eight theories, mainly from the behavioural sciences, to construct the UTAUT. The eight theories are the Model of PC Utilization (MPCU), the Social Cognitive Theory (SCT), the Theory of Reasoned Action (TRA), the Innovation Diffusion Theory (IDT), the Technology Acceptance Model (TAM), the Theory of Planned Behaviour (TPB), the Combined TAM and TPB (C-TAM-TPB) and the Motivation Model (MM), discussed in more detail in Chapter 2.

Although the amount of IS research focusing on the use and acceptance of IT artifacts [2]has been numerous, research on the continuance (i.e., the continued use) of IT artifacts has unfortunately not enjoyed a comparable level of attention. As such it can be viewed immature, since currently, only a relatively low number of scientific publications exists in this area. While initial acceptance and use of IT artifacts are important, long-term viability and eventual success depend on *continued* use, rather than initial acceptance.

Continuance is not entirely an alien concept in information systems research. The innovation diffusion theory, in its five-stage adoption decision process (i.e., knowledge, persuasion, decision, implementation

[2] *IT artefacts, first defined by March and Smith (1995), are constructs (i.e., vocabulary, symbols), models (i.e., abstractions, representations), methods (i.e., algorithms, practices) and instantiations (i.e., implemented prototype systems) (Mingers, 2001). As such, IT artefacts are designed, developed, implemented, modified and used by humans in predominantly social settings.*

Furthermore, internationally, the world faces health care challenges of avian influenza, Human Immunodeficiency Virus (HIV) and tuberculosis (TB), all placing a further burden on health care delivery. This is especially true for Sub-Saharan Africa. Based on statistics, it is estimated that the region constitutes 11% of the world's population, however, carries 24% of the global burden of disease, while having only 3% of the world's health workers at its disposal (Sampaio, 2007). Furthermore, it is estimated that two-thirds of all HIV-infected adults and children reside in Sub-Saharan Africa, while in 2006, an estimated 72% of all AIDS-related deaths occurred in the region. For South Africa, it is crucial to address these challenges in an economical and effective way.

Information and communication technologies (ICT) offer a possible solution in providing the necessary information systems to assist health care workers in their efforts. Systems development methodologies, forming a critical component of information systems development, are therefore especially relevant to addressing these challenges.

1.3 Research in Information Systems

A diversity of research approaches (i.e., paradigms) can be identified in information systems, since it interacts with a broad range of research fields and disciplines.

The most prominent of these disciplines include computer science, economics, sociology, mathematics and psychology, each embracing very distinctive research traditions. Benbasat and Weber (1996:397) however argues for uniformity within the IS discipline as a whole, stipulating that "*our own view is that we need both a paradigm (one or more) and diversity in the IS discipline. A paradigm will serve to provide coherence to the IS discipline and assist to characterize the phenomena that make it different from other disciplines. In short, it is needed to articulate the core of the discipline*". Without this core, it is feared by the authors that the IS discipline will fragment and eventually be taken over by a more established discipline.

In comparison, Robey (1996) argue that any diversity of research methods and paradigms must be embraced. It is postulated that this will provide a wider range of knowledge traditions upon which to base research and theory, advantageous in the IS discipline, which explore real-world complexities. Robey (1996), however, accepts that such an approach also needs a disciplined methodological pluralism to avoid becoming totally anarchistic.

acceptance and use, including their impact on individuals, work groups and organisations (Lee, 1999b). One of the first theories used to investigate the acceptance and use of IT artefacts was introduced by Fishbein and Ajzen (1975), namely the TRA. Other notable theories include the TPB, IDT, TAM and UTAUT, further discussed in Chapter 2.

1.3.2 Design Science

The origins of design science can be located in the engineering discipline. As such, design science's main goal is to extend the boundaries of human capability by developing ground-breaking and innovative artefacts (Simon, 1996). Such artefacts are, however, not exempt from behavioural theories. To the contrary, their creation relies on existing theories, including behavioural theories applied, examined, changed and extended by researchers (Markus *et al.*, 2002).

The importance of design science is well recognised in IS literature. Benbasat and Zmud (1999) argued that IS research must be relevant, with relevance being directly related to applicability in design. However, designing useful IT artefacts is complex, owing to the necessity of creative advances in specific domain areas, in which theory is most often inadequate. This can be seen as IT solutions applied to new application areas not previously considered (Markus *et al.*, 2002).

Green *et al.* (2004) stated that these areas, including health, provide excellent opportunities for IS research to make significant contributions, especially by linking design and behavioural science. This is achieved firstly, by designing new IT artefacts of relevance and secondly, by studying their acceptance, use and continuance. In conclusion, Benbasat and Zmud (2003) confirmed that the focus of IS researchers should be on how to best design IT artefacts, looking at elements of compatibility and ease of use.

In an influential article, Iivari (2007), when considering design science outcomes, stressed the need for constructive research methods in the development of IT artefacts, required to establish scientific rigor. It is critical to distinguish IS design science from the normal practice of developing IT artefacts. In other words, developing a particular IT artefact does not represent research. This would have implied that any software developer is a researcher. Iivari (2007) therefore emphasised that design science should be based on a paradigmatic framework, which includes a sound ontology, epistemology and methodology.

As such, any science, including behavioural and design sciences, should be based on a well defined ontology, epistemology and methodology (i.e., research methodology).

1.4 Ontology, Epistemology and Research Methodology

This section outlines the three well-established philosophical areas of research (i.e., ontology, epistemology and methodology), generally considered the building blocks of research. All published

- **Descriptive knowledge** aims to describe and/or comprehend how things are, normally by using theories and/or hypotheses.

- **Prescriptive knowledge** concerns mainly how to achieve specific ends in an effective manner.

It is important to understand the epistemological viewpoint of any research in order to fully understand the results. As such, different research paradigms can be identified in literature.

Mingers (2001:242) defines a paradigm as a *"construct that specifies a general set of philosophical assumptions covering, for example, ontology (what is assumed to exist), epistemology (the nature of valid knowledge), ethics or axiology (what is valued or considered right), and methodology (actual research method(s))".*

One of the most widely classifications of research paradigms is that of Chua (1986) and Orlikowski and Baroudi (1991), which divided research into positivist, interpretive and critical studies, illustrated in Figure 1.2.

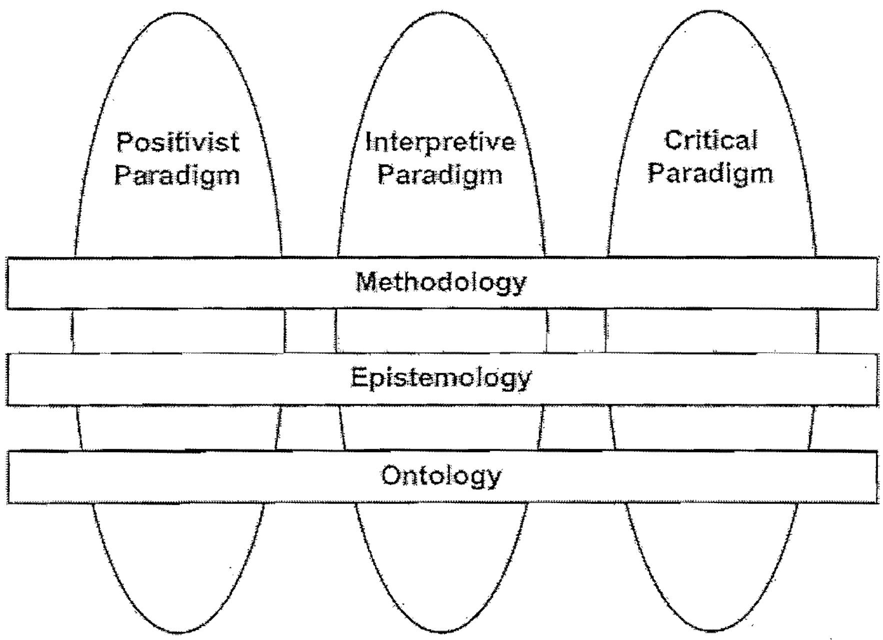

Figure 1.2: The three main research paradigms as defined by Chua (1986)

- **Positivist studies** are based on the existence of a priori fixed relationships within phenomena, which are typically explored with a form of structured measurement instrumentation, like surveys or experiments (Orlikowski and Baroudi, 1991). Such studies serve primarily to test theory in an attempt to increase predictive understanding of phenomena. The researcher is an observer, acts as an outsider to the process and tries not to intervene in the situation. Observation usually starts with a theory or predetermined relationships (i.e., hypotheses). New knowledge is only created when it can be verified through measurement. To be valid, the results must be replicable and applied universally.

1.4.3 Research Methodology

Research methodology refers to how, and more specifically, the method by which reality becomes known (Punch, 1998). Methodology is derived from the Greek words *methodos*, signifying method, and *logos*, signifying reason. Research methodology, however, does not only include the methods used in research, but also pertains to the logic, potentialities and limitations of these methods. In this context, research methodology can be viewed as the philosophical evaluation of investigative techniques used within sciences.

Research is normally accomplished by making use of research methods and techniques considered appropriate.

The best way of explaining the difference between a research method and a technique is by means of an example. A survey, case study, or experiment can be viewed as a research method, while a questionnaire, interview, or observation is a research technique utilized in research methods. Each research paradigm typically employs a specific research methodology, consisting of specific methods and techniques. Based on Mingers (2001), positivistic studies mainly utilize the quantitative research methodology, e.g., a survey implemented by means of a questionnaire, while interpretive studies mainly utilize the qualitative research methodology, such as interviews captured by transcripts.

It is important to note that a specific research method or technique can be utilized in both quantitative and qualitative research methodologies, e.g., case studies. With the quantitative research methodology, case studies may be performed by means of structured interviews (e.g., interviews using questionnaires), while with the qualitative research methodology, case studies may again be performed by means of unstructured interviews or observations. In this study, to a lesser extent, four case studies are implemented by means of structured interviews, specifically during the applicability check (Rosemann and Vessey, 2008) stage of the research, thereby ensuring that the conceptual research model is practically relevant. Applicability checks are defined in section 1.9.

This studies main research method, however, is a survey, implemented as a web-based questionnaire, generally known as a web-based survey.

In the next two sections, the specific purpose and significance of this study will be explored.

1.5 Purpose of the Study

The main objective of this study is to *explore* and *understand* the factors affecting and influencing the use and effectiveness of systems development methodologies in the health information systems sector. This

1.6 Significance of the Study

Information systems are an applied discipline. In IS research, it makes little sense if the results are not applicable in the real world. The aim of this research therefore is to contribute to both theory and practice.

- **Theoretically**, this study is both new and innovative, since there has been no previous research with reference to literature that focused on the use and effectiveness of SDMs in health information systems. The analysis of the UTAUT and EDT based conceptual research model will further contribute to the knowledge base, specifically with regard to acceptance and continuance theory. IT artifacts differ in design and as such also differ in their use and acceptance, as postulated by Iivari (2007). It is therefore important to verify as to whether the UTAUT and EDT are indeed valid theories for the study of SDMs use and continuance.

- **Practically**, by exploring the antecedents influencing the use and effectiveness of SDMs, a valued contribution will also be made by providing a guideline to IS health professionals. Based on this guideline, practice can address specific antecedents for SDM use and continuance (i.e., effectiveness), relevant to their unique environment.

Furthermore, an effort was made to address some of the issues outlined in the article of Benbasat and Barki (2007), titled *Quo vadis, TAM?* In this paper, the authors draw attention to the need of redirecting IT acceptance research towards potentially more fruitful avenues, away from TAM++ research[3].

Both Iivari (2007) and Benbasat and Barki (2007) highlighted the unintentional side effect of technology acceptance and use theories, drawing researchers' attention away from a key IS research objective, namely the design of IT artifacts.

Behavioural studies cannot be considered more important than design studies, since without new innovative artefacts, created with design science, behavioural science will be limited. In this regard, agreement must be acknowledge, since both design and behavioural science have a significant role to play in the IS academic field.

Furthermore, Benbasat and Barki (2007) postulate that it was not the intention of Davis *et al.* (1989) that future researchers reiterate the importance of perceived usefulness without investigating what actually contributes to a system's usefulness. Resulting from this, this study attempts to include a broader perspective of what factors impact the use and effectiveness of SDMs with regard to health information systems (e.g., considering the effect of direct and indirect benefits on performance expectancy).

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[3] *TAM++ research refers to the practice of simply adding one or two constructs to TAM.*

iii. Are specific components (i.e., methods, tools, techniques), or all components of SDM being used? This is referred to as vertical use (McChesney and Glass, 1993; Iivari and Huisman, 2007).

iv. Are components of different SDMs combined into new custom methodologies in HIS development? This is referred to as method engineering (Iivari *et al.*, 2000).

v. Are specific types of methodologies used for specific types of HIS applications? This tendency is referred to as contingency or situation method engineering (Harmsen *et al.*, 1994).

vi. Does the organisational size or IS department size influences the use of SDMs?

vii. Does the educational level of the individual influences the use of SDMs?

viii. What factors (e.g., performance expectancy, effort expectancy, facilitating conditions) influence the use of systems development methodologies in HIS development?

ix. What underlying confirmation types in relation to SDMs are important when evaluating confirmation (refer to EDT, discussed in Chapter 2)? Therefore, is developer confirmation (i.e., impact of SDMs on developer), customer confirmation (i.e., impact of SDM on customer), or the impact of SDMs on the organisation (i.e., organisational confirmation) more important when measuring SDM confirmation?

x. What culture types are significant when evaluating organisational culture? Organisational culture is interpreted in terms of four culture types (i.e., group, developmental, rational, hierarchical) (Denison and Spreitzer, 2007). Which one of these cultures is less or more relevant when considering the use of SDMs?

xi. What factors (e.g., confirmation, satisfaction) influence the continued used (i.e., effectiveness) of software development methodologies in HIS?

xii. How well does the conceptual research model fit, or explain the surveyed data obtained?

Iivari *et al.* (2000) and Huisman and Iivari (2006) envisaged that using a software development methodology is more effective than using none at all. SDMs introduce structure, thereby improving efficiency of the software design process and enabling more consistent outcomes. In a development environment where product quality is becoming increasingly important, while application size and diversity are growing, a mechanism to ensure quality is essential. Will this be proven to be so in practice? Will developers by their continued use (i.e., continuance) of SDMs portray that they are effective?

This study aims to answer some of the research questions, specifically research question xi and xii, by utilizing SEM, highlighted next.

of the strength and direction of the interrelationships among multiple dependent and independent variables and their measurements.

ii. Other statistical techniques typically only allow a single relationship between dependent and independent variables (Hair *et al.*, 2006). In SEM, multiple relations between dependent and independent variables are allowed.

iii. Unlike other statistical techniques which can only consider a limited number of variables, SEM can evaluate complex theoretical models, portraying complex phenomena (Schumacker and Lomax, 2004).

iv. SEM is able to model multiple dependent variables, as well as multiple independent variables (Raykov and Marcoulides, 2000).

v. In SEM, a variable can be modelled as being both a dependent and independent variable (Schumacker and Lomax, 2004). This is more rational in real world settings where variables are neither manipulated, nor controlled.

vi. SEM can represent unobserved variables, which are theoretical constructs not directly observed (Raykov and Marcoulides, 2000).

vii. SEM takes measurement error of independent variables into account during statistical analysis, unlike regression analysis using the traditional linear regression formula[7] (Schumacker and Lomax, 2004). This element is critical. As can be seen in traditional linear regression formula, the only error considered is the random error in Y. The traditional regression model is therefore based on the assumption that all independent variables (e.g., X) are measured without error (Blunch, 2008).

    This assumption is rarely mentioned, but nevertheless unrealistic in behavioural science. SEM in comparison do not assume that the independent variables have no measurement error, but can include a error measure for each independent variable.

    In Figure 1.3, the measurement model includes the measures A1, A2 and A3 for construct A and measures B1, B2 and B3 for construct B. Each measure has associated with it a measurement error, for example A1 has the measurement error e1. These elements together form the measurement model.

[7] *The traditional linear regression formula is* $Y = b_0 + b_1X + \varepsilon$ *where* Y *is the dependent variable and* X *is the independent variable,* b_0 *is the intercept of the regression line,* b_1 *is the gradient of the regression line refer to as the regression coefficient, and* ε *is the random error in* Y.

The direct effect of factor B on C is equal to regression coefficient b1, while the indirect effect of B on C through the *mediator* variable A is the product of the coefficient weights b2 and b3, based on the Sobel product coefficient approach (Sobel, 1982).The total effect of B on C can be calculated as b1 + (b2*b3). Total, direct and indirect effects, as well as their significance can be calculated manually in multiple regression (Sobel, 1987). However, nearly all SEM software packages calculate these effects and their significance automatically, irrespective of the complexity of the model.

The concepts of direct, indirect and total effects are closely linked to the concept of mediation. Mediation refers to an indirect effect of an independent variable on a dependent variable that passes through a mediator variable, depicted in Figure 1.5 (a) (Shrout and Bolger, 2002). As such, a mediator variable falls in the causal pathway between an independent and dependent variable. Mediation can best be illustrated by the Theory of Planned Behaviour (Ajzen, 1991), which stipulates that the effects of perceived behaviour control on actual behaviour are mediated by behavioural intention.

Baron and Kenny (1986) advocated that SEM is the most efficient and least problematic way of testing for mediation. Because of the capacity of SEM to simultaneously estimate multiple equations and include latent variables, it avoids problems of over- and underestimation of mediated effects by controlling for measurement error. It also allows for the estimation of those models that include multiple mediators and combinations of mediated and moderated effects.

This process is discussed in greater detail in Chapters 5 and 6.

The next two sections cover the most important terms used in this research and present the research strategy.

1.9 Definition of Terms

In the next paragraphs, short definitions of the most important terminologies and acronyms used in this study are presented.

There is rarely a clear distinction between adoption, adaptation, acceptance and use of IT artefacts (e.g., innovations) in literature. Especially adoption, acceptance and use are applied randomly, denoting different concepts in different studies.

According to Kwon and Zmud (1987), the implementation process of an innovation (e.g., SDM) consists of various phases. Illustrated in Figure 1.6, six phases are identified, namely initiation, adoption, adaptation, acceptance, use and incorporation. Initiation is the first phase, when the requirement for change is acknowledge. Subsequently, the adoption phase is entered when a conscious decision is made to use the innovation, and the required resources are allocated. During the adaptation phase, the new innovation is altered to better suit the project or organizations requirements. In the acceptance phase, the innovation is accepted as standard, and in the use phase become part of daily practice. Incorporation refers to the further development and maintenance of the innovation.

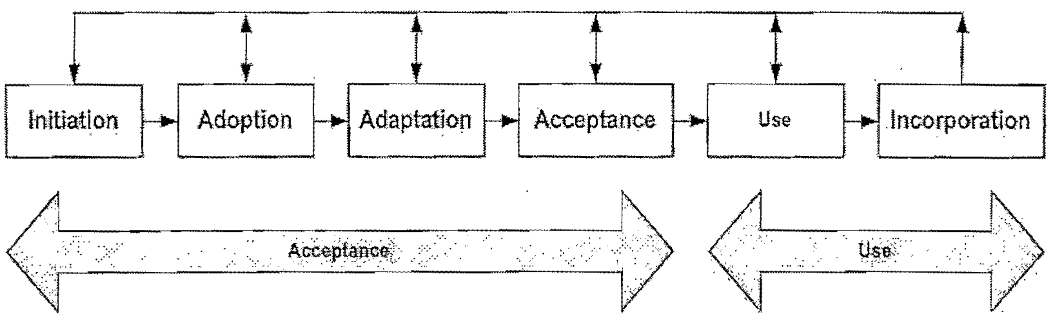

Figure 1.6: Implementation process model (derived from Kwon and Zmud (1987:233))

To ensure a norm, this study will refer to the first four phases of Kwon and Zmud (1987) implementation process model as acceptance, and the last two phases of the implementation process model as use.

More specifically, **acceptance**, as applied in this study, refers to the strength of an individual's intention to use an innovation, given that behaviour intention predicts actual behaviour (Davis *et al.*, 1989; Fishbein and Ajzen, 1975; Wilson and Lankton, 2004). This research employs behavioural intention (i.e., intention to use) to indicate acceptance, based on three unique reasons.

Information system refers specifically to a computerised information system, as defined by Iivari and Maansaari (1998). In their article, the authors specifically highlight the difference between an information system and a computerised information system or sub-system. A information system is classified as a *"sub-system of an organizational system, comprising the conception of how the communication- and information- aspects of an organization are composed and how these operate, thus describing the communication-oriented and information-providing actions and arrangements existing within that organization"* (Iivari and Maansaari, 1998:502). A computerised information sub-system is defined as a "*sub-system of an information system, whereby all actions within the sub-system are performed by one or several computer(s)*" (Iivari and Maansaari, 1998:502).

Health information system, also referred to as **health informatics** or **medical informatics**, is the application of information technology and information science to the theoretical and practical problems of medical education, clinical practice and biomedical (Shortliffe and Blois, 2001). Examples of health information systems, therefore practical implementations of IS related to health care, are Electronic Medical Records (EMRs), Picture Archiving and Communication Systems (PACS), Clinical Decision Support Systems (CDSS) and Computerised Physician Order Entry (CPOE). These are discussed in more detail in Chapter 4. The academic discipline of Health Information Systems can be viewed as a combination of health care (i.e., health sciences), information science, engineering and computer science.

Systems development methodology (SDM) is an orderly approach to carry out at least one stage of the systems development life cycle, by using relevant tools, techniques, or guidelines, based on an underlying philosophy (Wynekoop and Russo, 1995).

Applicability checks are assessments made by practitioners of the research produced by academics (Rosemann and Vessey, 2008). The aim of applicability checks is to improve the practical relevance of research. This is accomplished by performing applicability checks with practitioners on research objects (e.g., theories, models, frameworks, technical artifacts).

In SEM, a construct or factor is equivalent to a latent or unobserved variable. Figure 1.8 depicts the relationship between a latent variable and its measurement variables.

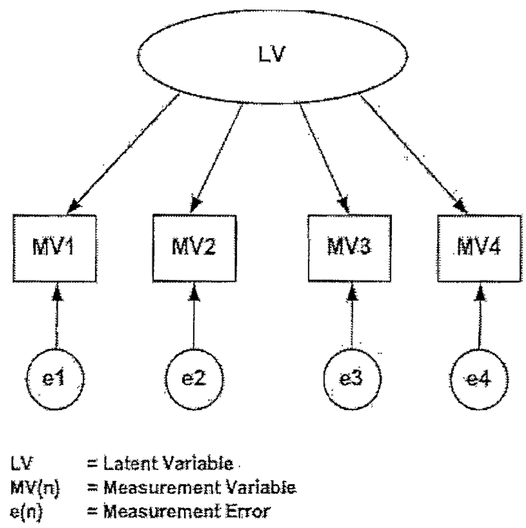

Figure 1.8: Latent and measurement variables

Factor analysis is a statistical method used to analyse possible interrelationships among measurement variables. It is also used to elucidate these variables in terms of their common underlying dimension or factor (Byrne, 2001). As such, it is one of the oldest and best known procedures to investigate the relations between sets of observed and latent variables. Two basic types of factor analysis can be identified, namely exploratory and confirmatory factor analysis.

- **Exploratory factor analysis** (EFA) is used in situations where the relations between observed and latent variables are unknown, unclear, or uncertain. The analysis is thus focused on determining how and to what extent observed and latent variables (i.e., factors) are related (Byrne, 2001). By examining the relationships (i.e., factor loadings) of observed variables, it is possible to identify which of them exhibit high factor loading on specific factors. Generally, this process is considered exploratory, as no prior knowledge of relations is known.

- **Confirmatory factor analysis** (CFA) is generally used when the researcher has some prior knowledge of the underlying latent variable structure. This knowledge, frequently based on theory, empirical research, or both, assists the researcher in postulating relations between measurement variables and factors, allowing the measurement model to be tested. This typically performed with SEM, specifically focusing on the measurement model.

Independent variable is a variable thought to be the cause of some effect (Field, 2009).

Dependent variable is a variable considered to be affected by changes in one or more independent variables (Field, 2009).

- **Structural model** defines the relationships between the unobserved variables, therefore between the constructs, generally evaluated by means of a model fit indices and path coefficients in SEM (Byrne, 2001).

The main objective of **confirmatory research** is to verify a theoretical model (i.e., conceptual research model) (Schumacker and Lomax, 2004). As a prerequisite, the theoretical model may not be modified during SEM analysis.

Exploratory research differs from confirmatory research, since it allows the theoretical model to be modified during SEM analysis.

1.10 Organisation of the Remainder of the Study and Conclusion

The research strategy followed in this research consists of four distinct phases, each of which is briefly outlined below (illustrated in Figure 1.9).

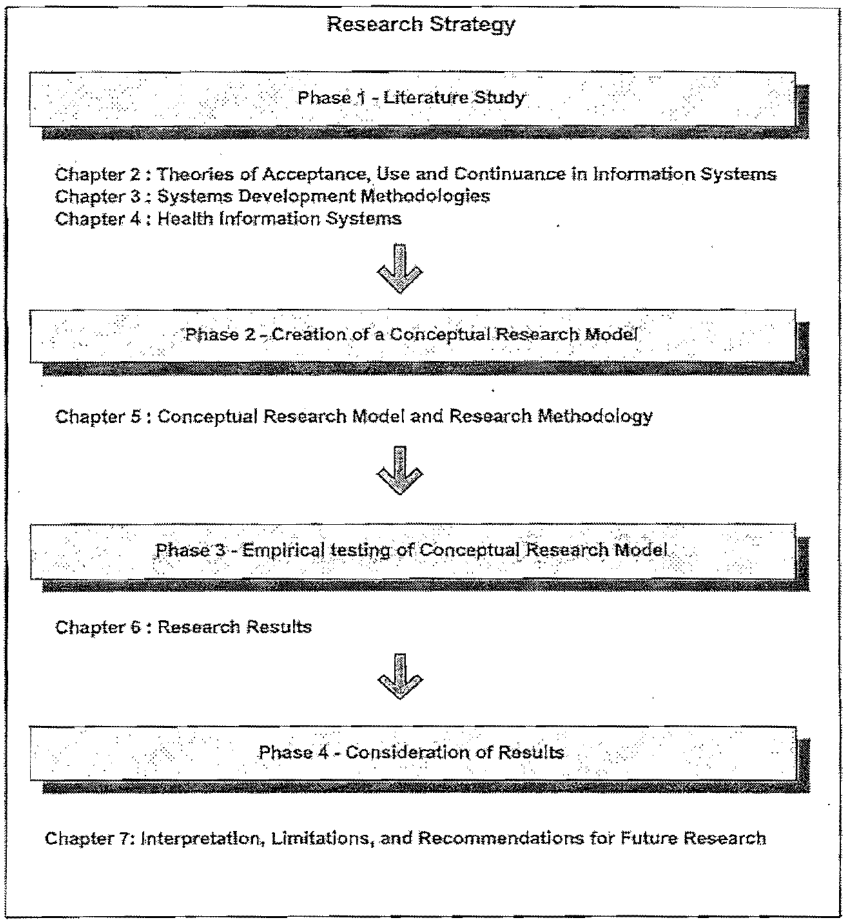

Figure 1.9: Research strategy

Chapter 7 (Interpretation, Limitations and Recommendations for Future Research) constitutes the results and shortcomings of the study. The chapter concludes with a number of recommendations for future studies.

This chapter provided a brief overview of the major elements of this research.

As such, the study was categorised as a behavioural positivistic study, utilising a web-based survey as the main method of research. Limited structured case studies (i.e., applicability checks) to verify the practicality of the conceptual research model were used. The purpose of this study, which is to identify the factors influencing the use and effectiveness of SDMs in HIS and their significance with regard to HIS and theory building, were also highlighted. Specific research questions were developed, followed by some critical advantages of SEM, providing some background as to why SEM was chosen as the main statistical analysis method. In conclusion, critical terms, used in this study were defined.

In the next chapter, acceptance, use and continuance theories will be considered. These form the base of this study's conceptual research model.

2.2 Background

The information systems discipline is diverse, with many researchers originating from diverse research fields. Various IS researchers have studied computer science, physics, mathematics, psychology, sociology, engineering and economics, thereby influencing the theories used, methods applied and research topics explored. It is therefore natural that different views on the nature of theory exist in the field of IS (Lee, 2001).

The cause of IS theory diversity cannot be found only in its multidiscipline researcher origins, but also correlates directly to one of its founding moments. In 1980, the first International Conference on Information Systems was held. During the conference, Keen (1980) presented a paper highlighting certain *reference disciplines* (e.g., psychology, sociology, management sciences) as being more mature than IS. As such, they could be used by IS researchers to obtain mature theories and models. In view of this, he argued that IS researchers could learn from the theoretical foundations and formal methods of these reference disciplines.

Subsequently, these reference disciplines became an ideal platform for IS researchers wishing to increase publication output and methodological rigor. Benbasat and Weber (1996), however, stated that although diversity clearly has its place, it does not excuse IS researchers from the responsibility of creating their own unique theories. The creation of distinctive theories is critical if the IS discipline wish to distinguish itself from other research areas. Baskerville and Myers (2002) subsequently proposed that IS researchers re-think referencing other disciplines, proposing that the IS discipline itself must become a source of reference for other disciplines.

In the next section, an overview of what a theory is, the main components of a theory, how theory is created and a classification of theories in IS are provided.

2.3 Overview of Theory

Popper (1980) saw the work of science as taking a proposed theory, deducing an observational prediction from it and testing the prediction. If the prediction fails, the theory has been refuted and needs to be reconsidered. If the predictions are supported, the theory has not been refuted. This position is commonly referred to as the hypothetical-deductive model.

But what is theory? Spata (2003) defines theory as an organised body of statements or assumptions that creates hypotheses, thereby attempting to explain behaviours within a specific content. Lammers and Badia (2005) further describe theory as a system or set of ideas frequently dealing with the reasons for specific behaviour, thus facilitating the researcher to organise and assimilate specific relationships discovered. This is an important function, since without theory to aid in classifying the numerous based on rigorous design theories. This element is critical, since considering IS disciplines as a design science, producing relevant IT artifacts based on theory and scientifically evaluated, a more equitable view of IS research is presented.

Recently, Rosemann and Vessey (2008) proposed an appropriate new step(s) in the research process, namely applicability checks. Applicability checks, implemented in focus groups or other forums, can be introduced either before, or after the normal research process. In this research, applicability checks are performed mainly in the theory building phase of the study. By applying applicability checks, it was possible to follow a strict scientific approach, while still incorporating practical relevance.

2.3.1 Elements of Theory

Weber (2003a), in his editorial comment, explicated his view of theory, namely that it is an account intended to explain or predict some phenomena under investigation. Phenomena can be defined as the state(s) of things, or event(s) occurring to things. As such, when theory is developed, it seeks to account for the state(s) of some things, or an event(s) occurring to some things.

For example, if the aim is to build an exploratory theory on the use and effectiveness of systems development methodologies, an attempt is made to specify relations seeking to associate various constructs (e.g., dependent and independent variables) to one another. Use and effectiveness can be viewed as the dependent variables that need to be explained or predicted. They form the focal constructs in the theory. The other constructs are independent variables of interest, as they can possibly be related in some way with changes in the value of the dependent variables (e.g., use, effectiveness). These constructs are generally referred to as supplementary constructs.

Hunt (1991) regard theory as consisting of four key components, namely "definitions of terms" or variables, a domain in which the theory will be applicable, a set of relationships between variables (i.e., hypotheses) and specific predictions (Hunt, 1991).

- The "definition of terms" satisfies the common questions of who and what.
- The domain in which the theory will apply highlights the conditions where the theory is expected to be valid by using the common questions of when and where.
- The relationship of variables specifies the reasoning of how and why variables are related.
- Lastly, the specific predictions specify whether an event could, should, or would occur.

Consisting of four recommended activities, listed in Table 2.2, they can be applied iteratively by IS researchers.

Table 2.2: Theory building approaches (derived from Weber, 2003a)

Activity	Definition
Define the constructs of a theory	• A new theory can be created by specifying new constructs. • New constructs can be introduced into an existing theory. • Constructs can be deleted from an existing theory. • The constructs of an existing theory can be defined differently, therefore conceptualised differently.
Define the relationships or associations among constructs	• New relationships and associations among existing or new constructs can be created. • Relationships can be deleted among constructs of an existing theory. • Re-define the existing relationships more precisely in an existing theory.
Define the lawful state space of a theory	• Specify more precisely the values or combination of values of a construct for which the theory will be valid or invalid.
Define the lawful event space of a theory	• Identify events for which either the initial, or subsequent state is valid or invalid.

In this study, the first two activities in Table 2.2 were mainly employed to create the conceptual research model.

It is, however, important to note that a limiting factor to be considered with any theory is whether the theory applies only to certain values for each of the constructs. For example, when considering the use and effectiveness of system development methodologies in health information systems, any research theory used must be bound by assumptions regarding implicit values, time and space. This choice of boundaries directly affects the "generalisability" of the theory. A theory with few or wide boundaries are more generalisable than theories with many constraints. Again, Weber (2003a) outlines ways of making a theoretical contribution by specifying more precise values for one or more constructs in theories.

In the next section, the classification of theories in IS will be considered, thereby completing the theoretical introduction to theory.

2.3.3 Classification (Taxonomy) of Theories in Information Systems

Gregor (2006) conducted a "meta-theoretical exploration" of theory used in the IS discipline, subsequently proposing a classification of IS theory.

This taxonomy is mainly based on the four primary goals of theory, namely analysis and description, explanation, prediction and prescription.

The theory classification performed by Gregor (2006) was based on a review of *MIS Quarterly* and *Information System Research* articles from March 2003 to June 2004. All theories discovered could be incorporated, thereby confirming the taxonomies' validity. From the results, it appears that most theories used in the designated IS research articles were of the type explaining and predicting. By far the most popular of this type of theory was the Technology Acceptance Model (Davis, 1989), designated as a behavioural or more specifically an acceptance and use theory.

It is important to note that these five theory classes or types do not exist independently, but are interdependent. For example, the most basic type of theory, the analytic theory, is a required component for the development of all other theory types. The main reason for this is that clear and concise definitions, presented with the theory of analysing, are required in all theory formulation. Furthermore, both theories of explaining and theories of predicting are incorporated in theories of explaining and predicting. Figure 2.1 depicts the interrelationships among the five theory types.

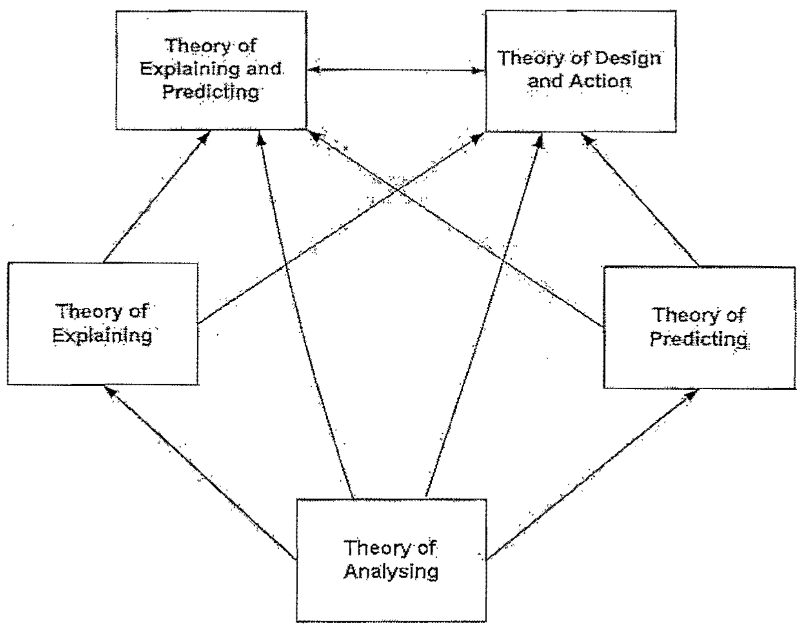

Figure 2.1: Interrelationships among the five theory types (Gregor, 2006:630)

In the next section, acceptance and use theories are highlighted, especially the UTAUT, which forms a core element of this study's conceptual research model.

2.4 Acceptance and Use Theories

Technology acceptance has been, and will continue to be a popular research topic for information systems researchers. As long as companies and organisations continue to invest in new information technologies, researchers will continue exploring ways of improving their acceptance and usage ratios.

In the following sections, each of these eight "behavioural" theories and the UTAUT are discussed.

It is important to demarcate research that do not use acceptance and use theories derived from the cognate discipline, but actively seek to inductively develop theoretical frameworks of technology acceptance and use. These studies can be classified as more interpretive than positivistic. The most prominent of these studies include Orlikowski (1993), Sarker and Wells (2003) and Scheepers *et al.* (2006). Orlikowski (1993), which mainly employed grounded theory, developed a theoretical framework for conceptualizing the organisational issues that influence the adoption and use of CASE tools. The author found factors of social context (i.e., non-organisational context) the intentions and actions of key players to be significant. Sarker and Wells (2003) focused on the use and adoption of mobile handheld devices from the perspective of the consumer. A framework was developed to provide an integrated view of the key issues related to mobile device use and adoption. Divided into three parts (i.e., input, process, output), it highlighted aspects like user characteristics, technology characteristics, experimentation and adoption behaviours. Scheepers *et al.* (2006) similarly followed an interpretive approach in exploring the adoption of mobile computing from a user perspective. Utilizing two case studies of Australian health care organizations, they concentrated on the factors experience, use and satisfaction. Specific themes identified included content accuracy, ease of use and timeliness, concentrating more on the organisational context than the professional or individual context. A more in-depth perspective was therefore obtained by considering the individual's different social "contexts" (i.e., organizational, professional, individual). In this study, the organizational context of the individual will be primarily considered, since SDMs use and effectiveness are intimately linked to the organization.

It is important to note that the UTAUT is a theory specific to the IS discipline. The development of theories unique to a discipline is crucial, as not only the identification and classification of IS specific phenomenon are needed, but also theories that will be acknowledged as belonging to the IS discipline (Weber, 2003b). The need for IS researchers to employ theories identified as belonging to the IS discipline must therefore be promoted. Considering this fact, it was decided to use the UTAUT as the core theory in this study, even though any of the other eight theories could be applied. Although each of the eight theories will be discussed next, the only purpose thereof is to enlighten the UTAUT.

2.4.1 Theory of Reasoned Action (TRA)

An important body of behaviour science draws on intention-based theories focusing on the behavioural intentions of individuals to predict use, also known as behavioural intention theories. Behavioural intention theories were originally associated with the work of Fishbein and Azjen (1975), which focused on identifying the antecedents of behavioural intention, such as attitudes, social influences and facilitating conditions. The Theory of Reasoned Action (TRA), also its later iteration, the Theory of Planned Behaviour, the Technology Acceptance Model, the Combined TAM and TPB and the Motivational Model are all prominent intention-based theories, also referred to as expectancy-value theories.

- **Behavioural intention** is the expressed desire to perform a specific behaviour. Important to note, it is presumed to be the direct antecedent of **actual behaviour** (Fishbein and Ajzen, 1975).

- **Actual behaviour** is the actual behaviour, therefore the observable response of an individual (Fishbein and Ajzen, 1975).

The TRA has been applied to a variety of research areas.

Some of the most recent studies include that of Kim *et al.* (2007), creating and validating an integrated conceptual model of Internet acceptance in Korea, using TRA and TAM. The conceptual research model specifically considered the relationship between external variables and individuals' acceptance of the Internet. External variables were classified into three categories, namely individual factors (e.g., experience, self-efficacy), task factors (e.g., task interdependence) and organisational factors (e.g., organisational support). The study reported significant relationships between experience and ease of use, usefulness and ease of use, usefulness and experience. Furthermore, organisational support directly influenced ease of use, usefulness and subjective norm. Interestingly, it was found that actual usage is not influenced by subjective norm as postulated by TRA, but influenced by usefulness, ease of use and experience.

Hsu and Lin (2008), while investigating blog usage using TRA, developed a conceptual research model using social influence factors, technology acceptance factors and knowledge sharing factors. Results indicated that the technology acceptance factors of ease of use and enjoyment were important, especially enjoyment. Furthermore, it was found that perceived usefulness had no effect. The knowledge sharing factors of altruism and reputation were both found significant, while from a social influence perspective, community identification was found plausible. Social norm, however, was not significant in influencing users' intentions to blog.

Ramayah *et al.* (2009) used TRA to explore factors influencing the intention of investors in Malaysia to use Internet stock trading. Results portrayed that attitude and subjective norm had a significant influence on behavioural intent. The external variables, perceived ease of use and perceived usefulness, significantly influenced attitude, while injunctive norm and descriptive norm again influenced subjective norm.

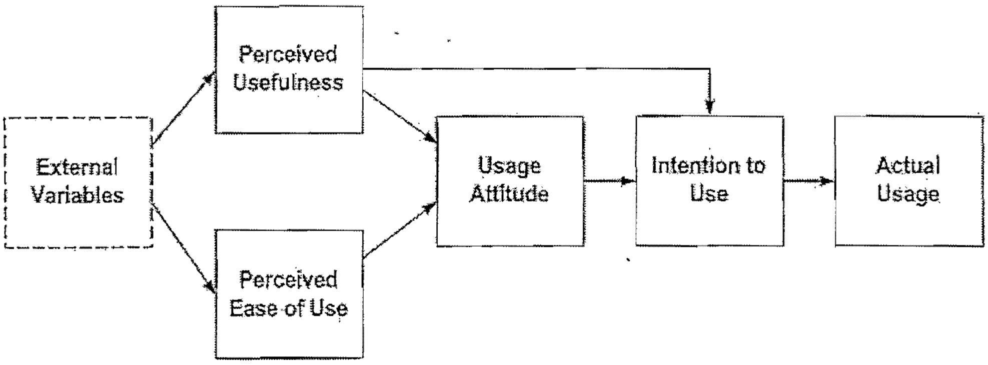

Figure 2.4: Technology acceptance model (derived from Davis *et al.*, 1989:985)

The main constructs of TAM, as defined by Davis *et al.* (1989) and depicted in Figure 2.4, are the following:

- **External factors** relate to external variables like user characteristics or organisational factors (Davis *et al.*, 1989).

- **Perceived usefulness** is the degree to which individuals believe their job performance will improve by utilizing IT (e.g., information systems) (Davis *et al.*, 1989).

- **Perceived ease of use** is the level to which an individual deems the use of IT free of effort (Davis *et al.*, 1989). Davis *et al.* (1989) also observed a positive association between perceived usefulness and ease of use.

- **Usage attitude** is the positive or negative assessment of behaviour by an individual (Fishbein and Ajzen, 1975). It is postulated by Davis (1989) that attitude towards use mediates the effects of perceived usefulness and perceived ease of use on behavioural intention (Davis, 1989).

- **Intention to use**, also referred to as behavioural intention, is the willingness of the individual to perform the given behaviour, influenced by attitude towards use and perceived usefulness (Davis, 1989).

- **Actual usage**, therefore the actual use of IT (e.g., information systems) is postulated by Davis (1989) to be determined by intention to use.

It is interesting to note that perceived usefulness has repeatedly been found to be the principal antecedent of user attitude towards IT usage (Venkatesh *et al.*, 2003). Ease of use unfortunately is not so consistent in predicting user attitude towards IT usage, especially during later stages of usage. Longitudinal studies suggest that the diminishing effect of ease of use over time points to a lessening of the user's anxiety regarding ease of use, mainly based on becoming comfortable with more experience (Szajna, 1996). Furthermore, Szajna (1996) found that perceived ease of use had a direct effect on

Yu *et al.* (2009) implemented a modified version of the extended TAM or TAM2, examining the factors that determined the acceptance of health information systems by caregivers in long-term facilities. The research model was only able to explain 34% of caregivers' intention to use HIS. Confirmatory factor analysis was performed to evaluate the measurement model, while structural equation model was used to validate the causal model, similarly to this study. Results confirmed that perceived usefulness, perceived ease of use and computer skills had a direct positive influence on caregivers' intention to use HIS. In comparison, image was found to have a negative impact. Image, subjective norm and computer skills, however, were found to have an indirect effect through the factor, ease of use. The demographic factors of age and experience were found to be insignificant.

Aggelidis and Chatzoglou (2009) explored the willingness of Greek hospital personnel to use state of the art information technology (i.e., health information systems), while performing their tasks. The study utilized TAM, extended by some exogenous variables, explained 87% of the variance of behavioural intention. Results indicated that perceived usefulness, facilitating conditions, ease of use, social influence, attitude and self-efficacy, all significantly influence individuals' behavioural intention. Training was also found to have a strong indirect impact on behavioural intention through the mediators, ease of use and facilitating conditions. Findings also indicated the existence of significant positive relations between perceived usefulness and anxiety, self-efficacy and social influence and lastly, facilitating conditions and social influence.

2.4.3 Motivational Model (MM)

With psychological origins, based on the self-determination theory by Deci and Ryan (1985) and Deci *et al.* (1991), the Motivational Model is a well-established theory. It consists of two main constructs originating in the technology acceptance domain, namely intrinsic motivation and extrinsic motivation.

- **Intrinsic motivation** is defined as a behaviour resulting from the satisfaction of performing the behaviour itself (Vallerand and Bissonnette, 1992).

- **Extrinsic motivation** is defined as behaviour for the sake of something else, referred to as valued outcomes, therefore anything except satisfaction (e.g., promotion) (Vallerand and Bissonnette, 1992).

Deci and Ryan (1985) included a third construct, namely "amotivational" style, although not well represented or tested in the technology acceptance domain.

Several models that will be reviewed, measure extrinsic motivation with factors such as ease of use, subjective norm and usefulness. Davis *et al.* (1992) first applied MM in the context of IT. In their research, Davis *et al.* (1992) operationalised these two constructs in a questionnaire in order to measure their effects on behavioural intention of students regarding two software packages. Extrinsic motivation was measured through perceived usefulness, while intrinsic motivation was measured through enjoyability.

perceived usefulness and perceived enjoyment, whilst intention towards use was not directly affected by ease of use.

2.4.4 Theory of Planned Behaviour (TPB)

The Theory of Planned Behaviour (TPB) is an expectancy-value model, extending the Theory of Reasoned Action (Ajzen, 1985; Ajzen and Madden, 1985). Adding the construct perceived behavioural control, it provides for non-voluntary factors outside the individual's control, mainly based on the opinion that behavioural performance is established by motivation (i.e., intention) and ability (i.e., behavioural control) (Ajzen, 1991).

Perceived behavioural control entails beliefs regarding facilitating conditions, as well as perceptions of ability. Therefore, based on the TPB, intentions towards adopting new IT are best predicted by the following three perceptions:

- Innovative activity is personally desirable (i.e., attitude).
- Innovative activity is supported by social norms (i.e., subjective norms).
- Innovative activity is allowed (i.e., perceived behavioural control).

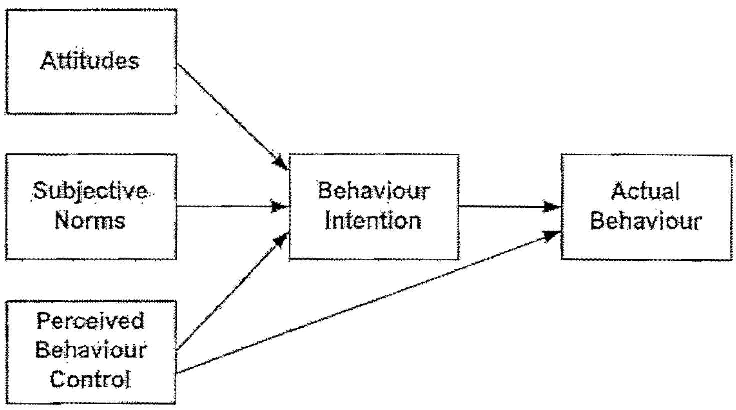

Figure 2.6: Theory of planned behaviour (derived from Ajzen, 1991:181)

The main constructs of TPB are depicted in Figure 2.6 and defined by Ajzen (1991) as follows:

- **Attitudes:** Derived from TRA (section 2.4.1).
- **Subjective norm:** Derived from TRA (section 2.4.1).

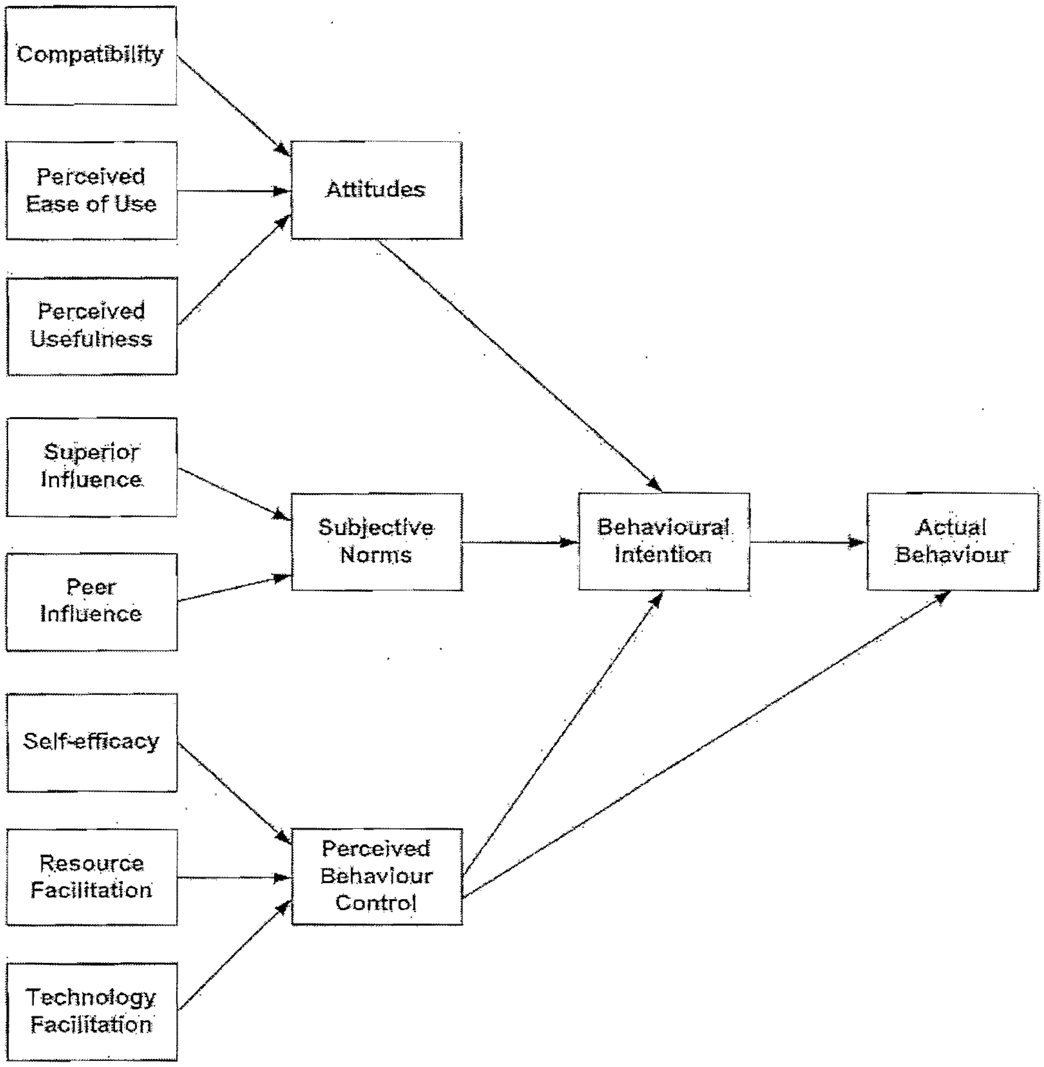

Figure 2.7: Decomposed theory of planned behaviour (derived from Taylor and Todd, 1995b:146)

Depicted in Figure 2.7, the decomposed TPB was developed by Taylor and Todd (1995b). As such, it decomposes attributes into compatibility, perceived usefulness and perceived ease of use, furthermore, subjective norms into peers' influence and superiors' influence and finally, perceived behavioural control into self-efficacy, technology and resource facilitating conditions.

Taylor and Todd (1995b) tested the new DTPB with a study of computer resource centre usage by comparing TRA, TPB and DTPB, all of which performed adequately. Although a slight prediction increase with the DTPB was obtained, the improved understanding of the domain and specific behavioural intention was significant. Several studies have utilized this theory to explore user acceptance of information systems, including Chau and Hu (2001) and Hsu and Chiu (2004b).

- **Actual Behaviour**: Derived from TPB (section 2.4.4).

A study by Taylor and Todd (1995a) revealed C-TAM-TPB explaining 60% of variance related to the behavioural intention for inexperienced users and 43% of variance related to the behavioural intention for experienced users. It further explained 21% of variance related to the actual behaviour for experienced users and 17% of variance related to the actual behaviour for inexperienced users.

The greater prediction power of the theory related to actual behaviour for experienced users may indicate that prior experience shaped expectations. Also, perceived behavioural control was more prominent than usefulness with regard to behavioural intention for experienced users, again suggesting that prior experience influenced behaviour intent. For inexperienced users, behavioural intention was mainly influenced by usefulness, followed by perceived ease of use. This suggested that inferred beliefs, beliefs that are assumed, rather than beliefs that are observed, are more relevant in determining inexperience individual's behavioural intention.

2.4.6 Model of PC Utilization (MPCU)

Triandis (1971) proposed a social psychological model to predict behaviour, generally referred to as the Triandis model. According to this model, behaviour is determined by what individuals prefer to do (i.e., attitudes), what individuals believe they must do (i.e., social norms) and what individuals have done (i.e., habits), as well as their behaviours' expected outcome. Triandis (1971) further postulated that attitudes consist of cognitive, affective and behavioural components:

- The **cognitive component** entails the individual's beliefs.
- The **affective component** is the individual's articulated likes or dislikes.
- The **behavioural component** is the individual's behavioural intention.

Subsequently, Triandis (1980) presented a more comprehensive model of interpersonal behaviour, of which a subset is depicted in Figure 2.9. The implication of this model is that social factors, affect and perceived consequences (e.g., near-term consequences, long-term consequences), influence behavioural intentions, which in turn influence behaviour. Furthermore, even when intentions are high, the behaviour may not occur if facilitating conditions are absent. The model also includes the constructs social situation, habit hierarchies (i.e., culture) and genetic biological factors, all postulated to affect behaviour directly and/or indirectly (Khalifa and Verner, 2000; Thompson *et al.*, 1991).

- **Affect towards use** is defined as feelings of pleasure, irritation, hate or disgust, associated with the use of a PC (Thompson *et al.*, 1991).

- **Job-fit** is an individual's belief regarding the level of job performance improvement when using a PC (Thompson *et al.*, 1991).

- **Long-term consequences** refer to outcomes having a pay-off in future (e.g., flexibility in changing jobs, increasing opportunity for meaningful work) (Thompson *et al.*, 1991).

- **Social factors** refer to the influence of social norms, which depends on the indications received from others, reflecting generally accepted norms in society (Thompson *et al.*, 1991).

- **Complexity** is the degree to which PCs is perceived complicated to use and comprehend (Thompson *et al.*, 1991).

- **Facilitating conditions** refer to factors making an act easy to achieve. In the context of PC use, this may relate to training or provision of assistance (Thompson *et al.*, 1991).

- **Utilization of PCs** is the actual use of a personal computer.

In a later work, Thompson *et al.* (1994) tested the MPCU, but included prior experience as an independent variable for all the antecedents of PC utilization. Prior experience was measured, based on self-reported skill level and the length of time the individual has used a PC. Results indicated that prior experience directly influenced the utilization of personal computers. The indirect influence of prior experience through the six antecedents of PC utilization, although present, was less pronounced. Thompson *et al.* (1994) therefore highlighted the importance of including experience as a factor when considering IT acceptance and use models, resulting in it being included in this study's conceptual research model.

Al-Khaldi and Wallace (1999) explored the model of PC utilization among knowledgeable workers in Saudi Arabia. Their conceptual research model is noteworthy, as it combines the MPCU with the attitude components postulated by Triandis (1971). Results indicated that utilization of PCs is determined by individual attitudes, facilitating conditions like PC access, personal characteristics like PC experience and social factors.

Khalifa and Verner (2000) studied the factors affecting the use of systems development methodologies, specifically the waterfall model and prototyping, by employing the Triandis model. Two important determinants were found to be statistically significant, namely process quality and facilitating conditions. The use of SDMs were measured in terms of depth of use (i.e., the extent to which prototyping and the waterfall approach were used in the various phases of the Software Development Life-Cycle (SDLC)) and

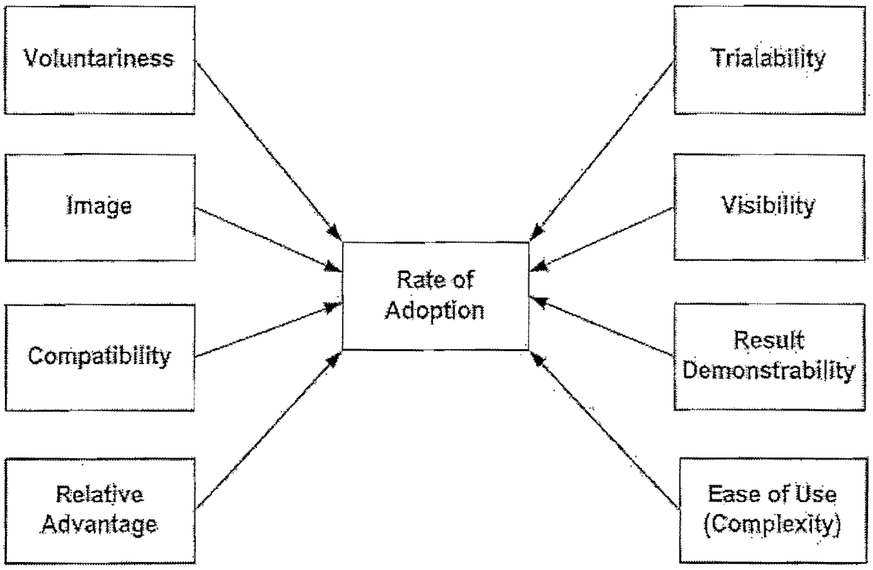

Figure 2.11: Innovation diffusion model (derived from Moore and Benbasat, 1991a:195)

Moore and Benbasat (1991a) developed a conceptual research model to measure perceptions of using IT innovations, based on the IDT and depicted in Figure 2.11. This was accomplished by adapting and expanding the factors influencing innovation adoption presented by Rogers (1976), by included additional factors from related theories. Observability was divided into result demonstrability and visibility, based on the findings that observability was influenced by these two factors. Furthermore, voluntariness was included from the diffusion research of Bayer and Melon (1989).

The main constructs of the IDT as used in the adoption of IT innovations, defined by Moore and Benbasat (1991a), are the following:

- **Voluntariness of use** relates to the perception of how voluntary the use of an innovation is (Moore and Benbasat, 1991a).

- **Image** relates to the level it is presumed using an innovation will improve the status of an individual (Moore and Benbasat, 1991a).

- **Compatibility** is the degree to which the innovation is compatible with existing values or needs (Moore and Benbasat, 1991a).

- **Relative advantage** is the level to which an innovation is considered better than its predecessor (Moore and Benbasat, 1991a).

- **Trialability** refers to the degree to which an innovation may be experimented with, before making a decision on adoption or rejection (Moore and Benbasat, 1991a).

compatibility, perceived usefulness, self-efficacy, technical support and training and perceived ease of use. Compatibility was postulated to influence behavioural intention to use, perceived usefulness and perceived ease of use. Self-efficacy and technical support and training were both postulated to affect perceived usefulness and perceived ease of use. Results indicated that perceived ease of use, compatibility, perceived usefulness and self-efficacy are important antecedents for users' behavioural intent. Interestingly, compatibility had the strongest total effect. Technical support and training was found to have no direct effect on perceived ease of use and perceived usefulness, although a significant effect on self-efficacy was observed.

Tung *et al.* (2008) combined the IDT and TAM, thus proposing a combined technology acceptance model. Two additional research parameters were added, namely trust, a belief construct, and perceived financial cost, an external variable. Investigating the acceptance by nurses of an electronic logistic information system, SEM analysis was employed to evaluate the research model. Results showed that perceived ease of use, compatibility, perceived usefulness and trust had a strong positive influence on behavioural intention to use, with perceived usefulness having a stronger effect than perceived ease of use. Perceived financial cost was also found to have a strong negative influence on behavioural intention to use. The conceptual research model was able to explain 70% of the variance observed, indicating a relatively high explanatory capacity. Tung *et al.* (2008), however, stressed the need to find additional variables to improve the accuracy of their predictions of usage intentions.

In a study performed by Vishwanatha *et al.* (2009), the IDT was again combined with TAM. Focusing on the attitudes of prescriber clinicians towards IT in general, but Personal Digital Assistants (PDAs) in particular, a pre- and post implementation survey was performed. Early and late adopters were identified statistically. From results it was found that early adopters were younger and less experienced (i.e., residents), while late adopters were more experienced, but less positive towards IT. However, as time progresses, late adopters evolved a more positive attitude towards the use of IT.

2.4.8 Social Cognitive Theory (SCT)

Social Cognitive Theory (SCT), a competitor of the behavioural intention theories, represents another distinct approach to understanding human behaviour (Bandura, 1977). Centred on the principle that environmental influences (e.g., social pressures, situation characteristics), personal factors (e.g., cognitive, personality) and behaviour are reciprocally (i.e., commonly) determined, Bandura, (1977) referred to these relationships as the *triadic reciprocality*, portrayed in Figure 2.12.

The main constructs of the SCT are depicted in Figure 2.13, defined by Compeau and Higgins (1995) as follows:

- **Encouragement by others** refers to the support received from people to whom an individual looks to obtain guidance (Compeau and Higgins, 1995).

- **Other's use** relates to the actual behaviour of others (Compeau and Higgins, 1995).

- **Support** can be defined as the availability of help (i.e., assistance) to individuals who require it (Compeau and Higgins, 1995).

- **Outcome expectations** refer to the satisfaction obtained from success (Compeau and Higgins, 1995).

- **Self-efficacy** is the judgment of one's ability to perform a particular behaviour or task (Compeau and Higgins, 1995). People in general prefer or enjoy activities they feel they are capable of performing and dislike those they feel they cannot successfully accomplish.

- **Affect** refers to the individual's keenness or liking of a particular behaviour (Compeau and Higgins, 1995).

- **Anxiety** relates to feelings of nervousness and unease when performing a specific behaviour (Compeau and Higgins, 1995). Hackbarth *et al.* (2003) suggest anxiety is the fearfulness resulting when an individual is faced with the possibility of using IT. The study results of Hackbarth *et al.* (2003) confirm the premise that anxiety mediates the effect of IT experience on perceived ease of use. Therefore, IT experience lessons a user's anxiety when using IT.

- **Usage** or use is influenced by self-efficacy, affect, anxiety and expectations of outcome.

Compeau *et al.* (1999), based on a subset of Compeau and Higgins (1995) conceptual research model, completed a longitudinal study on computer use. Factors excluded from the Compeau and Higgins (1995) research model included encouragement by others, other's use and support. Results indicated a significant relationship between self-efficacy and outcome expectancy, anxiety and use and self-efficacy and affect. Furthermore, performance expectancy influenced affect, which again directly related to use. Findings of this study confirmed many of the results obtained in the cross-sectional study of Compeau and Higgins (1995), further strengthening the predictive capability of the constructs self-efficacy and outcome expectations.

Young *et al.* (2005) conducted a study exploring the outcome expectancy and self-efficacy beliefs as predictors of individuals' intentions to communicate with their physicians on advertised drugs. The research model consisted of three factors, namely personal factors (i.e., outcome expectancy, self-

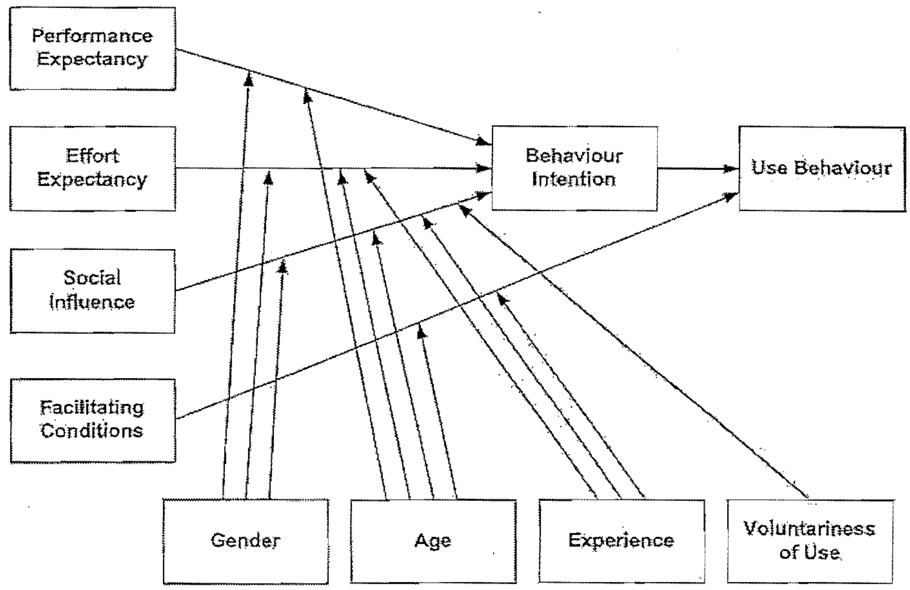

Figure 2.14: Unified theory of acceptance and use of technology (derived from Venkatesh *et al.*, 2003:447)

The main constructs of the UTAUT are depicted in Figure 2.14 and defined by Venkatesh *et al.* (2003) as follows:

- **Performance expectancy** is the level of perception that using a particular system (e.g., information system) will improve an individual's performance (Venkatesh et. al., 2003). Furthermore, Venkatesh *et al.* (2003) postulated that performance expectancy is moderated by both gender and age.

- **Effort expectancy** is the degree of perception that using a particular system is easy (Venkatesh et. al., 2003). Venkatesh *et al.* (2003) postulated that gender, age and experience will be moderators of effort expectancy.

- **Social influence** is the level of perception that others, important to a person, believe they should use a particular system (Venkatesh et. al., 2003). Venkatesh *et al.* (2003) expected an interaction between social influence and the moderating variables gender, age, voluntariness and experience.

- **Facilitating conditions** is the level of perception that an infrastructure exists to assist the use of a particular system (Venkatesh et. al., 2003). Venkatesh *et al.* (2003) further postulated that facilitating conditions will be moderated by experience and age.

Performance expectancy, social influence and effort expectancy are therefore direct antecedents of behaviour intention, while facilitating conditions is a direct antecedent of use behaviour. Venkatesh *et al.* (2003) further postulated that behavioural intention would have a significant positive influence on technology usage.

Although relatively a new model, the UTAUT has been included in a number of research studies.

A 2007 study by Al-Gahtani *et al.* (2007) used the UTAUT to explore the use of desktop computer applications in Saudi Arabia. Findings indicated that the conceptual research model, based on the UTAUT, was able to explain 39.1% of the intention to use variance and 42.1% of the usage variance. It was also found that performance expectancy positively affected behavioural intention, although no effect between performance expectancy and the moderating variables, gender and age, could be established. Further results revealed that, even if the moderating variables were taken into consideration, effort expectancy did not have a significant effect on behavioural intention.

Chang *et al.* (2007) performed a field study on a pharmacokinetics-based (i.e., specifically antibiotic prescription) clinical decision support system (CDSS) acceptance, utilizing the UTAUT. The conceptual research model used the UTAUT without adding any external variables. All the moderating variables of gender, age, experience and voluntary use were also excluded. Results indicated that the model explained 28% of the variance regarding behavioural intention and 43% of the variance with regard to use behaviour. Furthermore, both performance expectancy and effort expectancy had a significant impact on behavioural intention.

Kijsanayotin *et al.* (2009) investigated the factors influencing health IT adoption in community health centres in Thailand. Utilizing PLS analysis, a conceptual research model was evaluated containing the main constructs of the UTAUT (i.e., performance expectancy, effort expectancy, behavioural intent, use behaviour, social influence, facilitating conditions) and external variables voluntariness, IT knowledge and experience. Results showed that behavioural intention was a function of performance expectancy, effort expectancy, social influence and voluntariness. The positive effects of facilitating conditions and experience on behavioural intention were also confirmed. Noteworthy was that experience appeared to have a stronger effect on actual use than facilitating conditions.

Wang and Shih (2009) investigated the antecedents regarding use of information kiosks in relation to e-government, utilizing the UTAUT. The study specifically explored the moderating effect of gender and age on the relationships between the antecedents of behavioural intention and actual behaviour. Results obtained indicated that performance expectancy, social influence and effort expectancy had a significant positive effect on behavioural intent. Behavioural intent and facilitating conditions again affected actual use. An interesting finding was that social influence affected behavioural intent more prominently for women than for men. This implied that women are more inclined to be influenced by important referents than men. With reference to age, effort expectancy was found to be more prominent for older than for younger individuals. This implied that user friendliness of the kiosk systems was a major factor for attracting older citizens to adopt kiosks.

2.5.1 Review of Post-Acceptance Research

Acceptance and use theories' main focus is the study of constructs motivating individuals to accept a new information technology. Although acceptance and use theories are an essential step towards understanding the "success" of IT, the measurement of long-term feasibility and practicality (i.e., effectiveness) depends on *continued* use (Bhattacherjee, 2001a; Hsu *et al.*, 2006).

Continued use of information technology can, as a result, serve as an indication of how effective it is, therefore how successful it is in accomplishing its goal. Understanding continued use or "continuance" in contrast to initial use or "acceptance" is the goal of continuance theories and post-acceptance research.

Continuance is not entirely an alien concept in information systems research. The IDT, in its five-stage adoption decision process (i.e., knowledge, persuasion, decision, implementation, confirmation), proposes that adopters, during a final "confirmation" stage, re-evaluate their acceptance decision (Rogers, 2003). It is only during this "confirmation" phase that a decision is made to either continue or discontinue use.

Unfortunately, most researchers employing acceptance and use theories view continuance as an extension of acceptance behaviour. Subsequently, similar pre-acceptance constructs to explain both acceptance and continuance decisions are being utilized (Mathieson, 1991). Therefore, an implicit assumption that continuance co-varies with acceptance, exists (Taylor and Todd, 1995b). However, these studies, based on acceptance and use theories, are unable to explain the acceptance-discontinuance anomaly, defined by Bhattacherjee (2001a) as the discontinuation after initial acceptance and use.

Recently, researchers have questioned whether the criteria for IT adoption would be the same as for continued IT usage. When endeavouring to empirically validate the determinant structure of continued IT usage behaviour (e.g., Karahanna *et al.*, 1999; Bhattacherjee, 2001a; Bhattacherjee, 2001b), the following two approaches have been followed:

- The first approach provides employees' existing perspectives (e.g., Theory of Reasoned Action, Innovation Diffusion Theory) to explore the continued usage behaviour (Karahanna *et al.*, 1999; Parthasarathy and Bhattacherjee, 1998), generally known as longitudinal studies.

- The second approach provides a new perspective to explain continued IT usage behaviour (Bhattacherjee, 2001a; Bhattacherjee, 2001b; Bhattacherjee and Premkumar, 2004), typically by using the expectancy disconfirmation theory.

It is important to note that Jasperson *et al.* (2005) provides a research model aimed at coalescing research on post adoptive use behavior, based to a great extend on confirmation and disconfirmation, net benefits from individual and organisational perspectives. In this study's conceptual research theory, the different perspectives regarding benefits will be explored in more detail, discussed in more detail in Chapter 5.

Table 2.6 provides an overview of DeLone and McLean's (2002) success model variables.

Table 2.6: IS success model variables (DeLone and McLean, 2002)

Variable	Description
Information quality	Relates to an individual's perceptions regarding information systems output, specifically looking at accuracy, legibility, timeliness, consistency and reliability.
System quality	Relates to an individual's perceptions regarding the information process system itself, specifically considering ease of use and usability.
Service quality	Relates to an individual's perceptions regarding the IS service quality, specifically evaluating responsiveness and assurance.
Intention to use / Use	Derived from the TRA.
User satisfaction	Relates to an individual's satisfaction regarding the output of an information system.
Net benefits (individual, department, or organisational level)	Relates to impact of the information system at different levels, for example, at individual, departmental or organisational level. • At Individual level it can be improved work performance. • At organisational level it can include higher growth or profits.

Further research based on satisfaction and success theories include that of Kettinger and Lee (1994; 1997), Pitt *et al.* (1995) and Wang and Tang (2003), which incorporated service quality as a antecedent of user satisfaction, using the SERVQUAL measurement instrument, developed by Parasuraman *et al.* (1985).

Parasuraman *et al.* (1985) defined service quality in terms of the difference between expected and received service. Even more profound, they postulated that only by meeting or exceeding customer expectations, can service quality be ensured. Kettinger and Lee (1994) found two aspects of IS service quality, namely reliability and empathy, significant predictors of user satisfaction. Pitt *et al.* (1995) added service quality to the IS success model and surmised that SERVQUAL would be a suitable measuring instrument for IS service quality. From this approach, Wang and Tang (2003) adapted SERVQUAL to create a multiple-item measuring instrument, validated in the context of e-commerce service quality.

Although the Delone and McLean (2002) IS success model and the Parasuraman *et al.* (1985) SERVQUAL instrument are available for measuring IS success, the EDT may possibly offers a more suitable approach when combined with acceptance and use theories like the UTAUT, discussed next.

2.5.3 Expectation Disconfirmation Theory (EDT)

The Expectation Disconfirmation Theory, another example of a continuance theory proposed by Oliver (1980), is commonly used to explore post-purchase behaviour (Oliver, 1993). As such, it is well suited to

The main constructs of the Expectation Disconfirmation Theory are depicted in Figure 2.15, as defined by Oliver (1980).

- **Expectations** indicate the expected behaviour of a product (Spreng *et al.*, 1996), forming the baseline or reference for measuring confirmation, either negative or positive, which directly influences satisfaction.

- **Perceived Performance** refers to the perceptions users form after using a product (Bhattacherjee, 2001a).

- **Confirmation** is the relation between perceived performance and initial expectation (Spreng *et al.*, 1996).

- **Satisfaction**: EDT posits that consumer satisfaction directly influences continued used and therefore product continuance. Satisfied users will lead to the use of a product, while dissatisfied users will stop using a product (Spreng *et al.*, 1996). As such, users can be satisfied in two alternative ways. Firstly by positive confirmation, or secondly if by negative confirmation, only if their initial expectations were very high, even if such expectations were not experience in practice.

- **Repurchase Intention (continuance)** relates to the level of continued used of a product (Bhattacherjee (2001a).

The first study utilizing EDT (referred to as ECT in IS research) in IS continuance research was that of Bhattacherjee (2001a), which considered online banking customers. Results established that satisfaction was a significant antecedent for continuance, which in turn is determined by two constructs, namely users' confirmation and perceived usefulness. In a later study exploring the intent of continuance of business-to-consumer e-commerce, Bhattacherjee (2001b) again established that continuance was determined by satisfaction and perceived usefulness, similar to Bhattacherjee (2001a). The construct of loyalty incentives, postulated to affect continuance, was found to be insignificant.

Khalifa and Liu (2002) empirically validated the hypothesis that the desires of customers, and not only expectations, affect satisfaction. McKinney *et al.* (2002) similarly validated the EDT in a study of online retailing, considering both disconfirmation and the quality of the Web retail site.

Recently, EDT has been combined with TAM by Bhattacherjee and Premkumar (2004). In the study, consisting of two longitudinal studies, one investigating computer-based training and the other rapid application development, a temporal research model was validated. Results indicated that confirmation and satisfaction were critical in explaining changes in users' beliefs and attitudes towards continuance. Bhattacherjee and Premkumar (2004) further recommended that these constructs be included in future research models of usage, a proposal that is implemented in this study.

Chapter 3 : Systems Development Methodologies

3.1 Introduction

The aim of this chapter is to review systems development methodologies. SDMs, serving as a core element of this study's ontology, are the main IT artifacts being examined. It is therefore necessary to highlight those elements of SDMs important to this study, resulting in this second literary review chapter. Firstly, a brief background and overview of the history of SDMs is provided, highlighting the development of SDMs from systems development life-cycle methodologies to the more modern agile systems development methodologies. Next, SDMs are defined, covering the relative confusion regarding the distinction between a methodology and a method. Subsequently, a dynamic framework for the classification of SDMs is outlined, as used in Chapter 6. This is followed by a review of the effectiveness and use of SDMs, specifically looking at contingency and method engineering. Finally, research on the acceptance and use of SDMs is presented, concluding with a review of the chapter.

Capability Maturity Model Integration (CMMI) is probably the best known, can also be used. The ISO/IEC (International Electrotechnical Commission) 15504, also referred to as the Software Process Improvement Capability Determination (SPICE), is another framework used for evaluating software development processes. ISO/IEC 9126-1, however, is a standard for the appraisal of software quality, specifically considering aspects like software functionality, efficiency, usability and reliability. All of these solutions to quality assurance of software directly or indirectly necessitate the implementation of a SDM. SDMs therefore must be considered relevant.

In the next section, a brief historic overview of SDMs will be given. Although a subdivision of SDMs, somewhat similar to systems development approaches, is made in this discussion, it should not be considered a classification of SDMs. A formal classification will follow at a later stage.

3.3 Historical Overview of Systems Development Methodologies

Initially, in the 1960s and 1970s, software developers worked alone in their own areas of expertise (Boehm, 1988). The emphasis therefore was on the skills of the developer, especially with regard to coding, with limited focus on requirements, documentation and control. In the absence of coding standards, individuality and creativity of the developer, coupled with the necessity to write programs as efficient as possible, led to the creation of complex and sometimes incomprehensible program code. Referred to as "code and fix" development, the fix portion became increasingly expensive, owing mainly to inadequate analysis and design. Also, as software development projects grew in size, more people were involved in the process, necessitating the implementation of some planning and control procedures.

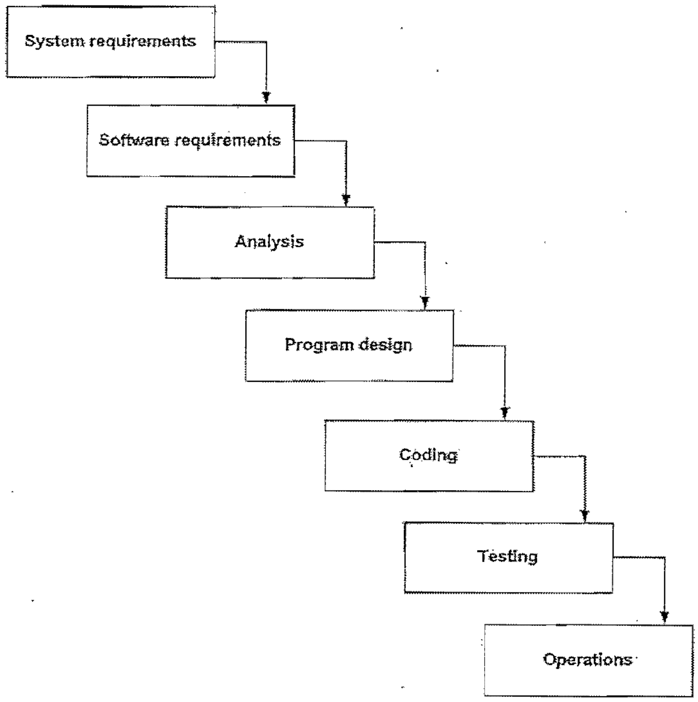

Figure 3.2: Waterfall model (derived from Royce, 1970:329)

A number of models based on the SDLC phases can be differentiated, including the waterfall and spiral models. The waterfall model, developed in the 1970s and a direct implementation of the SDLC, is attributed to Royce (1970). Illustrated in Figure 3.2, each subsequent phase of the model will only start when the previous phase has been finalised.

A major characteristic and indirect limitation of the waterfall model is that the software development project will cycle through the phases only once. This implies that all software development must be completed at the end of a cycle, with no changes allowed to the system or software requirements after finalisation of the phases. Since requirements change during the development cycle, it is often discovered that the developed software has become outdated by the time it is implemented.

With the spiral model, developed in the 1980s (Boehm, 1986; 1988), this limitation was removed, allowing for iteration through the SDLC. An initial pass through the SDLC is completed using a subset of the software requirements, generally referred to as prototyping. The resulting software, namely a prototype, is then used as a starting point for the next cycle of the spiral model. This process, referred to as the incremental model, continues adding new functionality during each cycle until a final software product is delivered.

As might be expected, highly sequentially structured process models like the SDLC have inherent impediments (Boehm, 2002).

viewed more a blended methodology. Focusing on the underlying nature and structure of an organisation, its philosophical viewpoint asserts that, if software is based on data, which is relatively stable, it will ensure a solid foundation with limited risks. IE, however, recognises the importance of business processes and balances the modeling of data and processes accordingly. .

Joint Application Development (JAD), which is a technique, not a methodology, was conceived by Chuck Morris and Tony Crawford at IBM in the late 1970s (Wood and Silver, 1989). Entailing strong user involvement, the aim of JAD is to obtain the most complete and detailed understanding of user requirements. This is especially important for SDMs based on the SDLC, where each subsequent phase of development depends on the successful completion of the previous phase (Avison and Fitzgerald, 2006). In Europe, the Participatory Design (PD), based on JAD, has been widely accepted, owing to the involvement of the entire user community (Iivari *et al.*, 1998). Because user acceptance is gained early in the project, the project is more likely to meet user requirements.

3.3.3 Object-Oriented (OO) Systems Development Methodologies

Object-Oriented Systems Development Methodologies (OOSDM) developed in the 1980s focus on concepts like object, class, encapsulation, inheritance and polymorphism, ideally suited for the re-use of code. In OOSDM, no distinction is made between data and processes, instead the attributes of data structures and related methods are encapsulated in a single entity, referred to as an object (Coad and Yourdon, 1991).

Some of the most well known OOSDM include the Coad-Yourdon Object-Oriented Analysis Design (OOAD) methodology (Coad and Yourdon, 1991), Rational Unified Process (RUP) (Jacobson *et al.*, 1991), FUSION (Coleman *et al.*, 1994) and Object Modeling Technique (OMT) (Rumbaugh *et al.*, 1991).

IBM's Rational Unified Process (RUP) origins can be traced back to the software company Objectory, established by Ivar Jacobson in 1987 (Avison and Fitzgerald, 2006). In 1995, Objectory was acquired by the Rational Software Company, subsequently purchased by IBM in 2002, resulting in the development of the Rational Objectory Process. In 1998 the Rational Objectory Process was renamed to RUP, a methodology that can be defined as iterative, incremental, highly customisable, based on the spiral model, utilizing the Unified Modelling Language (UML) for data, business and object modelling.

UML is a widespread modelling language under control of the Object Management Group (OMG), employed in most modern methodologies (Booch *et al.*, 1999). RUP is sometimes described as a software engineering process, or configurable process framework, based on the fact that it can be modified to specific needs, characteristics, or constraints of an organisation.

Six sigma is another well known engineering-based methodology, conceived and developed by a senior engineer and quality manager, named Bill Smith, at Motorola in 1986 (Snee and Hoerl, 2002). Although not technically a SDM, it is an approach for managing process and product quality that can be applied to systems development, especially where failure can result in the loss of human life. Six sigma prescribes a quality level of no more than 3.4 defects per million opportunities.

3.3.6 Process Maturity Frameworks

Process maturity frameworks, such as the Capability Maturity Model (CMM), while also not SDMs, provide structure and tools enabling companies to improve their development processes. This is accomplished by evaluating the processes used during software development, specifying the characteristics each identified process maturity level should obtain, rather than prescribing a particular process (Avison and Fitzgerald, 2006). As such, it is a descriptive model, describing the essential attributes of a specific maturity level, instead of a prescriptive model, directing how to improve.

Development of the CMM started in 1986 at the SEI of Carnegie Mellon University with the assistance of the MITRE Corporation (Humphrey and Sweet, 1987). Released in the early 1990s, the assessment model referred to as the Process Maturity Model (PMM), consists of five levels, i.e., initial, repeatable, defined, managed and optimising. Measuring the maturity of software development processes, it asserts that a process of higher maturity will lead to increased productivity, reduced cycle time and fewer defects (Humphrey, 1988). In 2002, the CMM was replaced by the CMMI, which is aligned with more modern iterative approaches, rather than conventional sequential SDLC methodologies.

3.3.7 Agile Software Development Methodologies

Recognising that today's development environment cannot support the long development times required by the heavyweight plan-driven methodologies (e.g., SSADM, YSM, IE, RUP), the development of ASDM or agile methodologies became imperative. Although initially referred to as lightweight methodologies, mainly to highlight the difference from the more heavyweight plan-driven SDMs, the term was subsequently changed to agile methodologies (AgileAlliance, 2001). It was believed that the word lightweight did not convey the essence of the new methodological approach, while the term agile better represented the idea of lightness and responsiveness.

Agile methodologies are essentially based on preceding methodologies, ideas and practices. These include Boehm's spiral model (1988), RUP, prototyping, RAD and PD. Some of the most commonly known agile methodologies include Scrum, developed in 1995 (Schwaber and Beedle, 2002), eXtreme Programming (XP), developed in 1996 (Beck, 2000), Dynamic Systems Development Methodology (DSDM), developed by the DSDM Consortium in 1994 (Stapleton, 2003), Adaptive Software Development (ASD), developed in 2000 (Highsmith, 2000) and Crystal Clear, developed in 1999 (Cockburn, 2002).

that their organisations were using agile methods (Ambler, 2007). Although this figure cannot be generalised, the intent of agile methodologies, addressing aspects of the systems development process that might be lacking in other heavier methodologies, must be respected.

It is important to note that different degrees or levels of agility within any SDM exist. This can clearly be witnessed by the many in-house developed methodologies based on formal SDMs, which allow for agility in the development process. As such, these custom methodologies can be considered examples of continuance, discussed later in the chapter.

In the next two sections, a more detailed view of what a SDM is and how it can be classified, is provided.

3.4 Systems Development Methodology

There are relative indecision and diverse opinions as to the meaning of the term SDM in the information systems domain. As such, no universally accepted definition of SDMs, generally acknowledged by the information systems community, is available (Wynekoop and Russo, 1997; Iivari *et al.*, 2000; Avison and Fitzgerald, 2006). This is especially true for studies focusing on the use of SDMs (Wynekoop and Russo, 1993).

Wynekoop and Russo (1995) defined a methodology as an orderly approach to carry out at least one stage of the systems development life-cycle, by using relevant tools, techniques, or guidelines, based on an underlying philosophy. Although relatively a short definition, it provides a useful description of a SDM.

Jayaratna (1994:37) emphasised that a SDM must provide an unambiguous way of structuring system development, stating that "*methodologies contain models and reflect particular perspectives of 'reality' based on a set of philosophical paradigms. A methodology should tell you 'what' steps to take and 'how' to perform those steps but most importantly the reasons 'why' those steps should be taken, in that particular order*".

Another noteworthy definition is that of Avison and Fitzgerald (2006:568), which defines a SDM as a way to accomplish the development (or part of the development) of software, established on a set of rationales and an underlying philosophy. Naturally this includes a definition of phases, tasks, tools[12], guidelines and documentation.

To summaries, a methodology therefore, based on an underlying philosophy, specifies how a project is to be divided into stages, which tasks to perform at each stage, which supporting tools may be used and which people should be managed. The underlying philosophy provides the theories and assumptions on which the software development is based.

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[12] *Tools can be defined as automated means of completing a task(s) (Brinkkemper, 1996).*

The second type of inconsistency referred to by Iivari and Maansaari (1998), is category problems. This implies that there is uncertainty with distinguishing between SDMs and techniques, as perceived by Keyes (1992).

Generally, a technique refers to a more limited, well-defined procedure of system development. For example, Palvia and Nosek (1993) define a technique as a way of accomplishing a specific task in the systems life-cycle.

3.4.3 Systems Development Methodology and Systems Development Approach

Additional confusion exists with regard to distinction between a systems development approach and a systems development methodology (Iivari *et al.*, 1998). To address this problem, we will use for purposes of this study, the following definition of SDMs, advanced by Huisman and Iivari (2003; 2006):

According to Huisman and Iivari (2003; 2006), a systems development methodology consists of the combination of four elements, namely a system development approach, a system development process model, a system development method and a system development technique.

- **System development approach** represents the philosophical view of a methodology. and is the collection of basic concepts, leading principles and beliefs underlying information systems development (Iivari *et al.*, 1998; 2000). Examples of system development approaches include the structured approach, object-oriented approach and agile approach.

- **System development process model** can be defined as a depiction of the series of stages through which a system evolves (Wynekoop and Russo, 1993). Examples of process models include linear-sequence, prototyping, evolutionary model, spiral model and incremental model.

- **System development method** consists of instructions and rules, structured in a logical manner, to conduct one or more phases of system development (Brinkkemper, 1996). Examples include IE, SSADM and XP.

- **System development technique** is a procedure to perform a development activity (Brinkkemper, 1996). Examples include entity-relationship diagrams, decision tables, action-diagrams and data flow diagrams.

This definition of what constitutes a SDM, presents a possible solution to the method versus methodology debate.

This general abstract class (i.e., super class) has basic features inherited by all the SDMs (i.e., sub-classes), defined as a software development approach. Software development approaches themselves are further abstracted into another super class, namely system development paradigms, which set out specific paradigmatic assumptions and beliefs. At the lowest level of this four levelled abstraction are system development techniques and tools.

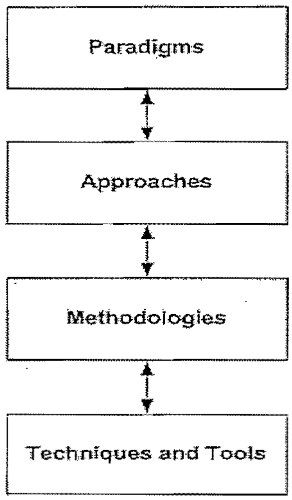


Figure 3.3: Four-levelled dynamic classification framework

The four levels of this dynamic classification framework are depicted in Figure 3.3, defined by Iivari *et al.* (2000) as follows:

- **Systems development paradigm** can be described as the collection of assumptions adopted by a professional community to allow its members to share perceptions, thereby engaging in commonly shared practices (Hirschheim and Klein, 1989). Four categories of assumptions can be identified, namely ontology, epistemology, research methodology and research ethics. The first three of these were discussed in Chapter 1 (Iivari *et al.*, 2000). Ethics relate to the moral values and beliefs that should guide all IS research.

- **Systems development approach** can be defined as a collection of aims, guiding principles, basic concepts and development process principles, focusing the development team's understanding and actions during software development (Iivari *et al.*, 2000). Aims specify the reason for the approach, while guiding principles constitute the common philosophy. Fundamental concepts define the focus and unit of analysis in the approach, while development process principles express essential aspects of the development process in the approach. This is equivalent to the definition of systems development approach as defined by Huisman and Iivari (2003; 2006).

- **Systems development methodology** is defined as a codified collection of procedures which purpose is to direct the work and co-operation of the various stakeholders involved in the creation of information systems (Iivari *et al.*, 2000).

Abbreviations used in Figure 3.4 are defined in Table 3.2.

Table 3.2: Abbreviations used in Figure 3.4 (derived from Iivari *et al.*, 2000:190)

Approaches	
SA/SD	Structured Analysis/Structured Design
IM	Information Modelling
IE	Information Engineering
DSS	Decision Support Systems
STD	Socio-Technical Design
Infol.	Infological
OO	Object-Oriented
Interact.	Interactionist
SA-based	Speech Act-based
SSM	Soft Systems Methodology
PWP	Professional Work Practice
TU-ist	Trade Unionist
Agile	Agile Software Development
Methodologies	
XP	Extreme Programming
Scrum	Scrum
SSAD	Structured Systems Analysis and Design
IE	Information Engineering
ETHICS	Effective Technical and Human Implementation of Computer-based Systems methodology
...	
Techniques	
PP	Pair Programming
DFD	Data Flow Diagram
ERD	Entity Relationship Diagram
STD	State Transition Diagram
ISD	Information Structure Diagram
IOA	Input/Output Analysis diagram
...	

The four paradigms used by Iivari *et al.* (2000) are based on the well-known four major paradigms identified by Burrell and Morgan (1979), developed initially for sociology and organisational research.

Table 3.4: Approaches as defined by Iivari *et al.* (2000:192-194)

FUNCTIONALIST APPROACHES			
Structured Approach	**Information Modelling Approach**	**Decision Support Systems (DSS)**	**Sociotechnical Approach**
Goal	**Goal**	**Goal**	**Goal**
Productively develop high quality, reliable and maintainable software.	Organisational expansive development of integrated information systems in a co-ordinated way.	Support semi-structured decision making.	Impeding users must have a major role in the design of the system
Guiding Principles and Beliefs	**Guiding Principles and Beliefs**	**Guiding Principles and Beliefs**	**Guiding Principles and Beliefs**
Separate essential model from implementation model. Meticulous documentation. Top-down process models to hide complexity.	Separation of conceptual (i.e., theory of discourse) and internal schemas. Conceptual schema is the core model on which applications are built.	Support decision making. DSS evolving.	Unrestricted design process. Joint optimisation.
Fundamental Concepts	**Fundamental Concepts**	**Fundamental Concepts**	**Fundamental Concepts**
Essential model v. implementation model, data flow, data store, cohesion, coupling.	Conceptual schema, internal/external schema.	Specific DSS (e.g., Clinical Decision Support Systems, discussed in next chapter), DSS generator.	Technical system, social system
Principles of development process	**Principles of development process**	**Principles of development process**	**Principles of development process**
A step-by-step process of analysis (waterfall, prototype).	Incremental conceptual schema design.	Evolutionary development.	User participation, evolution.
Example Methodology: Structural System Analysis and Design	*Example Methodology: Information Engineering*	*Example Methodology: Keen and Scott Morton's Methodology*	*Example Methodology: Effective Technical and Human Implementation of Computer-based Systems methodology (ETHICS)*

Table 3.4 (continue): Approaches as defined by Iivari *et al.* (2000:192-194)

NON-FUNCTIONALIST APPROACHES		
Soft Systems Methodology Approach	**Trade Unionist Approach**	**Professional Work Practice Approach**
Goal	**Goal**	**Goal**
Learning methodology supporting discussions on needed and practical changes.	Create circumstances for effective worker involvement, thereby assisting democracy at the workplace.	Encourage professionalism of information systems designers.
Guiding Principles and Beliefs	**Guiding Principles and Beliefs**	**Guiding Principles and Beliefs**
Use of "human activity systems".	Collective resource approach founded on trade union involvement.	Methodologies can support practitioners, but not substitute for experience.
Fundamental Concepts	**Fundamental Concepts**	**Fundamental Concepts**
Human activity systems.	Computer and tools under control of each user.	Dualities (e.g., performance v. management, reflection v. action, product-oriented v. process-oriented, analysis v. design, planning v. evaluation).
Principles of development process	**Principles of development process**	**Principles of development process**
Stream of cultural analysis.	Co-operative design.	All dualities are mutually dependent, therefore must be carried out simultaneously.
Example Methodology: Checkland's methodology, Checkland and Scholes's methodology		

3.6 Effectiveness of Systems Development Methodologies

Research on SDM effectiveness is very limited, and no standard criteria for measuring SDM effectiveness could be found. Wynekoop and Russo (1997) suggested that user satisfaction with the product, developer satisfaction with the process, design complexity, system maintainability, system quality and developer productivity must be utilized to measure the effectiveness of SDMs.

Vavpotic and Bajec (2009), in their paper presenting an approach for evaluating SDMs, outlined an evaluation model, considering two aspects, namely social and technical dimensions.

- The social dimension focuses on the appropriateness of a SDM with regard to the social and cultural qualities of a development team.

- The technical dimension considers the appropriateness of a SDM with regard to the technical qualities of a project or organisation.

As such, Vavpotic and Bajec (2009) divided their effectiveness measurement into five factors, namely implication of SDM use on the system to be developed, implication of SDM use on the project, implication of SDM use on SDM users, implication of SDM use on the organisation and implication of SDM use on the customer. Each of these factors was measured by specific measurement variables, listed in Table 3.6.

Table 3.6: Measurements of SDM effectiveness (derived from Vavpotic and Bajec, 2009)

Factors	Measurement Variables
Implication of SDM use on software product	Quality, usability, reliability, maintainability and efficiency of the new system. *Added elements by authors: Correctness, Extensibility*
Implication of SDM use on project (process)	Time consumption, project costs, project control and estimation of project risks. *Added elements by authors: Repeatability, Adaptability, Accountability*
Implication of SDM use on SDM users	Facilitation of collaboration, understanding of responsibilities and duties.
Implication of SDM use on the organisation	Facilitation of standardisation, improvement of an organisation's reputation.
Implication of SDM use on customers	Increase in customers' trust in organisation, increase in satisfaction with the organisation.

Vavpotic and Bajec (2009) validated their SDM evaluation model by utilizing four different case studies, i.e., two from organisations developing pre-packaged business software solutions for small companies, an organisation creating custom software solutions and the IT department of an average size bank. In all four resisted. Industry surveys (Ambler, 2006) found that the acceptance of agile systems development methodologies is still in a preliminary phase, with respondents illustrating limited knowledge of agile methodologies. For organisations having utilized conventional SDMs for years, the move towards agile methodologies also presents significant challenges, including a major change in management style, alteration to new systems development processes, need for better co-operation among project members and compatibility of technologies (Nerur *et al.*, 2005). Thus, the same situation facing traditional heavyweight SDMs in industry, is also encountered by agile methodologies (Roberts *et al.*, 1998).

- The second aspect relates to the fact that a SDM might not be suited to the social characteristics of the software development team or organisation. For example, a non-innovative development team will most probably reject an innovative SDM, while a rigorous SDM will also not be accepted by an open-minded liberal organisation (Gallivan, 2003; Iivari and Huisman, 2007).

To improve SDM usage, it is therefore essential to consider both the technical and social suitability of a methodology.

It is important to distinguish between explicit and implicit SDM use, since, even if research indicates a low acceptance figure, it does not necessarily imply a low influence level. Iivari and Maansaari (1998) identified two distinct types of SDM use, namely explicit and implicit use.

- Explicit use refers to the actual use of a SDM, by using specific techniques or tools in a development phase as signified by the SDM.

- Implicit use refers to the use of knowledge gained by learning a SDM, making it part of the individual's or organisation's standard practices, possibly used only years after the knowledge was acquired.

In this study, an attempt is made to capture both these SDM usage types.

Based on the difficulty of quantifying the use of SDM, it was decided to consider two major dimensions of use:

- Firstly, the absolute use of SDMs is measured in terms of vertical and horizontal use. Vertical use relates to the intensity of SDM usage, while horizontal use reflects the percentage of individuals or projects utilizing a SDM (Iivari and Huisman, 2007).

- Secondly, the impact of SDMs on software quality and output of the individual or organisation is considered. This dimension strongly relates to the confirmation construct of the EDT.

Culture seems to have an influence on the contingency approach followed. Zhu (2002) found that the "at the outset" approach was more favoured in North America, while "a fixed pattern" approach was more preferred in Europe. In China, the "along development dynamics" approach appeared more prominent.

The methods used for enabling contingency in IS are commonly referred to as contingency design methods (Goepp *et al.*, 2008). Contingency design methods' main focus is the selection of the most appropriate methods and techniques to fit a software development project.

Goepp *et al.* (2008) identify eight DESIGN methods, namely method engineering, Euromethod, V-model, Van Slooten, Kiefer, Morley 1, Morley 2 and Zhu WSR, outlined in Table 3.7.

Research on SDM use in practice has found that SDMs are applied adaptively, customised to fit the organisation and project in question. This corroborates the opinion that a unique method-in-action is created for each development project. This fact supports the argument that method engineering is a critical element to contemplate when measuring the use of SDMs (Fitzgerald, 1998).

A term frequently come across in method engineering is Situation Method Engineering (SME), which basically designates the construction of a method adapted to a specific project (Henderson-Sellers, 2003). In Figure 3.6, the typical configuration architecture of SME is presented (Brinkkemper, 1996:277). The method base refers to the repository of fragments (i.e., method building blocks), normally underpinned by a meta-model. In this context, a meta-model refers to a conceptual model of a method(s). The idea of a method fragment was presented by Harmsen *et al.* (1994), who defined a fragment as a re-usable logical part of a method. Fragments additionally can be categorised into product and process fragments, depending on the context. Meta-methods refer to both method fragments and the guidelines how to combine them.

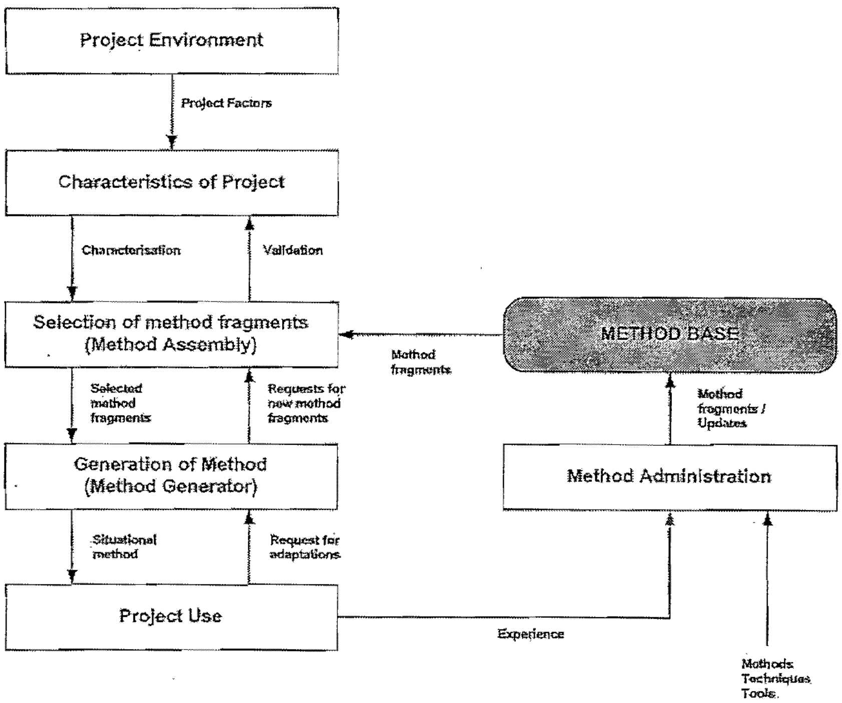


Figure 3.6: Configuration architecture of situation method engineering (derived from Brinkkemper, 1996:277)

The project environment and specific characteristics of the project influence the selection of method fragments from the method base. These fragments are assembled in a coherent situation method, which is then used in practice. Based on experience gained with the method, input is again provided to the method base through method administration interface. From literature, a number of approaches to the implementation of SME are evident (Bajec *et al.*, 2007).

development methods. This study will at a high level, explore to what extent method engineering is implemented in HIS.

In the next section, a review of research on the acceptance and use of SDMs is presented, followed by a summary of the aspects considered in this chapter.

3.8 Research of Acceptance and Use of Systems Development Methodologies

Existing research has mainly examined individual and organisations' acceptance and use of SDMs from a technology perspective. These studies consider SDMs as technology innovations, and utilize theories like TAM, IDT, MCPU and TPB (Johnson, 1999; Riemenschneider *et al.*, 2002; Hardgrave and Johnson, 2003; Hardgrave *et al.*, 2003), to explore and explain SDM acceptance and use.

Although these theories are appropriate for examining the acceptance of SDMs, their main focus is technology constructs (i.e., perceived usefulness of technology, perceived ease of use of technology). Non-technology factors (e.g., social aspects), also having merit, have largely been neglected. For example, individual characteristics (e.g., self-efficacy) and organisational characteristics (e.g., organisational culture) can play a critical role in the acceptance of SDMs (Sultan and Chan, 2000; Iivari and Huisman, 2007; Vavpotic and Bajec, 2009).

It is important to note that the acceptance of SDMs is quite different from the acceptance of tools like integrated development environments or programming languages (Agarwal and Prasad, 2000). SDMs dictate explicit behavioural rules, specifying the way developers and development teams should function and raise questions regarding compatibility with current managerial philosophies and practices. It is also important to distinguish between the acceptance of specific software development tools and techniques versus the acceptance of an entire SDM, since it is possible to use particular tools or techniques in the absence of a formal methodology. Furthermore, the acceptance of a SDM signifies a much more radical change for developers than acceptance software development tools or techniques (Roberts *et al.*, 1998). Developers' resistance to such change, often results in the failure of SDMs.

The implementation of certain components of a SDM, while not implementing others, can be a precarious endeavour. Most methodologies are designed to be internally rigorous and consistent, based on a minimum set of procedures. It is in this area of adaptation that contingency and method engineering research have a critical role to play as previously discussed.

In the review of literature on the acceptance and use of SDMs, seven articles empirically exploring individual acceptance of SDMs, two articles empirically exploring organisational acceptance of SDMs and four articles

	(Structured)	pressure*, perceived compatibility*, perceived organisational mandate*	
Hardgrave and Johnson (2003)	Object-oriented systems development	Subjective norm*, organisational usefulness*, personal usefulness, perceived behavioural control (internal)*, perceived behavioural control (external)	Behavioural intent
Templeton and Byrd (2003)	Systems development methodology	Perceived ease of use*, perceived compatibility, trialability*, knowledge of proximity, voluntariness	Relative advantage
		Organisational acceptance of SDMs	
Higgins and Hogan (1999)	Information engineering (IE) systems development methodology and software	Cross-functional team spirit*, top management support*, user participation*, technical transfer	Perceived success of IE implementation
Griffin and Brandyberry (2008)	Systems development methodology (SDM)	Perceived ease of use, perceived usefulness, firm's revenue, number of employees, application type, application size, customer, speed of delivery, programming language, quality awareness, CMMI rating attained	Actual use
		Important factors in the implementation of SDMs	
Roberts *et al.* (2001)	SDM offered by consultant companies	External support	Actual use
Meso *et al.* (2006)	Systems development methodology	Contingency*	Actual use
Iivari and Huisman (2007)	Systems development methodology	Organisational culture orientation*, mandatory SDM use*, social norms concerning SDM use*	Actual use
Bygstad *et al.* (2008)	Systems development methodology	Usability*	Actual use

*** found to be statistically significant; ** found to be statistically significant on intermediate dependent variables; ( ) considered to be important**

Johnson (1999) considered Object-Oriented Systems Development (OOSD) by utilizing a survey of hundred and fifty systems developers. The study postulated specific elicited beliefs, including perceived usefulness as measured by process usefulness, product usefulness, career usefulness, communication usefulness, social pressure, perceived ease of use and underlying behaviour intent. Employing a research model based on the TPB, support was found for perceived usefulness and perceived ease of use.

Khalifa and Verner (2000) studied several determinants for software developers' use of two specific process development methods, waterfall and prototyping. The study focused on eighty two senior software developers from Hong Kong and Australia, measuring factors of use (i.e., depth of use, breadth of use), facilitating among subjective norm, organisational usefulness, perceived behaviour control (internal) and behavioural intent. No support was found for the influence of personal usefulness and perceived behavioural control (external). The final research model was able to explain 63% of a developer's behavioural intent to use OOSD.

Research on factors influencing organisational acceptance include that of Griffin and Brandyberry (2008), using TAM to review the adoption of SDMs at organisational level. Specifically considered, were organisational factors, such as revenue, number of employees, application type, application size, speed of delivery, programming language, quality awareness and CMMI rating attained. Unfortunately, no statistical significance could be obtained.

A number of previous studies focused on the characteristics of individual developers (e.g., experience) and organisations (e.g., management support), in addition to those of SDMs. Sultan and Chan (2002) reported that specific characteristics of the technology (e.g., relative advantage, perceived compatibility, complexity) are not significant in differentiating between OO technology adopters and non-adopters. This result contradicted those of similar studies (Hardgrave *et al.*, 2003). The reason for this may be adopters and non-adopters already being informed of the stated benefits of OO technology, possibly differing in adoption decisions owing to other factors (e.g., characteristics of individual developers or organisations).

Research furthermore also focuses on specific factors (e.g., organisational culture, usability) that may influence acceptance of SDMs. Studies on the assimilation of OO technology suggested that learning-related factors, such as training and external support, are positively related to organisational assimilation of OO technology. Additionally, organisational culture has been found to be an important factor affecting perceptions towards SDMs use.

The study further recognised that organisations seem to acquire a number of sub-cultures in different departments, but hypothesised that a homogeneous culture will exist in a specific department. Results indicated that the deployment of SDMs by developers is primarily coupled with a hierarchical culture. Managers again exhibit critical attitudes towards the use of SDMs in a strong rational culture.

A further important contribution by Iivari and Huisman (2007) is to define practical implications for the industry. For example, when considering an organisation with a dominant developmental culture, it is suggested to either obtain a methodology that supports that culture, or adopt a methodology (i.e., contingency) to include developmental features.

Bygstad *et al.* (2008) investigated the relationship between SDMs and usability. A survey of two hundred and fifty nine IT Norwegian companies was done. Results indicated that companies considered usability to be linked with SDMs use. This is encouraging, since while SDMs concentrate on developing software, usability concentrates on the user utilizing the software. A central issue not really resolved in this paper is, while the implementation of usability requires user involvement in software development, there is no apparent process definition of how this should occur. However, it is argued by software development theorists that usability can effortlessly be incorporated into formal SDMs. It must nonetheless be acknowledged that differences between developers and users exist, requiring users' involvement across organisational structures and management levels (Iivari, 2006; Boivie *et al.*, 2006). The incorporation of users is not unique to usability, but is also evident in agile methodologies, where users' participation is a major requirement.

Meso *et al.* (2006) conducted an experimental study to determine whether matching SDM type to application characteristics, results in more effective knowledge-work processes among development team members. In the study comprising fifty seven subjects and twenty two project teams, two hypermedia systems development methodologies (i.e., Relationship Management Methodology, Object-Oriented Hypermedia Design Methodology) were compared to two conventional software engineering methodologies (i.e., Object-Oriented Design methodology, Rapid Application Design). Results obtained, indicated a positive effect when matching SDMs to application domains (i.e., contingency).

Most system development activities are directed or guided by the use of a methodology, thereby utilized to solve a specific problem. Problem-solving theorists classify solution techniques as either weak, or strong (Howard *et al.*, 1999). Howard *et al.* (1999) hypothesised that weak problem-solving approaches are universal in nature, accommodating a significant number of problems, while strong problem-solving approaches are specialised, producing solutions that are optimal. As such, Meso *et al.* (2006) classify methodologies as weak-typed or strong-typed. Weak-typed methodologies include Anderson Consulting Method 1, Ernest and Young's Navigator, SSADM and IE. Strong-typed methodologies include Relationship Management Methodology, Neural-Network Development Methodology and Object-Oriented Hypermedia

Surveys			
Rumpe and Schroder (2002)	XP	Project success	Continuous presence of customers
Misra *et al.* 2009	Agile	Success factor framework	Customer satisfaction, customer collaboration, customer commitment, decision time, corporate culture, control, personal characteristics, training

Similar to the results of studies on heavyweight SDMs, research on agile methodologies shows that individual characteristics (i.e., experience, abilities) are critical in the acceptance and use of such methodologies (Cockburn and Highsmith, 2001; Cohn and Ford, 2003; Ceschi *et al.*, 2005). The reason for this may be agile methodologies focusing on the individual, or the project team (i.e., developers, analyst, testers, project leaders, end users).

A further attribute of agile methodologies, namely compatibility, was also found to be an important factor in the acceptance and use of agile methodologies (Schatz and Abdelshafi, 2005). Moreover, Nerur *et al.* (2005) highlighted that organisational characteristics, such as organisational culture, teamwork and training, are important, similar to the results obtained by Sultan and Chan (2002) and Iivari and Huisman (2007).

One major difference between studies of agile methodologies and heavyweight SDMs is that the latter usually concentrate on factors associated with software developers and organisations only, whereas studies on agile methodologies also examine factors associated with users, such as customer relationships (Nerur *et al.*, 2005). This can probably be attributed to the more active role users are playing during the development life-cycle in agile development, compared to minimal user participation in most traditional SDM activities.

Although difficult to compare studies directly, it is possible to identify a trend towards more in-house or customised methodologies, as opposed to formal methodologies. This is clearly illustrated by the increase in such methodologies, as reported by Griffin and Brandyberry (2008).

Based on the literary review of SDMs use, it can be inferred that the existing acceptance and use theories (e.g., TAM, TPB, IDT) offer well proven constructs for measuring specific qualities of SDMs, such as perceived usefulness and perceived ease of use. Non-technology factors (i.e., social aspects), including individual and organisational qualities, are less prominent. In this study, technology and non-technology factors will be evaluated.

In the following section, a short summary is provided on this chapter.

Chapter 4: Health Information Systems

4.1 Introduction

In this chapter, the last in the literary study phase, health information systems are discussed. The purpose is to provide the background for forthcoming chapters, where results of the web-based survey will be discussed, also referencing specific HIS and health concepts. The chapter starts with a short background to HIS, particularly looking at the impact of HIS related to quality of care and costs, followed by a historic overview of HIS. Next, the terms "health informatics," "medical informatics" and "health information systems" are discussed. A short review is performed on the relationship between HIS and health care systems at large, and attention is also given to the scope of HIS. This is followed by an overview of formal medical terminology coding standards, critical for effective HIS interaction. Since HIS are in essence distributed systems, it is also important to review the most prevalent health care communication standards. Special consideration is then given to clinical information systems (e.g., Electronic Medical Record (EMR), Picture Archiving and Communication Systems (PACS), Computerised Physician Order Entry (CPOE)), a sub-grouping in HIS. This

4.2.1 Quality Impact of Health Information Systems

In 1999, the Institute of Medicine's (IOM) Committee on Quality of Health Care in the United States (US) published a report named "To Err is Human: Building Safer Care Systems" (Shapiro and Jay, 2003). This report highlighted the shockingly high error rates in US health care, nearly 98 000 deaths and more than 1 million preventable medical errors at an estimated cost of $29 billion annually.

As a result, new health policies have been introduced in the US primarily to improve quality. One such policy is that health care organisations need to set target goals for achieving best practices, based on evidence generated from clinical interventions. To assist in this process, the American Business Roundtable in 2000 formed the Leapfrog Group, consisting of major Fortune 500 companies. These companies sought to ensure valued returns, despite being faced with ever-increasing health care costs. The Leapfrog Group's intention therefore is to compel health care organisations to adopt practices that will ensure optimum patient outcomes, error prevention and cost savings.

The Leapfrog Group postulated that if US health care organisations could implement only the first three of their four recommended quality and safety practices, more than 57 000 unnecessary deaths can be avoided, more than 3 million medication errors circumvented and costs slashed by $12 billion (Leapfrog, 2009). The four practices or leaps prescribed by the Leapfrog Group are the implementation of CPOE, evidence-based hospital referrals, experienced intensive care unit (ICU) staff and the Leapfrog Safe Practices Score.

- With CPOE, staff must submit all medical orders via information systems linked to prescribing error prevention software, thereby leading to a reduction in serious prescribing errors.

- Evidence-based hospital referrals allow patients to select a health care provider with the best experience and results.

- Staffing ICUs with highly experienced staff, trained in critical care medicine.

- The National Quality Forum endorsed 34 Safe Practices, contained in the Leapfrog Safe Practices Score, which can greatly lessen the risk in certain medical processes.

Although no similar endeavour is imminent in South Africa, developing countries can learn from developed countries, thereby adopting appropriate quality aspects of health practices.

a broader exploration of factors beyond TPB and TAM. As in the research of Hu *et al.* (1999), a subtle difference in technology acceptance decision making between professional and ordinary users was found.

Health care professionals are generally more pragmatic, concentrating more on the usefulness of a technology than its ease of use, considering technology-practice compatibility to be crucial and attaching limited weight to suggestions or opinions of others.

Chau and Hu (2002a) explored the decision of physicians to accept telemedicine technology. Based on relevant prior research, a generic research framework was developed. Results obtained from SEM analysis, suggested that the research model exhibited a satisfactory overall fit to the collected data and was capable of providing a 43% explanation of a physician's acceptance of telemedicine technology.

4.12 Bioinformatics

Bioinformatics, also referred to as computational biology, is essentially a cross-disciplinary activity, involving aspects of computer science, information systems, software engineering, mathematics and molecular biology (Baldi and Brunak, 1998). Most practitioners would agree that computational biology is associated with the design of algorithms, whereas bioinformatics involves the application of the algorithms to real biological problems.

Bioinformatics, however, is far more than only the creation of biological algorithms and as such, has attained the status of a new scientific discipline. Bioinformatics is the assigned name of computationally intensive activities associated with genomics, proteomics, transcriptomics, glycomics, metabolomics and pharmacogenomics, defined in Table 4.12 (Zvelebil and Baum, 2007).

Table 4.12: The bioinformatics family (Zvelebil and Baum, 2007)

Bioinformatics family	Description
Genomics	Determination of the DNA sequence of genes and, through the specialty of functional genomics, the identification of the functional role of these genes in cellular biology.
Proteomics	The study of all the proteins expressed within the cell. These include determining the number, level and turnover of all expressed proteins, their sequence and protein interactions within the cell and across the cell membrane.
Transcriptomics	Study of mRNA molecules, which are involved in the transcription of DNA codes and their transport from the nucleus to the cell.
Glycomics	Study of cellular carbohydrates.
Metabolomics	Study of the small molecules generated in the synthetic and degradation pathways of cellular metabolism.
Pharmacogenomics	The identification of genetic markers that assist in predicting whether a patient will respond well to a therapy, or experience side effects.

Table 4.10 defines nine categories of functionality an ideal CPOE system should contain.

Table 4.10: Functionalities of a CPOE system (Coiera, 2003)

Functionality	Description
Basic Field Edits	For each order generated, physicians are provided with default values, predefined selection lists and required fields, guiding them to enter the order accurately and completely.
Structured Orders	Provides a set of templates for each ordered service.
Groups of Predefined Orders	Represents an order set or clinical pathway identified by the health care facility as the recommended care for a particular diagnosis, procedure, or patient management strategy.
Order Checking	Checks orders for drug interactions (drug-drug, drug-allergy, food-drug), contra-indications, proper dosing and possible duplicate orders.
Complex order with specialised tools	Provides physician with tools like dose calculators to complete complex medication orders.
Order relevant patient data display	Guarantees that relevant patient data is displayed, needed to guide physician's decision making.
Order relevant patient data capture	Prompts a physician to enter critical information to complete an order.
Rules-based prompting and alerts with order entry	Provides physicians with an alert informing them of specific rules they should follow in terms of dosing levels of medications.
Rules-based surveillance with alerts outside of order entry	Presents physicians with new information about the patient, such as laboratory results or significant changes in patient vital signs.

Form the description above, it is easy to identify the potential value of a CPOE system. It includes a decrease in medical errors, adherence to standard medical practices and a reduction in unnecessary tests and procedures, thereby reducing costs (Ash and Bates, 2005).

4.9.6.2 Use of CPOE Systems

Despite the considerable potential of CPOE systems, their adoption has been slow. Research indicates that physicians have opposed the use of CPOE systems, mainly because of the increased computer interaction and consequent reduction in patient interaction (Aarts *et al.*, 2004).

Furthermore, medical order creation is considered a highly collaborative process. In a case study performed by Goörman and Berg (2000), it was found that interdependence is a key factor to medical order creation, since both nurses and doctors play an active role in entering medical orders. Gorman *et al.* (2003) contend that the current model of health care delivery underpinning CPOE is too naïve and suggest a model of distributed cognition among health professionals, creating orders in a collaborative environment.

In Table 4.9, a small extract of studies performed in the field of PACS is given, highlighting the specific research area and results obtained.

Table 4.9: Research in the field of PACS

Authors	Research Area	Results
Bauman and Gell, (2000)	Usage	Users reported that PACS expectations were met in 81% of cases, 65% declared their PACS were cost effective. The most striking response was that 97% of the users would recommend PACS to others.
Hayt *et al.* (2001)	Resource location	PACS solves the problem of tracking the location of patient films and radically improves the reporting process.
Reiner *et al.* (2001)	Radiologists' productivity	Reported a 16.2% reduction in the overall time required for soft-copy interpretation of CT scans.
Siegel and Reiner (2002)	Workflow	Used PACS as a tool to re-engineer overall work flow, both in the imaging department and throughout the health care enterprise.
Cabrera (2002)	New roles	New roles (jobs) become available (e.g., PACS technologist, PACS analysts, PACS system administrators, PACS operators, PACS trainers).
White *et al.* (2004).	Benefits	Benefits to emergency departments, in terms of rapid access to images, simultaneous viewing by multiple physicians and image manipulation.
Warfel and Chang (2004)	Diagnoses	PACS shortens the time of diagnoses, results in less circulation of paperwork, improves report reliability.
Yu and Hilton (2005)	Work practices	High level of acceptance, users satisfied with the accessibility of images.
Mariani *et al.* (2006)	Time	Although an increase in caseload volume is reported after PACS implementation, case turnaround times (i.e., time between case availability on PACS and sign-off by radiologist) decreased for all case types.
Mates *et al.* (2007)	Workflow considerations – preliminary reports	PACS provides radiologists the opportunity of being removed from the physical location of patients and the site of imaging.
Duyck *et al.* (2008)	Acceptance and use	Studied the individual acceptance of PACS at a hospital radiology department. Again, acceptance decisions were made independent of supervisors, with positive attitude towards PACS usefulness.
Fridell *et al.* (2009)	Radiologists' work	Radiologists reported an increase in image production, resulting in an increase in work-related stress.

From the studies, it can be concluded that PACS has generally been well accepted in the health care industry. Although it has increased the workload of radiologists in some instances, the overall effect on health care is positive.

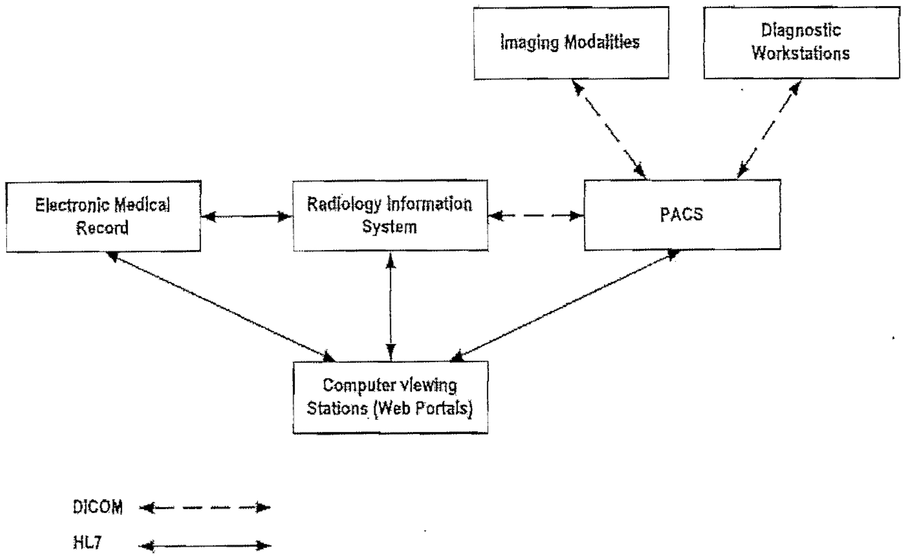


Figure 4.10: Schematic of a PACS (derived from Hood *et al.*, 2006:71)

A major benefit of PACS digital images is that they are easily stored, managed and distributed among users, compared to analogue film (Huang, 2010). With analogue film, the image existed only in one location at a time. With PACS, digital images are available both within and between health institutions, 24 hours a day. This is especially true of web-based PACS, giving referring clinicians in an outpatient setting unprecedented level of access to report data and images (Shullman, 2009).

Bandwidth[16] in PACS is critical, since medical image files are large, averaging in the order of 10 to 50 megabytes (MB) per study (e.g., 36 MB per computed tomography study or 16 MB per two-view conventional x-ray study) (Mehta *et al.*, 1999). In comparison, a digital camera produces image files between 250 and 500 kilobytes, (i.e., 50-100 times smaller) (Osborn, 2008).

The capacity of PACS to handle large image files has seen it not only serving as a repository of diagnostic medical images, but also audio and video, live images, structured and unstructured data and even native file formats like Microsoft Word, collectively referred to as multimedia.

4.9.5.2 Use of PACS

Today, the PACS industry is well established, offering archiving solutions and reading stations that fulfil the needs of most health care providers (van de Wetering and Batenburg, 2009; Huang, 2010). As such, there is

[16] *The rate at which data is transmitted in a specific time interval (Osborn, 2008).*

- The American Institute of Medicine developed a consensus standard for EMR, specifying eight core EMR functionalities (i.e., health information and data, results management, order entry and management, decision support, electronic communication and connectivity, patient support, administrative processes, reporting) (Chheda, 2007). A consensus standard was required since a number of commercial EMR systems and vendors were providing EMR solutions with various combinations of the above-mentioned functional components.

- Another movement towards standardisation is the American National Standards Institute Health care Information Technology Standards Panel, created in 2005. Its main aim is to promote interoperability in health care, resulting in the creation of EMR standards, including laboratory result reporting (Chheda, 2007).

- The Continuity of Care Record (CCR) standard was developed by the American Society for Testing and Materials International. This standard, expressed in XML, specifies the principal health information (e.g., patient demographics, insurance information, diagnosis and problem list, medications, allergies, care plan) of a patient, which can be sent electronically from one caregiver to another.

- The Continuity of Care Document (CCD) standard was developed through a collaborative effort between ASTM International and HL7 (Chheda, 2007). Combining the benefits of CCR and the HL7 CDA, it consists of a mandatory textual part (XML) and optional structured parts based on HL7 RIM.

- The openEHR standard is a specification based on the results of the European Union's Good European Health Record-Project, used and refined in a series of further European and Australian projects (OpenEHR Foundation, 2009). Its design principles, described by Beale *et al.* (2001), are maintained by the openEHR Foundation, a non-profit foundation supporting the open research, development and implementation of openEHR.

  The main characteristic of openEHR is a two-level modelling approach for EHRs.

  i. The first level is the reference model, reduced to a relatively small set of classes to support requirements and record management functions.

  ii. The second level involves openEHR archetypes, each representing one clinical concept by constraining instances of the openEHR reference model (Beale, 2002).

4.9.4.1 Use of Electronic Medical Record

In a study by Zieger (2008a), focusing on acceptance of EMR in the US, it was found that most medical practitioners are resistant to EMRs, not only because of their financial and workflow impact, but also the fear of governmental misuse and control. This might account for the low figure of 5-15% of practices in the US using EMR, as found by Bates *et al.* (2003).

In another study by Zieger (2008b), it was found that the US is adopting EMR systems much slower than other countries. For example, the Netherlands reported a 98% EMR adoption rate, with New Zealand 92% (Williams and Boren, 2008). Williams and Boren (2008) also posit that after Hurricane Katrina in 2005, when most paper-based medical records were destroyed, attention was again drawn to the importance of EMR.

In a study by Yasunaga *et al.* (2008) on the status of computerised medical records in Japan, it was reported that hospitals and clinics had a 10% EMR adoption rate. The main reason attributed to this low percentage was the high introduction costs of EMR. Research further reported that EMR use by Israeli physicians is very high, representing a fully immersed environment and leading the world in the use of EMR technology (Lejbkowicz *et al.*, 2004).

Europe also reported high rates of EMR use. In 1995, 80% of primary care physicians in the UK used computerised facilities and over 60% were using EMR during consultations. Seventy per cent of Danish doctors used EMR, with 60% in Sweden and 40% in the Netherlands (Als, 1997).

Although potential benefits are eminent, EMRs do not produce fully paperless processes.

Campbell *et al.* (2006) described the phenomenon of paper-persistence after implementation of a CPOE. Attributed to current limitations of clinical applications, complete paperless systems are also problematic. Limitations and shortcomings of EMRs were outlined by Hartzband and Groopman (2008). These included copied repetitive notes, desensitising clinicians to new possibly vital clinical data and more attention directed towards the computer, resulting in less attention devoted to the patient during consultation.

Scenarios such as the above resulted in paper-based workarounds. For example, Hartzband and Groopman (2008) presented an anecdote of a colleague who, to manage the workload, only copied the same electronic notes in the EMR, while using index cards to handwrite new diagnoses and treatments.

Saleem *et al.* (2009) explored factors causing employees to rely on paper alternatives. Semi-structured interviews with twenty respondents at a large Veterans Affairs Medical Centre in the US were completed. Participants included clinicians, administrators and IT specialists across several service areas. Eleven distinct

4.9.4 Electronic Medical Records

Clinical information largely resides within the patient record, which is the single point of storage and access to patient clinical data (Coiera, 2003). The patient record therefore is a critical component of any clinical information system. Traditionally, patient records have a number of distinct functions, both formal and informal, catalogued in Table 4.5.

Table 4.5: Functions of patient record (Coiera, 2003)

Functions of Patient Record
Offers a tool for communication among health care staff actively caring for a patient.
During the period of care, the patient record is the single point of access to all clinical data.
Provides an informal working space to note ideas and impressions, thereby developing a narrative on patient care.
After completion of medical care, the patient record is the single archive point of clinical data, used for further care or medical research.

Previously, only paper-based systems have been used for patient records. Since the introduction of electronic medical records (Woodward, 1995), this practice is changing. In 1991, the Institute of Medicine released an influential report (i.e., The Computer-Based Patient Record (CPR): An Essential Technology for Health Care), actively promoting the adoption of computer-based patient records as standard medical practice in the US by 2001.

CPR, which may not contain all the information of a patient's paper-based medical record, has become essential for the proper management of patients (Ishikawa *et al.*, 2007). Based on US statistics, a surge in the use of CPR is evident, a trend that is expected to continue. It is envisaged that within the next ten to fifteen years, CPR will become an essential aspect of all HIS (Haux, 2006).

fluid aspirated from joints. Since time is of the essence, LIS on average can provide confirmed diagnostic results to clinicians within 24 hours.

Most studies in the field of laboratory information systems focus on matters affecting quality assurance (Campos, 1999; Asare and Caldwell, 2000; Barenfanger, 2003), quality improvement through cost reduction and improved specimen turnaround times (Park *et al.*, 2005). In effect, laboratory information systems improve the quality of medical treatment by increasing the satisfaction of medical personnel and patients, improving laboratory processes and through decision-making assistance provided by CDSS.

In the case of outpatients, it is believed that quick and accurate laboratory results can relieve the uneasiness of patients when visiting a hospital for the second time to have laboratory results confirmed. In the case of an inpatient, a correct diagnosis can be made by combining laboratory systems with CDSS, ensuring faster recovery, thereby reducing the time a patient has to stay in bed.

4.9.3 Pharmacy Information Systems

Pharmacy information systems receive and process orders for medication (Van Bemmel and Musen, 1997). Currently, in most cases paper-based medication orders are received and transcribed by the pharmacist into a pharmacy information system. A delay therefore is experienced between creating a medication order by a physician and the availability thereof electronically.

The reliability of information in pharmacy information systems is generally good, as pharmacists use expert knowledge and contextual information to validate orders before dispensing medication. Unfortunately, if not part of an EMR or hospital information system, pharmacy data is not easily accessible for other HIS. Nevertheless, the importance of pharmacy data for preventing medication errors has urged health institutions to upgrade their pharmacy systems.

4.9.1 Hospital Information Systems

It has been demonstrated that the use of IT and information systems in the health care sector, especially in hospitals, improves the quality of health care, reduces cost and enhances the efficiency and effectiveness of medical and administrative staff (Scott, 2007). Ammenwerth *et al.* (2003) postulate that if hospitals do not implement hospital information systems, inefficiency and a decline in patient trust will result.

In both literature and practice, there is some confusion as to what a hospital information system entails. Zviran (1990) stated that the portfolio of hospital information systems includes all aspects of hospital management (e.g., administration, patient management, medical applications, facilities management). Siemens, a leading provider of hospital information systems, regards it as an integrated information system, proactively managing the clinical, financial and administrative processes of a hospital (Siemens, 2009).

In general, a comprehensive hospital information system consists of five components (Coiera, 2003).

- A patient scheduling, admission, discharge and transfer (ADT) system, providing basic patient encounter management facilities.

- A financial system, for example, a Patient Accounting and Billing system, a Human Resources (HR) system for payroll and personnel administration and a Materials Management (MM) system for purchasing stock items.

- Departmental systems, such as radiology, including PACS, laboratory and pharmacy systems.

- Point-of-care systems, such as Critical Care Information Systems, CPOE, and CDSS.

- EMR, encompassing all of the above components in one functional integrated hospital information system.

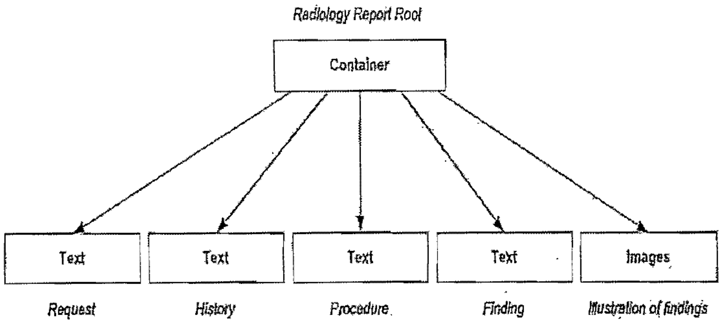


Figure 4.6: SR document tree (Riesmeier *et al.*, 2001:796)

A relatively new developing component of DICOM is Structured Reporting (DICOM-SR), which is a document architecture, specifying tags and sections to write radiology reports (Riesmeier *et al.*, 2001), illustrated in Figure 4.6.

Both Hl7 and DICOM are relative complex standards, which resulted in only a few concepts to be outlined.

In the next section, clinical information systems, forming the core element of HIS, are highlighted.

4.9 Clinical Information Systems

In the 1990s, it became clear that one technique for reducing health related expenditure was the creation of information systems that would assist health care professionals in their daily activities. The development of clinical information systems was a natural evolution within health informatics, resulting in integrated health information, combining both administrative and clinical data (Van de Velde and Degoulet, 2003).

Most clinical information systems are designed exclusively for a specific clinical department, for example, radiology information systems (RIS) for radiology, laboratory information systems (LIS) for clinical laboratories and pharmacy information systems (PIS) for pharmacies (van Bemmel and Musen, 1997). Hospital information systems include both clinical and administrative information systems. For example, most hospital information systems include a financial, human resources and materials management (i.e., stock) information system.

4.8.1 Health Level 7 (HL7)

The HL7 communication standard was developed in 1987 with the main objective of formatting and exchanging data between health care institutions and also between these institutions and health care insurers (Blazona and Koncar, 2007). HL7 stipulates a number of flexible standards, guidelines and methodologies, outlined in Table 4.3, by which various clinical and administrative information systems, located in hospitals and 3th party organisations, can communicate with one another.

Table 4.3: HL7 standards (Blazona and Koncar, 2007)

HL7 Standards	Description
Reference Information Model (RIM)	Conceptual standard expressing the data content needed in clinical or administrative environments. RIM is often presented as a high-level class UML diagram.
Clinical Document Architecture (CDA)	Health document standard based on eXtensible Markup Language (XML), intended to specify clinical documents.
Clinical Context Object Workgroup (CCOW)	Application standard primarily used to facilitate the process of using particular objects of interest (e.g., user, patient, clinical encounter, charge item), existing in unrelated applications. The user then experiences all these unrelated applications in a unified, cohesive way, also referred to as Context Management.
HL7 Message Standard (Core Standard)	Defines a series of electronic messages, known as interactions, to support all health care communications, based on XML encoding syntax.

Currently, the HL7 standard is managed by Health Level Seven Inc., a non-profit standardisation organisation, consisting of more than 40 country-specific affiliated organisations (König, 2005). The Level 7 specifically refers to the seventh layer of the ISO Open Systems Interconnection (OSI) Reference Model. This reference model divides a communication protocol into seven layers, with the top or seventh layer known as the application layer (Huang *et al.*, 2005). HL7 therefore focuses on the application layer protocols for the health care domain, independent of the lower six OSI reference model layers.

4.8.2 Digital Imaging and Communications in Medicine (DICOM)

In 1993, the American College of Radiology and the National Electrical Manufacturers Association developed a standard to format communication and store digital images, referred to as DICOM (Robertson, 2007).

4.7.2 International Statistical Classification of Diseases and Related Health Problems (10th Revision)

ICD-10 was published in 1992 under the auspices of the World Health Organisation (WHO), consisting of 200 000 codes of which 120 000 are diagnostic, mainly used for diagnostic and procedural related coding (van Drimmelen-Krabbe *et al.*, 2009). Initially developed for reporting mortality data, it is seen as one of the first attempts to codify medical data. The complete ICD-10 code set consists of three parts (World Health Organisation, 2009).

- Firstly, it is a system of alphanumeric code categories, not numeric categories (e.g., ICD-9).

- Secondly, ICD-10 Clinical Modifications (ICD-10-CM) is a system of 3-character alphanumeric codes, using numeric digits and alphabet letters (except I and O), for reporting clinical conditions. For example, J03 is acute tonsillitis with J denoting the disease and 03 the site of illness, or with J03.0 (streptococcal tonsillitis) also including the causative organism.

- Thirdly, ICD-10 Procedure Coding System (ICD-10-PCS), employing a 7-character alphanumeric code structure, codifies specific health care procedures. For example, ODT10ZZ is open resection of the upper oesophagus.

4.7.3 Current Procedural Terminology (4th Edition)

CPT-4 is a listing of descriptive terms and identifying codes for describing medical, surgical and diagnostic services and procedures, first developed in 1966 under the auspices of the American Medical Association (AMA) (American Medical Association, 2009).

Three categories of CPT-4 codes can be identified.

- Firstly, Category I CPT-4 codes, describing a procedure with a 5-digit CPT-4 code. For example, 43235 is the CPT-4 code for a gastroscopy.

- Secondly, Category II CPT-4 (Performance Measurement) codes, which are tracking codes used for performance measurement, consisting of four digits, followed by an alpha character.

- Thirdly, Category III CPT-4 (Emerging Technology) codes, which are temporary tracking codes used for new and emerging technologies, consisting of four digits, followed by an alpha character.

is a French word originating from battlefield scenarios, where swift decisions had to be made regarding who waits for care, who needs immediate care, and who is beyond benefit of care.

In addition, ancillary services or professional service departments exist, providing services to both outpatients in an ambulatory environment or primary health clinic and inpatients in district, private or tertiary hospitals. Ancillary departments provide diagnostic and therapeutic services at the request of clinicians, including radiology, clinical laboratory, physical therapy, occupational therapy, respiratory therapy, medicine (e.g., pharmacy), to name but a few. For example, a patient requiring fetal ultrasound that cannot be performed by her physician will be referred to the appropriate ancillary area, such as diagnostic imaging or radiology. The professional service department will then bill the patient or third party health insurer and send a report of the procedure to the referring clinician.

Health informatics, however, is more than just information systems, it also includes auxiliary components specific to health care, e.g., formal medical terminologies coding standards and health information communication systems, discussed in the next two sections.

4.7 Formal Medical Terminologies Coding Standards

Medical coding can be defined as the conversion of specific diseases, injuries, procedures and medical consumables spoken descriptions into numeric or alphanumeric codes (Coiera, 2003).

But why are formal medical terminology codes standards important in health care? Health care providers generally use different clinical terms, meaning the same thing. However, exchanging clinical information among different health care providers is a critical requirement necessitating a comprehensive formal medical terminology coding standard in any HIS architecture. Without it, it would be impossible to communicate the description of diseases, medical and surgical procedures, illness severity, drugs utilization, clinical laboratory tests and patient outcomes. As such, it forms the basis of fair reimbursement in health care, ensuring accurate and consistent communication of medical data among all participants in the health care industry.

Health informatics can also be viewed as a basic medical research with possibly multiple areas of application, illustrated in Figure 4.3 (Shortliffe and Blois, 2001). Basic research can be defined as the search for new knowledge, while application research applies this knowledge in practice.

In health informatics, a close relationship between the application areas in medical practice and the identification of basic research exists. In general, health informatics researchers obtain guidance from one of the health application areas (e.g., radiology), providing some problem that needs to be addressed. Thereafter, prototypes of possible solutions are produced. These prototypes are then transformed into the actual HIS (e.g., PACS).

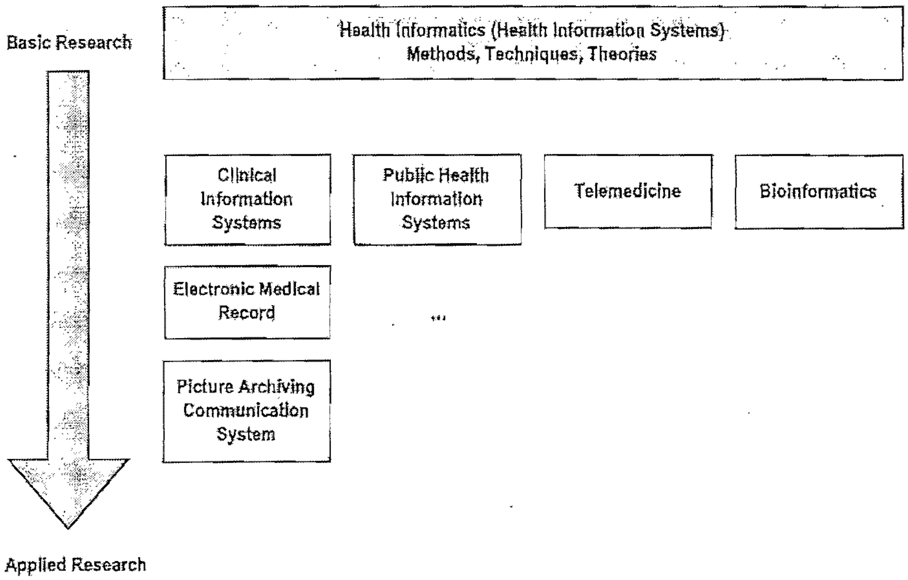


Figure 4.3: Health Informatics as a basic medical science (Masys *et al.*, 2000:308)

This is similar to other basic sciences where results of past experience are used to understand, formulate and encode findings for future processing (Shortliffe and Blois, 2001). These newly discovered findings (i.e., knowledge) can assist in patient care, health planning and basic biomedical research.

4.6 Relationship between Health Information Systems and the Health Care System at large

A health information system cannot exist independently, but is essentially one entity within a comprehensive health system framework.

As can be seen from this short overview, there seems to be some uncertainty as to the precise meaning of the terms "health informatics" and "medical informatics." Table 4.1 presents some of the definitions of medical informatics proposed by prominent authors in the field.

Table 4.1: Medical/health informatics definitions

Definition	Authors
Medical Informatics is informational technologies focusing on the patient care medical decision process. Health Informatics is informational technologies focusing on all health care dimensions.	Shires and Ball (1975b)
Medical informatics consists of the theoretical and practical aspects of ICT, based on the knowledge obtained by employing it in medicine and health care.	Van Bemmel (1984)
Health informatics is the use of ICT in all areas of medicine (e.g., medical care, medical teaching and medical research).	Collen (1986)
Medical informatics is the designation given to the academic disciplines seeking to organise and managing information in support of medical research, education and patient care.	Masys (1989)
Medical informatics is the problem-oriented information science investigating all forms of computer processing in health care.	Lincoln (1990)
Medical Informatics is the disciple focusing on the cognitive, information processing and communication tasks of medical practice, education and research.	Greenes and Shortliffe (1990)
Medical informatics is the information science optimising the computer analysis, storage, retrieval and transfer of patient and health care data.	Parsons (1993)
The aim of medical informatics is to enhance the quality of care and develop new IT to increase the cost-effectiveness of such. Its focus therefore is the methods of managing medical information and not diseases, organ systems, or particular molecules.	Altman (2001)
Health informatics is a new research area, intended for examining and managing the flow of information in health care and medicine.	Adhikari and Lapinsky (2003)

A brief consensus definition of the terms "health informatics", "health information systems" and "medical informatics", used in this study, is the application of information technology and information science to the theoretical and practical problems of medical education, clinical practice and biomedical research. For the purpose of this study, these three terms will be considered equivalent, although medical informatics is generally regarded as a part of health informatics.

It is important to note that not all research perform on information systems cannot directly be transferred to health information systems. The rational for this proposition is that the health care discipline requires a far higher level of quality than would be needed for most other information systems. This is based mainly on the fact that human life is at stake, requiring a higher standard of information system, specifically focus on precision, accuracy and quality. For example, CPOE systems have been found to have a determental effect among communication between health care professionals (Dykstra, 2002) and misinterpretations (Beuscart-Zéphir *et al.,* 2005). This is unique, since in general IS would be beneficial in most environments with no

While these systems were frequently linked to billing software, their department- or task-oriented nature ultimately hampered attempts to integrate them into cohesive information systems. It was not until the 1990s that health organisations attempted to integrate and network many department-based information systems, thereby creating health networks.

Health networks were mainly the result of an IT transformation, with networks transformed from a simple collection of hardware components, to a diverse collection of distinct networks, each consisting of a wide range of hardware, software and network technologies. These new information system structures were known as mixed-architecture systems or client-server networks. This resulted in making information systems based on proprietary operating systems (e.g., mainframe, midrange) obsolete, introducing a new era of non-proprietary or open software.

This new era introduce greater flexibility in the implementation and operation of information systems, while at the same time increasing cost effectiveness (Wang, 1994). Unfortunately, even with this cost reduction, it is only in recent years that clinical information systems made a real impact on the level of patient care provided by health institutions

In the next section, health informatics, medical informatics and health information systems will be highlighted.

4.4 Information Systems, Health Information Systems, Health Informatics, Medical Informatics

Information systems specifically denote computerised information systems, as defined by Iivari and Maansaari (1998). In their article, the authors highlight the difference between an information system and a computerised information system or sub-system. An information system is classified as a *"sub-system of an organizational system, comprising the conception of how the communication- and information- aspects of an organization are composed and how these operate, thus describing the communication-oriented and information-providing actions and arrangements existing within that organization"* (Iivari and Maansaari, 1998:502). A computerised information sub-system is defined as a *"sub-system of an information system, whereby all actions within the sub-system are performed by one or several computer(s)"* (Iivari and Maansaari, 1998:502).

Health information systems, which is also referred to as health informatics or medical informatics, is the application of information technology and information science to the theoretical and practical problems of medical education, clinical practice and biomedical (Shortliffe and Blois, 2001). Examples of health information systems, which is the practical implementation of information systems specifically for the health care industry include Electronic Medical Records (EMRs), Picture Archiving and Communication Systems (PACS), Clinical Decision Support Systems (CDSS) and Computerised Physician Order Entry (CPOE).

In the 1990s, bioinformatics mainly focused on the Human Genome Project, which produced the full human DNA sequence (Collins and McKusick, 2001). Today, more than a hundred organisms have been sequenced (Janssen *et al.*, 2003). This has resulted in the availability of an immense amount of bioinformatics data. Therefore, the focus of current bioinformatics research is on the development of new and efficient mathematical and algorithmic methods to explore this data (Masulli and Mitra, 2009).

In conclusion, a review of aspects discussed in this chapter will be presented.

4.13 Conclusion

This chapter provided an overview of health information systems. It started with a background to HIS, specifically considering its quality and costs impact, followed by a historic review. Hence, the difference between health informatics, medical informatics and HIS was explained. In essence, health informatics and HIS are the same, with medical informatics considered a sub-grouping of health informatics. This was followed by a short review of the relationship between HIS and health care systems at large, specifically looking at primary, secondary and tertiary levels. Formal medical terminology coding standards, including ICD-10 and CPT-4, and communication standards, including HL7 and DICOM, were considered. Special attention was also given to clinical information systems (e.g., EMR, PACS, CDSS, CPOE), the main grouping of information systems in HIS. A brief overview of public health information systems, i.e., telemedicine and bioinformatics followed. From the foregoing, the importance of information systems to health care services is indisputable.

There is evidence that clinical information systems can address imperatives in developed and developing countries to enhance patient outcomes, reduce costs and provide access to knowledge. However, evidence in itself will not be enough to ensure the widespread adoption of HIS. One concern is that, while the correction of a number of clinical anomalies, such as improper drug dosage, is feasible, the impact of these new workflow procedures and processes might lead to cognitive overload of the clinician and therefore may not be practical.

The optimal use of HIS will require selective re-engineering of the health care system, especially in the context of developing countries like South Africa. The use of CPOE and EMR will have to be accepted, since they are the enabling technologies for PACS, CDSS and other clinical information systems of critical importance. Governments and medical insurers will have to determine who will bear the costs of EMR and CPOE, as initial investment will be substantial, even with cost savings in the long run. South Africa is contemplating this step. How and when this will be accomplished, is still unknown.

Chapter 5: Conceptual Research Model and Research Methodology

5.1 Introduction

This chapter presents the study's conceptual research model and research methodology. As the only chapter addressing the creation of the conceptual research model, it fulfils the role of drawing the previous three literary review chapters into one theoretical artefact and stipulating the validation method (i.e., research methodology) employed. Starting with a background to the reasons for a conceptual research model, some important theoretical aspects are highlighted. This is followed by an introduction to the generic framework for technology acceptance, used extensively in health care research. Specific research questions, focusing on how they relate to the identified research hypotheses and the conceptual research model, are then discussed. Next, an introduction to the research methodology of this study, namely survey research is given.

Survey research, divided into distinct phases (i.e., specification of sample frame, selection of sample, development of measurement instrument, operationalisation of measurement instrument, pilot test of

As such, conceptual research models are central to both exploratory and confirmatory research, depicted in Figure 5.1.

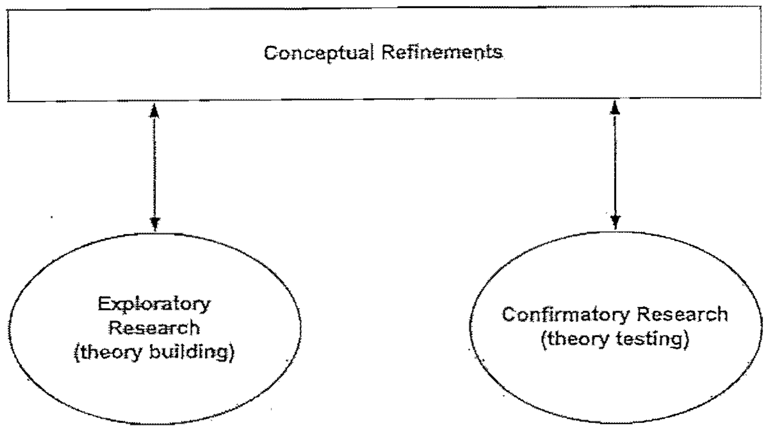


Figure 5.1: Exploratory and confirmatory research (derived from Straub, 1989:149)

In exploratory research, the main aim is theory building, while in confirmatory research the main aim is theory testing. This implies that during exploratory research constructs may be removed or added after the development of the conceptual research model, while it is not advised in confirmatory research (Tabachnick and Fidell, 2007).

With reference to Chapter 2, one way of creating theories in information systems is by improving and extending existing theories. Both UTAUT and EDT are well-established and validated theories. By combining these theories, adding new constructs specific to the discipline of HIS and defining relevant new relationships among constructs, it is envisaged that new theoretical and practical knowledge will be gained.

It has been found that health care practitioners are hesitant to use information and communication technologies (Schaper and Pervan, 2007). This resulted in a growing concern within HIS research that there may be specific factors contributing to the delay in the acceptance and utilization of ICT. The use of technology acceptance models within the field of HIS is relatively limited, although several studies utilizing UTAUT were discovered.

Han *et al.* (2004), in a study on physicians' behavioural intention towards mobile technology in Finland, created a conceptual research model by modifying TAM and UTAUT. In the research model, behavioural intention was employed as the dependent variable, predicted by four determinants (i.e., perceived usefulness, perceived ease of use, social influence, compatibility) and one moderator (i.e., fragmentation of working space), as well as one external variable (i.e., fragmentation of working time). The adapted

Based on these studies, it seems as if individual characteristics as well as organisational and cultural factors, plays a vital role in the acceptance and use of any technology. These factors will be elucidated by using the generic framework of technology acceptance (Hu *et al.*, 1999), discussed in the next section.

5.3 Generic Framework for Technology Acceptance

The generic framework for technology acceptance expands technology acceptance theories by taking into account various socio-technical issues. As such, the framework provides a foundation upon which conceptual research models can be developed to explain different technology acceptance scenarios. This requirement was confirmed by Hardgrave *et al.* (2003), which suggested the inclusion of individual and organisational factors when studying the acceptance and use of SDMs. The proposed framework of Hu *et al.* (1999) used in this study suggests that an individual's decision to accept a technology can be explained by factors pertaining to the individual context, technological context and implementation context.

- The individual context denotes the fundamental characteristics of individual users (e.g., software developers), such as experience, attitude towards use, self-efficacy, career consequence and compatibility. Conceivably, software developers as a group may exhibit characteristics that differ from other individuals, studied in relation to technology acceptance. Furthermore, it is possible that characteristics significant to other information technologies are not significant to SDM users. For example, in the study by Chau and Hu (2002b), attitude towards telemedicine technology was found to play a critical role in the technology acceptance decisions of physicians, constituting the second most important determinant of acceptance.

- The technological context focuses on the attributes of the technology (i.e., SDMs) under investigation. Three characteristics will be considered in this study, namely performance expectancy, effort expectancy and result demonstrability. Interestingly, perceptions of a technology rather than objective attributes of a technology were found to be more relevant to the acceptance decision (Moore and Benbasat, 1991).

- The implementation context refers to the specific environment (i.e., organisation) where SDM use takes place, encompassing determinants like social influence, voluntariness, organisational culture, customer influence, facilitating conditions and relevant policies. Again, the environment in which software developers function may exhibit characteristics that are distinct (Hu *et al.*, 1999).

In review, within the individual context, the investigative focus is essentially on individual characteristics and the assessment of their plausible effects on technology acceptance. From the technological context point of view, perceived technology characteristics may be more relevant than objective technological characteristics. This implies that from both a cognitive and behavioural perspective, perception might have a greater influence than reality. The focus of the technological context therefore is to identify important perceived SDM

With exploratory research, the goal is to gain new insights into specific phenomena by developing an exploratory model (Tull and Hawkins, 1987). The exploratory model is normally based on specific hypotheses, where each hypothesis is presented as a relationship between two constructs. Typically, hypotheses are based on specific research questions.

Before the research questions are dealt with, it is important to note that although UTAUT includes age and gender as moderating variables, these variables were not included in the conceptual research model, whilst only captured for demographical purposes.

Age and gender are postulated to create different effects on perceptions, beliefs and attitudes (Morris *et al.*, 2005), thereby moderating the effect of predictors on technology acceptance (Venkatesh *et al.*, 2003). While previous studies have shown that attitude towards the acceptance of new information technology is more salient in the case of younger individuals and subjective norm more salient in the case of women (Morris and Venkatesh, 2000), it is postulated that in the software development field these variables have minimal influence. Furthermore, considering the relatively controversial history of South Africa, it was decided not to address factors that could possibly be viewed as discriminatory. They are therefore left for future studies.

5.4.1 Research Questions

This research aims to answer the following questions (refer Chapter 1):

i. What systems development methodologies are mainly used in the development of health information systems (HIS)?

ii. Are SDMs rigorously applied in all system developments, or conveniently, also referred to as horizontal use (McChesney and Glass, 1993; Iivari and Huisman, 2007)?

iii. Are specific components (i.e., tools, techniques), or all components of SDM being used? This is referred to as vertical use (McChesney and Glass, 1993; Iivari and Huisman, 2007).

iv. Are components of different SDMs combined into new custom methodologies in HIS development? This is referred to as method engineering (Iivari *et al.*, 2000).

v. Are specific types of methodologies used for specific types of HIS applications? This tendency is referred to as contingency or situation method engineering (Harmsen *et al.*, 1994).

vi. Does the organisational size or IS department size influences the use of SDMs?

5. Will performance expectancy influence the user's attitude towards SDM use (relates to hypothesis 5)?

6. Does effort expectancy influence the user's attitude towards SDM use (relates to hypothesis 6)?

7. Does user attitude towards SDM use affect the acceptance of SDMs (relates to hypothesis 7)?

8. Does experience influence the user's attitude towards SDM use (relates to hypothesis 8)?

9. Is there a relationship between self-efficacy and the user's attitude towards SDM use (relates to hypothesis 9)?

10. Is there a relationship between experience of the individual and self-efficacy (relates to hypothesis 10)?

11. Will personal innovativeness influence the attitude of the individual with reference to SDMs (relates to hypothesis 11).

12. Does career consequence influence the user's attitude towards SDM use (relates to hypothesis 12)?

13. Does compatibility influence the user's attitude towards SDM use (relates to hypothesis 13)?

14. Does customer influence (i.e., customer requirement that SDMs be utilized) impact SDM acceptance (relates to hypothesis 14)?

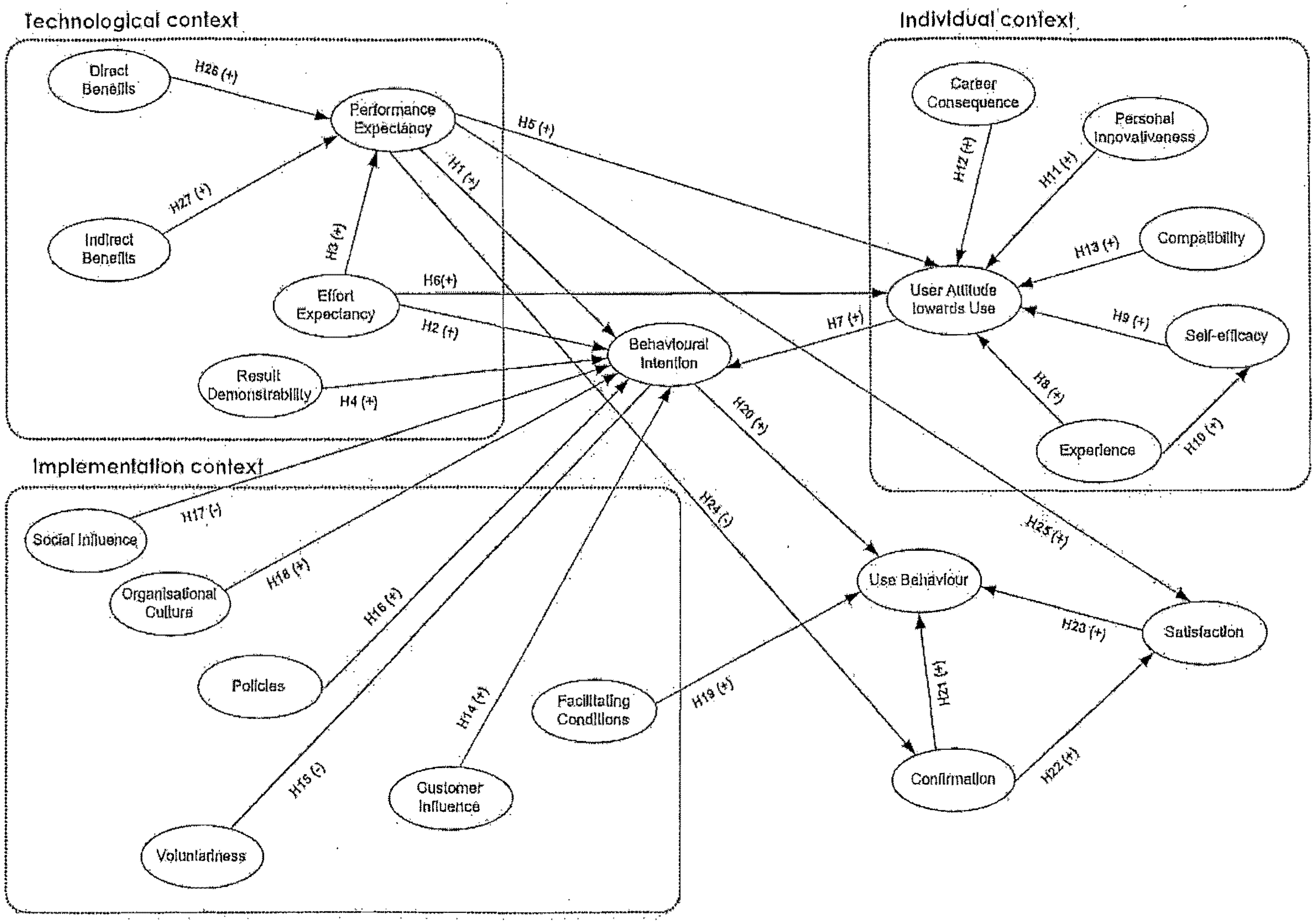
15. Is there a relationship between voluntariness and SDM acceptance (relates to hypothesis 15)?

16. Do policies (e.g., government regulations, law, guidelines) influence the acceptance of SDMs (relates to hypothesis 16)?

17. Is there a relationship between social influence (i.e., behavioural intent) and the acceptance of SDMs (relates to hypothesis 17)?

18. Is there a relationship between organisational culture and the behavioural intent to use SDMs (relates to hypothesis 18)?

19. Do facilitating conditions like internal and external resources, time, money and a supporting project management tool affect the use of SDMs (relates to hypothesis 19)?



H(n) hypothesis n
(+) positive relation
(-) negative relation

Figure 5.3: Conceptual research model

construction of performance expectancy by Venkatesh et. al. (2003) from the eight behavioural theories is perceived usefulness, extrinsic motivation, job-fit, relative advantage and outcome expectations (Hennington and Janz, 2007).

In previous acceptance studies, performance expectancy has shown to be a strong predictor of intention to use information technology (Davis, 1989; Venkatesh and Davis, 2000) and SDMs (Riemenschneider *et al.*, 2002, Hardgrave *et al.*, 2003). Overall, theoretical foundations and prior research suggest that higher performance expectancy will result in higher intention to use. Intention to use can be defined as the degree to which an individual intends to use a SDM (Chau and Hu, 2002a).

Hypothesis 2

H_2 : Effort expectancy has a direct positive influence on an individual's intention to use a SDM.

Effort expectancy is the ease of use level associated with the use of a SDM (Venkatesh et. al., 2003), i.e., the extent the individual considers the use of a SDM to be free of effort (Davis *et al.*, 1989). The core factors used for the construction of effort expectancy by Venkatesh et. al. (2003) from the eight behavioural theories is ease of use and complexity (Hennington and Janz, 2007).

Although previous studies showed effort expectancy to have a significant influence on intention to use behaviour (Davis, 1989; Schaper and Pervan, 2007; Chang *et al.*, 2007), some studies did not exhibit the same effect (Jayasuriya, 1998; Hu *et al.*, 1999; Chau and Hu, 2002b; Ma and Liu, 2004). Notwithstanding these results, it was decided to include effort expectancy in the conceptual research model, thereby limiting deviation from UTAUT.

Hypothesis 3

H_3 : Effort expectancy has a direct positive influence on performance expectancy.

This hypothesis follows from Davis (1989) who confirmed a mediation effect between ease of use and perceived usefulness. A system is perceived as useful if it is easy to use, as confirmed by Wilson and Lankton (2004) and Hu *et al.* (1999). In this research, it is believed that individuals are more likely to accept the use of SDMs, if perceived easy to use.

Hypothesis 4

H_4 : Result demonstrability has a direct positive effect on an individual's intention to use a SDM.

Result demonstrability is the degree to which the benefits of using a certain SDM element are tangible (Rogers, 2003). Originally part of IDT, it is not included in UTAUT (Venkatesh et. al., 2003). Research suggests that result demonstrability has a positive influence on adoption of IT innovations (Moore and Benbasat, 1991). However, studies in the field of SDM acceptance were unable to confirm this relationship attitude towards use. The main reason for this assumption is that attitude towards use is included in the conceptual research model, not present in the UTAUT. As such, it is postulated that experience will influence user attitude as found by Leonard-Barton (1987), therefore serving as an antecendent in the conceptual model.

Hypothesis 9

H_9 : Self-efficacy has a direct positive influence on an individual's attitude towards the use of a SDM.

Self-efficacy refers to individuals' beliefs or judgements about their capability to use a SDM (Compeau and Higgins, 1995). As such, it is not concerned with skills, but rather with the individual's judgement of his or her ability (Bandura and Adams, 1977).

As a construct of SCT, also forming part of the perceived behavioural control construct of TPB (Ajzen; 1991), it was included in the facilitating conditions construct of UTAUT (Venkatesh *et al.*, 2003). This was performed since Venkatesh *et al.* (2003) found that self-efficacy was insignificant, owing to the effect of being captured by effort expectancy.

However, studies found self-efficacy to have a significant influence on behavioural intention (Hsu and Chiu, 2004a; Mead *et al.*, 2003). In SDM related research, Cockburn and Highsmith (2001) found that high self-efficacy has a positive impact on individuals' use of SDMs.

With reference to the individual context, it was therefore decided to consider self-efficacy as a determinant of user attitude towards use.

Hypothesis 10

H_{10} : Experience has a direct positive influence on self-efficacy.

Individuals with higher levels of experience are likely to have higher levels of self-efficacy (Chau and Hu, 2001).

Hypothesis 11

H_{12} : Personal innovativeness has a direct positive influence on individual's attitude towards the use of a SDM.

Personal Innovativeness refers to the keenness of an individual to try out new information technologies (Agarwal and Prasad, 1998). Lu *et al.* (2005), in the context of information technologies, refer to personal innovativeness in information technology (PIIT) as the willingness of an individual to try out any new information technology. Lu *et al.* (2005) therefore hypothesized that a higher level of PIIT will result in more

Hypothesis 14

H_{14}: Customer influence has a direct positive influence on an individual's intention to use a SDM.

Customer influence refers to the extent a customer base demonstrates interest in the use of SDMs. This reflects the impression an individual has that his or her customer base encourages the use of a SDM. Lau and Kwok (2007) reported a positive influence of customers on e-commerce acceptance by small and medium enterprises.

It is important to distinguish customer influence from social influence which includes peer influence and superior influence. As such, customer influence indirectly induces the individual to conform to the use of SDMs, unlike peer influence and superior influence which directly pressure the individual. This indirect "external" requirement was found during applicability checks to be prominent and subsequently included as a antecendent of behavioural intention.

Hypothesis 15

H_{15}: Voluntariness has a direct negative influence on an individual's intention to use a SDM.

Voluntariness is the individual's level of perception that he or she has a choice in using SDMs (Venkatesh *et al.*, 2003). Although considered a moderating variable on social influence in UTAUT, it was decided to include voluntariness as a determinant variable of behavioural intent in the conceptual research model.

Studies reported that voluntariness affects attitude toward use, which again is a determinant of behavioural intent (Karahanna *et al.*, 1999). Moore and Benbasat (1991) and Agarwal and Prasad (1999) found a direct states that is a direct link between voluntariness and organisational mandate (i.e., whether the use of a SDM is mandated by an organisation) further state that different levels of voluntariness are evident in practice.

Studies in the use of SDMs or other IT innovations suggest that, unless management prescribes their use, software developers often do not use them. A significant negative relationship has therefore been observed between voluntariness and SDM acceptance (Iivari, 1996; Riemenschneider *et al.*, 2002; Hardgrave *et al.*, 2003). Based on the studies by Iivari (1996), Riemenschneider *et al.* (2002) and Hardgrave *et al.* (2003), it was decided to include voluntariness as an antecedent of behavioural intention.

Hypothesis 16

H_{16}: Policies has a direct positive influence on an individual's intention to use a SDM.

Policies or laws are general rules of conduct established by an authoritative body, in the case of health information systems, mainly governmental authoritative bodies (Lau and Kwok, 2007). Policies, in the context of this study, can therefore be defined as the degree to which external regulation(s) require the use of a SDM.

Facilitating conditions are the level an individual considers the organisational and technical infrastructure to support the use of SDMs (Venkatesh *et al.*, 2003). The core factors used for the construction of facilitating conditions by Venkatesh et. al. (2003) from the eight behavioural theories is perceived behaviour control, facilitating conditions and compatibility (Hennington and Janz, 2007). In the context of perceived behaviour control define in TPB, especially external factors were considered by Venkatesh et. al. (2003), which reflected the availability of resources needed to use a technology. Facilitating conditions therefore indicate the resources available (e.g., time, finance, external consultants, internal and external training) for SDM use (Lu *et al.*, 2003).

Previous technology adoption studies reported a positive influence of facilitating conditions on innovation use (Chang *et al.*, 2007; Chau and Hu, 2002b). Venkatesh *et al.* (2003) found that facilitating conditions significantly predict intention to use, but are insignificant when both performance expectancy and effort expectancy constructs are introduced in the research model. However, a significant relation was reported between facilitating conditions and use behaviour by Venkatesh *et al.* (2003).

Hypothesis 20

H_{20} *: Intention to use a SDM has a direct positive influence on actual SDM use.*

Behavioural intention refers to the strength of a person's intention to use a SDM (Davis *et al.*, 1989). The intention-behaviour relationship is generally recognised as conclusive (Davis *et al.*, 1989; Venkatesh and Davis, 2000; Venkatesh *et al.*, 2003). It is therefore postulated that intention to use SDMs will have a significant influence on actual SDM usage.

Hypothesis 21

H_{21} *: Confirmation has a direct positive influence on actual SDM use.*

Confirmation, also refer to as disconfirmation in the marketing literature, is the comparison of expectation-performance gaps, measured as worse than expected (negative confirmation), better than expected (positive confirmation), or expected (zero confirmation) (Spreng and Page, 2003).

Studies have shown that confirmation has a positive impact on use behaviour (Bhattacherjee, 2001a; Bhattacherjee, 2001b; Premkumar and Bhattacherjee, 2008).

Hypothesis 22

H_{22} *: Confirmation has a direct positive influence on user satisfaction.*

Satisfaction, a psychological construct, has been studied in various contexts, including job satisfaction, satisfaction with product or service and end-user satisfaction with IT usage (Premkumar and Bhattacherjee, 2008).

Hypothesis 26

H_{26} : *Direct benefits have a direct positive influence on performance expectancy.*

Direct benefits are the benefits of using a SDM that are directly visible to the individual (Quaddus and Hofmeyer, 2005; Quaddus and Hofmeyer, 2006). It is postulated that direct benefits will positively influence performance expectancy.

Hypothesis 27

H_{27} : *Indirect benefits have a direct positive influence on performance expectancy.*

Indirect benefits are the benefits of using a SDM that are not directly visible to the individual (Quaddus and Hofmeyer, 2005; Quaddus and Hofmeyer, 2006). It is postulated that indirect benefits, like direct benefits, will have a positive influence on performance expectancy.

In conclusion, although not presented in the conceptual research model, the following research questions will be evaluated during the analysis of the demographical data.

Does organisational size[18] *have an effect on the use of SDMs.*

Will IS department size[19] *influence the use of SDMs.*

Does educational level[20] *have an effect on the use of SDMs.*

In the next section, the development of the conceptual model is considered.

5.5 Development of Conceptual Research Model

Theory constitutes the cornerstone of all research. As such, the worth of any theory is increased by its application in different situations and diverse environments (Lammers and Badia, 2005). In relation to this study, will the UTAUT and EDT show their worth by also being relevant in exploring this study's phenomenon under investigation?

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[18] *Organisational size refers to the staff complement of an organisation.*

[19] *IS department size refers to the staff complement of an IS department.*

[20] *Agarwal and Prasad (1999) postulated that the level of education reflects users' ability to learn about an innovation and therefore should have a positive influence on the use of such innovations.*

While UTAUT considers the acceptance and use of technology, EDT is employed solely to explain post-adoptive behaviour following experience with SDMs. Since each theory has separate origins based on dissimilar antecedent variables, it is argued that independently, they only provide partial understanding of users' cognitive processes related to SDM usage. It is therefore postulated that when combined, these theories may jointly provide a more complete understanding of the cognitive processes and behaviours related to the use and effectiveness of SDMs.

While prior research examined UTAUT and EDT independently in explaining technology usage and continuance, to the best of our knowledge, no study as yet has combined them to investigate SDM usage.

In conclusion, the strength of the UTAUT model and the reason for researchers employing it, relates to its strong theoretical foundation, comprehensiveness and the rigor of its development (Schaper and Pervan, 2007; Han *et al.*, 2004). Critics posit that the UTAUT model is a reincarnation of TRA and TPB (Benbasat and Barki, 2007), while Bagozzi (2007) state the UTAUT model omits important independent variables. Although considered, previous results obtained with the UTAUT in IS research where favourable, confirming the decision to use the UTAUT as the main reference theory.

Next, the research methodology will be discussed.

5.6 Research Methodology

Olivier (2004) characterises research as an investigation to discover facts and thereby extend the accepted body of knowledge.

To reach this goal, research must be undertaken in a meticulous and methodical way, employing a suitable research methodology, thereby affirming its reliability and trustworthiness. Only by establishing research on this basis, newly discovered knowledge can be relied on.

This study is based on the positivistic school of thought, utilizing a conceptual research model based on relevant behavioural theories. Researchers employing a positivist perspective, assume the existence of a priori established relationships within phenomena, which can be characterised and measured empirically (Orlikowski and Baroudi, 1991).

In this study, survey research will be utilized as the predominant research method, employing a web-based questionnaire as the principle data collection technique. With survey research, the focus is on the accurate estimation of identified characteristics relevant to the whole population. However, survey researchers rarely study the whole population, but instead focus on one or more samples drawn from the population.

- Secondly, the main technique used is structured and pre-defined questions in a questionnaire, constituting the data to be analysed.

- Thirdly, data is collected on a subsection of the study population, referred to as a sample. Data is collected in a manner allowing generalisation of the study population.

- Fourthly, the existence of clearly defined independent and dependent variables, specified in a theoretical model (i.e., conceptual research model), depicting expected relationships, statistically verified against data obtained from the questionnaire.

Survey research is most appropriate when questions focus on what is happening, also how and why it is happening (Newsted *et al.*, 1998). Furthermore, if control of the independent and/or dependent variables is unachievable (e.g., experimental research allows only independent variables to be controlled) or undesirable, requiring a phenomenon of interest to be studied in its natural setting, survey research is ideal.

Based on the aim of this study and its targeted population, it was decided to implement a survey research, specifically for the purpose of exploration.

In the following sections, the steps followed in this study's survey process will be considered. These include the specification of sample frame, selection of sample, development of measurement instrument, operationalisation of measurement instrument, pilot test of measurement instrument, data collection and coding of data by means of a codebook.

5.6.2.1 Specification of Sample Frame

The most critical element of sampling procedures is the choice of a sample frame (Dillman, 2007).

It was decided to use as a sample frame for this study, members of three medical informatics associations, namely the American Medical Informatics Association, Health Informatics Society of Australia and the South African Health Informatics Association. The main reason for this decision was the availability of relatively accurate contact details of individuals in these organisations, representative of the health informatics sector in these countries. Naturally, without an accurate contact list, a very low response rate may result. Furthermore, to obtain participants from both developing and developed countries, South Africa, Australia and the US were chosen.

A large number of medical and health informatics associations exist, including the American Health Information Management Association, Alliance of Medical Internet Professionals, Asia Pacific Association for Medical Informatics, Association of Medical Directors of Information Systems, Canadian Organisation for

5.6.2.4 Operationalisation of Measurement Instrument

To operationalise the identified constructs in the conceptual research model, a researcher must select the measurement scale items (i.e., measurement item questions) and scale types, and combine them in some form of measurement instrument. In this study, the measurement instrument is a web-based questionnaire. This questionnaire was developed in HyperText Markup Language (HTML) and Javascript, and hosted on the web-page of the Natural Science faculty, North-West University, Potchefstroom Campus (http://www.puk.ac.za/fakulteite/natuur/comp/intro.html).

Consisting of three HTML pages, it provided an introduction (intro.html), the survey questions (survey.html) and a confirmation (confirm.html). The introduction page specified the reasons for the study and the research details, the survey page contained the measurement instrument (refer Addendum B), and the confirmation page verified that the questionnaire was received and thanked participants for their co-operation. The questionnaire consisted of input boxes, drop-down lists and radio buttons. It furthermore included extensive entry field validation, specifically developed to ensure that all required fields were entered before permitting a participant to submit a survey. This ensured no missing values recorded in survey responses, a critical requirement for SEM analysis.

The questionnaire was divided into two sections, namely demographical data and the operationalised construct of the conceptual research model.

- Participants' demographical data was obtained first, including age, gender, educational level, business area, organisational size, IS department size, years organisation has developed software, years participant has developed software, country and leading area of specialisation.

- The conceptual research model constructs were operationalised in specific questions, divided into four sections.

The operational definitions (i.e., questions or measures) of the conceptual research model were developed by referencing previous studies in which these constructs were operationalised, exhibiting sufficient reliability and validity. This conferred content validity to the measurement instrument. Naturally, adaptation of these questions to the subject area of SDMs required certain changes in wording. For example, performance expectancy was operationalised by three measures adopted from Venkatesh *et al.* (2003), with some slight changes made to the wording thereof.

It is important to note that since performance expectancy is an unobserved variable, it cannot be measured directly. Unobserved variables (i.e., latent variables) must therefore be operationalised by the use of

Table 5.1: Operationalisation of constructs in the conceptual research model

Variable(s)	Operational Definition / Question(s)	Reference(s)
Performance Expectancy (PE) – the level an individual deems using a SDM will assist in improving job performance (Venkatesh *et al.*, 2003).		
PE1	Using a SDM improves my productivity.	Chau and Hu (2001); Venkatesh *et al.* (2003)
PE2	Using a SDM is useful in my job.	
PE3	Using a SDM enhances my work efficiency.	
Direct Benefits (DB) - the direct benefits (e.g., improve software quality, reliability, maintainability) of using a SDM.		
DB1	Using a SDM improves the quality of the software product.	Quaddus and Hofmeyer (2005); Quaddus and Hofmeyer (2006)
DB2	Using a SDM improves the reliability of the software product.	
DB3	Using a SDM makes it easier to maintain the software product.	
DB4	Using a SDM enhances communication during the software development process.	
Indirect Benefits (IB) - the indirect benefits (e.g., improve trust, loyalty, competitiveness) of using a SDM.		
IB1	Using a SDM improves relations (e.g., trust, loyalty) between the organisation/IS department and customers/users.	Quaddus and Hofmeyer (2005); Quaddus and Hofmeyer (2006)
IB2	Using a SDM improves the organisation's competitiveness.	
Effort Expectancy (EE) - the level of ease related to the use of SDM (Venkatesh *et al.*, 2003).		
EE1	SDMs are too complex for me to use.	Chau and Hu (2001); Venkatesh *et al.* (2003)
EE2	Learning to use a SDM is easy for me.	
Social Influence (SI) - the level an individual senses important others believe he or she must use a SDM (Venkatesh *et al.*, 2003).		
SI1	Colleagues who influence my behaviour think I should use a SDM.	Chau and Hu (2001), Venkatesh *et al.* (2003)
SI2	Senior managers in my organisation/IS department support the use of a SDM.	
Organisational Culture (OC) - includes basic assumptions and beliefs, values, rituals and practices of a group (Hofstede *et al.*, 1990, Iivari and Huisman, 2007).		
OC1	The IS department I work in is like an extended family.	Iivari and Huisman (2007)
OC2	The bond that holds the IS department together is loyalty.	
OC3	The IS department I work in emphasises staff as vital.	
OC4	The IS department I work in is a dynamic place.	
OC5	The bond that holds the IS department together is commitment to innovation.	
OC6	The IS department I work in emphasises attaining of new skills/products/services.	
OC7	The IS department I work in is a very formally structured place.	
OC8	The bond that holds the IS department together is formal rules.	
OC9	The IS department I work in emphasises stability.	

Customer Influence (CI) - the influence of customers on SDM use (Lau and Kwok, 2007).		
CI1	Important customers/users requested that a SDM be used.	Lau and Kwok (2007)
CI2	Important customers/users recommended that a SDM be used.	
Voluntariness (VO) - the level an individual perceives he or she can choose to use or not to use a SDM (Venkatesh *et al.*, 2003).		
VO1	Using a SDM is compulsory in my organisation/IS department.	Riemenschneider *et al.* (2002); Hardgrave *et al.* (2003)
VO2	My manager requires me to use a SDM.	
Policies (PL) - the level to which external regulations require the use of a SDM (Lau and Kwok, 2007).		
PL1	Using a SDM improves adherence to prescribed legal guidelines (e.g., confidentiality, security).	Lau and Kwok (2007).
PL2	My organisation is obliged by governmental regulations to use a SDM.	
PL3	My organisation employs a SDM as required by specific process maturity models (e.g., CMMI, ISO/IEC 15504 (SPICE)).	
Behavioural Intent (BI) - intention to use or continue using a SDM (Riemenschneider *et al.*, 2002).		
BI1	I intent to use a SDM in future.	Chau and Hu (2001); Riemenschneider *et al.* (2002); Hardgrave *et al.* (2003)
BI2	I plan to continue using a SDM.	
Use Behaviour (UB) - actual utilization of a SDM.		
UB1	Percentage wise, for how many software development projects do you use a SDM.	Riemenschneider *et al.* (2002); Hardgrave *et al.* (2003)
UB5	I use all the SDM components (e.g., tools, techniques) when developing software.	
UB9	I actively combine components of different SDMs.	
Result demonstrability (RD) – the level to which SDMs are deemed to demonstrate tangible advantages (Riemenschneider *et al.*, 2002).		
RD1	I could communicate to others the consequences of using a SDM.	Riemenschneider *et al.* (2002)
RD2	I would have no difficulty explaining why SDMs may or may not be beneficial.	
Confirmation (EF) – individual perception of the congruence between expectation of SDM use and its actual performance (Bhattacherjee, 2001a).		
CF1	To provide the customer/user with a reliable software product, SDMs were ...	Premkumar and Bhattacherjee (2008)
CF2	To provide the customer/user with a maintainable (e.g., interoperable, extendible) software product, SDMs were ...	
CF3	To help the organisation/IS department produce a high quality software product, SDMs were ...	
CF4	To help the organisation/IS department improve the management (e.g., control) of the software development process, SDMs were ...	
CF5	To help the organisation improve its profitability, SDMs were ...	
CF6	To help the organisation improve its competitiveness, SDMs were ...	
CF7	To improve the developer's productivity, SDMs were ...	
CF8	To enhance a "share understanding" (e.g., work value, problem-solving	

Most items were measured on a six-point Likert-type scale, utilizing the wording "Disagree Strongly", "Disagree", "Disagree Slightly", "Agree Slightly", "Agree" and "Agree Strongly".

The confirmation constructs, although also measured on a six-point Likert-type scale, utilized the wording "Greatly Worse Than Expected", "Much Worst Than Expected", "Worst Than Expected", "Better Than Expected", "Much Better Than Expected", and "Greatly Better Than Expected". The satisfaction construct was measured using the wording "Extremely Displeased/Dissatisfied", "Very Displeased/Very Dissatisfied", "Displeased/Dissatisfied", "Pleased/Satisfied", "Very Pleased/Very Satisfied" and "Extremely Pleased/Extremely Satisfied".

5.6.2.5 Pre-test of Measurement Instrument

The use of questions developed or validated in previous studies, naturally does not automatically guarantee content validity, since the validity of a measurement instrument may not be persistent across different technologies and user groups (Straub, 1989). It is therefore crucial to conduct a pre-test to examine the measurement instrument.

To ensure acceptance in terms of the above, interviews were conducted with two individuals in the health information systems development area to evaluate the content of the questionnaire. Both individuals are employed in the health care sector, one as a project manager at a hospital information system vendor and the other an IT director of a medical insurance company.

Following satisfactory content evaluation, the questionnaire was examined in specific areas, including wording, design, user-friendliness and consistency. Fellow staff members at the School of Computer, Statistical and Mathematical Sciences (North-West University, Potchefstroom Campus) were requested to review the questionnaire online and to provide comment. Colleagues were able to confirm the correct use of wording and concepts, and statistical viability of the questionnaire. Follow-up interviews were conducted, inviting suggestions on the wording and sequence of the measurement items (i.e., questions). Based on the feedback, several modifications were made, including the removal of double negative questions.

The resulting instrument was considered more communicative and appropriate for SDM evaluation and the targeted health information system context.

5.6.2.6.2 Survey Measurement Errors

The sample used in this study consisted of 1000 subjects, which provided an adequate sample size (>200) for SEM analysis. A simple random sampling technique was followed, thereby minimising sampling error. By employing a pilot test of the questionnaire, measurement errors were limited. A low response rate was experienced, which could imply a non-response error.

Non-response error refers to a specific category of individuals not represented in the sample, since they have the propensity of not responding (Dillman, 2007). When individuals who responded differ considerably from those who did not, it is problematic to forecast how the entire sample would have responded. Generalising from the sample to the population then becomes complicated, affecting the validity of inferences made and questioning the external validity.

Pinsonneault and Kraemer (1993:94) states that a "*poor response rate is particularly troublesome for descriptive studies because their usefulness lies in their capacity to generalize the findings to a population with high confidence. Such low response rates jeopardize any attempt to generalize findings in an adequate way*". Although this study contains exploratory, confirmatory and descriptive elements, the main focus is exploratory, reducing to some extent the high external validity requirements of a pure descriptive research survey.

Non-response errors are frequently examined through post-survey adjustments. These adjustments are based on comparing the demographic and socio-economic differences between individuals who responded and those who did not, alternatively comparing the difference between early and late respondents (King and He, 2005).

In this study, the difference between early and late respondents based on the number of days will be compared. The underlying assumption of this technique is that late respondents are similar to non-respondents. Therefore, by comparing the variances between early and late results, the direction of non-response error can be estimated. The only risk is the conjecture that late respondents are similar to non-respondents.

5.6.2.7 Coding of Data (Codebook)

Survey data received via e-mail was first transferred to Microsoft Excel record by record, thereafter automatically transferred to SPSS.

The variance of variable X is represented by the formula

$$Var(X) = \frac{\sum_{i=1}^{n}(X_i - \bar{X})(X_i - \bar{X})}{n-1},$$

while the covariance of variables X and Y is represented by the formula

$$Cov(X,Y) = \frac{\sum_{i=1}^{n}(X_i - \bar{X})(Y_i - \bar{Y})}{n-1}, \text{ where } \bar{X} = \frac{\sum_{i=1}^{n}(X_i)}{n} \text{ and } \bar{Y} = \frac{\sum_{i=1}^{n}(Y_i)}{n}.$$

The covariance of the variable X with X is equal to the variance of X, therefore $Var(X) = Cov(X,X)$.

Covariance and variance are unstandardised measures, dependent on the unit of measurement of the variables, unlike correlation, also a measure of association, which is a standardised measure, therefore independent of the unit of measure of the variables.

Normally, correlation is expressed in the form of a correlation coefficient. One popular correlation coefficient is the Pearson correlation coefficient (r), which is a standardised covariance between two variables, obtained by dividing the covariance of the two variables by the standard deviation of both variables.

The standard deviation of X is represented by the formula

$$sd(X) = \sqrt{\frac{\sum_{i=1}^{n}(X_i - \bar{X})(X_i - \bar{X})}{n-1}},$$ therefore the Pearson[23] correlation coefficient formula of variables X and Y is $r = \frac{Cov(X,Y)}{sd(X)sd(Y)}$. The value of a correlation coefficient ranges between -1 and 1[24].

Based on the data, a sample covariance matrix is calculated (Schumacker and Lomax, 2004). Referred to as a variance-covariance matrix, specifically an observed sample variance-covariance matrix, it typically

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[23] *Important to note, with the Pearson correlation coefficient both X and Y must be interval scale variables. If X and Y are ordinal variables, the Spearman rank or Kendall's tau correlation coefficient can be used. Similarly, if X and Y are nominal variables, the Phi correlation coefficient can be used.*

[24] *1 indicates that X and Y are perfectly positively correlated, -1 indicates that X and Y are perfectly negatively correlated and 0 indicates no linear relationship between X and Y.*

predictive consistency and therefore less vulnerable to inaccurate, incorrect and incoherent theoretical models and data (Cassel *et al.*, 1999; Haenlein and Kaplan, 2004).

Cassel *et al.* (1999) pointed out that in non-experimental analysis, the consistency of PLS analysis is a viable and often preferable alternative to the aspirations of covariance-based analysis. They suggested that MLE is best used for theory testing and development, while PLS is more oriented towards predictive application.

Barclay *et al.* (1995) suggested that PLS is generally recommended for the exploratory or predictive research model, where emphasis may be more on theory development. SEM, or covariance-based analysis, is more suited for confirming how well a theoretical model fits observed data, generally requiring much stronger theory than PLS path modelling.

The two methods should be viewed as complementary, although PLS path modelling is a precursor to SEM.

In Table 5.2, PLS path modelling is compared to the covariance-based SEM.

Table 5.2: PLS path modelling compared to covariance-based SEM (Gefen *et al.*, 2000)

Criteria	Partial Least Squares (PLS) Path Modelling	Covariance-based SEM
Objective	Same as linear regression, to show high R^2 and significant t-values, thereby rejecting the null hypothesis of no effect.	To show that the null hypothesis (i.e., the conceptual research model) is corroborated by the data, indicating that the complete set of paths as specified is plausible.
Approach	Variance-based	Covariance-based
Theory base required	Does not necessarily require sound theory base. Supports both explanatory and confirmatory research.	Requires sound theory base. Supports confirmatory research, but to a lesser extent, exploratory research.
Assumptions	Relatively robust to deviations from a multivariate distribution.	Typically needs multivariate normal distribution.
Epistemic relationship between a latent variable and its measures	Can be modelled in either formative, or reflective mode	Typically only with reflective indicators
Sample size	Minimal recommendations range from 30 to 100.	Minimal recommendations range from 200 to 800.

Only covariance-based SEM will be used in this study's data analysis phase, since it provides an all inclusive and comprehensive technique for testing and confirming the conceptual research model.

- Repeatability of the measurement instrument entails that, if completed by the same individual several times, the same values should be obtained.

- Internal consistency, also referred to as composite reliability, estimates reliability of a group of measurement items (measuring a specific concept) by correlating them (Straub, 1989). One common way of computing correlation values among the measurement items is by using Cronbach's alpha[26] (α) (Hair *et al.*, 2006). A low Cronbach's alpha implies that the measurement items (i.e., questions) perform poorly in capturing the construct, whereas a high Cronbach's alpha implies the opposite (Churchill, 1979).

Different opinions on acceptable values of Cronbach's alpha are observed in literature, for example Bagozzi and Yi (1988) and Iivari (2006) suggest a value above 0.6, Hair *et al.* (2006) above 0.7, Nunnally and Bernstein (1994) above 0.6 for exploratory research and above 0.7 for confirmatory research.

This study will use Cronbach's alpha to assess internal consistency, specifically, values above 0.6.

5.7.2.2 Content Validity

Content validity, also known as face validity, refers to the extent a measurement instrument reflects the intended research domain (i.e., includes all relative theoretical and practical considerations) (Carmines and Zeller, 1979; Hair *et al.*, 2006).

In general, a measurement instrument has content validity if it includes all aspects of constructs being measured.

Carmines and Zeller (1979) and Churchill (1979) advise researchers to perform a comprehensive review of literature relating to the construct used and reference experts in the field, specifying what (and what not) is included in the domain of the construct.

[26] *Cronbach alpha's can be calculated as*

$$Cronbach\_\alpha = \left(\frac{k}{k-1}\right)\left(1-\frac{\sum_{i=1}^{k} S_i^2}{S_p^{\ 2}}\right)$$

where k *is the number of items in the scale,* S_i^2 *is the variance of item i and* $S_p^{\ 2}$ *is the variance of total score.*

Construct validity is frequently assessed with Exploratory Factor Analysis (EFA), which identified the underlying latent constructs that explain the pattern of correlations within a set of measurement items (Straub *et al.*, 2004). As such, EFA is data driven, imposing no substantive constraints on the data and no restrictions on the pattern of relationships between observed and latent variables.

With CFA, typically used in SEM, the pattern of loadings of the measurement items on the latent constructs is specified explicitly in the measurement model. The fit indices of the pre-specified measurement model are examined, providing a good indication of the extent to which the measurement model accounts for the covariance in the data. Some of the most common fit indices include the Chi-square (X^2) and Comparative Fit Index (CFI), discussed in more detail in section 5.7.3.

If the fit indices are acceptable (i.e., within acceptable ranges as specified in Table 5.3), the measurement item path estimates is used as input to the calculation of the CR and AVE measures, as specified by Fornell and Larcker (1981). The main reason for this requirement is that CR and AVE calculations require measurement error, provided by CFA, if performed in SEM. Hair *et al.* (2006) advocate that the measurement item path estimates or loadings (λ) should be at least >0.5 and ideally >0.7 for CFA.

Convergent validity and discriminant validity directly capture the goodness of fit of the measurement model (i.e., how well the measurement items relate to the constructs).

- **Convergent validity** is shown when each measurement item correlates strongly with its assumed theoretical construct or factor. In this study, the convergent validity of each construct will be evaluated based on CR and AVE. The acceptable level of CR is higher than 0.7, while the acceptable level of AVE is 0.5 (Hair *et al.*, 2006; Fornell and Larcker, 1981). In essence, if AVE is higher than 0.5, it implies that more than half of the variances observed in the measurement items are accounted for by the latent construct they are theoretically related to (Chin and Newsted, 1999; Hair *et al.*, 2006).

- **Discriminant validity** is can be defined as "the extent to which a construct is truly distinct from other constructs" (Hair *et al.*, 2006:778). Fornell (2010:324) again states that "discriminant validity is the extent to which latent variable A discriminates from other latent variables (e.g., B, C, D)". The establishment of discriminate validity is crucial for conducting latent variable analysis. Commonly, three techniques can be applied, namely paired constructs test, multitrait-multimethod matrix and AVE versus shared variance (Fornell, 2010). In this study, the AVE versus shared variance technique will be applied.

  Igbaria *et al.* (1994:183), with reference to Fornell and Larcker (1981), states that "the variance shared between measures of two different constructs (the squared correlation) should be lower than

5.7.3.1 Measure of Absolute Fit

The most fundamental absolute fit index is the Chi-square (X^2) statistic. A non-significant Chi-square indicates failure to reject the null hypothesis that the observed sample variance-covariance matrix is identical to the estimated population variance-covariance matrix, generally accepted as evidence of an adequate fit. Researchers therefore aim to obtain a non-significant Chi-square (Schumacker and Lomax, 2004) in SEM. However, it must be noted that X^2 is influenced by sample size. If the sample size is >200, it is unlike to obtain a non-significant X^2, even if the model fits the data. Similarly, if the sample size is <100, it is likely to obtain a non-significant X^2, even if the model does not fit the data.

Since the X^2 statistic is sensitive to sample size, the sample size of 226 in the current study can lead to a rejection of a model differing in a trivial way from the data. It is therefore prudent to also examine other model fit indices.

The Chi-square expressed in relation to its degrees of freedom (df [29]) is one measure that can be used to minimise the effect of sample size (Kelloway, 1998). Different interpretations of the values for X^2 / df are found in literature, but values between 2 and 5 generally indicate a good fit (Bollen, 1998). Naturally, values less than 2 are even better, indicating a very good fit (Hatcher, 1994).

Further absolute fit indices include Goodness-of-Fit Index (GFI), Root Mean Square Residual (RMR) and Root Mean Squared Error of Approximation (RMSEA) (Hair *et al.*, 1998).

- GFI is independent of the sample size and relatively robust against departures from normality (Kelloway, 1998; Schumacker and Lomax, 2004). In essence, it measures how well the variances and covariances predicted from the parameter estimates, reproduce the sample covariance. Values higher than 0.9 generally are assumed to be indicative of a good fit (Kelloway, 1998). A variant of this statistic is the Adjusted Goodness-of-Fit Index (AGFI), which includes an adjustment for model complexity.

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[29] *The degrees of freedom (df) in SEM can be expressed as*

$$df = \frac{1}{2}[(p)(p+1)] - k$$

*where **p** is the total number of observed variables and k is the number of free or estimated parameters (Hair et al., 2006).*

5.7.3.4 Cut-off Criteria for Fit Indices

The accepted cut-off criteria for fit indices vary in different publications. Hu and Bentler (1999:27) stated that "it is difficult to designate a specific cut-off value for each fit index because it does not work equally well with various conditions". Browne and Cudeck (1993), Hair *et al.* (2006), Kline (2005), Hu and Bentler (1999), Marsh and Hau (1996), Kelloway (1998), Schumacker and Lomax (2004) and Hatcher (1994) suggested specific cut-off values, presented in Table 5.3.

Table 5.3: Criteria for model fit

Model fit index	Suggested Criteria
Chi-square (X^2)	a. X^2 statistic to degrees of freedom (df) (X^2 / df) ratio <= 2 (Hatcher, 1994) b. X^2 / df < 3 (Kline, 2005) c. X^2 / df between 2 and 5 indicate good fit (Kelloway, 1998) d. Non-significant value of X^2 (Schumacker and Lomax, 2004)
Comparative Fit Index (CFI)	a. CFI>= 0.9 (Marsh and Hau, 1996; Hair *et al.*, 2006) b. CFI >= 0.95 (Hu and Bentler, 1999)
Adjusted Goodness of Fit Index (AGFI)	AGFI > 0.70 (Shumacker & Lomax, 2004)
Tucker Lewis Index (TLI)	a. TLI >= 0.9 (Marsh and Hau, 1996; Hair *et al.*, 2006) b. TLI >= 0.95 (Hu and Bentler, 1999)
Root Mean Square Error of Approximation (RMSEA)	a. RMSEA <= 0.06 (Hu and Bentler, 1999) b. RMSEA <= 0.05 (close fit); 0.05 <= RMSEA <= 0.08 (fair fit); RMSEA > 0.1 (poor fit) (Browne and Cudeck, 1993)

One key aspect is that simpler theoretical models with smaller samples should be subject to more strict cut-off values than more complex models with larger samples (Hair *et al.*, 2006).

change in the construct affects the observed measures, changes in the observed measures of a formative construct cause change in the unobserved factor (i.e., the formative construct) (Jarvis *et al.*, 2003). This implies that if one observed measure of a formative construct changes, a change in the formative construct will result, but not necessarily in other observed measures of the construct.

One approach to understand reflective and formative constructs is to contrast them to unidimensional and multidimensional constructs.

- Reflective constructs by definition is unidimensional in that all their measurement items should measure the same aspect or dimension.

- Formative constructs by definition is multidimensional in that their measurement items measure different aspects or dimensions.

It is important to note that all formative constructs are multidimensional, but not all multidimensional constructs are formative. In formative constructs, each dimension is measured by only one measurement item, while in multidimensional constructs more than one measurement item can be used to measure a dimension. For example, in this study's conceptual research model, SDM confirmation and organisational culture are multidimensional constructs.

In Table 5.4, the major differences between reflective and formative models are defined (Jarvis *et al.*, 2003).

Table 5.4: Summary of differences between types of measurement models (derived from Jarvis *et al.*, 2003:201)

Principle Factor (Reflective) Model	**Composite Latent Variable (Formative) Model**
Direction of causality is from construct to measurement item.	Direction of causality is from measurement item to construct.
Measurement items are expected to be correlated (i.e., co-vary together).	No reason to expect that measurement items are correlated (i.e., not co-vary together).
Removing a measurement item does not alter the meaning of the construct.	Removing a measurement item alter the meaning of the construct.
Measurement error is considered at measurement item level.	Measurement error is considered at construct level.

The matter of specifying whether a construct is formative or reflective is critical in SEM. Incorrect specification of a construct has lead to measurement errors in the marketing and consumer domain (Jarvis *et al.*, 2003). This is confirmed by Petter *et al.* (2007) to be present also in the information systems domain.

Furthermore, the reliability and construct validation criteria used for reflective constructs are not applicable to formative constructs (Diamantopoulos and Winklhofer, 2001). Reliability testing for formative constructs is problematic, since indicators are not reflective and therefore show limited internal consistency. Similarly, convergent validity, measuring correlation among measures of a construct, is not relevant for formative constructs.

Diamantopoulos and Winklhofer (2001) and Straub *et al.* (2004) found that most studies therefore neglect to perform any validation of formative constructs. However, Straub *et al.* (2004) considered it to be a mandatory practice for researchers to specifically consider content validity and reliability of formative constructs.

- With reference to content validity, if possible, nomological validation should be performed for formative constructs. Nomological validation is performed by examining whether correlations among constructs in the measurement model make sense (Hair *et al.*, 2006). In relation to formative constructs, this implies that non-significant measures be removed (Diamantopoulos and Winklhofer, 2001). However, it may be wise to keep non-significant items if removing them will result in the lost of content validity.

Chapter 6: Research Results

6.1 Introduction

The chapter presents the statistical analysis performed in this study. As the only chapter addressing the empirical evaluation of the conceptual research model, it mainly utilizes SEM to measure the validity of this model. The chapter starts with a short background to SEM, followed by a discussion on the response rate of the web-based survey. Data screening and data cleaning concerns are considered, including missing data, non response and out-of-range values. Subsequently, the results of descriptive statistics performed on the demographical data of respondents are discussed, also considering specific research questions (e.g., whether organisational size influences the use of SDMs or not). Next, the research model reduction based on theoretical reasoning is explained, as well as the specific statistical assumptions again be highlighted, followed by the model identification, model estimation, model testing and model modification phases. Similar to CFA, the structural model analysis will also follow the same logical sequence of five phases (i.e., model specification, model identification, model estimation, model testing, model modification).

In the next section, specific aspects related to response rate analysis will be discussed.

6.3 Response Rate Analysis

Two hundred and twenty six responses were received from a possible one thousand responses. Therefore, the participation rate equalled 22.6%, with 226 cases available for data analysis.

In Table 6.1, the country of employment of each participant is listed. It can be seen that most responses were received from South Africa, followed by the United States and Australia.

Table 6.1: Actual response rate per country

		Frequency	Percentage	Valid Percentage	Cumulative Percentage
Valid	Australia	45	19.9	19.9	26.3
	South Africa	97	42.9	42.9	62.8
	United States	84	37.2	37.2	100.0
	Total	226	100.0	100.0	

To calculate the participation rate per county, it is necessary to compare the actual responses to potential responses for each country, listed in Table 6.2.

Table 6.2: Potential response rate per country

		Frequency	Percentage	Valid Percentage	Cumulative Percentage
Valid	Australia	263	26.3	26.3	26.3
	South Africa	169	16.9	16.9	43.2
	United States	568	56.8	56.8	100.0
	Total	1000	100.0	100.0	

- Non-response errors were evaluated by utilizing multiple-group analysis to compare early and late respondents (Schumacker and Lomax, 2004). Two groups were created in AMOS dividing the sample into early and late respondents, each associated with a separate data file. Before considering the structural invariance across groups, the fit indices were evaluated for each group, establishing acceptable measurement models. Multigroup testing was then performed comparing the chi-square values and path parameter estimates, and evaluating the critical ratios of differences. In the critical ration matrix, all cell values were equal to 0.000 for selected paths. This indicates that the path coefficients of selected paths are not significantly different between early and late respondents. Structural invariance is therefore upheld, indicating that there is no significant difference between early and late responds.

Since data was automatically transferred to statistical software, no manual input was required after data collection. To a great extent, the survey design (i.e., input checking, required entries) followed in this study assisted in ensuring data integrity.

In the next section, demographical data analysis is performed.

6.5 Demographic Data Analysis

To ensure useful and accurate answers to the research questions, a representative sample of the population is required (Fawcett and Downs, 1986). To verify this requirement, demographical data analysis of survey participants needs to be performed.

In the following tables, the descriptive statistics of participants are shown. As can be seen from this data, the sample is representative of the population to an acceptable level and did not suggest a response bias.

Age demographics are shown in Table 6.5(i). Most participants, namely 43.8%, were in the age bracket 21 to 30, with only 1.3% in the bracket 51 to 60. Again, the cross tabulation between age and country is provided in Table 6.5(ii).

Table 6.5: Age distribution of survey participants (i) / Age and country cross tabulation (ii)

(i)

		Frequency	Percentage	Valid Percentage	Cumulative Percentage
Valid	21-30	98	43.8	43.8	43.8
	31-40	89	39.7	39.7	83.5
	41-50	34	15.2	15.2	98.7
	51-60	3	1.3	1.3	100.0
	Total	224	100.0	100.0	

(ii)

		Country			Total
		Australia	South Africa	United States	
Age	21-30	20	40	38	98
	31-40	17	37	35	89
	41-50	8	15	11	34
	51-60	0	3	0	3
	Total	45	95	84	224

In Table 6.7(i), the specific health areas identified by respondents as their main focus are shown. As can be seen, the most identified areas were hospital information systems (45.1%), followed by laboratory information systems (13.4%) and pharmacy information systems (12.9%). It was noteworthy that 8.9% of respondents indicate EMR, clearly indicating the importance of this HIS enabling information system. Table 6.7(ii) portrays the cross tabulation between health area and country.

Table 6.7: Health area of survey participants (i) / Health area and country cross tabulation (ii)

(i)

		Frequency	Percentage	Valid Percentage	Cumulative Percentage
Valid	Hospital Information System	101	45.1	45.1	45.1
	Patient Administration System	1	.4	.4	45.5
	Pharmacy Information System	29	12.9	12.9	58.4
	Laboratory Information System	30	13.4	13.4	71.8
	Radiology Information System	12	5.4	5.4	77.2
	Critical Care Information System	1	.4	.4	77.6
	Dental Information System	1	.4	.4	78.0
	Electronic Medical Record	20	8.9	8.9	86.9
	Picture Archiving and Communication System	9	4.0	4.0	90.9
	Telemedicine	6	2.7	2.7	93.6
	Medical Practice (GP) Information System	3	1.3	1.3	94.9
	Computer-based Physician Order Entry System	6	2.7	2.7	97.6
	Ambulatory Information System	5	2.4	2.4	100.0
	Total	224	100.0	100.0	

Organisational size is depicted in Table 6.8(i). Of the 224 respondents, 22.8% are employed by relatively small sized companies, although 5.8% of individuals are working for organisations with more than a 1000 employees. Table 6.8(ii) represents a cross tabulation between organisational size and country.

Table 6.8: Organisational size (i) / Organisational size and country cross tabulation (ii)

(i)

		Frequency	Percentage	Valid Percentage	Cumulative Percentage
Valid	0-100	51	22.8	22.8	22.8
	101-200	31	13.8	13.8	36.6
	201-300	26	11.6	11.6	48.2
	301-400	23	10.3	10.3	58.5
	401-500	18	8.0	8.0	66.5
	501-600	16	7.1	7.1	73.6
	601-700	16	7.1	7.1	80.7
	701-800	13	5.8	5.8	86.5
	801-900	9	4.0	4.0	90.5
	901-1000	8	3.6	3.6	94.1
	>1000	13	5.9	5.9	100.0
	Total	224	100.0	100.0	

(ii)

		Country			Total
		Australia	South Africa	United States	
FC4 (org.size)	0-100	14	33	4	51
	101-200	8	20	3	31
	201-300	11	11	4	26
	301-400	10	10	3	23
	401-500	0	5	13	18
	501-600	0	3	13	16
	601-700	1	5	10	16
	701-800	1	2	10	13
	801-900	0	1	8	9
	901-1000	0	4	4	8
	>1000	0	1	12	13
	Total	45	95	84	224

Table 6.9(i) portrays the size of the information system department. It is noteworthy that 19.2% of respondents work in information system departments of 31 to 40 individuals, while 55.4% work in information system departments having more than 40 employees. Table 6.9(ii) reflects the cross

In Table 6.10, the result of the bivariate correlation between organisational size and information system department size is shown.

Table 6.10: Bivariate correlation between organisational size and IS department size

			FC4 (org.size)	FC5 (dev.team.size)
Spearman's rho	FC4 (org.size)	Correlation Coefficient	1.000	.819**
		Sig. (1-tailed)	.	.000
		N	224	224
	FC5 (dev.team.size)	Correlation Coefficient	.819**	1.000
		Sig. (1-tailed)	.000	.
		N	224	224

**. Correlation is significant at the 0.01 level (1-tailed).

Cohen (1988) proposed the following values for interpretation of correlation coefficients, displayed in Table 6.11.

Table 6.11: Correlation coefficient interpretation

Coefficient	Description
0.1 - 0.29	Small correlation
0.3 – 0.49	Medium correlation
0.5 – 1.0	Large correlation

A relatively large correlation coefficient (Spearman's rho=0.819, p=0.01) is visible, indicating a marked relationship between organisational size and IS department size.

No significant relationships among the use of SDMs and organisational size (Spearman's rho = -0.035, p>0.05), or IS department size (Spearman's rho=-0.024, p>0.05) were found. Similarly, no significant relationships among the use of SDMs and respondents' age (Spearman's rho=0.013, p>0.05), gender (Spearman's rho=-0.029, p>0.05), or educational level (Spearman's rho=-0.083, p>0.05) were evident.

Whether more in-house or commercial SDMs are being used, is indicated in Table 6.14. It can be seen that 47.3% of respondents specified that they are using a commercial SDM, with 28.1% indicating the use of a in-house developed SDM. The number of developers using in-house developed SDMs is significant, since if this number is considered in relation to only those respondents who are using a SDM (i.e., 169), the percentage of 28.1% rises to 37.8%.

Table 6.14: In-house and commercial SDMs used

		Frequency	Percentage	Valid Percentage	Cumulative Percentage
Valid	NAP	55	24.6	24.6	24.6
	Commercial SDMs	106	47.3	47.3	71.9
	In-house Developed	63	28.1	28.1	100.0
	Total	224	100.0	100.0	

***NAP = Not Applicable**

With reference to individuals specifying that they were using more than one SDM, some of the major approaches used are portrayed in Table 6.15. In total, 19.8% of respondents are using agile methodologies (i.e., agile approach) followed by 18.6% using in-house developed SDMs and 16.9% structured SDLC. Agile methodologies seem to be a major player in the health care IS development area, although the older structured approach methodologies (i.e., structured approach) are still significant.

Table 6.15: Major types of SDMs and approaches used

		Approaches	Frequency	Percentage	Valid Percentage	Cumulative Percentage
Valid	NAP		55	15.5	15.5	15.5
	Structured SDLC	Structured	60	16.9	16.9	32.4
	Custom In-house Developed		66	18.6	18.6	51.0
	Agile	Agile	70	19.8	19.8	70.8
	MS Solutions Framework	Object-oriented	33	9.3	9.3	80.1
	RUP	Object-oriented	17	4.8	4.8	84.9
	CMMI	Process Maturity Framework	39	11.0	11.0	95.9
	Software Engineering (Sigma Six)	Structured	14	4.1	4.1	100.0
	Total		237	100.0	100.0	

Table 6.18: Percentage use of SDMs

		Frequency	Percentage	Valid Percentage	Cumulative Percentage
Valid	10%	55	24.6	24.6	24.6
	40%	28	12.5	12.5	37.1
	50%	18	8.0	8.0	45.1
	60%	36	16.1	16.1	61.2
	70%	26	11.6	11.6	72.8
	80%	31	13.8	13.8	86.6
	90%	30	13.4	13.4	100.0
	Total	224	100.0	100.0	

Respondents were subsequently asked whether they actively combine different SDMs. In total, 59.5% of them answered in the affirmative as indicated in Table 6.19. Clearly, a relative high level of method engineering is also present in the health care software development field.

Table 6.19: Actively combining different SDM components

		Frequency	Percentage	Valid Percentage	Cumulative Percentage
Valid	NAP	55	24.6	24.6	24.6
	Disagree Strongly	3	1.3	1.3	25.9
	Disagree	6	2.7	2.7	28.6
	Disagree Slightly	27	12.0	12.0	40.6
	Agree Slightly	38	17.0	17.0	57.6
	Agree	40	17.8	17.8	75.4
	Agree Strongly	55	24.6	24.6	100.0
	Total	224	100.0	100.0	

Table 6.20: Use specific SDMs based on characteristics of the specific software project

		Frequency	Percentage	Valid Percentage	Cumulative Percentage
Valid	NAP	55	24.6	24.6	24.6
	Disagree Strongly	7	3.1	3.1	27.7
	Disagree	9	4.0	4.0	31.7
	Disagree Slightly	29	12.9	12.9	44.6
	Agree Slightly	39	17.4	17.4	62.0
	Agree	45	20.1	20.1	82.1
	Agree Strongly	40	17.9	17.9	100.0
	Total	224	100.0	100.0	

In Figure 6.1, the path diagram of the parsimonious conceptual research model is depicted. Addendum D reflects the AMOS representation.

It is important to note that this parsimonious conceptual research model was formulated theoretically, not empirically. Therefore, reduction was based on behavioural theories and previous research results (Chou and Bentler, 2002; MacCallum, 1986).

From here on, the parsimonious conceptual research model will be referred to as the conceptual research model. In the next section, specific assumptions of SEM analysis are highlighted, critical to appraise before proceeding with the measurement model validation and structural model validation.

6.7 Structural Equation Modelling Analysis Assumptions

It is important to assess the assumptions made with SEM analysis. These include a random sample of the population (Schumacker and Lomax, 2004) and that no missing values or outliers are present. As emphasised in Chapter 5, a random sample was obtained. In section 6.4, no missing values and no outliers were also confirmed. However, another four important assumptions of SEM analysis are linearity between measurement variables, multivariate normal distribution, multicollinearity and non-positive definite matrices.

6.7.1 Linearity between measurement variables

A general assumption of multivariate statistics is that all variables have a linear relationship (Kline, 2005). Since it is not always practical to check scatterplots of all variables with all other variables, Tabachnick and Fidell (2006) suggested a spot check of some combinations of variables. This was subsequently performed, depicted in Addendum E. However, another possible check for linearity is Bartlett's test of sphericity.

Bartlett's test of sphericity is employed to explore the hypothesis that the variables in the population are uncorrelated. This implies that the population correlation matrix is an identity matrix, with each variable correlating perfectly with itself (r =1), but no correlation with any of the other variables (r =0). As such, it can be used to evaluate the strength of the linear association in the correlation matrix.

One of the major reasons why data transformation is not universally recommended is that transformed variables and their analyses are harder to interpret. According to Tabachnick and Fidell (2006), non-normal distribution is quite common in larger samples. This does not necessarily indicate a problem with the measurement items, but rather reflects the underlying nature of the construct being measured, or even the characteristics of the respondents.

Tabachnick and Fidell (2006) further stipulate that the skewness and kurtosis measures are too sensitive in large samples, while statistically significant skewness will not make a substantive difference in the analysis when samples of 200 and more cases are present. Furthermore, maximum likelihood estimation is relatively robust with regard to violation of normality (Chou and Bentler, 2002).

Considering the above-stated controversial opinions, it was decided not to transform the data for SEM analysis.

6.7.3 Multicollinearity

Multicollinearity occurs when there is a strong correlation between two or more predictor variables[34] in a model (Kline, 2005). This is a problem in multivariate analysis, since, if multicollinearity among predictor variables exists, it becomes improbable that unique estimates will be obtained.

To assess multicollinearity, the VIF (i.e., $VIF = \frac{1}{1-R^2}$) for predictor variables was calculated. Kline (2005) advises that a VIF value of 4 or more suggests a presence of multicollinearity, although Myers (1990), Fields (2009) and Hair *et al.* (2006) only propose a value of 10 or more.

To assess multicollinearity, two separate analyses were performed, first calculating the VIF values for the hypothesised predictor variables (i.e., effort expectancy, performance expectancy, attitude, organisational culture, customer influence, voluntariness, policies) of construct behaviour intent and secondly, the VIF values for the hypothesised predictor variables (behavioural intent, facilitating conditions, confirmation, satisfaction) of construct use, depicted in Table 6.22 and 6.23.

[34] *Relates to regression analysis, when an outcome variable (dependent variable) is predicted from one predictor variable (independent variable) in simple regression, or several predictor variables (independent variables) in multiple regression (Field, 2009).*

6.8 Measurement Model Validation

The measurement model, also referred to as the outer model, shows the link of each construct to a set of indicators (i.e., measurement items, measurement variables) measuring the construct. In this study, measurement model validation is based on confirmatory factor analysis. CFA requires the examination of relationships among latent variables and measurement items, in effect seeking to statistically test the significance of the hypothesised factor model (i.e., measurement model) (Tabachnick and Fidell, 2006).

Furthermore, to calculate CR and AVE values, confirmatory factor analysis needs to be performed to obtain the standardised factor loading (i.e., λ_i) of each measurement item. CR and AVE are again used to evaluate convergent validity and discriminant validity of the factors in the measurement model, discussed in section 6.8.6.

It is recommended by Schumacker and Lomax (2004) that five distinct phases be followed when measurement model analysis is performed. These phases include model specification (i.e., development of measurement model), model identification (i.e., establish model constraints), model estimation (i.e., executing statistical analysis of model), model testingn (i.e., considering the model fit indices) and model modification (i.e., modify model for better fit), outlined next.

6.8.1 Model Specification

Model specification is the first step of measurement model analysis and refers to the phase in which the relationships among constructs and their measurement items (i.e., observed variables) are specified. This measurement model (i.e., operationalisation of measurement instrument) should be based on all relevant theory, research and information available to the researcher. In Chapter 5, the operationalisation of the measurement instrument was performed, specifying which observed variable measures which construct. Important to note, facilitating conditions are measured by the five observed variables (i.e., FC1, FC2, FC3, FC6, FC7), while use behaviour are measured by three observed variables (i.e., UB1, UB5, UB9).

In AMOS, the observed variables are linked to latent variables. Observed variables are represented as rectangles while latent variables are represented by ovals. Measurement errors on observed variables are represented by circles. All path coefficients between observed variables and latent variables are unfixed, while the latent variables variances are set to one. All latent variables are then correlated.

generalised least squares (GLS) and maximum likelihood estimation. MLE was used for measurement model estimation.

Furthermore, to confirm the stability of the estimates, it was decided to employ a re-sampling method, namely bootstrapping[35] (Gefen *et al.*, 2000). Subsequently, model estimation included the bootstrapping procedure with re-sampling set at 200, as recommended by Chin (1998).

6.8.4 Model Testing

After model estimation has been performed, the model should be tested, therefore, it should be determined how well the measurement model fits the data. This is generally accomplished by means of fit indices, as discussed in Chapter 5. The fit indices of the measurement model are depicted in Figure 6.3.

CMIN

Model	NPAR	CMIN	DF	P	CMIN/DF
Default model	400	1811.617	1553	.000	1.167
Saturated model	1953	.000	0		
Independence model	62	14582.017	1891	.000	7.711

Baseline Comparisons

Model	NFI Delta1	RFI rho1	IFI Delta2	TLI rho2	CFI
Default model	.876	.849	.980	.975	.980
Saturated model	1.000		1.000		1.000
Independence model	.000	.000	.000	.000	.000

RMSEA

Model	RMSEA	LO 90	HI 90	PCLOSE
Default model	.027	.021	.033	1.000
Independence model	.173	.171	.176	.000

Figure 6.3: Fit indices from AMOS for measurement model

[35] *Bootstrapping refers to the process of drawing a specified amount (default 200) of subsamples and estimating models for each subsample (Hair et al., 2006). The estimates of all these subsamples are then statistically combined to provide the "best" possible estimated coefficients.*

and Bernstein, 1994) are regarded acceptable, although higher Cronbach's alpha values are seen indicative of a more reliable scale (Hair *et al.*, 2006).

7

In Figure 6.4 the Cronbach's alpha statistics as obtained in SPSS for the construct performance expectancy and direct benefits are depicted. It is important to check the item-total statistics, especially the Cronbach's alpha if item deleted-value. In general, this value should be lower than the Cronbach's alpha of the scale (e.g., performance expectancy=0.931).

Reliability Statistics for performance expectancy

Cronbach's Alpha	N of Items
.931	3

Item-Total Statistics for performance expectancy

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
PE1 (performance expectancy)	7.33	9.674	.866	.894
PE2 (performance expectancy)	7.30	9.773	.869	.892
PE3 (performance expectancy)	7.05	9.069	.844	.915

Reliability Statistics for direct benefits

Cronbach's Alpha	N of Items
.892	4

Item-Total Statistics for direct benefits

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
DB1 (direct benefit)	11.84	13.221	.791	.851
DB2 (direct benefit)	11.96	13.680	.750	.866
DB3 (direct benefit)	11.92	12.806	.764	.861
DB4 (direct benefit)	11.93	12.963	.748	.867

Figure 6.4: Reliability SPSS statistics for performance expectancy and direct benefits

Since all the Cronbach's alpha of latent variables, calculated in SPSS and portrayed in Table 6.25 are higher than 0.60, reliability of the measurement items is corroborated.

- Convergent validity was assessed by calculating CR and AVE for each latent variable. Based on Hair *et al.* (2006), all calculated CR values of latent variables must be above 0.7, while all calculated AVE values of latent variables must be above 0.5 (Fornell and Larcker, 1981). Since the nomological validation and VIF value (VIF = 2.932) of facilitating conditions were satisfactory.

- Discriminant validity reflects the degree to which each construct is unique. Adequate discriminant validity is demonstrated when a latent variable shares more variances with its measurement items than with other latent variables in the conceptual research model. To establish discriminant validity, the calculated AVE of two constructs should be higher than the shared variance (i.e., squared correlation) among them (Fornell and Larcker, 1981; Farrell, 2010).

  Table 6.26 displays each latent variable's AVE and the shared variance with all other constructs. It can be seen that for all related constructs, that their shared variance is less than the calculated AVE values. Discriminant validity is therefore supported.

In the next section, outcomes of the structural model evaluation are discussed.

6.9 Structural Model Validation

Only after the measurement model is validated, can structural model validation begin. The structural model, also referred to as the inner model, shows the link (i.e., relationships) of each construct to a set of other constructs in the conceptual research model.

Similar to measurement model validation, it is recommended by Schumacker and Lomax (2004) that five distinct phases be followed when structural model analysis is performed. These phases include model specification (i.e., development of conceptual research model), model identification (i.e., establish model constraints), model estimation (i.e., executing statistical analysis of model), model testing (i.e., considering the model fit indices) and model modification (i.e., modify model for better fit), outlined next.

6.9.1 Model Specification

Model specification is the first step of structural model analysis and refers to the phase in which the relationships (i.e., paths) among constructs of the structural model are hypothesised a priori (Kline, 2005). This structural model should be based on all relevant theory, research and information available to the researcher as reviewed in Chapter 5. It is important to note that, when a relationship between two constructs is hypothesised to exist, the parameter for the relationship is unfixed and therefore estimated. However, when the relationship between two constructs is hypothesised to not exist, the parameter is fixed to zero and not estimated.

6.9.2 Model Identification

Model identification is the next crucial step before any model estimation is performed. A basic requirement for model identification is that the number of observations (i.e., sample moments) must be greater than, or equal to the number of model parameters (Kline, 2005). As such, a structural model can be under-identified, just-identified, or over-identified (Schumacker and Lomax, 2004; Tabachnik and Fidell, 2006).

- An under-identified model refers to a model where one or more parameters cannot be uniquely determined, since there is not enough information (e.g., constraints).

Furthermore, to confirm the stability of the estimates and the significance of the path coefficients, it was decided to employ a re-sampling method, namely bootstrapping, to confirm the predictive ability of the hypothesised paths (Gegen *et al.*, 2000). Subsequently, model estimation included the bootstrapping procedure with re-sampling set at 200, as recommended by Chin (1998).

6.9.4 Model Testing

After model estimation has been performed, the model should be tested, therefore, it should be determined how well the structural model fits the data. This is generally accomplished by means of fit indices, as discussed in Chapter 5.

The fit indices of the structural model are shown in Table 6.27.

Table 6.27: Structural model goodness of fit indices analysis

Fit Indices	Observed fit indices	Recommended value
X^2/df	1.794	<3
CFI	0.882	>= 0.9
TLI	0.889	>= 0.9
RMSEA	0.060 (PCLOSE=.000)	<0.05

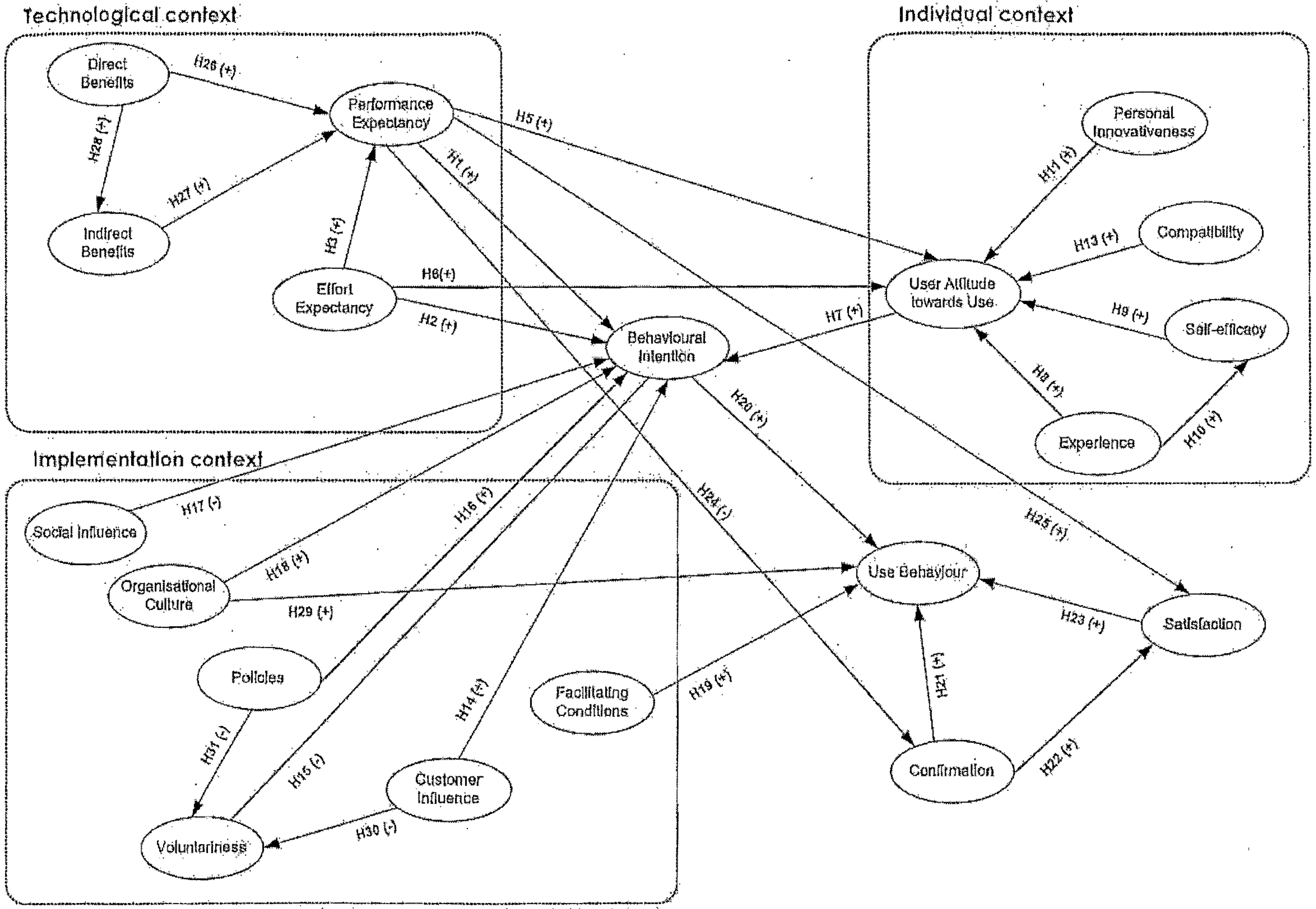
As can be seen, the CFI, TLI and RMSEA fit indices are not within recommended ranges, indicating that the initial structural model did not fit the sample data adequately.

It was therefore necessary to further explore the structural model in the model modification phase.

6.9.5 Model Modification

Model modification seeks to improve model fit, thereby searching for a model better fitting model that will yields more significant parameters. In literature, two approaches to model modification can be identified, namely forward search and backward search (Chou and Bentler, 2002).

- With the forward search approach, a better fitting model is obtained from a limited model. Crucial, a successful forward search depends on the correct specification of the initial structural model.



H(n) hypothesis n
(+) positive relation
(-) negative relation

Figure 6.6: Conceptual research model after model modification

Hypothesis 31

H_{31} : Policies have a direct negative effect on voluntariness.

The relationship between policies and voluntariness is also theoretically reasonable. Again, for developers and organisations forced by governments and health care controlling bodies to employ SDMs, the voluntariness of using SDMs will be negatively influenced. Since the policies construct, similar to the customer influence construct, forms part of the identified factors obtained during the applicability checks performed, minimal research is available on this construct. Once again, further research on this relationship is suggested.

The practice of adding paths is controversial and contested by several authors, mainly based on the fact that models adapted during statistical analysis, are exploratory and not confirmatory (Kenny *et al.*, 1998). Generally, confirmatory research in structural modelling presumes that the model was specified without looking at the data, only at theory.

Exclusive reliance on statistical criteria, and not theoretical criteria, for re-specifying a model is therefore believed to result in misleading models. However, since this research is an exploratory study and the paths added theoretically justifiable, the structural model's consistency is maintained. It is considered that by removing non significant paths in a theoretical model, the fit of the model will improve. This was not performed in this study, since the non significant paths where relevant to hypotheses testing and could not be removed by affecting the overall validity of the conceptual research model.

rejected. A PCLOSE value of 0.05 or more (e.g., 0.650), as in the case of the structural model, signifies the acceptance of the null hypothesis of a close fit.

As can be seen, the structural model fit indices are within accepted ranges. Important to note that these fit indices in effect combine the measurement model and the structural model (i.e., CFA and path analysis) to give an overall fit of the hypothesised conceptual research model.

In addition to the fit indices, two further methods of structural model assessment are performed.

First, the path coefficients among constructs in the structural model are examined, thereafter the squared multiple correlation (R^2) of the final endogenous construct is inspected.

- The path coefficients among constructs in a SEM model are similar to standardised regression coefficients (i.e., beta or β) in regression analysis, indicating the strength of statistical relationships. As such, they relate directly to the research hypotheses, highlighted in section 6.10.

- In essence, by examining the final endogenous variable R^2 value, the predictive capability of the model is established (Barclay *et al.*, 1995; Fornell and Larker, 1981). R^2 directly measures the percentage of variation that is explained by the model. Since the final dependent construct is **use**, and its R^2 value is 0.681, the R^2 of the overall model is 0.681, specifying the explanation power of the conceptual research model to be 68.1%.

The effect size (f^2) of an independent variable (i.e., exogenous variable) on a dependent variable (i.e., endogenous variable) can be calculated as $f^2 = \frac{[R^2(included) - R^2(excluded)]}{1 - R^2(excluded)}$ where $R^2(included)$ and $R^2(excluded)$ are the R^2 provided if the independent variable is included or excluded in the structural equation respectively (Cohen, 1988; Chin, 1998).

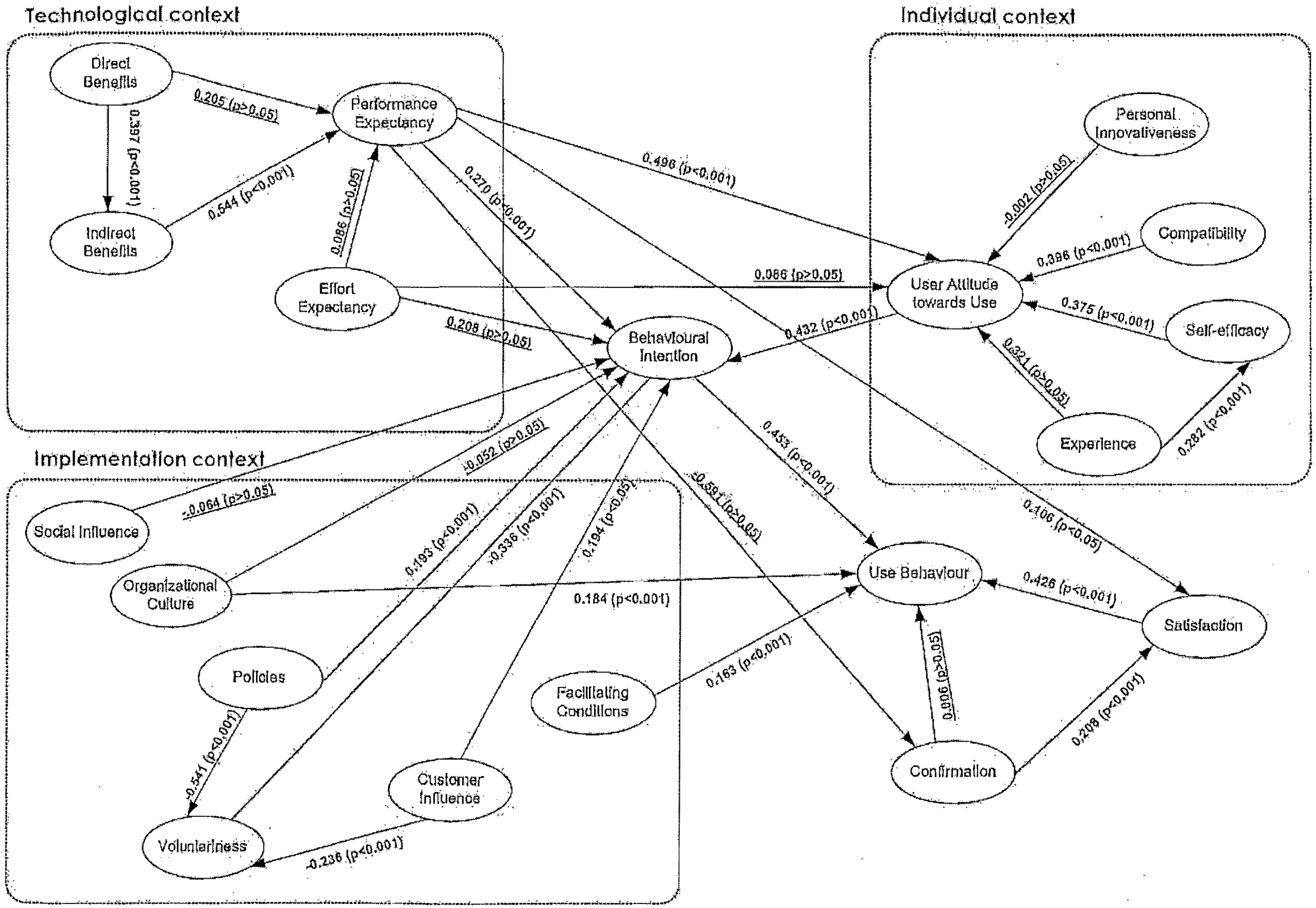
6.10 Hypotheses Evaluation

During hypotheses evaluation, the hypotheses represented by paths in the structural model are assessed. Table 6.33 displays the standardised estimated path coefficients (i.e., standardised estimates) of the hypotheses in the structural model. All hypotheses are divided into the specific categories of technological context, individual context, implementation context and consequences. Consequences refer to the main endogenous variables in the conceptual research model.

As can be seen, most path coefficients were statistically significant at $p < 0.001$, indicated by *** in the p column of the table. The path significance level of $p<0.05$ was set as the cut-off point for supported hypotheses.

Critical in the analysis of path models, is not only to consider the direct effects represented by the direct paths (i.e., hypotheses) among constructs, but also the indirect effects as discussed in Chapter 1. This is similar to effect-analysis, performed in regression analysis with one dependent variable. Naturally, in path analysis more than one dependent variable can be taken into account (Hair *et al.*, 2006).

Indirect effects specifically must be considered for unsupported hypotheses, as the possibility of significant indirect effects among exogenous (i.e., independent) and endogenous (i.e., dependent) variables of a hypothesis might exist (Tabachnick and Fidell, 2006; Hair *et al.*, 2006). Subsequently, model estimation was done again. This time, bootstrapping was performed with re-sampling set at 2000 to determine total, direct and indirect effects, as well as their significance levels.



Note: Underlined – not supported

Figure 6.8: Conceptual research model - structural model analysis

Hypothesis 27 (H_{27}) examined the influence of indirect benefits on performance expectancy. No support was found (beta=0.205, $p>0.01$). Although surprising, the indirect effect discovered between indirect benefits and performance expectancy was significant.

Hypothesis 28 (H_{28}) found a significant relationship between indirect benefits and direct benefits (beta=0.397, $p<0.001$).

<u>Individual Context</u>

Hypothesis 7 (H_7) was supported with user attitude towards use having a direct positive influence on an individual's intention to use a SDM (beta =0.432, $p<0.001$). The finding of Taylor and Todd (1995), Hu *et al.* (1999), Schaper and Pervan (2007) and Aggelidis and Chatzoglou (2009) could be corroborated.

Hypothesis 8 (H_8) stated that experience will have a direct positive influence on an individual's attitude towards the use of a SDM. Results were not significant (beta =0.321, $p>0.5$). A significant indirect effect between experience and an individual's attitude towards the use of a SDM was found through the moderating variable self-efficacy (beta=0.105, $p<0.001$).

Hypothesis 9 (H_9) was supported (beta =0.375, $p<0.5$). Self-efficacy was found to have a direct positive impact on an individual's attitude towards SDM use. Although only a relatively lesser regression weight of 0.375 was established, indicating an individual's attitude towards SDM use, it is expected to increase by a 0.375 standard deviation, giving an increase of one standard deviation in self-efficacy. Both Cockburn and Highsmith (2001) and Mead *et al.* (2003) reported similar results.

Hypothesis 10 (H_{10}) examined the effect of experience on self-efficacy. The result revealed that experience had a direct effect on self-efficacy (beta =0.282, $p<0.001$).

Hypothesis 11 (H_{11}) tested the direct effect of personal innovativeness on an individuals' attitude towards the use of a SDM. Results were insignificant (beta =0.002, $p>0.5$).

Hypothesis 13 (H_{13}) explored the direct effect of compatibility on an individual's attitude towards the use of a SDM. The results indicated that compatibility had a direct positive effect (beta =0.396, $p<0.001$), corroborating the results obtained by Riemenschneider *et al.* (2002) and Huisman and Iivari (2002).

<u>Implementation Context</u>

Hypothesis 14 (H_{14}) was supported (beta =0.194, $p<0.05$). The result that customer influence has a direct positive effect on an individual's intention to use a SDM is noteworthy. Since this hypothesis was developed

Consequences

Hypothesis 20 (H_{20}) tested the direct influence of intention to use a SDM on actual SDM use. The hypothesis was supported as expected (beta=0.453, $p<0.001$).

Hypothesis 21 (H_{21}) surprisingly was not supported (beta= 0.006, $p>0.1$). This result was unpredicted, since studies (Bhattacherjee, 2001a; Bhattacherjee, 2001b; Premkumar and Bhattacherjee, 2008) have found that confirmation has an effect on use behaviour. A significant indirect effect between confirmation and the use of a SDM was found, however, through the moderating variable of satisfaction (beta=0.088, $p<0.001$).

Hypothesis 22, (H_{22}) unlike hypothesis 21, was significant (beta= 0.208, $p<0.001$). This result was expected since the EDT postulated that confirmation has a direct influence on user satisfaction.

Hypothesis 23 (H_{23}) examined the effect of user satisfaction on actual SDM use. Results indicated that user satisfaction had a significant direct impact on actual SDM use (beta=0.426, $p<0.05$.).

The interpretation of these results is conferred in Chapter 7. The last section in this chapter provides a short deliberation of the statistical analysis performed.

6.11 Conclusion

The chapter presented descriptive statistics and SEM statistical results obtained. Starting with a short overview of SEM, attention was drawn to the importance of validating the measurement instrument before considering hypotheses validation. Specific attention was given to data screening and data cleaning, required to ensure valid data analysis. Descriptive statistics, mainly using frequency tables, were performed. Essential assumptions, made with SEM analysis, were assessed, including linearity, multivariate normal distribution, multicollinearity and non-positive definite matrices.

The above was followed by a discussion on the reduction of the conceptual research model to obtain a more parsimonious model. This step is advisable after empirical data has been obtained to ensure adequate sample size for evaluating the theoretical model, based on the sample size obtained. Measurement model validation, specifically reliability, content validity and discriminant validity were explored, utilizing CFA. Logically, after confirming a valid measurement instrument, the structural model, representing the research hypotheses, must be validated (i.e., evaluated). Based on acceptable fit indices, the supported and unsupported hypotheses were briefly discussed. Not only direct effects, but also indirect effects, specifically for unsupported hypotheses, were considered.

Chapter 7: Interpretation, Limitations and Recommendations

7.1 Introduction

In this chapter, constituting the final phase of the study, the interpretation of results obtained in Chapter 6 will be discussed. First, a short background to scientific research is given, followed by the study's purpose and findings regarding the two model contained in the conceptual research model, namely the measurement model and structural model. Based on the generic framework of technology acceptance, research questions are reviewed, highlighting the results obtained and their implications. Limitations of the study are considered, followed by practical and theoretical contributions. Closing remarks and recommendations for future research are made, trusting that these will inspire information systems researchers to further conduct research in the essential field of health information systems.

The perception of causation[36] is problematic, especially in non-experimental research methods (e.g., surveys) (Tabachnick and Fidell, 2006). Correlation cannot be used to prove causation, since the fact that two events are associated with one another, does not imply a cause and effect relationship. Interpreting to the contrary would be a logical fallacy.

Correlation, however, is a central, but not sufficient, condition to construe causal inferences with reasonable confidence. In effect, causality is related to research design, not a statistical technique, requiring an appropriate method of data collection. To make causal inferences, a researcher needs to gather data by using a controlled or randomised experiment, while controlling extraneous variables. Having gathered empirical data in this fashion, and if it can be established that the experimentally manipulated variable is correlating with the dependent variable, casual inference(s) is reasonable. In short, only if empirical data is gathered by explicit methods, correlation can imply causation.

In the following section, findings regarding the descriptive analysis are presented.

7.4 Findings regarding Descriptive Analysis

Descriptive analysis, performed in SPSS, mainly explores the demographical data of participants, including age, gender, educational background, health area in which they specialise, as well as the organisational and department size in which they work.

Most respondents were in the age group 21-30 (43.8%), with a total gender division of 152 males and 72 females. In total, 47.8% successfully completed their tertiary studies. Major health areas stipulated by individuals as their main focus area included hospital information systems (45.1%), laboratory information systems (13.4%), pharmacy information systems (12.9%) and electronic medical records (8.9%). Most respondents (22.8%) were employed by relatively small organisations (0-100 employees), with IS department sizes ranging from 31 to 40 (19.2%) being the most prevalent. In general, an overall satisfactory demographical sample was obtained.

During descriptive analysis, specific research questions were addressed. Below, these questions are briefly stipulated with reference to results obtained.

i. *What systems development methodologies are mainly used in the development of health information systems (HIS)?* Frequency distribution indicates that the agile approach (defined in Chapter 4) had the highest frequency, followed by the structured approach. The relatively higher use (19.8%) of agile systems development methodologies was surprising, but may be related to its focus on the individual

[36] *Causation is the relation between cause and event (Tabachnick and Fidell, 2006).*

vi. *Confirm whether organisational size or IS department size influences the use of SDMs.* Based on statistical analysis, no significant relationship between the use of SDMs and organisational size (Spearman's rho = -0.035, p>0.05) or IS department size (Spearman's rho=-0.024, p>0.05) was found. Importantly, this cannot be viewed as contrary to results reported by Khalifa and Verner (2000), which found team size significantly related to SDM usage. Organizational size and IS department size in effect do not determine team size, since external contractors can be included, increasing team size significantly. This insignificant result of organisational size and IS department size to affect the use of SDMs may indicate that other factors, especially in the health information systems development, play a more prominent role. These may include policies and customer influence, which seems to be vital in the health care development area.

vii. *Confirm whether the education level of the individual influences the use of SDMs.* No significant relationships between the use of SDMs and educational level (Spearman's rho=-0.083, p>0.05) were evident.

Having successfully addressed the descriptive statistics analysis, measurement model analysis and structural model analysis are considered next.

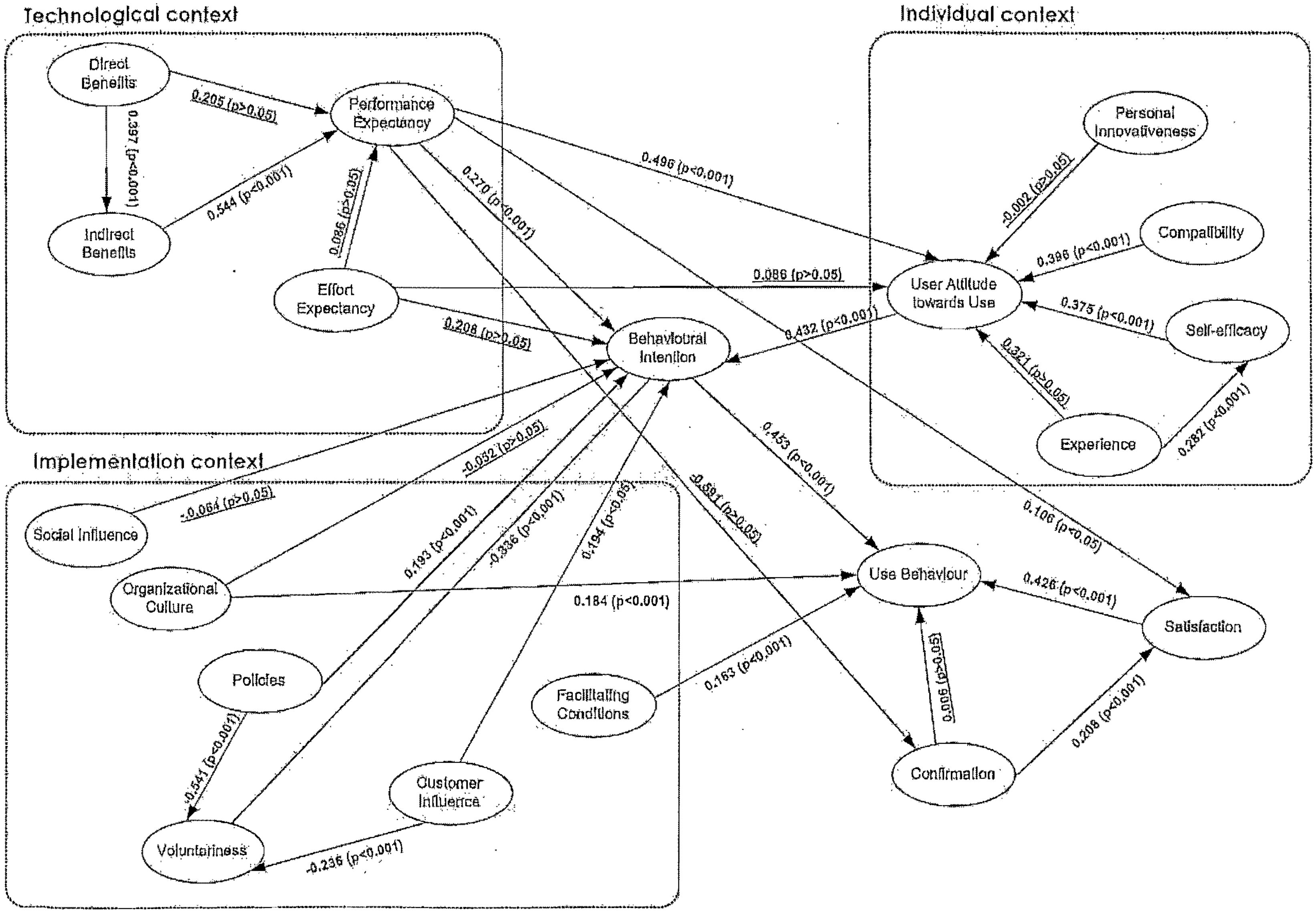
7.5 Findings regarding the Measurement Model Analysis

The validity of the measurement instrument was initially determined before structural model analysis was performed. This was done to ensure that measurement model created was indeed valid in the context of SDMs use in health information systems.

The process entailed the evaluation of measurement model reliability, content validity and construct validity (i.e., convergent validity and discriminant validity) by employing Cronbach's alpha, CR and AVE values. This ensured that the measurement instrument used to study the hypothesised relationships was indeed valid and reliable. Furthermore, it confirmed that the best possible results would be obtained when conducting structural model analysis, discussed next.

7.6 Findings regarding the Structural Model Analysis

After it was established that the measuring instrument being used was valid, structural model analysis was performed. Utilizing SEM in AMOS, the conceptual research model's structural model was evaluated, based on fit indices, path coefficients relating to research hypotheses and the predictive capability of the model. All fit indices employed were within acceptable ranges, with the final endogenous variable (i.e., use) R^2 value at 0.681, indicating the explanation power of the conceptual research model to be 68.1%.



Note: Underlined – not supported

Figure 7.1: Conceptual research model - structural model analysis (replicated from Chapter 6)

The remaining five research questions were answered based on the results obtained with structural model analysis, briefly stipulated below.

viii. *What factors (e.g., performance expectancy, effort expectancy, facilitating conditions) influence the use of systems development methodologies in HIS development?*

The discussion of results is based on the generic framework of technology acceptance, specifying the technological context, individual context and implementation context.

<u>**Technological Context:**</u> With regard to the technological context, ten hypotheses were defined (i.e., H_1, H_2, H_3, H_5, H_6, H_{26}, H_{27}, H_{28}, H_{24}, H_{25}).

Results indicated that performance expectancy had a direct influence on behaviour intent to use a SDM (H_1: beta=0.270, $p<0.001$), while effort expectancy's direct effect on behaviour intent was unsupported (H_2: beta=0.208, $p>0.05$). Effort expectancy direct effects on performance expectancy (H_3: beta=0.086, $p>0.05$) and user's attitude towards use were also unsupported (H_6: beta=0.086, $p>0.05$), clearly indicating that the factor effort expectancy was non significant in the research model. This may indicate that developers do not consider SDMs as difficult, being a mature artefact in which most IS graduates would have received training. Direct benefits had a direct influence on performance expectancy (H_{26}: beta=0.544, $p<0.001$), while indirect benefits only had a direct influence on direct benefits (H_{28}: beta=0.397, $p<0.001$), none on performance expectancy (H_{27}: beta=0.205, $p>0.05$). This may be due to indirect benefits not considered as relevant to performance expectancy as direct benefits. Furthermore, a significant direct influence of performance expectancy on satisfaction was found (H_{25}: beta=0.106, $p<0.001$), but none on confirmation (H_{24}: beta=-0.591, $p>0.05$). This was surprising, but again this can be due to the fact that SDMs are relative mature, allowing developers to measure the value of SDMs on actual performance and not expected performance. In addition, a significant direct influence of performance expectancy on the user's attitude towards SDM use was found (H_5: beta=0.496, $p<0.001$), the latter being a factor of the individual context.

Performance expectancy can therefore be identified as the major factor in the technological context regarding the behaviour intent of the individual to use SDMs.

<u>**Individual Context:**</u> Referring to the individual context, six hypotheses were defined (i.e., H_7, H_8, H_9, H_{10}, H_{11}, H_{13}).

Results indicated that user attitude towards SDM use had a direct influence (H_7: beta=0.432, $p<0.001$) on the behavioural intent to use a SDM. Factors having a direct influence on attitude

Based on the analysis performed in Chapter 6, with regard to confirmation, it was found that developer confirmation (f^2= 0.31) had the most significant effect on confirmation, followed by organisation confirmation (f^2= 0.17) and customer confirmation (f^2= 0.08). Therefore, if the individual deem the use of SDMs to be positively confirmed, it is a good indication of his or her level of satisfaction, more so than organisational or customer confirmation. However, the individual also considers positive confirmation with regard to the organisation as important, but must less so for customers. This clearly indicates levels of confirmation, the first being the individual, followed by the organisation and finally the customer.

x. *What underlying factors are important when evaluating organisational culture?* Organisational culture is interpreted in terms of four culture types (i.e., group, developmental, rational, hierarchical). Which of these cultures are more, or less relevant when considering the use of SDMs?

The hierarchical culture (f^2= 0.28) was found to have the most significant effect, followed by developmental (f^2= 0.16), group (f^2= 0.11) and rational (f^2= 0.06). This is similar as the results obtained by Iivari and Huisman (2007), indicating that deployment of SDMs when considering the developer is primarily coupled with a hierarchical culture.

xi. *What factors (e.g., confirmation, satisfaction) influence the effectiveness of software development methodologies in HIS?* Effectiveness was measured as the continued use (i.e., use behaviour) of SDMs. Based on analysis performed in Chapter 6, satisfaction (f^2= 0.24) with SDMs had the most significant effect, followed by behavioural intent (f^2= 0.19), organisational culture (f^2= 0.06) and facilitating conditions (f^2= 0.09). Therefore, continue use depends to a great extend on the level of satisfaction of the individual with SDMs.

If the paths coefficients are examined, a significant direct positive effect between satisfaction and use behaviour (H_{23}: beta=0.426, $p<0.05$) is evident. There are also a direct significant effect between confirmation and satisfaction (H_{22}: beta=0.208, $p<0.001$) and behavioural intent and use behaviour (H_{20}: beta=0.453, $p<0.001$). No significant direct effect was found between confirmation and use behaviour (H_{21}: beta=0.006, $p>0.05$), although an indirect effect was noted (indirect H_{21}: beta=0.088, $p<0.001$).

Based on this analysis, satisfaction constitutes the major factor affecting the effectiveness of SDMs. If the individual is not satisfied with the use of a SDM, even if the ideal organisational culture or facilitating conditions are present, it may negatively affect the continued use of the a SDM.

7.8 Implications of the Present Study

It is essentail to note that this study is unique, since is the first known of that explores the use and effectiveness of SDMs in the area of health information systems (i.e., phenomenon). Specifically for the health care industry, the development of reliable and quality information systems is critical, since only by having access to pertinent health information, can the correct decisions relating to diagnostics and medical treatments be made. Systems development methodologies are especially relevant in this regard, since they yield benefits such as increase productivity and higher quality software (Iivari *et al.*, 2000). In the following two sections, specific theoretical and practical implications of the present study are presented.

7.8.1 Theoretical Implications of the Present Study

The study made several theoretical contributions.

From the standpoint of acceptance and use theory, this research adds to the body of knowledge relating to the applicability of UTAUT and EDT in information systems, specifically health information systems. Although UTAUT was largely supported, the direct association between effort expectancy and behavioural intent, as postulated, could not be validated. Furthermore, with regard to EDT, this study also could not validate the direct association between confirmation and use behaviour, although an indirect effect was discovered. All other antecendents in the UTAUT and EDT were however found to be significant, confirming that the combined UTAUT and EDT conceptual research model are valid and theoretically justifiable. Importantly, by combining the two theories, each providing distinct determinants, a more in-depth understanding of the phenomenon under investigation was obtained.

Furthermore, relationships in the empirical data were considered by fitting the complete conceptual research model to the empirical data using SEM. Non significant relationships were re-evaluated by considering indirect effects, which are automatically calculated by most SEM software packages. By specifically considering indirect effects and not only direct effects, a deeper understanding into the interrelationships between factors in the research model was obtained. This theoretical aspect of path analysis is generally ignored by researchers, most evaluating only direct effects.

Bivariate correlations for non significant hypotheses were also performed. Although most of these bivariate correlations were found to be significant in SPSS, during conceptual research model testing, using SEM, they were found to be insignificant. It is therefore evident that with complex theretical models, more intricate interrelationships are taken into account. This naturally leads to questions related to deductions made with less complex models, taking only two, three of four constructs into consideration. This *study therefore* additional step proposed by Rosemann and Vessey (2008) was found to be productive in theory development and suggested to future researchers.

In conclusion, while much of behavioural science in IS focused on the acceptance of IT artefacts, less attention is given to continuance or continued usage. The expectation disconfirmation theory is currently the dominant referenced theoretical framework for explaining user continuance of IT in cross-sectional studies (Premkumar and Bhattacherjee, 2008). This study therefore employed the EDT, specifically to measure the individual's intention to continue using SDMs. In essence, if SDMs are effective, individual software developers will continue their use, while if ineffective, their use will be terminated. Utilizing a theory to measure effectiveness is unique, since in general specific aspects like information quality, system quality and service quality, part of the IS success model of Delone and Maclean (2002), are used. In EDT, these specific measures are used to quantify the confirmation construct, postulated to affect use behaviour and satisfaction.

7.8.2 Practical Implications of the Present Study

Results of this study contributed to practice in a number of ways.

Firstly, the study made a contribution to the discipline of information systems and health informatics by providing insights with regard to factors affecting the use and effectiveness of SDMs in health care information systems.

Among all constructs, user or individual attitude towards the use of SDMs, performance expectancy, voluntariness, organisational culture, policies and customer influence were found to directly influence the behavioural intent to use SDMs. The direct effect of the individual's attitude towards use is vital (f^2 = 0.34), implying that if the idividual has a positive attitude towards the use of SDMs, it will significantly impact the acceptance and use of SDMs. Factors influencing users' attitude towards SDM use include compatibility and self-efficacy. Individuals considering SDMs more compatible to the work methods they employ, have a more positive attitude towards SDM use. Managers therefore need to confirm that the SDM that are considered for implementation is compatible to developer's software development style. Otherwise, developers will have to work longer and harder to unlearn old routines and learn new ones, not always conducive to productivety and profitablility. Self-efficacy, which is influenced by the individual's experience, was also found to positively affect attitude towards SDM use. Self-assured and confident individual's that know how to use a SDM is therefore beneficial. No relationship between experience and user's attitude towards SDM use was found. An indirect effect, however, was established through the moderating variable of self-efficacy. Performance expectancy also had a relative large effect (f^2 = 0.26) on behaviour intention.

behavioural intent would be significant. This may indicate that the SDM has entered a relatively mature state, with the antecedents of effort expectancy in effect being captured by performance expectancy. In the conceptual research model, performance expectancy was related to direct and indirect benefits. From statistical analysis, it was found that direct benefits had a significant direct impact on performance expectancy, while indirect benefits only had an indirect effect through the mediator direct benefits. Individuals are therefore more concern with the direct benefits of SDM use than its indirect benefits.

As such, by utilizing a conceptual research model, a lens was provided to better view factors affecting the use and effectiveness of SDMs, thereby better informing practice. Practice, by knowing the determinants of behavioural intention and actual behaviour, can take appropriate action to increase the acceptance and use of SDMs.

Results obtained through descriptive statistics were also informative. Firstly, they confirmed that the study was representative of the population. Furthermore, they revealed that compatibility was the major reason for not using SDMs, indicating that for those users which were not using a SDM, SDMs were viewed as predominantly not well suited to their way of developing software. The introduction of agile systems development methodologies seems to lessen this concern, with a relatively high number of individuals reporting their use. Noteworthy, is the large number of in-house developed methodologies in the sample population, highlighting a possible move towards methods being engineered, rather than commercially purchased. Contingency, or situation method engineering, was also found to be prevalent. Most respondents indicated that structured SDLC methodologies were mostly used for complex, long running projects, while shorter, fast delivery projects, were mostly utilizing agile methodologies. It was also found that software engineering methodologies were more frequently used when developing technically sophisticated information systems, such as radiology information systems, PACS and CPOE. CMMI was more prevalent in hospital information systems, pharmacy information systems and laboratory information systems, with mainly governmental institutions being the customer, or otherwise customers specifically requiring the use of CMMI.

Furthermore, it was found that organisational size, IS department size and education level of the individual had no correlation with SDM behavioural intent or use behaviour. This could be based on the fact that in the health information systems development area, SDMs are more privilent, reducing the possible influence of these factors. Also, if the use of SDMs is made mandatory throught policies and customer influences, any organisation that wish to operate in the health information systems sector will have to comply, irrespectively of their size.

In conclusion, the use of SDMs in information systems development is not irrelevant, but to the contrary, approriate for the foreseeable future. Information systems, developed for health care, must be able to meet the highest standards, based on the crucial role they play in patient care. A patient's well-being may never be jeopardised by poorly developed information systems. The use of SDMs is a critical factor in ensuring more reliable and effective health information systems.

ii. Various companies use spam filters to block e-mails. Unfortunately, there is a thin line between what is acceptable and what is considered to be spam when sending unsolicited e-mails. Researchers therefore must be aware of the possibility that their e-mail might be blocked or deleted without them being notified. This is a critical concern, since there is no way of identifying these occurrences, or method of remedying them.

iii. The multiple contact method acceptable with normal paper-based surveys differs significantly from e-mail solicitation. Respondents might become highly irritated with multiple requests. It is therefore suggested that no more than 4 requests for survey participation be sent. Even with 4, research can face possibly "unfriendly" responses, unfortunately encountered during this study.

iv. In today's virus and spyware environment, it is often not safe to click on links in e-mails received from unknown sources. Ensuring that the respondent has confidence in the originating party is essential.

Based on these elements, it is recommended that future researchers consider obtaining a sponsoring organisation, specifically a medical or health informatics association, through which to solicit responses. An official e-mail from a well-known organisation is more likely to survive the spam filters, and less likely to be ignored and discarded.

With regard to the suggestion of this study to investigate more complicated theoretical models, a final recommendation is made. If the number of factors that are considered in a theoretical model escalates, the likehood of confusion increases. To minimise this aspect, it is suggested that researchers consider the use of a framework to group related factors in specific "contexts" or "focus areas". This in effect diminishes the theoretical models intricacy into a more coherent structure, allowing for a more parsimonious model. This was the strategy followed in the present study.

In the final section of this study, a short synopsis of the study is provided.

7.10 Conclusion

The present study attempted to provide some insights into the use and effectiveness of SDMs in health information systems, considering relevant antecedents and their relationships. From a literary review, it was established that no previous research was done in the field of SDM use in health information systems, thereby suggesting that an exploratory research approach be adopted. An exploratory study was conducted, however, containing elements of both confirmatory and descriptive research.

Executed in discrete steps, four phases were defined. In phase one, constituting the literary review, theories used in IS, systems development methodologies and health information systems were outlined. In the second

References

AARTS, J., DOOREWAARD, H. & BERG, M. 2004. Understanding implementation: the case of a computerized physician order entry system in a large Dutch university medical centre. *Journal of the American Medical Informatics Association*, 11(3):207-216.

ADHIKARI, N. & LAPINSKY, S.E. 2003. Medical informatics in the intensive care unit: overview of technology assessment. *Journal of Critical Care*, 18(1):41-47.

AGARWAL, R. & PRASAD, J. 1998. A conceptual and operational definition of personal innovativeness in the domain of information technology. *Information Systems Research*, 9(2):204-215.

AGARWAL, R. & PRASAD, J. 1999. Are individual differences germane to the acceptance of new information technologies?. *Decision Sciences*, 30(2):361-391.

AGARWAL, R. & PRASAD, J. 2000. A field study of the adoption of software process innovations by information systems professionals. *IEEE Transactions on Engineering Management*, 47(3):295-308.

AGGELIDIS, V.P. & CHATZOGLOU, P.D. 2009. Using a modified technology acceptance model in hospitals. *International Journal of Medical Informatics*, 78(2):115-126.

AGILEALLIANCE. 2001. Manifesto for agile software development. http://www.agilemanifesto.org Date of access: 11 Feb. 2010.

AGRESTI, W.W. 1986. New paradigms for software development. Washington DC: IEEE Computer Society Press. 259 p.

AJZEN, I. 1985. From intentions to actions: a theory of planned behaviour, action control from cognition to behaviour. New York: Springer. 29 p.

AJZEN, I. 1991. The Theory of Planned Behaviour. *Organizational Behavior and Human Decision Processes*, 50(2):179-211.

AJZEN, I. & MADDEN, T.J. 1985. Prediction of goal-directed behaviour: attitudes, intentions, and perceived behavioural control. *Journal of Experimental Social Psychology*, 22(5):453-474.

AL-GAHTANI, S.S., HUBONA, G.S. & WANG, J. 2007. Information Technology (IT) in Saudi Arabia:

AVISON, D.E. & FITZGERALD, G. 2006. Information systems development: methodologies, techniques and tools. 4th ed. Maidenhead: McGraw-Hill. 645 p.

BAGOZZI, R.P. 2007. The legacy of the technology acceptance model and a proposal for a paradigm shift. *Journal of the Association for Information Systems*, 8(4):244-254.

BAGOZZI, R.P. & YI, Y. 1988. On the evaluation of structural equation models. *Journal of the Academy of Marketing Science*, 16(1):74-94.

BAILEY, J.E. & PEARSON, S.W. 1983. Development of a tool for measuring and analyzing computer user satisfaction. *Management Science*, 29(5):530-545.

BAJEC, M., VAVPOTIČ, D. & KRISPER, M. 2007. Practice-driven approach for creating project-specific software development methods. *Information and Software Technology*, 49(4):345-365.

BALDI, P. & BRUNAK, S. 1998. Bioinformatics: the machine learning approach. 2nd ed. Cambridge, MA: MIT Press. 351 p.

BANDURA, A. 1977. Self-efficacy: towards a unifying theory of behavioural change. *Psychological Review*, 84(2):191-215.

BANDURA, A. 1986. Social foundations of thought and action: a social cognitive theory. Englewood Cliffs, NJ: Prentice-Hall. 617 p.

BANDURA, A. & ADAMS, N.E. 1977. Analysis of self-efficacy theory behavioral change. *Cognitive Therapy and Research*, 1(4):287-310.

BANDYOPADHYAY, K. & FRACCASTORO, K.A. 2007. The effect of culture on user acceptance of Information Technology. *Communications of the Association for Information Systems (AIS)*, 19(23):522-543.

BARCLAY, D., HIGGINS, C. & THOMPSON, R. 1995. The Partial Least Squares (PLS) approach to causal modeling: personal computer adoption and use as an illustration. *Technology Studies*, 2(2):285-309.

BARENFANGER, J. 2003. Utilizing laboratory information systems to improve quality. *Clinical Microbiology Newsletter*, 25(6):44-48.

BARON, R.M. & KENNY, D.A. 1986. The moderator - mediator variable distinction in social psychological research: conceptual, strategic, and statistical considerations. *Journal of Personality and Social Psychology*, 51(6):1173-1182.

BENBASAT, I. & ZMUD, R.W. 1999. Empirical research in information systems: the practice of relevance. *MIS Quarterly*, 23(1):3-16.

BENBASAT, I. & ZMUD, R.W. 2003. The Identity crisis within the discipline: defining and communicating the discipline's core properties'. *MIS Quarterly*, 27(2):183-194.

BEUSCART-ZÉPHIR, M.C., PELAYO, S., ANCEAUX, F., MEAUX, J.J., DEGROISSE, M. & DEGOULET, P. 2005. Impact of CPOE on doctor–nurse cooperation for the medication ordering and administration process. *International Journal of Medical Informatics*, 74(7):629-641.

BHATTACHERJEE, A. 2000. Acceptance of Internet applications services: the case of electronic brokerages. *IEEE Transactions on Systems, Man, and Cybernetics - Part A: Systems and Humans*, 30(4):411-420.

BHATTACHERJEE, A. 2001a. Understanding information systems continuance: an expectation-confirmation model. *MIS Quarterly*, 25(3):351-370

BHATTACHERJEE, A. 2001b. An empirical analysis of the antecedents of electronic commerce service continuance. *Decision Support Systems*, 32(2):201-214.
1
BHATTACHERJEE, A. & PREMKUMAR, G. 2004. Understanding changes in belief and attitude towards Information Technology usage: a theoretical model and longitudinal test. *MIS Quarterly*, 28(2):229-254.

BICK, U. & LENZEN, H. 1999. PACS: the silent revolution. *European Radiology*, 9(6):1152-1160.

BLALOCK, H.M. 1961. Correlation and causality: the multivariate case. *Social Forces*, 39(3):246-251.

BLANCHARD, B.S. & FABRYCKY, W.J. 2006. Systems engineering and analysis. 4th ed. Upper Saddle River, NJ: Prentice Hall. 804 p.

BLAZONA, B. & KONCAR, M. 2007. HL7 and DICOM based integration of radiology departments with healthcare enterprise information systems. *International Journal of Medical Informatics*, 76(3):S425-S432.

BLOIS, M.S. 1986. What is medical informatics. *Western Journal of Medicine*, 145(6):776-777.

BLUNCH, N.J. 2008. Introduction to structural equation modeling Using SPSS and AMOS. Thousand Oaks, CA: Sage. 270 p.

BOAHENE, M. 1999. Information systems development methodologies: are you being served?

BURRELL, G. & MORGAN, G. 1979. Sociological paradigms and organizational analysis. New Hampshire: Heinemann Educational Books. 432 p.

BYGSTAD, B., GHINEA, G. & BREVIK, E. 2008. Software development methods and usability: perspectives from a survey in the software industry in Norway. *Interacting with Computers*, 20(3):375-385.

BYRNE, B.M. 2001. Structural equation modeling with AMOS: basic concepts, applications, and programming. Mahwah, NJ: Lawrence Erlbaum. 338 p.

CABRERA, A. 2002. Defining the role of a PACS technologist. *Journal of Digital Imaging*, 15(1):120-123.

CAMPBELL, E.M., SITTIG, D.F., ASH, J.S., GUAPPONE, K.P. & DYKSTRA, R.H. 2006. Types of unintended consequences related to computerized provider order entry. *Journal of the American Medical Informatics Association*, 13(5):547-556.

CAMPOS, J.M. 1999. Use of the laboratory information system to improve the quality and reduce the cost of microbiology testing. *Clinical Microbiology Newsletter*, 21(2):11-14.

CARMINES, E. & ZELLER, R.A. 1979. Reliability and validity assessment. Thousand Oaks, CA: Sage. 71 p.

CASSEL, C., HACKL, P. & WESTLUND, A.H. 1999. Robustness of partial least-squares method for estimating latent variable quality structures. *Journal of Applied Statistics*, 26(4):435-446.

CESCHI, M., SILLITTI, A., SUCCI, G. & DE PANFILIS, S. 2005. Project management in plan-based and Agile companies. *IEEE Software*, 22(3):21-27.

CHANG, I., HWANG, H., HUNG, W. & LI, Y. 2007. Physicians' acceptance of pharmacokinetics-based clinical decision support systems. *Expert Systems with Applications: An International Journal*, 33(2):296-303.

CHANG, M.K. & CHEUNG, W. 2001. Determinants of the intention to use Internet/WWW at work: a confirmatory study. *Information & Management*, 39(1):1-14.

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

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

COIERA, E. 2003. Guide to health informatics. 2nd ed. London: Hodder Arnold Publication. 440 p.

COLEMAN, D., ARNOLD, P., BODOFF, S., DOLLIN, C., GILCHRIST, H., HAYES, F. & JEREMEAS, P. 1994. Object-oriented development - the fusion method. Englewood Cliffs, NJ: Prentice Hall. 313 p.

COLLEN, M.F. 1986. Origins of medical informatics. *Western Journal of Medicine*, 145(6):778-785.

COLLINS, F.S. & MCKUSICK, V.A. 2001. Implications of the human genome project for medical science. *Journal of the American Medical Association*, 285(5):540-544.

COLPAERT, K. & DECRUYENAERE, J. 2009. Computerized physician order entry in critical care. *Best Practice and Research Clinical Anaesthesiology*, 23(1):27-38.

COMLEY, P. 2002. Online surveys and internet research. http://www.virtualsurveys.com/papers/popup_paper.htm Date of access: 11 Feb. 2010.

COMPEAU, D.R. & HIGGINS, C.A. 1995. Computer self-efficacy: development of a measure and initial test. *MIS Quarterly*, 19(2):189-211.

COMPEAU, D.R., HIGGINS, C.A. & HUFF, S. 1999. Social cognitive theory and individual reactions to computing technology: a longitudinal study. *MIS Quarterly*, 23(2):145-158.

CUSUMANO, M.A. 2004. Who is liable for bugs and security flaws in software?. *Communications of the Association of Computing Machinery (ACM)*, 47(3):25-27.

DAVIDSON, E.J. 1999. Joint Application Design (JAD) in practice. *Journal of Systems and Software*, 45(3):215-223.

DAVIS, G. 1982. Strategies for information requirements determination. *IBM Systems Journal*, 21(1):4-30.

DAVIS, F.D. 1989. Perceived usefulness, perceived ease of use, and user acceptance of information technology. *MIS Quarterly*, 13(3):319-339.

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

DAVIS, F.D., BAGOZZI, R.P. & WARSHAW, P.R. 1992. Extrinsic and intrinsic motivation to use computers in the workplace. *Journal of Applied Social Psychology*, 22(14):1111-1132.

DE DOMBAL, F.T. 1996. Medical informatics: The Essentials. Oxford: Butterworth-Heinemann. 133 p.

of Computer Mediated Communication, 6(1). http://jcmc.indiana.edu/vol6/issue1/eastin.html Date of access: 11 Feb. 2010.

EDWARDS, J.R. & BAGOZZI, R.P. 2000. On the nature and direction of relationships between constructs and their measures. Psychological Methods, 5(2):155-174.

EMORY, C.W. & COOPER, D.R. 1991. Business research methods. 4th ed. Homewood, IL: Irwin. 760 p.

ERSTAD, T.L. 2003. Analyzing computer based patient records: a review of literature. *Journal of Healthcare Information Management*, 17(4):51-57.

ESLAMI, S., DE KEIZER, N.F. & ABU-HANNA, A. 2007. The impact of computerized physician medication order entry in hospitalized patients - a systematic review. *International Journal of Medical Informatics*, 77(6):365-376.

FARELL, A.M. 2010. Insufficient discriminant validity: a comment on Bove, Pervan, Beatty, and Shiu. *Journal of Business Research*. 63(3):324-327.

FAWCETT, J. & DOWNS, F.S. 1986. The relationship of theory and research. 2nd ed. Philadelphia: F.A. Davis. 186 p.

FESTINGER, L. 1957. A theory of cognitive dissonance. Stanford, CA: Stanford University Press. 291 p.

FIELD, A. 2009. Discovering statistics using SPSS. 3rd ed. Thousand Oaks, CA: Sage. 821 p.

FISHBEIN, M. & AJZEN, I. 1975. Belief, attitude, intention, and behavior: an introduction to theory and research. Reading, MA: Addison-Wesley. 578 p.

FISHER, R.A. 1935. The design of experiments. Edinburgh: Oliver & Boyd. 252 p.

FITZGERALD, B. 1998. An empirical investigation into the adoption of systems development methodologies. *Information & Management*, 34(6):317-328.

FITZGERALD, B., RUSSO, N.L. & O'KANE, T. 2003. Software development method tailoring at Motorola. *Communications of the Association of Computing Machinery (ACM)*, 46(4):64-70.

FITZGERALD, B., RUSSO, N.L. & STOLTERMAN, E. 2002. Information systems development: methods in action. London: McGraw-Hill. 194 p.

FOMELL, C. & LARCKER, D.F. 1981. Evaluating structural equation models with unobservable variables

Euromethod Project. Paris, France.

GEORGIOU, A., AMPT, A., CRESWICK, N., WESTBROOK, J.I. & BRAITHWAITE. J. 2009. Computerized provider order entry - What are health professionals concerned about? A qualitative study in an Australian hospital. *International Journal of Medical Informatics*, 78(1):60-70.

GLASS, R. 1999. A snapshot of systems development practice. *IEEE Software*, 16(3):110-111.

GOEPP, V., KIEFER, F. & DE GUIO, R. 2008. A proposal for a framework to classify and review contingent information system design methods. *Computers & Industrial Engineering*, 54(2):215-228.

GOORMAN, E. & BERG, M. 2000. Modelling nursing activities: electronic patient records and their discontents. *Nursing Inquiry*, 7(1):3-9.

GORMAN, P.N., LAVELLE, M.B. & ASH, J.S. 2003. Order creation and communication in healthcare. *Methods of Information in Medicine*, 42(4):376-384.

GRABER, M., GORDON, R. & FRANKLIN, N. 2002. Reducing diagnostic errors in medicine: what's the goal?. *Academic Medicine*, 77(10):981-992.

GREEN, G.C., COLLINS, R.W. & HEVNER, A.R. 2004. Perceived control and the diffusion of software process innovations. *The Journal of High Technology Management Research*, 15(1):123-144.

GREENES, R.A. & SHORTLIFFE, E.H. 1990. Medical informatics. *Journal of the American Medical Association*, 263(8):1114-1120.

GREGOR, S. 2006. The nature of theory in information systems. *MIS Quarterly*, 30(3):611-642.

GRIEGER, D.L., COHEN, S.H. & KRUSCH, D.A. 2007. A pilot study to document the return on investment for implementing an ambulatory electronic health record at an academic medical center. *Journal of the American College of Surgeons*, 205(1):89-96.

GRIFFIN, A.S. & BRANDYBERRY, A.A. 2008. System development methodology usage in industry: a review and analysis. Proceedings of the Conference on Information Systems Applied Research. http://proc.conisar.org/2008/3522/CONISAR.2008.Griffin.pdf Date of access: 11 Feb. 2010.

GRIMM, L.G. & YARNOLD, P.R. 2000. Reading and understanding more multivariate statistics. Washington DC: American Psychological Association. 437 p.

GUNTER, B. 2005. Digital health - meeting patient and professional needs online. Mahwah, NJ: Lawrence

CRIS-94 Conference on Methods and Associated Tools for the Information Life Cycle. Maastricht, Amsterdam. p. 169-194.)

HARTZBAND, P. & GROOPMAN, J. 2008. Off the record-avoiding the pitfalls of going electronic. *New England Journal of Medicine*, 358(16):1656-1658.

HATCHER, L. 1994. A step-by-step approach to using the SAS system for factor analysis and structural equation modeling. Cary, NC: SAS Publishing. 588 p.

HAUSLER, P.A., LINGER, R.C. & TRAMMELL, C.J. 1994. Adopting Cleanroom software engineering with a phased approach. *IBM Systems Journal*, 33(1):89-109.

HAUX, R. 2006. Individualization, globalization and health - about sustainable information technologies and the aim of medical informatics. *International Journal of Medical Informatics*, 75(12):795-808.

HAUX, R., WINTER, A., AMMENWERTH, E. & BRIGL, B. 2004. Strategic information management in hospitals. An introduction to hospital information systems. New York: Springer.

HAYT, D.B., ALEXANDER, S., DRAKAKIS, J. & BERDEBES, N. 2001. Filmless in 60 days: the impact of picture archiving and communications systems within a large urban hospital. *Journal of Digital Imaging*, 14(2):62-71.

HENDERSON-SELLERS, B. 2003. Method engineering for OO systems development. *Communications of the Association of Computing Machinery (ACM)*, 46(10):73-78.

HENNINGTON, A.H. & JANZ, B.D. 2007. Information systems and healthcare XVI: physician adoption of electronic medical records: applying the UTAUT model in a healthcare context. *Communications of the Association for Information Systems (AIS)*, 19:60-80.

HIGGINS, S.H. & HOGAN, P.T. 1999. Internal diffusion of high technology industrial innovations: an empirical study. *Journal of Business and Industrial Marketing*, 14(1):61-75.

HIGHSMITH, J. 2000. Adaptive software development: a collaborative approach to managing complex systems. New York: Dorset House Publishing. 358 p.

HIRSCHHEIM, R. & KLEIN, H.K. 1989. Four paradigms of information systems development. *Communications of the Association of Computing Machinery (ACM)*, 32(10):1199-1216.

HIRSCHHEIM, R. & KLEIN, H.K. 2008. The structure of the IS discipline reconsidered: Implications and reflections from a community of practice perspective, *Information and Organization*, 18(4):280-302.

HUANG, H.K. 2003. Enterprise PACS and image distribution. *Computerized Medical Imaging and Graphics*, 27(2):241-253.

HUANG, H. K. 2010. PACS and imaging informatics: basic principles and applications. 2nd ed. Hoboken, NJ: Wiley. 649 p.

HUANG, S.Y. & CHANG, C.M. 2005. User acceptance of WAP services: test of competing theories. *Computer Standards and Interface*, 27(4):359-370.

HUGHES, J. 1998. Selection and evaluation of information systems methodologies the gap between theory and practice. *IEEE Proceedings on Software*, 145(4):100-104.

HUH, H.J., KIM, T. & LAW, R. 2009. A comparison of competing theoretical models for understanding acceptance behavior of information systems in upscale hotels. *International Journal of Hospitality Management*, 28(1):121-134.

HUISMAN, H.M. & IIVARI, J. 2002. The individual deployment of systems development methodologies. (*In* Lecture Notes in Computer Science. Vol. 2348. Proceedings of the 14th International Conference on Advanced Information Systems Engineering. London: Springer. p. 134-150.)

HUISMAN, H.M. & IIVARI, J. 2003. Systems development methodology use in South Africa. Ninth Americas Conference on Information Systems. p. 1040-1052.

HUISMAN, H.M. & IIVARI, J. 2006. Deployment of systems development methodologies: perceptual congruence between IS managers and system developers. *Information & Management*, 43(1):29-49.

HUMPREY, W.S. & SWEET, W.L. 1987. A method for assessing the software engineering capability of contractors. SEI-87-TR-23. *Software Engineering Institute*. Pittsburgh, Pennsylvania: Carnegie Mellon University.

HUMPHREY, W.S. 1988. Characterizing the software process: A maturity framework. *IEEE Software*, 5(2):73-79.

HUNG, S.Y., TANG, K., CHANG, C. & KE, C. 2009. User acceptance of intergovernmental services: An example of electronic document management system. *Government Information Quarterly*, 26(2):387-397.

HUNT, S.D. 1991. Modern marketing theory: critical issues in the philosophy of marketing science. Cincinnati, Ohio: Southwestern Publishing. 499 p.

systems development methodologies and approaches. *Journal of Management Information Systems*, 17(3):179-218.

ILIVEA, J., BARON, S. & HEALEY, N.M. 2002. Online survey in marketing research: pros and cons. *International Journal of Market Research*, 44(3):361-376.

ISHIKAWA, K., OHMICHI, H., UMESATO, Y., TERASAKI, H., TSUKUMA, H., IWATA, N., TANAKA, T., KAWAMURA, A., SAKATA, K., SAINOHARA, T., SUGIMURA, M., KONISHI, N., UMEMOTO, R., MASE, S., TAKESUE, S. & TOOYA, M. 2007. The guidelines of personal health data structure to secure safety healthcare. *International Journal of Medical Informatics*, 76(5):412-418.

INTRONA, L.D. & WHITLEY, E.A. 1997. Against method-*ism*: exploring the limits of method. *Information Technology & People*, 10(1):31-45.

IVES, B., OLSON, M.H. & BAROUDI, J.J. 1983. The measurement of user information satisfaction. *Communications of the Association of Computing Machinery (ACM)*, 26(10):785-793.

IVES, B. 1996. Editor's comments. *MIS Quarterly*, 20(3):xxxvii-xi.

JACOBSON, I., BOOCH, G. & RUMBAUGH, J. 1999. The unified software development process. Boston: Addison Wesley. 463 p.

JACKSON, M.A. 1975. Principles of program design. London: Academic Press. 299 p.

JACKSON, M.A. 1983. Systems development. London: Prentice-Hall.

JANSSEN, P., AUDIT, B., CASES, I., DARZENTAS, N., GOLDOVSKY, L., KUNIN, V., LOPEZ-BIGAS, N., PEREGRIN-ALVAREZ, J.M., PEREIRA-LEAL, J.B., TSOKA, S. & OUZOUNIS, C.A. 2003. Beyond 100 genomes. *Genome Biology*, 4(5):402-4.

JARVIS, C.B., MACKENZIE, S.B. & PODSAKOFF, P.M. 2003. A critical review of construct indicators and measurement model misspecification in marketing and consumer research. *Journal of Consumer Research*, 30(2):199-218.

JASPERSON, J.S., CARTER, P.E. & ZMUD, R.W. 2005. A comprehensive conceptualization of post-adoptive behaviors associated with information technology enabled work systems. *MIS Quarterly*, 29(3):525-557.

JAYASURIYA, R. 1998. Determinants of microcomputer technology use: implications for education and training of health staff. *International Journal of Medical Informatics*, 50(1):187-194.

KERLINGER, F.N. & LEE, H.B. 2000. Foundations of behavioral research. 4th ed. Belmont, CA: Wadsworth. 890 p.

KETTELHUT, M.C. 1992. Strategic requirements for IS in the turbulent healthcare environment. *Journal of Systems Management*, 43(5):6-9.

KETTINGER, W.J. & LEE, C.C. 1994. Perceived service quality and user satisfaction with the information services function. *Decision Sciences*, 25(5):737-766.

KETTINGER, W.J. & LEE, C.C. 1997. Pragmatic perspectives on the measurement of information systems service quality. *MIS Quarterly*, 21(2):223-240.

KEYES, J. 1992. How software is developed undergoing basic changes. *Software Magazine*, 12(1):38-55.

KHALIFA, M. & LIU, V. 2002. Satisfaction with internet-based services. (*In* Proceedings of the 35th Hawaii International Conference on System Sciences. p. 31-50.)

KHALIFA, M. & VERNER, J.M. 2000. Drivers for software development method usage. *IEEE Transactions on Engineering Management*, 47(3):360-369.

KIJSANAYOTIN, B., PANNARUNOTHAI, S. & SPEEDIE, S.M. 2009. Factors influencing health information technology adoption in Thailand's community health centers: applying the UTAUT model. *International Journal of Medical Informatics*, 78(6):404-416.

KIM, B.G., PARK, S.C. & LEE, K.J. 2007. A structural equation modelling of the Internet acceptance in Korea. *Electronic Commerce Research and Applications*, 6(4):425-432.

KIM, H., KIM, T. & SHIN, S.W. 2009. Modelling roles of subjective norms and eTrust in customers' acceptance of airline B2C eCommerce websites. *Tourism Management*, 30(2):266-277.

KIMBERLY, J.R. 1980. Data aggregation in organizational research: The Temporal Dimension. *Organization Studies*, 1(4):367-377.

KING, W.R. & HE, J. 2005. External validity in IS survey research. *Communications of the Association for Information Systems (AIS)*, 16(45):880- 894.

KLINE, R.B. 2005. Principles and practice of structural equation modeling. 2nd ed. New York: The Guilford Press. 366 p.

LAU, A.S.M. & KWOK, V.W.S. 2007. How e-government strategies influence e-commerce adoption by SMEs. *Electronic Government, an International Journal*, 4(1):20-42.

LEAPFROG. 2009. The Leapfrog Group fact sheet. http://www.leapfroggroup.org/about_us/leapfrog-factsheet Date of access: 11 Feb. 2010.

LEDBETTER, C.S. 2003. Leveraging patient data to support clinical practice. (*In* Ball, M.J., Weaver, C.A. & Kiel, J.M., *eds*. Healthcare Information Management Systems. New York: Springer. p. 532-546.)

LEE, A.S. 1999a. Rigor and relevance in MIS research: beyond the approach of positivism alone. *MIS Quarterly*, 23(1):29-33.

1

LEE, A.S. 2001. Editor's comments: research in information systems: What We Haven't Learned. *MIS Quarterly*, 25(4):v-xv.

LEE, A.S. 1999b. Inaugural editor's comments. *MIS Quarterly*, 23(1):v-xi.

LEE, B., BARUA, A. & WHINSTON, A.B. 1997. Discovery and representation of causal relationships in MIS research: a methodological framework. *MIS Quarterly*, 21(1):109-136.

LEE, M.K.O., CHEUNG, C.M.K. & CHEN, Z. 2005. Acceptance of Internet-based learning medium: the role of extrinsic and intrinsic motivation. *Information & Management*, 42(8):1095-1104.

LEE, S. & KIM, B.G. 2009. Factors affecting the usage of intranet: a confirmatory study. *Computers in Human Behavior*, 25(1):191-201.

LEE, T. 2004. Nurses' adoption of technology: application of Rogers' innovation-diffusion model. *Applied Nursing Research*, 17(4):231-238.

LEEDY, P.D. 1997. Practical research: planning and design. 6th ed. Upper Saddle River, NJ: Prentice-Hall. 304 p.

LEGRIS, P., INGHAM, J. & COLLERETTE, P. 2003. Why do people use information technology? A critical review of the technology acceptance model. *Information & Management*, 40(3):191-204.

LEJBKOWICZ, I., DENEKAMP, Y. REIS, S. & GOLDENBERG, D. 2004. Electronic medical record in Israeli's public hospitals. *Israeli Medical Association Journal*, 6(10):583-587.

LEONARD-BARTON, D. 1987. Implementing structured software methodologies: a case of innovation in charting and in direct patient care by staff in the ICU: a review of the literature. *International Journal of Medical Informatics*, 78(7):435-445.

MANGALARAJ, G., MAHAPATRA, R. & NERUR, S. 2009. Acceptance of software process innovations - the case of extreme programming. *European Journal of Information Systems,* 18(4):344-354.

MARASOVIC, C., KENNEY, C., ELLIOTT, D. & SINDHUSAKE, D. 1997. A comparison of nursing activities associated with manual and automated documentation in an Australian intensive care unit. *Computers in Nursing*, 15(4):205-211.

MARCH, S.T. & SMITH, G.F. 1995. Design and natural science research on information technology. *Decision Support Systems*, 15(4):251-266.

MARIANI, C., TRONCHI, A., ONCINI, L., PIRANI, O. & MURRI, R. 2006. Analysis of the X-ray workflow in two diagnostic imaging departments with and without a RIS-PACS system. *Journal of Digital Imaging*, 19(1):18-28.

MARKUS, M.L., MAJCHRZAK, A. & GASSER, L. 2002. A design theory for systems that support emergent knowledge processes. *MIS Quarterly*, 26(3):179-212.

MARSH, H.W. & HAU, K. 1996. Assessing goodness of fit: Is parsimony always desirable?. *Journal of Experimental Education*, 64(4):364-390.

MARTIN, J. & FINKELSTEIN, C. 1981. Information engineering. Carnforth: Savant Institute. 659 p.

MARTIN, J. 1990. Rapid application development. New York: MacMillan. 788 p.

MASULLI, F. & MITRA, S. 2009. Natural computing methods in bioinformatics: A survey. *Information Fusion*, 10(3):211-216.

MASYS, D.R. 1989. Medical informatics: gimpses of the promised land. *Academic Medicine*, 64(1):13-14.

MASYS, D.R, BRENNAN, P.F., OZBOLT, J.G., CORN, M. & SHORTLIFFE, E.H. 2000. Are medical informatics and nursing informatics distinct disciplines? The 1999 ACMI Debate. Journal of the American Medical Association, 7(3):304-312.

MATES, J., BRANSTETTER, B.F., MORGAN, M.B., LIONETTI, D.M. & CHANG, P.J. 2007. Wet reads' in the age of PACS: technical and workflow considerations for a preliminary report system. *Journal of Digital Imaging*, 20(3):296-306.

38(4):217-230.

MOORE, G.C. & BENBASAT, I. 1991a. Development of an instrument to measure the perceptions of adopting an information technology innovation. *Information Systems Research*, 2(3):192-222.

MOORE, G.C. & BENBASAT, I. 1991b. Predicting user intentions: comparing the technology acceptance model with the theory of planned behavior. *Information Systems Research*, 2(3):173-191.

MOORE, G.E. 1965. Cramming more components onto integrated circuits. *Electronics*, 38(8):114-117.

MORRIS, M.G. & VENKATESH, V. 2000. Age differences in technology adoption decisions: implications for a changing work force. *Personnel Psychology*, 53(2):375-403.

MORRIS, M.G., VENKATESH, V. & ACKERMANN, P.L. 2005. Gender and age differences in employee decisions about new technology: an extension to the theory of planned behavior. *IEEE Transactions on Engineering Management*, 52(1):69-84.

MORRISON, J. & GEORGE, J.F. 1995. Exploring the software engineering component in MIS research. *Communications of the Association of Computing Machinery (ACM)*, 38(7):80-91.

MYERS, R. 1990. Classical and modern regression with applications. 2nd ed. Belmont, CA: Duxbury. 488 p.

NERUR, S., MAHAPATRA, R. & MANGALARAJ, G. 2005. Challenges of migrating to agile methodologies. *Communications of the Association of Computing Machinery (ACM)*, 48(5):72-78.

NEWSTED, P.R., HUFF, S.L. & MUNRO, M. 1998. Survey instruments in information systems. *MIS Quarterly*, 22(4):553-554.

NIDOMOLU, S.R. & KNOTTS, G.W. 1998. The effects of customizability and reusability on perceived process and competitive performance of software firms. *MIS Quarterly*, 22(2):105-137.

NILES, H.E. 1922. Correlation, causation and Wright's theory of path coefficients. *Genetics*, 7(3):258-273.

NORRIS, A.C. 2002. Essentials of telemedicine and telecare. New York: Wiley. 177 p.

NUNNALLY, J.C. & BERNSTEIN, I.H. 1994. Psychometric theory. 3rd ed. New York: McGraw-Hill. 752 p.

OLIVER, R.L. 1980. A cognitive model for the antecedents and consequences of satisfaction. *Journal of Marketing Research*, 17(3):460-469.

PFLEEGER, S.L. 1999. Understanding and improving technology transfer in software engineering. *Journal of Systems and Software*, 47(2):111-124.

PINSONNEAULT, A. & KRAEMER, K.L. 1992. Survey research methodology in management information systems: an assessment. Working Paper #URB-022. http://crito.uci.edu/papers/1993/urb-022.pdf Date of access: 11 Feb. 2010.

PITT, L.F., WATSON, R.T. & KAVAN, C.B. 1995. Service quality: a measure of information effectiveness. *MIS Quarterly*, 19(2):173-187.

POPPER, K. 1969. Conjectures and refutations: the growth of scientific knowledge. 3rd ed. London: Routledge & Kegan Paul. 431 p.

POPPER, K. 1978. Three worlds, the tanner lectures on human values. Delivered at the University of Michigan.

POPPER, K. 1980. The logic of scientific discovery. London: Hutchinson. 480 p.

PREMKUMAR, G. & BHATTACHERJEE, A. 2008. Explaining information technology usage: A test of competing models. *Omega*, 36(1):64-75.

PUNCH, K.F. 1998. Introduction to social research: quantitative & qualitative approaches. London: Sage. 319 p.

QUADDUS, M. & HOFMEYER, G. 2005. An investigation into the factors influencing the adoption of B2B trading exchanges in small businesses in Western Australia. (*In* Pacific Asian Conference on Information Systems 2005 Proceedings. p. 44-58.)

QUADDUS, M. & HOFMEYER, G. 2006. Factors influencing the adoption of B2B trading exchanges in small businesses in Western Australia: A Field study Approach. (*In* Pacific Asian Conference on Information Systems 2006 Proceedings. p. 385-400.)

RADEMACHER, R. 2001. The changing profile Of information systems research: 1995-2000. *Journal of Computer Information Systems*, 42(1):13-16.

RAI, A., LANG, S.S. & WELKER, R.B. 2002. Assessing the validity of IS success models: an empirical test and theoretical analysis. *Information Systems Research*, 13(1):50-69.

RALYTÉ, J., DENECKÈRE, R. & ROLLAND, C. 2003. Towards a generic model for situational method engineering, Proceedings of the 15th Conference on Advanced Information Systems Engineering

ROSEMANN, M. & VESSEY, I. 2008. Toward Improving the relevance of information systems research to practice: The Role of Applicability Checks. *MIS Quarterly*, 32(1):1-22.

ROSS, D.T. & BRACKETT, J.W. 1976. An approach to structured analysis. *Computer Decisions*, 8(9):40-44.

ROSSI, M., RAMESH, B., LYYTINEN, K. & TOLVANEN, J. 2004. Managing evolutionary method engineering by method rationale. *Journal of the Association for Information Systems*, 5(9):356-391.

ROWLEY, J. 1998. Towards a methodology for the design of multimedia public access interfaces. *Journal of Information Science*, 24(3):155-166.

ROYCE, W.W. 1970. Managing the development of large software systems: concepts and techniques. *Proceedings IEEE Wescon*. p. 1-9.

RUMBAUGH, J., BLAHA, M., PREMERLANI, W., EDDY, F. & LORENSEN, W. 1991. Object-oriented modeling and design. London: Prentice Hall. 500 p.

RUMPE, B. & SCHRÖDER, A. 2002. Quantitative survey on extreme programming projects. (*In* Proceedings of International Conference on Extreme Programming and Flexible Processes in Software Engineering (XP2002). Alghero. Italy. p. 95-100.)

RUSSO, N., WYNEKOOP, J. & WALZ, D. 1995. The use and adaptation of systems development methodologies. (*In* Khosrowpour, M. *ed.* Managing Information and Communications in a Changing Global Environment. Pennsylvania. Idea Group Publishing.)

SAARINEN, K. & AHO, M. 2005. Does the implementation of a clinical information system decrease the time intensive care nurses spend on documentation of care?. *Acta Anaesthesiologica Scandinavica*, 49(1):62-65.

SAEKI, M. 1998. A meta-model for method integration. *Information and Software Technology*, 39(14):925-932.

SARKER, S. & WELLS, G. 2003. Understanding mobile hand-held device usage and adoption. *Communication of the ACM*, 46(12):35-40.

SALEEM, J.J., RUSS, A.L., JUSTICE, C.F., HAGG, H., EBRIGHT, P.R., WOODBRIDGE, P.A. & DOEBBELING, B.N. 2009. Exploring the persistence of paper with the electronic health record. *International Journal of Medical Informatics*, 78(9):618-628.

of surgery. *International Journal of Gynecology and Obstetrics*, 91(3):210-216.

SHAMLIYAN, T.A., DUVAL, S. DU, J. & KANE, R.L. 2008. Just what the doctor ordered. Review of the evidence of the impact of computerized physician order entry system on medication errors. *Health Services Research*, 48(1):32-53.

SHAPIRO, M.J. & JAY, G.D. 2003. High reliability organizational change for hospitals: translating tenets for medical professionals. *Quality and Safety in Health Care*, 12(4):238-239.

SHIRES, D.B. & BALL, M. 1975. Update on educational activities in medical informatics. (*In* Proceedings of the 5th Annual Conference of the Society of Computer Medicine. Washington.)

SHORTLIFFE, E.H. 1988. The state of the art in medical information sciences. (*In* Kuhn, R.L., *ed.* Frontiers of Medical Information Sciences. New York: Praeger. p. 11-18) .

SHORTLIFFE, E.H. & BLOIS, M.S. 2001. The computer meets medicine and biology: emergence of a discipline. (*In* Shortliffe, E.H., Perreault, L.E., Wiederhold, G. & Fagan, L.M., *eds.* Medical Informatics: Computer Applications in Health Care and Biomedicine. 2n ed. New York: Springer. p. 3-40.)

SHROUT, P.E. & BOLGER, N. 2002. Mediation in experimental and nonexperimental studies: new procedures and recommendations. *Psychological Methods*, 7(4):422-445.

SHULLMAN, A. 2009. Radiology's golden age: this multi-site imaging firm improved patient care and its financial standing through RIS/PACS automation. *Health Management Technology*, 30(2):12-14.

SIEGEL, E. & REINER, B. 2002. Work flow redesign: the key to success when using PACS. *American Journal of Roentgenology*, 178(3):563-566.

SIEMENS. 2009. Siemens to provide 37 hospitals and 300 clinics in South Africa with healthcare IT software. 13 July 2009. http://www.ehealthserver.com/siemens/253-siemens-to-provide-37-hospitals-and-300-clinics-in-south-africa-with-healthcare-it-software Date of access: 11 Feb. 2010.

SIMON, H.A. 1996. The sciences of the artificial. 3rd ed. Cambridge, MA: MIT Press. 213 p.

SITTIG, D.F., ASH, J.S., ZHANG, J., OSHEROFF, J.A. & SHABOT, M.M. 2006. Lessons from "unexpected increased mortality after implementation of a commercially sold computerized physician order entry system". *Pediatrics*, 118(2):797-801.

SMITH, J. 2000. Health management information systems: a handbook for decision makers. Buckingham, Philadelphia: Open University Press.

STRAUB, D.W. 1989. Validating instruments in MIS research. *MIS Quarterly*, 13(2):147-169.

STRAUB, D.W., BOUDREAU, M.C. & GEFEN, D. 2004. Validation guidelines for IS positivist research. *Communications of the Association for Information Systems (AIS)*, 13(24):380-426.

SULTAN, F. & CHAN, L. 2000. The adoption of new technology: the case of object-oriented computing in software companies. *IEEE Transactions on Engineering Management*, 47(1):106-126.

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

TABACHNICK, B.G. & FIDELL, L.S. 2007. Using multivariate statistics. 5th ed. Boston, New York: Pearson. 980 p.

TAYLOR, S. & TODD, P.A. 1995a. Assessing IT usage: the role of prior experience. *MIS Quarterly*, 19(4):561-570

TAYLOR, S. & TODD, P.A. 1995b. Understanding information technology usage: a test of competing models. *Information System Research*, 6(2):144-176.

TEMPLETON, G.F. & BYRD, T.A. 2003. Determinants of the relative advantage of a structured SDM during the adoption stage of implementation. *Information Technology and Management*, 4(4):409-428.

THOMPSON, R.L., HIGGINS, C.A. & HOWELL, J.M. 1991. Personal computing: toward a conceptual model of utilization. *MIS Quarterly*, 15(1):125-143.

THOMPSON, R.L., HIGGINS, C.A. & HOWELL, J.M. 1994. Influence of experience on personal computer utilization: testing a conceptual model. *Journal of Management Information Systems*, 11(1):167-187.

TRIANDIS, H.C. 1971. Attitude and attitude change. New York: Wiley. 232 p.

TRIANDIS, H.C. 1980. Values, attitudes, and interpersonal behavior. (*In* University of Nebraska (Lincoln campus). Department of Psychology. *eds*. Nebraska Symposium on Motivation. University of Nebraska Press. p. 196-259.)

TRUEX, D., BASKERVILLE, R. & TRAVIS, J. 2000. Amethodical systems development: the deferred meaning of systems development methods. *Accounting, Management and Information Technologies*, 10(1):53-79.

VENKATESH, V. 2000. Determinants of perceived ease of use: integrating control, intrinsic motivation, and emotion into the Technology Acceptance Model. *Information Systems Research*, 11(4):342-365.

VENKATESH, V. & DAVIS, F.D. 1996. A model of the antecedents of perceived ease of use: development and test. *Decision Sciences*, 27(3):451-481.

VENKATESH, V. & DAVIS, F.D. 2000. A theoretical extension of the Technology Acceptance Model: four longitudinal field studies. *Management Science*, 46(2):186-204.

VENKATESH, V. & MORRIS, M.G. 2000. Why don't men ever stop to ask for directions? Gender, social influence, and their role in technology acceptance and usage behavior. *MIS Quarterly*, 24(1):115-139.

VENKATESH, V., MORRIS, M., DAVIS, G.B. & DAVIS, F.D. 2003. User acceptance of information technology: toward a unified view. *MIS Quarterly*, 27(3):425-478.

VESSEY, I. 1991. Cognitive fit: a theory-based analysis of the graphs versus tables literature. *Decision Sciences*, 22(2):219-240.

VESSEY, I. & CONGER, S. 1994. Requirements specification: learning object, process, and data methodologies. *Communications of the Association of Computing Machinery (ACM)*, 37(5):102-113.

VESSEY, I. & GLASS, R.L. 1998. Strong vs. weak approaches to systems development. *Communications of the Association of Computing Machinery (ACM)*, 41(4):99-102.

VISHWANATHA, A., BRODSKY, L., SHAHA, S., LEONARD, M. & CIMINO, M. 2009. Patterns and changes in prescriber attitudes toward PDA prescription-assistive technology. *International Journal of Medical Informatics*, 78(5):330-339.

WALKER, A. 2002. Growing older: An ESRC research programme. *Quality in Aging*, 3(1):4-12.

WALLEY, P. & DAVIES, C. 2002. Implementing IT in NHS hospitals - internal barriers to technological advancement. *International Journal of Healthcare Technology and Management*, 4(3):259-272.

WALTER, Z. & LOPEZ, M.S. 2008. Physician acceptance of information technologies: role of perceived threat to professional autonomy. *Decision Support Systems*, 46(1):206-215.

WANG, C.B. 1994. Techno vision: the executive's survival guide to understanding and managing Information Technology. New York: McGraw-Hill.

WONG, D.H., GALLEGOS, Y., WEINGER, M.B., CLACK, S., SLAGLE, J. & ANDERSON, C.T. 2003. Changes in intensive care unit nurse task activity after installation of a third-generation intensive care unit information system. *Critical Care Medicine*, 31(10):2488-2494.

WOOD, J. & SILVER, D. 1989. Joint Application Design: how to design quality systems in 40% lss time. New York: Addison-Wesley. 350 p.

WOODWARD, B. 1995. The computer-based patient record and confidentiality. *New England Journal of Medicine*, 333(21):1419-1422.

WORLD HEALTH ORGANIZATION. 2009. International Classification of Diseases (ICD). http://www.who.int/classifications/icd/en/ Date of access: 11 Feb. 2010.

WRIGHT, D. & ANDROUCHKO, L. 1998. Telemedicine and developing countries, a report of study group 2 of the International Telecommunication Union development sector. *Journal of Telemedicine and Telecare*, 2(2):63-70.

WRIGHT, S. 1934. The method of path coefficients. *The Annals of Mathematical Statistics*, 5(3):161-215.

WU, I. & CHEN, J. 2005. An extension of trust and TAM model with TPB in the initial adoption of on-line tax: an empirical study. *International Journal of Human-Computer Studies*, 62(6):784-808.

WU, J., SHEN, W., LIN, L., GREENES, R.A. & BATES, D.W. 2008. Testing the technology acceptance model for evaluating healthcare professionals' intention to use an adverse event reporting system. *International Journal for Quality in Health Care*, 20(2):123-129.

WU, J., WANG, S. & LIN, L. 2007. Mobile computing acceptance factors in the healthcare industry: a structural equation model. *International Journal of Medical Informatics*, 76(1):66-77.

WYNEKOOP, J.L. & RUSSO, N.L. 1993. Systems development methodologies: unanswered questions and the research-practice gap. (*In* Degross, J., Bostrom, R. & Robey, D. *eds*, Proceeding of the Fourteenth International Conference on Information Systems. p. 181-190.)

WYNEKOOP, J.L. & RUSSO, N.L. 1995. Systems development methodologies: unanswered questions. *Journal of Information Technology*, 10(2):65-73.

WYNEKOOP, J.L. & RUSSO, N.L. 1997. Studying system development methodologies: an examination of research methods. *Information Systems Journal*, 7(1):47-65.

YAMADA, R.H. 1990. Mission critical health care systems. *Business Quarterly*, 55(1):99-104.

Addendum B

NORTH-WEST UNIVERSITY
YUNIBESITI YA BOKONE-BOPHIRIMA
NOORDWES-UNIVERSITEIT

The Use and Effectiveness of System Development Methodologies in Health Information Systems

Instructions

The questionnaire is divided into five segments, namely Demographics, Section One, Section Two, Section Three and Section Four.

Please complete the questions by clicking the relevant radio button or typing text in the applicable textarea. Please note that abbreviation SDM(s) are used extensively for System Development Methodologie(s).

To submit the questionnaire, please click on the SUBMIT button at the bottom of the page.

Demographics

Top

Please specify your age.	[ ] Years
Please specify your gender.	Male
Please specify your educational background.	Secondary/High School
Please specify your organizations business area.	General Health/Hospital/Medical Fund If Other, Please Specify
If active in the health sector, please specify your leading area of specialization.	Hospital Information System If Other, Please Specify
How long have your organization develop software.	[ ] years
Please indicate your organizational size.	0-100
Please indicate your IS department size.	0-10
Please specify the country your are working in.	South Africa If Other, Please Specify
If you are not using a SDM, please specify why not.	

No.	Statement	Disagree Strongly	Disagree	Disagree Slightly	Agree Slightly	Agree	Agree Strongly
12.	Colleagues who influence my behaviour think I should use a SDM.	⊙	○	○	○	○	○
13.	Senior managers in my organization/IS department support the use of a SDM.	⊙	○	○	○	○	○
14.	The IS department I work in is like an extended family.	⊙	○	○	○	○	○
15.	The bond that holds the IS department together is loyalty.	⊙	○	○	○	○	○
16.	The IS department I work in emphasizes staff as vital.	⊙	○	○	○	○	○
17.	The IS department I work in is a dynamic place.	⊙	○	○	○	○	○
18.	The bond that holds the IS department together is commitment to innovation.	⊙	○	○	○	○	○
19.	The IS department I work in emphasizes attaining of new skills/products/services.	⊙	○	○	○	○	○
20.	The IS department I work in is a very formally structured place.	⊙	○	○	○	○	○
21.	The bond that holds the IS department together is formal rules.	⊙	○	○	○	○	○
22.	The IS department I work in emphasizes stability.	⊙	○	○	○	○	○
23.	The IS department I work in is a very productive-oriented place.	⊙	○	○	○	○	○
24.	The bond that holds the IS department together is emphasis on goal accomplishment.	⊙	○	○	○	○	○

No.	Statement	Disagree Strongly	Disagree	Disagree Slightly	Agree Slightly	Agree	Agree Strongly
37.	Using a SDM improves my chances of a promotion.	⊙	○	○	○	○	○
38.	Using a SDM improve my prospects to work for other organizations.	⊙	○	○	○	○	○
39.	Using a SDM fits well with the way I develop software.	⊙	○	○	○	○	○
40.	A SDM is suitable with most facets of my work.	⊙	○	○	○	○	○
41.	Important customers/users requested that a SDM be used.	⊙	○	○	○	○	○
42.	Important customers/users recommended that a SDM be used.	⊙	○	○	○	○	○
43.	Using a SDM is compulsory in my organization/IS department.	⊙	○	○	○	○	○
44.	My manager requires me to use a SDM.	⊙	○	○	○	○	○

Section Three

Top

No.	Statement	Disagree Strongly	Disagree	Disagree Slightly	Agree Slightly	Agree	Agree Strongly
45.	Using a SDM improves adherence to prescribed legal guidelines (e.g., confidentiality, security).	⊙	○	○	○	○	○
46.	My organization is obliged by governmental regulations to use a SDM.	⊙	○	○	○	○	○
47.	My organization employs a SDM as required by specific process maturity models (e.g., CMMI, ISO/IEC 15504 (SPICE)).	⊙	○	○	○	○	○
48.	I intent to use a SDM in the future.	⊙	○	○	○	○	○

	Strongly		Slightly	Slightly		Strongly
60. I enjoy experimenting with new tools and techniques.	⊙	○	○	○	○	○

Section Four

Top

	Greatly Worst Than Expected	Much Worst Than Expected	Worst Than Expected	Better Than Expected	Much Better Than Expected	Greatly Better Than Expected
61. To provide the customer/user with a reliable software product, SDMs were ...	⊙	○	○	○	○	○
62. To provide the customer/user with a maintainable (e.g., interoperable, extendible) software product, SDMs were ...	⊙	○	○	○	○	○
63. To help the organization/IS department produce a high quality software product, SDMs were ...	⊙	○	○	○	○	○
64. To help the organization/IS department improve the management (e.g., control) of the software development process, SDMs were ...	⊙	○	○	○	○	○
65. To help the organization improve its profitability, SDMs were ...	⊙	○	○	○	○	○
66. To help the organization improve its competitiveness, SDMs were ...	⊙	○	○	○	○	○
67. To improve the developer's productivity, SDMs were ...	⊙	○	○	○	○	○
68. To enhance a "share understanding" (e.g., work value, problem-solving approach, ontology) between developers, SDMs were ...						

Addendum C

Dear [Reader],

I am a member of the School of Computer Science, Statistics and Mathematics of the Potchefstroom campus of the North-West University, as well as a PhD candidate, conducting a study to measure the use and effectiveness of systems development methodologies in health information systems.

In the next few days you will receive a request to participate in a web-based survey. The results of this survey will help academics and practitioners in identifying important factors contributing to the acceptance and continued use of systems development methodologies.

It would be greatly appreciate it if you could take a few moments to complete the survey.

Thank you in advance for your time and assistance.

Pieter Conradie
School of Computer Science, Statistics and Mathematics
North-West University
South Africa
[email]
[phone number]

Dear [Reader],

I am a member of the School of Computer Science, Statistics and Mathematics of the Potchefstroom campus of the North-West University, as well as a PhD candidate, conducting a study to measure the use and effectiveness of systems development methodologies in health information systems.

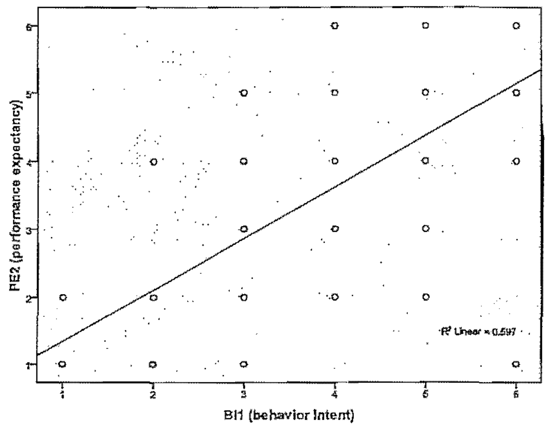
I wrote to you earlier requesting your help with a survey. Your thoughts and experiences are of the utmost importance. It will only take between 10-15 minutes of your time. All personal information is confidential and will not be made public.

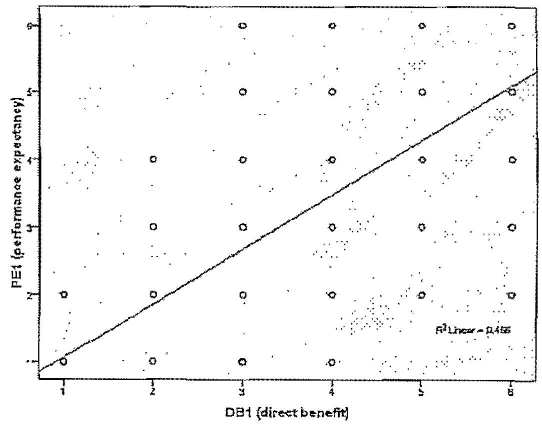
Please complete the web-based survey, your participation is indispensable. The link to the survey is http://www.puk.ac.za/fakulteite/natuur/comp/intro.html.

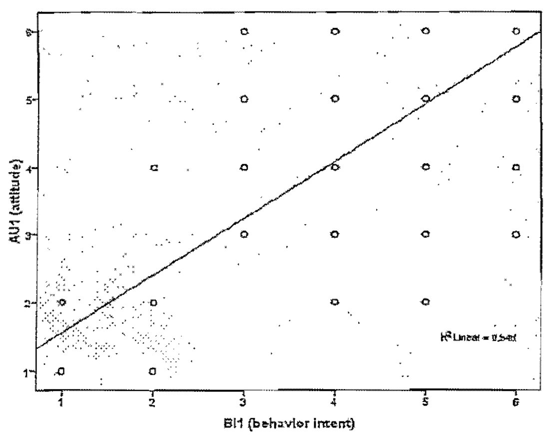
Thank you in advance for your time and assistance.

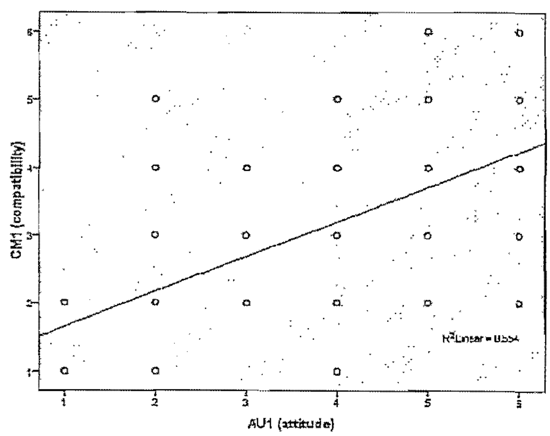
Pieter Conradie
School of Computer Science, Statistics and Mathematics
North-West University
South Africa
[email]
[phone number]

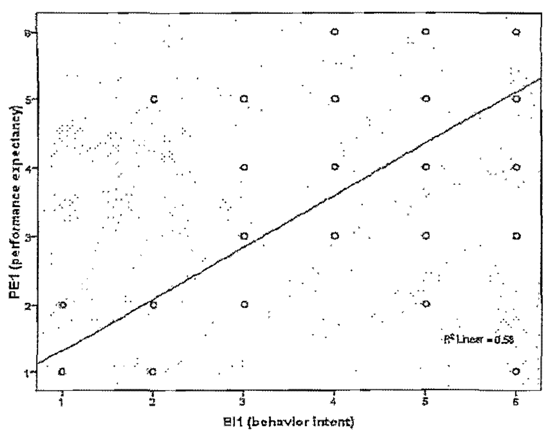
Addendum E

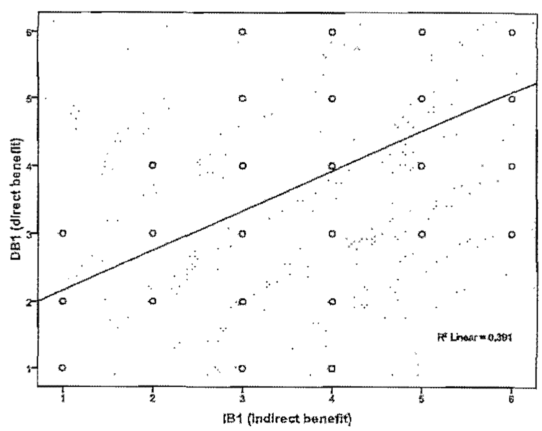

PE2 (performance expectancy)
BI1 (behavior intent)
R² Linear = 0.597


PE1 (performance expectancy)
DB1 (direct benefit)
R² Linear = 0.466


AU1 (attitude)
BI1 (behavior intent)
R² Linear


CM1 (compatibility)
AU1 (attitude)
R² Linear


PE1 (performance expectancy)
BI1 (behavior intent)
R² Linear = 0.58


DB1 (direct benefit)
IB1 (indirect benefit)
R² Linear = 0.391

			Estimate	S.E.	C.R.	P	Label
EX1	<---	Experience	1.073	.073	14.597	***	par_38
CF1	<---	Customer_Confirmation	1.407	.082	17.106	***	par_39
CF2	<---	Customer_Confirmation	1.380	.081	17.124	***	par_40
SF1	<---	Satisfaction	1.369	.089	15.402	***	par_41
SF2	<---	Satisfaction	1.361	.089	15.308	***	par_42
VO2	<---	Voluntariness	1.432	.081	17.605	***	par_43
VO1	<---	Voluntariness	1.417	.078	18.112	***	par_44
AU1	<---	Attitude	1.648	.093	17.766	***	par_45
IB1	<---	Indirect_Benefits	1.211	.078	15.480	***	par_46
IB2	<---	Indirect_Benefits	1.177	.076	15.403	***	par_47
EE1	<---	Effort_Expectancy	1.140	.068	16.808	***	par_48
EE2	<---	Effort_Expectancy	1.069	.071	15.042	***	par_49
UB9	<---	Use	1.978	.121	16.315	***	par_50
SI1	<---	Social_Influence	1.135	.072	15.732	***	par_51
SI2	<---	Social_Influence	.947	.074	12.853	***	par_52
UB5	<---	Use	1.178	.078	15.125	***	par_53
UB1	<---	Use	2.369	.154	15.341	***	par_54
BI1	<---	Behavior_Intent	1.513	.079	19.086	***	par_55
BI2	<---	Behavior_Intent	1.480	.079	18.758	***	par_56
FC2	<---	Facilitating_Conditions	1.107	.073	15.118	***	par_305
FC3	<---	Facilitating_Conditions	1.252	.086	14.611	***	par_306
FC6	<---	Facilitating_Conditions	.783	.064	12.268	***	par_307
FC7	<---	Facilitating_Conditions	.359	.063	5.706	***	par_308
EX2	<---	Experience	1.069	.071	15.042	***	par_331
FC1	<---	Facilitating_Conditions	.441	.059	7.433	***	par_332

			Estimate
CF1	<---	Customer_Confirmation	.904
CF2	<---	Customer_Confirmation	.905
SF1	<---	Satisfaction	.848
SF2	<---	Satisfaction	.844
VO2	<---	Voluntariness	.915
VO1	<---	Voluntariness	.931
AU1	<---	Attitude	.915
IB1	<---	Indirect_Benefits	.859
IB2	<---	Indirect_Benefits	.856
EE1	<---	Effort_Expectancy	.915
EE2	<---	Effort_Expectancy	.848
UB9	<---	Use	.871
SI1	<---	Social_Influence	.899
SI2	<---	Social_Influence	.770
UB5	<---	Use	.829
UB1	<---	Use	.837
BI1	<---	Behavior_Intent	.954
BI2	<---	Behavior_Intent	.945
FC2	<---	Facilitating_Conditions	.831
FC3	<---	Facilitating_Conditions	.812
FC6	<---	Facilitating_Conditions	.716
FC7	<---	Facilitating_Conditions	.371
EX2	<---	Experience	.848
FC1	<---	Facilitating_Conditions	.473