AN EMPIRICAL INVESTIGATION OF FACTORS AFFECTING CLOUD COMPUTING ADOPTION AMONG SMEs IN THE NORTH EAST OF ENGLAND

By

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Declaration

This statement and the accompanying publications have not previously been submitted by the candidate for a degree in this or any other university.

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Acknowledgment

I start this section with the first word revealed in the Quran "Read".

"Read: in the name of your Lord who created. He created man from a clot. Read, and your Lord is the Most Honourable. who taught with the pen. He taught man what he did not know."

This thesis is a result of more than four years of work during which I have been supported and accompanied by many people. Hereby, I would like to express my sincere gratitude to them for their existence through this long and sometimes difficult journey. First and foremost I would like to thank FAMILY. I wish to thank my parents for their unconditional and incredible support. My brother, sisters, and entire extended family were particularly supportive. I am forever indebted to them for their encouragement and support throughout my entire life.

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Related Publications

Refereed Journals

Alshamaila, Y., Papagiannidis, S. and Li, F. (2012) 'Cloud Computing Adoption by SMEs in the North East of England: A multi-perspective framework', *Journal of Enterprise Information Management*.

Refereed Conference Papers

Alshamaileh, Y., Papagiannidis, S. & Li, F. Year. Cloud Computing Adoption: An exploratory Study. In: 8th International Conference on Web Information Systems and Technologies (WEBIST), 2012 Porto, Portugal

Yazan Alshamaila, Savvas Papagiannidis, Teta Stamati. 2013. Cloud Computing Adoption in Greece, The Ukais International Conference on Information Systems. Oxford, England

ABSTRACT:

The growing adoption of cloud computing is changing the way business information systems are developed, scaled up, maintained and paid for. This not only applies to large organisations, but also increasingly to small and medium-sized businesses (SMEs). In particular, cloud computing promises to improve the reliability and scalability of IT systems, which allows SMEs to focus their limited resources on their core business and strategy. In the SME context, technology adoption and usage decisions are influenced by many factors. Despite the extensive literature, there is still limited research related to the factors which impact on SMEs' adoption of Information and Communication Technologies (ICT) innovations. By adopting the Technological, Organisational and Environmental (TOE) Model, this research project attempts to conceptualise cloud computing adoption and to enhance understanding of the range of factors affecting cloud computing adoption decision making in SMEs. This work utilises both qualitative and quantitative research methodologies to meet the research objectives. This study proposes a conceptual framework of SMEs' adoption of cloud computing. Before carrying out a survey to test this model, a preliminary empirical study involving 15 SMEs in the North east of England was conducted in order to specify the factors that can be included within the developed conceptual framework. Our pilot study findings were fed into the second stage of our empirical study involving 184 SMEs in the North East of England. Among the factors examined, relative advantage, uncertainty, innovativeness, and external computing support were found to have significant influence on whether SMEs adopted cloud computing. These findings have important implications and great value to the research community, managers and ICT providers, in terms of formulating better strategies for cloud computing adoption. The research model in this study can improve their understanding of why some SMEs choose to adopt cloud computing services, while seemingly similar ones facing similar market conditions do not.

Keywords: ICT Adoption, Small and Medium Enterprises, Cloud Computing, North East of England

Chapter 1. Study Background

1.1 Rationale and Context of the Study

The relation between SMEs and Information and Communication Technologies (ICT) innovation is mutually beneficial. On one hand, small and medium sized enterprises (SMEs, firms with 1-250 employees) form an essential ingredient of a country's economy as they are the main source of employment and technological development. In the United Kingdom, SMEs represent the vast majority of all enterprises (99% according to BIS (BIS, 2010)), a figure which is not atypical for other countries. The importance of SMEs is widely recognised in relation to the adoption and diffusion of ICT innovations, not only because of the importance of SMEs, but also because of their perceived creative, innovative and adaptive capabilities (Ritchie and Brindley, 2005). Successful SMEs are recognised as being an important component of innovation development and the consequent social benefits for all economies. On the other hand, technological advances and the constant development and deployment of new innovative ICT tools and applications provide many opportunities for SMEs to adopt and therefore benefit from ICTs (Wang *et al.*, 2011). In their study about ICT adoption and implementation, Pavic *et al* (2007) argue that ICT use among SMEs has many favourable consequences: Using innovation, customer responsiveness, efficiency gains and marketing SMEs can achieve a competitive advantage from advances in ICT. In fact, the extensive body of work that has surfaced on the adoption and use of new ICT has made this research stream evolve into one of the richest and most mature research streams in the information systems field (Venkatesh *et al.*, 2003; Jasperson *et al.*, 2005).

In reviewing ICT innovation adoption studies, it is noticeable that this field is constantly evolving and steadily expanding. This is combined with serious challenges associated with the implementation and adoption of ICT systems among organisations in general and SMEs in particular. The nature of the challenge of the adoption and diffusion of ICT innovation has changed dramatically from what it was 30 years ago (Lucas *et al.*, 2007). Today, emerging businesses find themselves in an environment of

rapid technological change. These changes may be a serious threat if ignored by the company, but they may also come to be valuable opportunities where appropriately adopted (Savioz and Blum, 2002). Businesses are not immune to these effects and must find a way of successfully adopting such new technologies. The issues related to maintaining, selecting, updating and managing information and communication technology are particularly challenging for small and mid-size organisations. According to THINKstrategies (2002), various small businesses cannot afford the in-house staff needed to plan, design, implement, and manage increasingly complex software and hardware, and networking kit In today's tough economic times, it is becoming increasingly hard for SMEs to justify such investment and on-going expenses. Many organisations are seeking alternative solutions that can reduce the total ownership costs of their ICT systems, with a few choosing to outsource them to third parties, in order to focus their limited time and resources on their core business. This has led to increased interest in on-demand computing, which often becomes a crucial element of the company's business model. The "*on-demand computing*" notion is considered to be the next strategic innovation on the ICT sourcing horizon. It is based on the same principle as traditional water, power, or other public utilities. Utility computing companies assure their customers will receive scalable IT-related capabilities provided "*as a service*" using Internet technologies to meet their business needs and reduce the running costs of their IT systems.

Central to the discussion of modern business computing is the concept of cloud computing. Cloud computing can be defined as *"a style of computing where massively scalable IT-related capabilities are provided as a service using Internet technologies to multiple external customers"* (Plummer *et al.*, 2008, p. 3). It is becoming increasingly difficult to ignore this trend, and the way in which it can be a key choice for offering cost-effective scalable ICT services. Despite the fact that virtualisation and outsourcing may be considered an early version of cloud, the novelty of cloud computing is the comprehensive method of providing scalable computing technologies as a service using high speed Internet connections (Plummer *et al.*, 2008; Leimeister *et al.*, 2010; Yadav and Zeng Wen, 2010). The results from a CIO survey on business priorities and strategies show that CIOs ranked cloud computing second among the top ten technology priorities in 2010 (Misra and Mondal, 2011). The growing adoption of cloud computing

is changing the way business information systems are developed, scaled up, maintained and paid for. This not only applies to large organisations, but also increasingly to SMEs. In particular, cloud computing promises to improve the reliability and scalability of IT systems, allowing SMEs to focus their limited resources on their core business. However, like any other technology, this type of computing service has a distinct set of problems and challenges associated with it, such as security, availability and lock-in**.** Given that cloud computing services and applications are relatively new, cloud computing lends itself to undertaking research related to adoption, in particular when it comes to SMEs.

Most researchers and stakeholders who are concerned with the adoption and diffusion of new ICT innovations usually focus on certain key questions (Zmud, 2000), for example: the factors that determine the rate, pattern, and extent of the diffusion of an innovation across a population of potential adopters; the factors that determine the general propensity of an organisation to adopt and assimilate innovations over time, and the factors that determine the propensity of an organisation to adopt and assimilate a particular innovation. Similarly, in the context of SMEs, Levy *et al* (2001) asked what makes SMEs different in their adoption of ICT innovations. According to Damanpour (Damanpour, 1991), research on a firm's innovation adoption has been an imperative part of this broad stream of research. After a review of the extensive literature in relation to ICT adoption and diffusion and the meta-analysis studies on the current trends and issues, it is apparent that even with the substantial effort and attention that has been devoted to ICT adoption research (Wang *et al.*, 2011), a number of significant gaps still exists. According to Ramdani and Kawalek (2007), most of the inconclusive findings in this area of research are attributed to factors such as differences in the ICT innovations studied, different methods of data collection, differences in the operationalisation of constructs, and differences in the innovation context. As a result, it is still not clear what makes SMEs different in their adoption of ICT innovations. More specifically, as far as cloud computing adoption is concerned, there is little systematic research into how SMEs proceed with cloud computing adoption, and what the technological, organisational and environmental factors and changes associated with this decision-making process are. Saya *et al.* (2010) point out that while extant research has studied cloud computing architecture (Rochwerger *et al.*, 2009), potential

applications (Liu and Orban, 2008), and costs and benefits (Assuncao *et al.*, 2009), the decision making on the adoption of cloud computing has not been empirically examined.

1.2 Research Objectives

The main aim of this research project is to contribute to a growing body of research on cloud computing, by determining the factors that influence and inhibit cloud computing adoption by SMEs in the North East of England, by empirically assessing a relevant theoretical framework. Part of the rationale for dedicating this effort to studying cloud computing is that this body of work has not reached the level of clarity or shared conceptions of more mature areas of computing (Kushida *et al.*, 2010).

- To develop a conceptual framework that can be used to study firms' adoption of cloud computing services.
- To empirically validate the conceptual framework qualitatively and ensure its validity.
- To identify the factors which encourage or limit the adoption of cloud computing by SMEs by testing the conceptual framework quantitatively with an appropriately-sized sample.
- To discuss the perception of SMEs and influential factors that relate to cloud computing adoption within SMEs in a way that can be applied to, and practically used by, the research community, managers and ICT providers who are interested in the swift adoption of new technologies.

This study has both an academic and practical rationale. This investigation will contribute towards filling the gaps in the ICT adoption literature in general, and the cloud computing adoption literature relating to SMEs in particular, in a number of ways. Following criticism of the limitations and repetitiveness of current ICT adoption research in terms of the theories used, such as Williams *et al.* (2009), who have expressed their concern over the homogeneity of current ICT adoption studies, this study will make use of a theoretical model that holistically considers factors from technological, organisational and environmental perspectives. It has been suggested that

more empirical studies are required to enable healthier understanding of the complex procedures and differentiating factors that affect information systems adoption rate and the impact upon small firms (Martin and Matlay, 2001). According to Martin and Matlay (2001), without suitable understanding, the motivation for ICT adoption and advance will not effectively help small firms' competitiveness. At the same time, the outcome will also be of practical importance and have great value to ICT managers and suppliers, in terms of formulating better strategies for cloud computing adoption. Cloud computing is not only of interest for large businesses, but also for SMEs (Jain and Bhardwaj, 2010). "*Gartner Research expects cloud computing to be a $150 billion business by 2014, and according to AMI partners, small and medium businesses are expected to spend over $100 billion on cloud computing by 2014*" (Sean *et al.*, 2011). As a result, the attention of software vendors has moved to the SME market, offering a vast range of cloud services. If SMEs have access to scalable technologies, they could potentially deliver products and services that in the past only large enterprises could deliver, thus flattening the competitive arena.

1.3 Organisation of the Thesis

The thesis opens with this introductory chapter, setting the stage for the rest of the work. Drawing on the relevant literature, chapter 2 provides an overview of ICT innovation adoption among organisations (distinguishing between SMEs and large enterprises), including the incentives for and barriers to adoption. It also reviews the relevant theories used in ICT innovation adoption and diffusion research in the context of small businesses. Key concepts in ICT innovation diffusion research, such as the ICT innovation diffusion process, types of ICT innovations and adopter categories are highlighted. This chapter also provides a review and assessment of ICT innovation adoption research, with a particular focus on research streams and the domains of ICT innovation adoption and diffusion in the context of small businesses.

After this review of the literature on ICT innovation adoption and diffusion, Chapter 3 develops a conceptual framework that can be used as a theoretical basis for studying SMEs' adoption of cloud computing. The explanatory variables and the developed hypotheses are outlined.

Chapter 4 highlights the two main contexts in this research project. This chapter begins by reviewing the general characteristics and definitions of SMEs; it then continues by discussing the development of cloud computing and related technologies. It also describes the common architecture and components of clouds in detail, discusses the opportunities and challenges of cloud computing, and provides a classification of cloud-based services and deployment models.

Chapter 5, the methodology chapter, looks at the overall research design. This includes a brief review of the research philosophy and a justification for the methodology applied in this research. Key aspects of the research design such as the survey design, the operationalisation of the key constructs, the pilot study and the details of the study's sample are presented in more detail. This chapter also outlines the analysis undertaken.

Chapter 6 is the first of two chapters reporting the empirical results. This chapter, as a preliminary empirical study, tests the conceptual framework developed earlier on a smaller sample of SMEs before carrying out a larger quantitative approach revolving around a survey.

Chapter 7 pays attention to the current level of ICT innovation adoption and the future prospects of cloud computing adoption among SMEs. Survey results of the adopted ICT innovations, adopters and non-adopters of cloud computing and the prospects among SMEs are discussed. This chapter also develops a statistical model that can be used to predict which SMEs are more likely to become cloud computing adopters. Chapter 7 looks specifically at the impact of technological, organisational and environmental factors on SMEs' adoption of cloud computing. These factors are used in a predictive logistic model to test the likelihood of the firm becoming a cloud service adopter.

Chapter 8, the final chapter, brings together the major findings from this research and discusses its contributions to the literature. The implications of these findings on the work of academic researchers, software/hardware vendors, and owners/managers of SMEs are addressed. Finally, the limitations of this study are highlighted and future research avenues are proposed.

Chapter 2. Literature Review

2.1 Introduction

Research into ICT innovation adoption is a continually expanding area, since new technologies are developing constantly (Wang *et al.*, 2011). ICT technologies maintain their persistent march into almost every aspect of the businesses world (Shiels, 2003; Alam and Noor, 2009). Concerns about new ICT innovations make management tasks extremely difficult, because issues regarding the adoption and implementation of new innovations need careful consideration. This chapter reviews ICT innovation adoption among organisations by discussing the incentives for and barriers to adoption, distinguishing between SMEs and large enterprises. It then presents the relevant theories and prior published research on which the development of the conceptual framework was based, including a review of prior ICT innovation adoption research that can be used to predict and understand the adoption and implementation of new products or technologies.

2.2 ICT innovation adoption

A large number of published studies have considered the adoption and diffusion of ICT-based innovations. Many studies consider innovation to be a key element for economic growth and effectiveness (Caldeira and Ward, 2003; Damanpour and Wischnevsky, 2006; Oliveira and Martins, 2011). A clear understanding of innovation can contribute to the practice of management (Van de Ven, 1984). Rogers (2003) defined an innovation as an idea or practice that is perceived as new by the adopting organisation. Damanpour (1991) also defined innovation as "*the generation, development, and adaptation of novel ideas on the part of the firm*". This type of innovation, from an IT perspective, refers to a new practice or operational idea (Lind and Zmud, 1991). Although these three definitions are similar, the one by Lind and Zmud directly sets the definition in the context of information systems and will be used in the rest of this work. In the new global economy, ICT has become a central issue for almost any modern organisation, and is considered a prime tool to enable businesses to compete (Malecki, 1997). Essentially, effective utilisation of ICT products can provide organisations with a strategic advantage and benefits which can positively influence

their competitiveness (Parida *et al.*, 2010). Firms that innovate earlier than others are more likely to obtain significant competitive advantages (Salavou *et al.*, 2004). Several studies have discussed adoption and diffusion concepts (e.g. (Kwon and Zmud, 1987; Rogers, 2003)). In this research project, adoption is defined as the generation, development and implementation of new technology (Damanpour, 1991). Rogers (2003) defined the diffusion of an innovation as the process by which innovations spread to individuals within a firm or firms within a population over time.

In an attempt to categorise IS innovations Swanson (Swanson, 1994) suggested three types in order to better understand the adoption of ICT innovations:

Type one: this is process innovation that improves the efficiency or effectiveness within the ICT function, such as Computer Aided Software Engineering (CASE), Systems programming, data administration, and object-oriented technologies for enhancing the efficiency of a firm.

Type two: this is an innovation that enhances the administrative work processes of firms, such as payroll, accounting systems, and decision support systems.

Type three: this includes innovations such as information and communication technologies embedded in the core technology of a business and which have strategic relevance for enabling firms to gain competitive advantages.

Table 2-1: ICT type and relevant studies. Source Yang et al. (Yang et al., 2007)

Innovation type	ICT	Researchers
Type I innovation	Work station	(Moore and Benbasat, 1991)
	DBMS and DDBMS	(Grover *et al.*, 1997)
	Data administration	(Swanson, 1994)
Type II innovation	Expert systems	(Grover *et al.*, 1997)
	Information centre	(Swanson, 1994)
Type III innovation	Open system	(Chau and Tam, 1997)
	ED1	(Grover *et al.*, 1997)

For instance, database management systems (DBMS) were classified as a type I innovation (See Table 2.1) while executive information systems (EIS) were classified as a type II innovation (Yang *et al.*, 2007). For technology such as e-commerce, it has been argued that this technology basically fits the third type of innovation, for the reason that it is usually embedded in the firms' main business processes or is extending core

business products and services (Al-Somali, 2011). When it comes to cloud computing, this has started to make its way towards changing the landscape of business. Previous studies maintain that cloud computing can be divided into three categories, since it can be applied to the integration of various service-oriented IT resources within an organisation's core business technology (Son and Lee, 2011). As Son and Lee (2011:5) argue:

> "*Cloud's application leads to a wide scope of changes in a firm's business operation, IT management, and strategic use of IT. In the technology aspect, cloud computing aggregates modern IT features (e.g. virtualization, service-oriented architecture, and grid computing) into a new business computing environment in response to the growing need for greater business integration, flexibility, and agility […] which involves the combination of existing technologies in ways that create significantly new products or services. These theoretical perspectives support innovation features pertaining to cloud computing and emphasize its strategic role of business value creation in organisations. Thus, it is useful to investigate the organisational adoption of cloud computing from technological innovation diffusion perspectives.*"

Based on the above, this research project considers cloud computing as falling into the third type of ICT innovations, and investigates the adoption of cloud computing from the perspective of information and communication technology innovations.

2.3 ICT innovation adoption stages

Typically, adoption studies have identified the temporal stages in the innovation process. By dividing organisational innovation into separate stages based on the sequence of the events and the innovation process, adoption studies can be classified according to the nature of each stage (Wolfe, 1994). Although there are variations in the naming of stages between researchers, generally speaking most researchers agree that the process of the innovation adoption can be divided into two major stages—initiation and implementation (Zaltman *et al.*, 1973; Rogers, 2003). The initiation stage consists of all the actions and events leading up to the decision to adopt, including activities concerning problem awareness, data gathering, attitude formation and estimation, and resource attainment. The implementation stage consists of all events involved in putting an innovation into use (Cooper and Zmud, 1990). Owing to the long duration of the initiation and implementation process and the difficulty of collecting longitudinal data, in their studies, most researchers usually try to examine one of these two main stages.

An innovation adoption decision occurs in the initiation phase. During this phase, the organisation gathers the necessary information about the innovation, advances their knowledge and evaluates more deeply whether and how it will be relevant and suitable to the firm, before reaching a decision on whether to adopt the technology or not (Rui, 2007). Since most large firms have adopted many ICT innovations, many studies have investigated the implementation and post-adoption phase (e. g. (Venkatesh and Davis, 2000; Lippert and Forman, 2005; Manju and Thatcher, 2005). However, as the attention of software vendors has moved recently to SMEs offering a vast range of computing services, more research regarding the pre-adoption and initiation phase is therefore needed (Ramdani, 2008).

ICT innovation adoption ladder: Organisations vary in their level of adoption for ICT services. Differences in SMEs' aptitude and motivation make them differ in the way they absorb and implement new innovations. SMEs are a focal part of business that can integrate and apply ICT innovations, mainly because it is easier for them to change direction compared to large firms. Nevertheless, a small percentage of SMEs possess adequate in-house ICT development capabilities, the necessary skilled staff and adequate technical knowledge for adoption (Bharati and Chaudhury, 2006). This makes SMEs vary in the level of adopting ICT services.

Several studies have discussed the idea of an SME adoption ladder (e.g. Zappalà and Gray, 2006; Beynon-Davies, 2007). The adoption ladder usually presents and illustrates a broadly applied technology-push framework that offering a sense of technology adoption and business development in incremental stages motivated by ICT uptake, business benefits and organisational transformation (Mpofu and Watkins-Mathys, 2011). One of the limitations with this explanation is that it describes a relatively complex process in a linear way. Zappalà and Gray (2006, p. 6) argue that *"although the adoption ladder provides a sense of technological progression, it is too linear to describe processes that are often non-linear and very complex… nor does this ladder help in understanding how ICT alters what SMEs can do or the resource implications of successful adoption…There is no indication of the dynamic processes that drive SMEs from one stage to the next".* As shown in Table 2.2, Zappalà and Gray

suggest that more generally, ICT adoption models for SMEs need to take into account both the organisational and external social contexts.

Table 2-2: ICT adoption within SMEs. Adopted from Zappalà and Gray (2006)

Adoption and use of ICT within SMEs		
Individual/ personal	Organisational	Business environmental
Pre-stage. Uninvolved: Indifferent, hostile		
Cultural/life style concerns	Lack of resources, unemployed; sole trader	Low ICT contact, no market demand
Stage 1: Threshold: keen to try ICT; unsure how		
Confident with email, Internet, ready for website	Internal email, sales customer activates, skills productivity issues	Market/ network push ICT use; source of advice not obvious
Stage 2: Beginner: recently online but unsure of where to go next		
Confident with e-mail, Internet, ready for website	Internal e-mail; sales, customer activities; skills productivity issues	Market/ network push ICT use; source of advice not obvious
Stage 3: Intermediate: Internet email, website, no ICT strategy		
Owner grows ICT knowledge, sees benefits of Web, ready to use ICT in admin, and ops	ICT skills and efficiency issues, network benefits	Use of advice and support networks; stronger competition push on costs, access/ delivery issues
Stage 4: Advances: ICT an integral part of business strategy		
ICT capabilities developed; ready for new approaches to business	Knowledge issues; outsourcing; ASP, ICT integrated in systems	Strong competitor and customer ICT skills, clear regulatory and legal frameworks
Stage 5: innovative: capability to exploit ICT strategically in process/product innovations		
Entrepreneurial; high ICT literacy; managers/ workers in effective autonomous working	Sharing corporate culture and vision; knowledge management/ sharing; networked	Strong value chain; Strategic partnership support network; global competition

Despite their significant position in local economies, SMEs had limited possibilities while competing with large-scale enterprises (LSE) on the global market (Kisielnicki, 2008). Barriers to ICT adoption can push firms back to earlier stages of adoption. In addition, barriers to the adoption of ICT are also changing over time and may vary along the adoption ladder (Parida *et al.*, 2010).

2.4 ICT innovations adoption in SMEs

Reviewing and profiling the existing literature on IS/IT adoption and diffusion may assist researchers in a number of ways. One is the identification of currently under-explored research issues, while another is the selection of theories and methods appropriate to their investigation. Together, these represent some of the critical issues to consider when conducting fruitful, original and rigorous research. Moreover, it is also important to identify the existing strengths and weaknesses of the pertinent research streams, promote discussion regarding critical issues in the area, and assist in the identification of alternative theoretical and methodological perspectives (Venkatesh *et al*., 2007; Williams *et al.*, 2009).

In reviewing ICT innovation adoption studies (e.g. Allen, 2000; Moore and Benbasat, 1991; Agarwal and Prasad, 1997; Davis, 1989; Kwon and Zmud, 1987; Williams *et al.*, 2009; Venkatesh *et al*., 2007; Jeyaraj *et al*., 2006; Fichman, 2004; Premkumar, 2003; Rogers, 2003; Lucas *et al.* 2007; Igbaria and Tan, 1997; Wang *et al.*, 2011; Swanson, 1994; Thong *et al*.; 1994), it is noticeable that the field is both constantly evolving and steadily expanding. In fact, the extensive body of work that has surfaced on the adoption and use of new ICT has made this research stream one of the richest and most mature research streams in the information systems field (Venkatesh *et al.*, 2003; Jasperson *et al.*, 2005). After a review of the extensive literature in relation to ICT adoption and diffusion in SMEs, and the meta-analysis studies on the current trends and issues, it is apparent that even with the substantial effort and attention that has been devoted to ICT adoption research (Wang *et al.*, 2011), a number of significant deficiencies still exist. The ICT innovation adoption in SMEs has well-understood limitations, some of which are methodological, while others are more theoretical.

ICT innovation adoption and diffusion research has primarily addressed the **individual acceptance** or rejection of systems in various organisational contexts, leaving organisational use or rejection within and between firms relatively unexplored (Lucas *et al.* 2007). The argument of Lucas *et al.* (2007) relies on the idea that some specific models, such as the TAM model, provide a solid and parsimonious theoretical base for explaining how individuals come to accept and use new IT. In actual fact, TAM reduced the predictors of an individual's intention to adopt a new IT innovation to a

core set of two technology acceptance measures: perceived usefulness and perceived ease of use. Other reasons for the popularity of TAM as the theoretical framework may be linked to the fact that TAM is a theory specifically developed for ICT implementation and adoption research. It is a theory "owned" by the IS research community, in a field in which theories are scarce (Lee *et al.*, 2003, p. 765). Regarding TAM, Korpelainen (2011) argued that its simplicity and parsimoniousness are the main *reasons for its popularity;* however, this has been achieved at the expense of leaving social and organisational factors outside the scope of the theory. The TAM model is considered an influential theory that provides an easy frame for studying individuals' IT adoption/use behaviours, combined with a set of solid measurement tools. As a result, TAM has engendered an explosion of research.

Despite this, however, TAM has discouraged further process studies, as the majority of studies on implementation have been found to make use only of survey methods (Lucas *et al.*, 2007). Williams *et al*. (2009) maintain that there have been a number of reviews and meta-analytic papers published in the area to date. However, perhaps due to the customary inclination of the IS/IT researcher to make use of TAM, almost all the existing studies have primarily focused upon reviewing the literature relating to technology acceptance, rather than on providing a comprehensive review of the broader issue of adoption and diffusion. Also, this overwhelming use of a single theory suggests that IS/IT adoption and diffusion research is gradually moving towards overall homogeneity, and this is a move which is likely to weaken the field of technology adoption research.

According to Rogers (2003), there are inherited biases in innovation adoption and diffusion studies, such as a pro-innovation bias and a recall problem. Furthermore, studies with an interest in technology diffusion and adoption show a strong bias towards assuming that a technological innovation is positive, and therefore conclude that the target population should eventually adopt that new innovation. The research to date has tended to allocate the "blame" for low adoption rates on individuals and firms, rather than on systems or situations (Allen, 2000).

Researchers limit their scope of inquiry by working within single theoretical perspectives (Wolfe, 1994). The innovation process is considered to be a non-linear and

complex process (Zappalà and Gray, 2006); thus, the implementation of a single perspective limits both the scope of a researcher's inquiry and the extent to which he/she can capture the innovation process (Wolfe, 1994). It can be argued that the main theories pay rather limited attention to contextual factors. Indeed, the link between power relations and ICT system use in organisations has been especially neglected. These theories, for example, assume that individuals may choose independently whether to implement the system or not, but, in reality, the implementation by a contemporary organisation of ICT is harmonised and centrally coordinated, with individuals often having little say about the organisation-wide adoption of ICT (Gallivan, 2001; Lee *et al.*, 2003). Benbasat and Barki (2007) state that the use of ICT systems has changed a great deal from the early days of TAM (see also Lyytinen and Damsgaard, 2001), and also suggest that the model does not address social contexts (Korpelainen, 2011). In fact, there is a call for the use of theories that focus on the level of the firm, and which not only consider organisational and environmental contexts, but also individuals. In particular, Klein and Sorra (1996) bemoan the absence of multi-determined, multi-level frameworks to capture the innovation adoption phenomena. A literature-based evaluation of the applicability of these theories to actual ICT innovation adoption behaviour has been conducted and different contexts (e.g. technological, organisational and environmental) are predicted to have an impact on the adoption of new ICT innovations. The technology, Organisation, and Environment (TOE) framework proposed by DePietro *et al*. (1990) is one such model that encompasses these different contexts.

Most researchers and stakeholders concerned with the adoption and diffusion of new ICT innovations usually focus on certain key questions (Zmud, 2000); for example, these may cover: the factors that determine the rate, pattern, and extent of the diffusion of an innovation across a population of potential adopters; the factors that determine the general propensity of an organisation to adopt and assimilate innovations over time; and the factors that determine the propensity of an organisation to adopt and assimilate a particular innovation. Similarly, in the context of SMEs, Levy *et al.* (2001) asked what makes SMEs different in their adoption of ICT innovations.

According to Ramdani and Kawalek (2007), most of the inconclusive findings in this area of research are attributed to factors such as the differences in the ICT innovations being studied, different methods of data collection, differences in the operationalisation of constructs, and differences in the innovation context. As a result, it is still not clear what makes SMEs different in their adoption of ICT innovations. More specifically, as far as cloud computing adoption is concerned, little systematic research has been conducted either on how SMEs proceed with cloud computing adoption, or on the associated technological, organisational and environmental factors and changes linked with this decision-making process. Saya *et al.* (2010) point out that while extant research has studied cloud computing architecture (Rochwerger *et al.*, 2009), potential applications (Liu and Orban, 2008), and costs and benefits (Assuncao *et al.*, 2009), decision making on the adoption of cloud computing has not been empirically examined.

2.5 Incentive and Barriers to ICT innovation adoption among SMEs

2.5.1 Incentives to ICT adoption in SMEs

At the firm and intra-firm level, ICT tools can improve internal and external communication, and make it faster, subsequently improving trading relationships (OECD, 2004; Quayle and Christiansen, 2004). Also, ICT ensures more effective management of the firm's resources and operational costs, including reducing sales, purchasing and operating costs (Kendall, 2001; Riemenschneider *et al.*, 2003). In the context of firm performance and customer services, a number of studies have found that ICT can play a great role in improving the range and quality of services to customers (Daniel and Grimshaw, 2002; Riemenschneider *et al.*, 2003; Quayle and Christiansen, 2004). Implementing ICT in SMEs can improve the quality of decision making in small firms (Malone, 1985), and enhance the activities of analysis, planning and control (Malone, 1985). In her review of ICT adoption and implementation, Korpelaine (2011) argues that ICT use among firms has many constructive consequences, for the reason that it can support interaction and collaboration, workplace learning (Andriessen, 2003), and work performance (Jones and Kochtanek, 2004)). By the same token, several studies (e.g. (Dedrick *et al.*, 2003; Harindranath *et al.*, 2008)) have validated the favourable consequences of using ICT technologies on organisation performance

profitability. These studies also reveal that ICT has an effect regarding intermediate performance measures, such as operational efficiency, cost savings, organisation and process flexibility (Alam and Noor, 2009).

2.5.2 Barriers to ICT adoption in SMEs

Although the SME sector is of increasing significance for its contribution to economic growth, it is argued that different SMEs in different sectors and different regions can be affected by several factors that discourage them from adopting ICT in their daily operations. Parida *et al.* (2010) list some factors that can prevent small firms from actively adopting and using ICT in SMEs. One of the important reasons why SMEs do not adopt ICT services is strongly linked to the perception that it is unsuitable for the nature of their specific business. It is important for a business management team to understand and appreciate the advantage of using specific ICT services. Parida et al. (2010) referred to the special situation of the EU as an example, where, in 2002, a study on SMEs from 19 different countries showed that almost half of the firms in the sample were not using the Internet for trading, mainly because they assumed that the Internet did not suit their product and/or business.

The limited ICT literacy of the owner or employees is another barrier for active ICT usage among SMEs. As discussed earlier, the manager is usually the owner of the business, and s/he has a strong influence on firms' decisions. Therefore, the view of the owner has a great effect on the usage decision for ICT services. This means that an SME is less likely to engage in particular ICT activity, if there is a lack of awareness of the potential of ICT solutions on the owner's side. Even if the financial resources are available, the manager's stance on using ICT tools may hinder the adoption process.

Arguably the most serious barrier to developing an ICT system will be that the associated cost for developing and maintaining the technology system would be higher than the expected benefits. Even if one was to assume that SMEs successfully managed to develop their own systems, this would typically continue to need updating and maintenance, which over time will continue to pose a challenge for the business, especially if they already lack technologically-skilled staff. In addition to the perceived on-going cost, other hidden costs are also likely to occur at any stage. The total perceived and actual cost can easily stretch the typically small SME ICT budgets.

Finally, there is the lack of standards and ICT-related applications for small firms. A variety of ICT service options are supposed to be an advantage in terms of simplifying the adoption of ICT among SMEs as SMEs have many choices to choose from. Difficulties arise, however, when a small business attempts to adopt a certain ICT technology product, and then finds they need to choose and commit to one option from a large group of diverse services provided, even before they are able to foresee the return on their investment. In addition, most advanced ICT tools are designed to fit the needs of large firms; they are most often too complex and expensive for small firms. The Table below summarises the main incentives and barriers.

Table 2-3: ICT innovation adoption-incentives and barriers

	Aspect	Source
Incentives	Improving communication	(OECD, 2004; Quayle and Christiansen, 2004; Peansupap and Walker, 2005)
	Effective management	(Kendall, 2001; Riemenschneider *et al.*, 2003)
	Improving quality of services	(Daniel and Grimshaw, 2002; Riemenschneider *et al.*, 2003; Quayle and Christiansen, 2004)
	Enhancing analysis, planning and control	(Malone, 1985).
	Support for interaction and collaboration	(Korpelainen, 2011)
Barriers	Limited ICT literacy	(Mehrtens *et al.*, 2001)
	Perception that it is unfeasible	(Parida *et al.*, 2010)
	Cost of development and maintenance	(Thinkstrategies, 2002; Parida *et al.*, 2010)
	Lack of standards and ICT-related applications	(Parida *et al.*, 2010)

2.6 Theories about ICT innovation adoption

The study of the diffusion of innovations has a multidisciplinary nature that involves various scientific fields (Rogers, 2003). According to AlQaisi (2009), two key disciplines, psychology and sociology, have had a great influence on the development of models and theories regarding ICT innovation adoption. These two disciplines emphasise technology acceptance behaviour, while the management of information and communication technology focuses on system features relative to technology acceptance. As a result, the adoption and diffusion of ICT innovations has become a heavily studied field. In reviewing ICT innovation adoption studies, it is noticeable that there are important challenges linked with the adoption of new technologies. In

response, many studies have started to investigate the process related to this topic, spawning an extensive literature on the field (Jeyaraj *et al.*, 2006; Korpelainen, 2011). Examples of these are the studies carried out by, for example, Kwon and Zmud, 1987; Moore and Benbasat, 1991; Thong, 1995; Premkumar, 2003a; Rogers, 2003; Ritchie and Brindley, 2005; Jeyaraj *et al.*, 2006; Venkatesh *et al.*, 2007. This extensive body of work that has surfaced on the adoption and the use of new ICT has made this research stream one of the richest and most mature in the information systems field (Venkatesh *et al.*, 2003; Jasperson *et al.*, 2005).

Studies of innovation diffusion have focused on both individual and organisation levels of analysis (Slappendel, 1996). Early literature on innovation diffusion was concerned with the acceptance of new ideas and innovations by independent individuals (Rogers, 2003). As early as in the late 50's developments in the field of innovation diffusion led to a growing interest in organisational innovation, i.e. innovation among organisations (March and Simon, 1958; Zaltman *et al.*, 1973). The field of innovation in organisations was refreshed in the 1980s by the study of new communication technologies (Van De Ven and Rogers, 1988). Damanpour (Damanpour, 1992) argued that large enterprises are more likely to adopt innovation. Process innovation historically seemed to favour the large, bureaucratic firm (Porter, 1998).

Researching ICT innovation adoption and diffusion in SMEs is different from studying adoption in large firms. *"Like any area of academic enquiry, the small firm is distinctive in the nature and kinds of research problems that it presents"* (Beaver and Prince, 2004, p. 35). It is often the case that a theory developed for large firms cannot be implemented in small-business (Thong *et al.* 1996). Small enterprises are not scaled-down versions of large enterprises (Welsh *et al.*, 1982; Thong, 1999). Small firms are not a homogeneous group; they are different and have special characteristics, objectives and qualities (Beaver and Prince, 2004). Small firms often have structures that are simple, but highly centralised (Thong *et al.*, 1996). Structural differences between small and large firms stem from the different frameworks that firms use to operate their business. The structural framework can differ based on the availability of (or substantially less sophisticated) information systems management (Kagan *et al.*, 1990) and also based on the size and the industry in which the firms operate. Previous studies

on ICT deployment have shown that large firms often use ICT infrastructures to harmonise and communicate across different organisational levels and divisions, and have been described as being willing to employ it in their daily operations more intensively; However, SMEs often use ICT for less formal communication (Wong and Sloan, 2004 ; Ramdani, 2008). SMEs tend to concentrate on basic functionalities, such as using electronic mail (e-mail), and also tend to focus on general applications (e.g. off-the shelf systems) to support specific organisational tasks such as administration and accounting (Wong and Sloan, 2004). This can be related to the levels of resource available, which are obviously greater in large firms (Buonanno *et al.*, 2005).

Smaller firms are more dynamic, innovative and responsive to market changes than large ones (Nolan and O'Donnell, 1991). SMEs are often seen as dynamic organisations that are supposed to easily adapt to modern ICT innovations. However, Lumpkin and Dess (Lumpkin and Dess, 2004) identified many reasons that may delay the adoption of ICT, such as a lack of awareness and knowledge. Although extensive empirical research has been conducted in the field of ICT innovation adoption and SMEs, there have been few studies that present a sufficient understanding of the decision–making practices of SMEs. This therefore makes studying ICT innovation diffusion in the SME sector a demanding task.

There are several popular theories and models which have been utilised in examining the nature of the adoption of an innovation by an organisation. Recent reviews of the predictors, linkages and biases in ICT innovation adoption research by Jeyaraj et al. (Jeyaraj *et al.*, 2006) and Williams et al (Williams *et al.*, 2009) have explored the theories and theoretical constructs implemented to investigate the adoption and diffusion of ICTs in different contexts. These reviews demonstrate that a rich, but diverse, body of theoretical and empirical work has been conducted to study the adoption and diffusion of ICT innovations. Williams et al. (Williams *et al.*, 2009) identified and listed approximately 50 theories in the database provided in their paper. The Technology Acceptance Model (TAM) has emerged as the most popular theory, with 88 (29%) studies employing it, followed by the Diffusion of Innovation (DOI) theory, which was used in 49 (16.3%) publications. The third largest category was the Theory of Planned Behaviour (TPB), which was utilised in 17 studies, followed by the

Theory of Reasoned Action (TRA). 47 other theories and 182 theoretical constructs were also recorded from the various studies. The following sections review the theoretical models and empirical studies used in predicting and understanding the adoption of technology innovations.

Ontologically, theories may consider different units of analysis (see Table 2.4), typically the user (micro-level), the firm (meso-level) or the market/innovation (macro-level). For user adoption, a number of models have been proposed in information systems research. Examples of key theories applied to study the adoption of ICT innovation and adoption at the individual level include the following: Theory of Reasoned Action (TRA) (Fishbein and Ajzen, 1975); Theory of Planned Behaviour (TPB) (Ajzen, 2002); Technology Acceptance Model (TAM) (Davis, 1989). The main aim of these models was to determine which factors influence user adoption and usage behaviour (Ndubisi and Jantan, 2003). Examples of key theories applied to study the adoption of ICT innovation and adoption at the firm (meso-level) is the TOE model (DePietro *et al.*, 1990), while DOI has described the diffusion processes at the market/ industry level (Cragg and King, 1993).

Table 2-4: Theoretical models

Theory	Level of analysis	Author
Theory of reasoned action (TRA)	Individual	(Fishbein and Ajzen, 1975)
Theory of planned behaviour (TPB)	Individual	(Ajzen, 2002)
Technology acceptance model (TAM)	Individual	(Davis, 1989)
Unified Theory of Acceptance and Use of Technology (UTA UT)	Individual	(Venkatesh *et al.*, 2003)
Theory on Diffusion of Innovation (DOI)	Organisation / market	(Rogers, 2003)
Resource-based theory (RBT)	Organisation	(Penrose, 1995) (Barney, 1986)
Technology-organisation-environment (TOE) framework	Organisation	(DePietro *et al.*, 1990)
Institutional theory	Organisation	(Selznick *et al.*, 1969)

Given that these are the most important theories in the ICT adoption field and since ICT innovation may be generally referred to as innovation in the organisation, the

application of computing technologies is effectively organisational innovation (Swanson, 1994). Consequently, it is important to review relevant theories and models.

2.6.1 Individual level theories

2.6.1.1 Theory of Reasoned Action (TRA)

The theory of reasoned action is aimed at better understanding the relationships that link human attitude, intentions, and behaviours (Glanz *et al.*, 2008). It operates on the assumption that individuals are usually quite rational and make systematic use of the information available to them (Ajzen and Fishbein, 1980). It is broadly applied to social psychology, which is concerned with the determinants of intended behaviour (Podder, 2010). Ajzen and Fishbein (1980) argue that individuals consider the implications of their actions before they decide to engage or not in a given behaviour. TRA uses behavioural intention (*BI*) as the main dependent construct. In addition to attitude, behaviour (*A*) and subjective norm (*SN*) are the main independent constructs in the model.

The main variables of TRA theory can be explained as follows:

Attitude towards behaviour: this refers to the degree to which performance of behaviour is positively or negatively valued (Ajzen and Fishbein, 1980). It is determined through an assessment of human's beliefs regarding the consequences arising from behaviour and an evaluation of the desirability of these consequences (Eagly and Chaiken, 1993). ***Intention:*** this is an indicator of a person's readiness to perform certain behaviour. Intentions are considered to be the immediate antecedent of behaviour. ***Subjective Norms:*** these deals with the influence of the social environment on behaviour. The term subjective norms is generally understood as an individual's perception that most people who are important to him/her think that he/she should or should not perform the behaviour in question (Ajzen and Fishbein, 1980).

According to TRA, the general subjective norms are determined by the perceived expectations of a specific referent individual(s) or group(s) and by a person's motivation to comply with these expectations. The contribution of the view of any given referent is weighted by the motivation that an individual has to comply with the wishes of that referent (Eagly and Chaiken, 1993). Several studies have considered TRA in terms of

the usage of technologies. For instance, one study by Liker and Sindi (1997) applied the TRA model to measuring attitudes and intention to use expert systems. The model was tested using a cross-sectional self-administered questionnaire completed by adopters and non-adopters in firms in the U.S. Social norms and perceived usefulness were found to predict intentions to use the system. According to Shantanu *et al.* (2003) TRA has to be modified to be relevant for different innovations, for example ERP systems. Sheppard *et al.* (1988) argues that the theory should agree on action, target, context, time frame and specificity in order to predict users' behaviour. Therefore, the main limitation of the theory stems from the assumption that behaviour is under volitional control. Consequently, the theory only applies to behaviour that is consciously thought out beforehand (Al-Qeisi, 2009). In spite of the fine predictability of TRA in many studies, it has become problematic as researchers have reported mixed results on the effect of subjective norms on behaviour attention (Podder, 2010). In an attempt to surmount the lack of elements in this model, Ajzen (Ajzen, 2002) developed the Theory of Perceived Behaviour, which contains perceived behavioural control as an extra element.

2.6.1.2 Theory of Planned Behaviour (TPB)

As a result of the limitations of the theory of reasoned action, Ajzen proposed the theory of planned behaviour. TPB defines central concepts in the social and behavioural sciences in a way that permits prediction and understanding of particular behaviours in specified contexts. Consequently, it is considered as a practical conceptual framework for dealing with the complexities of human social behaviour (Ajzen, 2002). Compared to TRA, TPB contains perceived behavioural control as an extra element that takes into consideration situations where an adopter has less than complete control over the behaviour. This can vary across situations and actions (Ajzen, 2002). As shown in Figure 2.1, individual behaviour is seen to be a function of three kinds of factors: human attitude towards the behaviour, the subjective norms surrounding the performance of the behaviour, and the new element –behavioural control. In defining these antecedents Eagly and Chaiken (1993) summarised them as follows:

Attitude toward behaviour refers to the individual's positive or negative beliefs about performing behaviour. It is determined through an assessment of an individual's

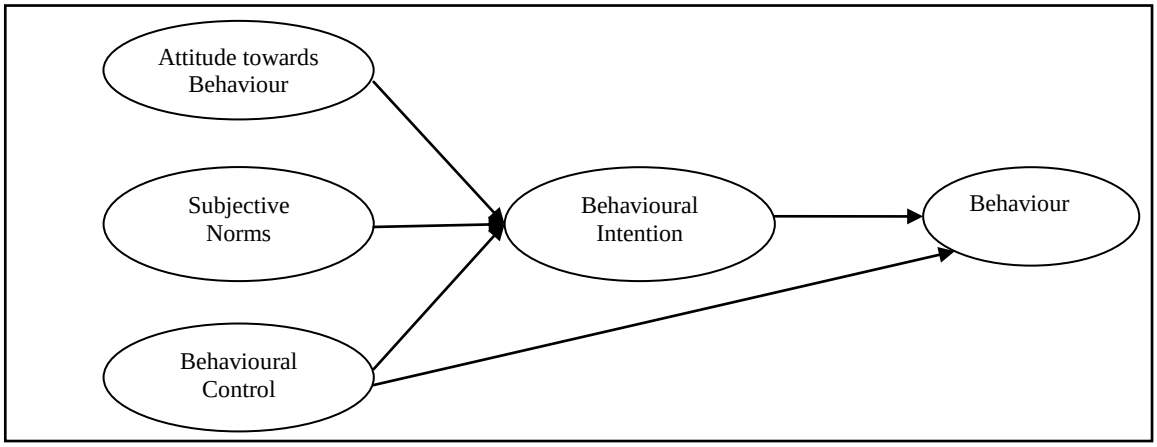
feelings regarding the effect of behaviour and an evaluation of the benefits of these consequences.

Subjective norm refers to one's perception of whether people important to the individual think the behaviour should be executed. The participation of the opinion of any given referent is weighted by the drive that an individual has to comply with the wishes of that referent.

Behavioural control refers to the individual's perception of the difficulty or ease of performing behaviour. This theory views the control that people have over their behaviour as lying on a continuum from behaviours that are easily performed to those requiring considerable effort, resources, and so on. In general, this element was added to include to all the non-controllable factors of the behaviour (Taylor and Todd, 1995).

Altogether, perception of behavioural control, attitude toward the behaviour and subjective norm are expected to initiate a behavioural intention for adopters. Typically, users execute their intention while they have full control to perform it. However, users sometimes face difficulties in acting in line with their intentions. This was the justification for adding the perceived behavioural control to the behavioural intention in this model. Together, intentions and behavioural control are important factors in the prediction of the dependent variable in this theory -the user behaviour.

Figure 2-1: TPB Model. Source: Ajzen (1991)



Several studies have considered TPB theory in relation to the use of technologies (e.g. Brown and Venkatesh, 2005; Riemenschneider and McKinney, 2001; Workman,

2005). For instance, in his study, Workman (2005) applied the TPB model to formulate hypotheses about the use, disuse, and misuse of an expert system decision support technology. The findings reported that positive attitudes and greater perceived control led to increased system use. In another study by Liao et al. (1999), jointly with the diffusion of innovation theory, this theory was applied to investigate the intention to adopt virtual banking. TPB theory was only moderately appropriate in predicting the adoption intention of virtual banking in the research setting. Only the hypothesis related to attitude towards virtual banking and subjective norms about virtual banking was supported. According to Mathieson et al. (2001), TPB requires different measures for the different situations / innovations to which it can be applied. In general, TPB can be used to study different innovations and it is not specific to any one type of innovation.

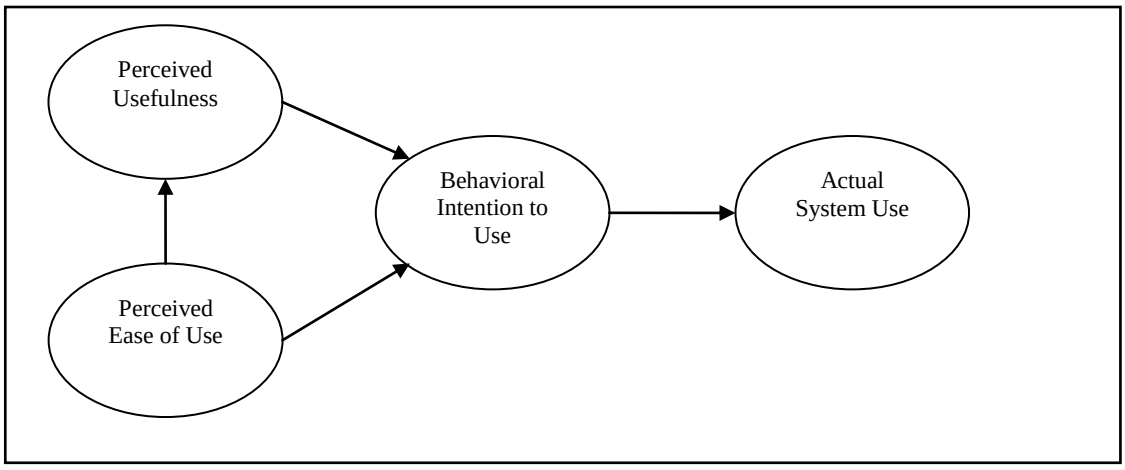
When it comes to the limitations of TPB, Ajzen (1991) assumed that behavioural control is in line with Bandura's self-efficacy concept (Bandura, 1977) in social cognitive theory. This point has been critiqued by Armitage and Conner (2001), who argued that self-efficacy is more concerned with the cognitive perception of control (based on internal control factors) while behavioural control explains general external issues (Armitage and Conner, 2001; Al-Qeisi, 2009). In his study to test TPB, Sniehotta (2009) identified a number of key shortcomings in this model. Firstly, he reported that one of the major criticisms of TPB is that it does not specify techniques to modify hypothesised cognitive determinants of intention and behaviour. Another problem with this model is that possible changes in beliefs will be attenuated through the hypothesised causal chain of events from beliefs, to intention, to behaviour caused by the imperfect empirical relationships between these variables. Nor does TPB account for intention / behaviour discrepancies (Sniehotta, 2009). For instance, Eagly and Chaiken (1993) reported examples for other factors, such as perceived self-identity and habit, which may predict intentions and behaviour. Finally, the most important of these criticisms is that the TBP fails to classify detailed elements that might predict behaviour. In other words, presenting behavioural control as an element that can include all non-controllable factors of the behaviour is not practical (Taylor and Todd, 1995). Based on previous studies, the DTPB extends the TPB by adding the relative advantage, compatibility, and complexity factor that has a direct influence on IT usage (Moore and Benbasat, 1991; Taylor and Todd, 1995; Al-Qeisi, 2009). By adding these elements

from the Innovation Diffusion Theory (DTI), Taylor and Todd (1995) claimed that the DTPB may be used as a tool to affect certain aspects of behaviour that managers might need to change through systems design and marketing adoption strategies. However, Podder (2010) pointed out that DTPB increased complexity compared to the small improvement in the predictive power.

2.6.1.3 Technology Acceptance Model (TAM)

The Technology Acceptance Model (TAM) is considered one of the key theories that provide a theoretical base for adoption, and it was modified to fit the information technology context (Davis, 1989; Davis *et al.*, 1989). Founded on the theory of reasoned action (TRA), this model was designed to further explain technology adoption and usage among individuals. The TAM theorises that both perceived usefulness and ease of use are significantly correlated with self-reported indicants of system use.

Figure 2-2: TAM Model. Source: Davis et.al. (1989).



Compared to the TRA, TAM replaces attitude beliefs with two main factors that affect users' decisions when they are presented with a new technology and their decision regarding how and when they will use it (see Figure 2-2 above). **Perceived usefulness** refers to "*the degree to which a person believes that using a particular system would enhance his/her job performance*", while **Perceived ease of use** refers to "*the degree to which a person believes that using a particular system would be free from effort*" (Davis, 1989).

Gentry and Calantone (2002) found that TAM is superior for explaining variance in behavioural intention within a procurement context, and the authors believe that this is at least partially due to TAM's use of two specific beliefs that apply to all attitudes in varying contexts. An important point to note is that, although TAM has been widely used to explain technology acceptance by users, there has been increasing concern about the appropriateness and comprehensiveness of TAM. A few scholars have criticised the model for its assumption that perceived ease of use and perceived usefulness are always the primary determinants of users' acceptance of technology systems (Park *et al.*, 2007). For example, Davis (1989) argues that studies should investigate more determinants that may also have an impact on perceived ease of use and perceived usefulness, and this could also improve the model's predictive power with the purpose of enriching the explanation of the adoption of technology innovations. Therefore, researchers conclude that the predictive power of TAM is limited, hard to increase and should be extended to include additional constructs to better explain the behavioural intention to use information systems (Legris *et al.*, 2003; López-Nicolás *et al.*, 2008). Venkatesh *et al.* (2003) point out that, unlike TRA, the final conceptualisation of TAM eliminates the attitude factor as an attempt to describe intention parsimoniously. TAM continues to evolve, with new determinants being presented as external determinants, as discussed in the following section.

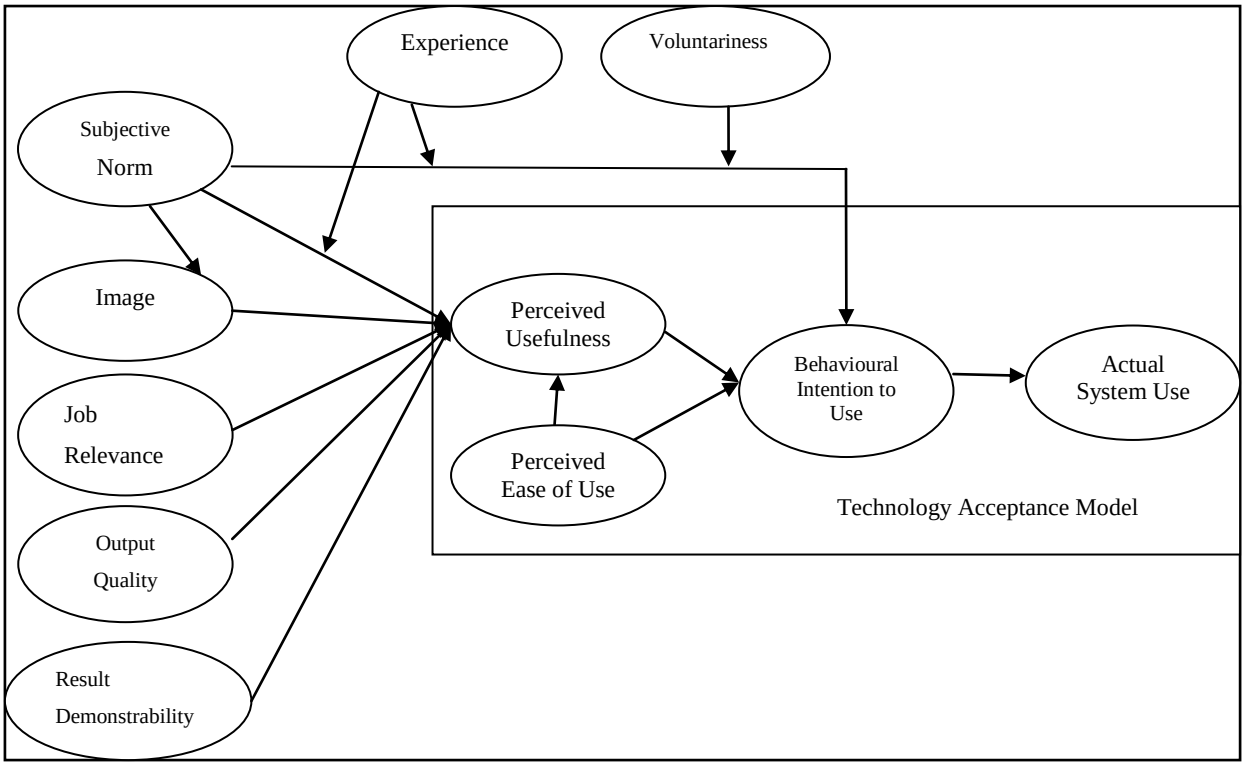
2.6.1.4 Extension of the Technology Acceptance Model (TAM2)

TAM2 extends TAM by adding subjective norm as a key supplementary factor that has a direct influence on intention in the case of a mandatory setting (Park, 2009). It can be seen from Figure 2.3 that TAM2 encompasses both social influence processes (subjective norm, voluntariness, and image) and cognitive instrumental processes (job relevance, output quality, result demonstrability, and perceived ease of use).

Definitions for the new constructs are as follows: **Voluntariness** as a moderating variable is defined as "*the extent to which potential adopters perceive the adoption decision to be non-mandatory*" (Venkatesh and Davis, 2000) p. 188). **Image *is*** defined as "*the degree to which use of an innovation is perceived to enhance one's status in one's social system*" (Moore and Benbasat, 1991, p. 195). **Job relevance** is defined as an individual's perception regarding the degree to which the target system is applicable

to his or her job. In other words, job relevance is a function of the importance of one's job to the set of tasks the system is capable of supporting (Venkatesh and Davis, 2000). **Output Quality** is defined as the degree to which person believes that the system performs job tasks, and how well the system performs those tasks (Venkatesh and Davis, 2000). **Subjective norm** is defined as a "*person's perception that most people who are important to him think he should or should not perform the behaviour in question*" (Fishbein and Ajzen, 1975, p. 302). **Result demonstrability** is defined by Moore and Benbasat as the "*tangibility of the results of using the innovation*" (Moore and Benbasat, 1991, p. 203).

Figure 2-3: TAM2; Source: (Davis et al., 1989) and (Venkatesh, 1999).



As Davis' TAM incorporates findings from the information systems literature, its use is becoming widespread in the diffusion of innovation literature. Numerous studies in many disciplines have applied TAM and TAM2 models. For example, Ndubisi and Jantan, 2003 (2003) tested the applicability of the TAM model to investigate the impact of technical backing, and computing skill, as anchors to perceptions of usefulness and ease of use, in determining information system usage by small businesses. The results of

the study showed that a positive relationship was found between technical backing and computing skill on one side, and information technology acceptance directly and indirectly via perceived usefulness and ease of use on the other. The researchers claimed that TAM can be used as a useful tool to illustrate the association between adopters' perceptions of the benefits and usability of their system.

Agarwal and Prasad (1999) attempted to investigate the impact of Individual Differences on the Acceptance of New Information Technologies. The authors considered that individual difference factors are essential in innovation acceptance. The main aim for this study was to understand the acceptance process by developing a theoretical framework and empirically testing it on the end users of an information technology innovation. Hence, Agarwal and Prasad started by demonstrating the acceptance process by hypothesising a theoretical model in which the relationship between individual differences and technology adoption was proposed to be mediated by the constructs of the technology acceptance model. The outcome established the rudimentary structure of the framework, this involve the mediating position of beliefs. In addition, the finding suggested that through perceived ease of use, several individual difference variables, such as individuals' roles with respect to technology (provider versus consumer), their level of education, and their prior experiences with similar technologies, have important effects on TAM's beliefs (Agarwal and Prasad, 1999).

on TAM's beliefs (Agarwal and Prasad, 1999).

Limitations of the TAM: Many writers have challenged Davis's model on the grounds that the major criticisms to TAM theory is that it presents only limited guidance about how to influence usage through design and implementation (Taylor and Todd, 1995; Venkatesh *et al.*, 2003). Another limitation with this model is the link between individual reactions to using information and intentions. In reality, an adopter may take into consideration many factors that in turn could influence his intention and/ or his decision, yet TAM specifies only a few factors for acting (Bagozzi, 2007). According to Bagozzi (2007), this approach fails to take the group, cultural, or social aspects of technology acceptance into account. Bagozzi (2007, p. 247) argues that:

> *"Much of human behaviour is not best characterized by an individual acting in isolation. To be sure, we sometimes act seemingly as individuals spontaneously, deliberatively, or in response to social pressure. But perhaps*

more often than not we act interpersonally, or as agents of organisations, or jointly with others, or in a holistic sense as members of collectives. Decisions with regard to technology acceptance and actual usage are often done collaboratively or with an aim to how they fit in with, or affect, other people or group requisites."

As can be seen from Table 2.5, a large and growing body of literature has investigated the diverse theories and theoretical constructs that exist, with a noticeable focus on the TAM model, and its constructs. This may lead to gradually moving towards overall homogeneity in ICT adoption studies and, consequently, this may weaken the field of technology adoption research. Based on this argument, Williams *et al.* (2009) suggest that authors, alongside journal reviewers and editors, need to work on greater use of the theoretical and methodological variety available to them, in order to prevent diffusion research from focusing on a limited domain.

Table 2-5: Examples of theory-based studies

Theory		Ref	Studies
TRA	**Main dependent construct(s)/factor (s):** Behavioural Intention, Behaviour **Main independent construct(s)/factor (s):** Attitude toward Behaviour, Subjective Norm,	(Liker and Sindi, 1997)	This research applied the TRA model to discuss user acceptance of expert systems. The model was tested using a cross-sectional design based on a self-administered questionnaire.
		(Mykytyn Jr and Harrison, 1993)	This research applied the TRA model to discuss the acceptance of strategic information systems by senior management.
		(Shantanu *et al.*, 2003)	This study applied the TRA model to discuss and evaluate user participation and involvement in the context of enterprise resource planning (ERP) systems. This study also examines the differences in the nature of user participation and involvement in ERP compared to other information systems.
		(Celuch *et al.*, 2004)	In this research project two attitudinal models adapted from the TRA were compared, which includes attitude and subjective norm components, and the TPB, which includes TRA facets and also examines a decomposed perceived behavioural control construct that consists of self-efficacy and perceived control.
TPB	**Main dependent construct(s)/factor (s):** Behavioural Intention, Behaviour **Main independent construct(s)/factor (s):** Attitude Toward Behaviour,	(Bobbitt and Dabholkar, 2001)	This research applied the TPB model to understand and predict the use of technology-based self-service. The proposed conceptual model contributed to better understanding of user decisions related to using technology-based self-service by thoroughly examining underlying consumer attitudes.
		(Brown and Venkatesh, 2005)	This research applied the TPB model to provide a more thorough understanding of the comparative factors involved in the process by

	Subjective Norm, Perceived Behavioural Control		which the life cycle stages govern and moderate the adoption of technology in the household.
		(Riemen-schneider and McKinney, 2001)	This research applied the TPB model to analyse variances in the beliefs of small firms executives about the implementation of Web-based electronic commerce. This research compared the beliefs of small business executives that had previously implemented Web-based electronic commerce and those who had not yet adopted it.
		(Chau and Hu, 2001)	This research project set out to discuss Information technology adoption by individual professionals. It represents a conceptual replication of earlier model comparison studies. The particular models under examination were the TAM, the TPB, and a decomposed TPB model, possibly suitable in the targeted healthcare professional setting.
		(Workman, 2005)	The theory of planned behaviour was applied in this study to formulate hypotheses about the use, disuse, and misuse of an expert system decision support technology.
TAM	**Main dependent construct(s)/factor (s):** Behavioural Intention to Use, System Usage **Main independent construct(s)/factor (s):** Perceived Usefulness, Perceived Ease of Use	(Dennis *et al.*, 1992)	In this investigation, the aim was to assess the results of two studies that replicated former study by Fred Davis on the issue of perceived usefulness, ease of use, and usage of information technology. The two studies emphasised on evaluating the psychometric properties of the ease of use and usefulness scales, while studying the association between usefulness, ease of use, and system usage.
		(Agarwal and Prasad, 1999)	This study applied the TAM model to propose a theoretical model of the relationship between individual differences and IT acceptance.
		(Chau and Hu, 2001)	This research discusses Information technology acceptance by individual professionals. It offers a conceptual replication of several previous model comparison studies. The particular models under investigation were the TPB, TAM and a decomposed TPB model, potentially suitable for the targeted healthcare professional setting.
		(Venkatesh *et al.*, 2002)	Based on Venkatesh and Speier (1999), the investigation was designed to reanalyse the results from both studies to improve an integrated framework of technology acceptance. The integrated framework specifically studied the influence of pre-training and training environment interventions (termed user acceptance enablers) to know how client perceptions are shaped prior to system implementation.
		(Taylor and Todd, 1995)	In this research, the TAM Model and two variations of the Theory of Planned Behaviour were compared to measure which model best helps to understand the adoption of information technology.

2.6.1.5 The Social Cognitive Theory

Social cognitive learning theory addresses the issue that provides a model for understanding, predicting, and changing human behaviour. It suggests that observational or social learning focuses on four important components of the behaviour that is being modelled. These are attention, retention, behaviour production, and motivation. Four major constructs for Social cognitive learning theory have been identified by Gibson (2004). Descriptions of the constructs are as follows:

Attention: Individuals have to attend to the main elements of the modelled behaviour in order to learn from observation. Attention can be affected by a number of determinants including one's characteristics such as sensory capacities, arousal level, past reinforcements. **Retention** is remembering what the individual paid attention to. Consequently, individuals may represent the response patterns in memory in symbolic form, either imaginably or verbally. **Behaviour production:** These processes involve reproducing observation in action. Given that individuals have the physical capabilities to respond appropriately, these actions would be employed to progressively amend to fit the model. **Motivation:** Individuals are more likely to adopt a new behaviour, if it indicates it will result in an optimistic outcome. People consider that if the modelled behaviour has received reinforcement, they will most likely receive reinforcement as well. Reinforcement also provides a motive or inducement to convert learning into behaviour (Gibson, 2004).

A framework based on the Social Cognitive Theory was developed by Compeau and Higgins (1995), in order to study the factors that can directly and indirectly affect performance on computer tasks. These factors were prior performance, outcome expectations, computer self-efficacy, and behaviour modelling. The results of this study indicated that behaviour modelling is positively connected with computer self-efficacy. In general, social cognitive theory is considered a useful tool for predicting both individual and group behaviour as it explains the methods by which behaviour can be modified or changed (Jones, 1989).

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

UTAUT aims to produce a unifying model of users' technology acceptance. This model was formulated by Venkatesh et al (2003) by reviewing and comparing dominant

models such as the TRA, TAM and TPB, all of which have been used to explain technology acceptance behaviour. As shown in Table 2.6, the theory holds that four key constructs of intention and usage are significant: performance expectancy, effort expectancy, social influence, and facilitating conditions. These constructs are considered direct determinants of usage intention and behaviour.

Table 2-6: UTAUT key constructs

Key Construct	Definition	Constructs from behavioural theories
Performance expectancy:	*"The degree to which an individual believes that using the expectancy system will help him or her to attain gains in job performance" (Venkatesh et al., 2003, p. 447).*	Five constructs from behavioural theories contribute to performance expectancy are: perceived usefulness (TAM/TAM2 and combined TAM -TPB), extrinsic motivation from Motivational Model, job-fit from Model of PC Utilisation, relative advantage (DOI), and outcome expectancy (SCT).
Effort expectancy:	*"The degree of ease associated with the use of the system"* (Venkatesh *et al.*, 2003, pp. 450)	Three constructs from behavioural theories that contribute to the performance expectancy concept are: perceived ease of use from the TAM, and complexity from MPCU and ease of use from DOI.
Social influence:	*"The degree to which an individual perceives that important others believe he or she should use the system"* (Venkatesh *et al.*, 2003, p. 451).	This definition captures three different constructs in existing models: subjective norms from (TRA, TAM2, TPB/DTPB, and combined TAM-TPB), social factors from (MPCU), and image from (DOI).
Facilitating condition:	*"The degree to which an individual believes that a Conditions organisational and technical infrastructure exists to support use of the system"* (Venkatesh *et al.*, 2003, p. 453).	This definition captures three different constructs in existing models: perceived behavioural control (TPB/DTPB and combined TAM-TPB), facilitating conditions (MPCU), and compatibility (DOI).

Based on the literature, the basic concept underlying this model is that users will form various beliefs and attitudes regarding the technology. As a result, this will influence their intentions to utilise specific technology and, in turn, this will have an impact on their actual use of the technology (Garfield, 2005). In their major study Venkatesh *et al.* (2003) claimed strong support for the UTAUT based on results from subsequent validation of UTAUT in a longitudinal study. They maintained that the new model (UTAUT) explains as much as 70% of the variance in usage intention. Several studies have considered the UTAUT model to discuss and test the invariance of the new measurement scale of the UTAUT instrument. For instance, the UTAUT model was used in finding out the perceptions users had of the mobile service in Northern Finland (Koivumki *et al.*, 2008). The researchers tried to examine how

different constructs assisted in the use of mobile services. The constructs included were: time of use, , prior experience with the mobile device and consumers' technology skills, influence on clients' perceptions of performance expectancy (usefulness) of the services, social influence, effort expectancy (ease of use), attitude towards the services and the intention to use the services again (Koivumki *et al.*, 2008). The results showed that time that clients spent using the devices did not affect his perception, but prior experience with the devices and user skills did have an impact. In another study (Verhoeven *et al.*, 2010), the model proved to be successful for the explanation of the different ICT skills but less so for the explanation of different frequencies of computer use. Relying on the basic constructs of UTAUT (performance expectancy, effort expectancy, anxiety, and facilitating conditions), gender or social class, and domain of study of the students, Verhoeven *et al.*, (2010) attempted to explain the varying frequencies of computer use and the differences in ICT skills in secondary school and in university.

When it comes to the limitations of UTAUT, perhaps the most important one is the large number of independent variables. According to Bagozzi (2007, p. 245) "*the exposition of UTAUT is a well-meaning and thoughtful presentation. But in the end we are left with a model with 41 independent variables for predicting intentions and at least eight independent variables for predicting behaviour*". He argues that this kind of contribution to the study of ICT adoption has reached a stage of chaos.

2.6.2 Organisation level theories

2.6.2.1 Institutional theory

According to Scott (2001), there has been little agreement on the definition of an "*institution*". In his attempt to define the term he assumed that that institutions are social structures that have reached a high level of resilience. Commonly, institutions are combined of cultural-cognitive, regulative elements and normative that, side by side with linked resources and activities, offers constancy and meaning to social life. The roots of institutional theory run deeply through the formative years of the social sciences (Scott, 2004). In this theory structures, including schemas, rules, norms, and routines, are used to considers the processes, and it become known as authoritative standards for social behaviour. It reviews how these features are shaped, diffused,

adopted, and adapted over period of time, and how they fall into decline and disuse (Ritzer, 2005). As noted before, Scott (2001) asserts that institutions consist of three pillars (structures): cognitive, normative and regulative structures. The cognitive pillar presents the rules that constitute the nature of reality and the frames through which meaning is made. For instance, symbols, signs and words have the effect of making sense of the on-going stream of happenings by shaping the meaning we attribute to objects and activities. The second pillar comprises a normative structure by which compliance is obtained through social obligation, and it specifies how things should be done through defining goals or objectives (e.g. winning the game or adopting a technology). The third pillar provides the basis of coercive power and it presents institutions' constraints and regularises behaviour. Moreover, regulative processes involve the capacity to establish rules, inspect or supervise others' conformity to them and rewards or punishments in an attempts to influence future behaviour. All these pillars have been identified by one or another social theorist as vital components of institutions. The institutional notion rejects the assumption that organisational phenomena are the products of rational choice based on technical considerations (Al-Somali, 2011). Rather, institutional influences both allow and constrain action. Institutionalists view an organisation as an active unit that is capable of responding in a strategic and innovative way to environmental pressures (Orlikowski and Barley, 2001). A number of studies across the social sciences have used institutional theory to examine the structure and behaviour of organisations (e.g. Orlikowski and Barley, 2001; Swanson and Neil, 2004).

Drawing upon institutional theory, a recent empirical study (Jan *et al.*, 2012) involving 172 subjects was conducted to examine three social environmental factors of coercive, normative and mimetic pressures within the e-learning context. The results indicate that two types of institutional forces, normative and mimetic, have a significant influence on attitude and intention to use e-learning, while coercive pressures appear not to do so. For organizations, the results suggest that training managers may need to build an e-learning community to create normative expectations and provide success stories of high profile employees' e-learning experiences to promote the adoption of their e-learning. In another study, Zheng's (2010) research was based on the fruit of information system adoption in business firms, and analyses the different essence

between firm and administration organization, exploring the mechanism of information systems and public organization institutions. The research constructs the e-government adoption model based on the institutional theory, and the final results were: the factors of organization commitment, group culture and superior coercive pressure are the most important factors influencing the information systems adoption decision.

2.6.2.2 Resource-Based Theory (RBV)

RBV has come to explain how firms can gain a sustainable competitive advantage by the exploitation of core competencies (for instance competencies, assets, know-how and capabilities) (Caldeira and Ward, 2003). In the economic literature, Penrose (1995, p. 24) presented a comprehensive explanation of RBV:

> *"A firm is more than an administrative unit; it is also a collection of productive resources, the disposal of which between different users and over time is determined by administrative decisions. When we regard the function of the private business firm from this point of view, the size of the firm is best gauged by some measure of the productive resources it employs"*.

The resource-based view (RBV) assumes that businesses have resources, a subset of which enables them to achieve a competitive advantage, and a subset of those that lead to superior long-term performance (see (Barney, 2001)). However, these resources need to fulfil the following criteria (referred to as VRIN) (Barney, 2001; Kristandl and Bontis, 2007):

Valuable: A firm's resources need to be able to increase revenues or reduce costs compared to what would have been the case if the firm did not own those resources (Barney, 2001); that is, it has to be able to generate a sustainable value for a firm (Kristandl and Bontis, 2007). **Rare**: Resources have to be heterogeneously distributed across companies. That is to say, they should not only be accessible to competitors (Kristandl and Bontis, 2007). **Inimitable**: Resources have to be incapable of being duplicated and not to be easy for competitors to copy them (Barney, 2001). **Non-substitutable** (non-transferable): Competitors should not have equivalent resources in order to substitute an otherwise inimitable resource (Kristandl and Bontis, 2007).

These resources and capabilities can be physical assets, human capital and organisational capital. Physical capital includes tangible resources such as financial

resources, technology, and machinery (Al-Somali, 2011). On the whole, the resource-based view has been supported in many empirical studies that have used this theory. Several studies have considered the RBV theory to discuss how firms create value technologies usage. For instance, in their study, Andreu and Ciborra (1996) attempted to investigate how IT innovation can help in learning aspects of the capability development process. They suggested that IT can be an active component of the firm's competitive advantage, because it can contribute to the fundamental process that transforms resources into core capabilities. Also, they argued that RBV concepts can be used to explain the learning process by which resources end up being components of the core capabilities in firms. The researchers concluded that whatever stakeholders do, using a commodity resource such as IT to improve a firm's competitiveness should aim at transforming a standard resource into a firm's central capability. The learning and transformation process can thus be more effective, by better embedding IT into the core capabilities of the organization (Andreu and Ciborra, 1996). In addition, the RBV has been used to explain the process of how firms create value from e-business. In their investigation, Zhao *et al.* (2008) studied causal relationships between strategic initiative, information technology (IT)-related resources, and e-business capabilities, and their roles in the adoption process. The authors suggest a model of e-business adoption process at the firm level. The findings were in line with the resource-based theory and presented empirical confirmation of the complementary synergy between front-end e-commerce capability and back-end IT infrastructure.

Despite the fact that the RBV emphasises the capabilities that any company should have or obtain to adopt e-business, and it considers intangible as well as tangible resources (Al-Somali, 2011), the RBT theory has been vigorously challenged by a number of writers. For instance, Barney (2001) points out that it is difficult (if not impossible) to locate a resource which satisfies all of the VRIN criteria. In addition, it ignores outside factors concerning the industry in general, and this contradicts the assumption that a firm can be profitable in a highly competitive market as long as it can exploit advantageous resources. Priem and Butler (2001) argued that different resource configurations can generate the same value for firms and thus would not be a competitive advantage. Finally, Hooley *et al.*, (1998) criticise the resource-based view

for its inward focus. They suggested that this theory would have been more convincing, if did not ignore the nature of market demand.

2.6.3 Market level theories

2.6.3.1 Diffusion of Innovation Theory (DOI)

Innovation diffusion theory is helpful when it comes to investigating the factors that facilitate or hinder technology adoption and diffusion. Diffusion is a social process in which subjectively perceived information about a new idea is communicated. An innovation is an idea, practice or object that is perceived as new by an individual or other unit of adoption. However, it is not clear to what extent this new alternative may be superior to the current practice. Therefore, it is the responsibility of the adopters to seek further information in order to cope with the uncertainty that new innovation would create (Rogers, 2003). In addition to politics and other disciplines, the DOI theory is a widely used theoretical framework in the area of technology diffusion and adoption (Dooley, 1999; Stuart, 2000). This theory was developed by Rogers as an attempt to illustrate how certain innovations diffuse in social systems. As expressed in his book, *Diffusion of Innovation*, Rogers (2003) classifies many issues that can improve our understanding of innovation adoption and diffusion. As discussed below, these issues include the innovation–decision process, attributions of the innovation and adopter categories.

Innovation Decision Process: Roger (p. 161) defined the innovation-decision process as: *"the process through which an individual or other decision making unit passes from first knowledge of an innovation, to forming an attitude toward the innovation, to a decision to adopt or reject, to implementation of the new idea, and to confirmation of this decision".* He demonstrates that the innovation-decision process can be described as a stage that an individual (or other decision-making unit) passes through. It starts with initial knowledge about the innovation to formulating an attitude regarding this innovation, to a decision regarding adoption or rejection, to implementation of the new idea, and to confirmation of this decision. This process consists of sub stages and actions over time through which an organisation or individual assesses whether or not this new innovation is compatible with on-going practice.

- *Knowledge*: The innovation-decision process starts with the knowledge stage. In this stage, the individual (or some other decision-making unit) is exposed to an innovation's existence and gains an understanding of how it functions.
- *Persuasion:* this stage refers to situations when a client (or some other decision-making unit) shapes a favourable or unfavourable attitude about the new notion.
- *Decision:* signifies the condition when a client (or some other decision-making unit) involves in activities that lead to a decision to adopt or not to adopt the innovation.
- *Implementation:* at the implementation phase, the individual (or some other decision-making unit) puts an innovation into actual use.
- *Confirmation:* this final stage refers to the state when an individual (or some other decision-making unit) try to reinforcement of an innovation-decision already made, or backs down from a previous adoption decision for one reason or another.

ICT innovation adoption cannot always be considered a simple process (Zappalà and Gray, 2006). Perhaps the most challenging question about this description of Rogers regarding the innovation adoption process is that, although the stages listed above provide a sense of technological progression for adopters, the extent to which this process can be considered a linear process is not certain. Neither do we have sufficient empirical evidence that the proposed stages exist in reality. In fact, Rogers (2003, p. 187) argues that *"a definitive answer is difficult to provide. It is not easy for a researcher to probe the intrapersonal mental process of an individual respondent. Nevertheless, there is tentative evidence from previous studies supporting the concept of stages in the innovation-decision process".* Rogers then provided examples of evidence from previous studies, such as (Beal and Rogers, 1960; Coleman *et al.*, 1966), where the respondents in these studies report that to some extent they passed through these stages. Frambach and Schillewaert (2002) explained that when it comes to organisational adoption, normally two major phases (consisting of different sub-stages) can be recognised: initiation and implementation (e.g. (Zaltman *et al.*, 1973). The firm becomes more aware about the technology of the innovation in the initiation stage, and forms an attitude towards it (Gopalakrishnan and Damanpour, 1994). In the implementation phase, the firm decides to purchase and make use of the innovation

(adoption and continued use). This stage mean the lunch of the actual use of an innovation (Frambach and Schillewaert, 2002).

Attributes of the Innovation: Rogers (2003) suggested that it was apparent from the adoption and diffusion literature that much effort has been put into studying adoption through determining the characteristics of the different adopter categories. Still, very little effort has been expended on analysing innovation/technology differences (that is, in investigating how the properties of innovation affect their adoption rate). The attributes of innovation according to Rogers (2003) are discussed below.

- *Relative Advantage:* the degree to which an innovation is perceived as better than the idea it supersedes.
- *Observability:* the degree to which the results of an innovation are visible to others.

- *Compatibility:* the degree to which an innovation is perceived as consistent with existing values, past experiences, and the needs of potential adopters.
- *Trialability:* the degree to which an innovation may be experimented with on a limited basis.
- *Complexity:* the degree to which an innovation is perceived as relatively difficult to understand and use.

Fichman and Kemerer (1993) argued that these characteristics can be explained in an uncomplicated manner. Firms are more likely to implement innovations that offer noticeable advantages, that do not deeply change existing practices and that are not complex and are easy to understand. A high relative advantage and compatibility for an innovation would affect the rate of diffusion in a positive way. In contrast, observability and trialability are both correlated to risk and may increase the adopters' uncertainty about the technology (Fichman and Kemerer, 1993). Difficulties arise, however, when an attempt is made to measure these attributes for specific innovations or technology, since they may not in all cases be the key perceived characteristics for adopters. For this reason, Rogers (2003) suggests that studies that use these attributes are required to elicit

the major attribute of a new innovation from the respondents as a prior step to measuring these attributes as predictors of the rate of adoption.

Characteristics of Innovators: In social systems, most often users adopt the innovation in an over-time sequence, and they do not usually adopt it at the same time. Therefore, adopters can be classified into categories on the basis of when they first begin using a new idea. This classification can be divided as follows according to the author: innovators, early adopters, early majority, late majority, and laggards. These characteristics are described as follows:

Innovators: Venturesome **-** Innovators are considered as gatekeepers, because they play an important role in launching the new idea and by bringing the innovation to the system's boundaries. Nevertheless, innovators usually have to have sustainable financial resources to absorb the possible loss from an unprofitable innovation. Also, they should have the ability to have more awareness and implement complex technical knowledge, and have the ability to deal with a high level of uncertainty about the innovation at the time of adoption.

Early adopters: Respect **–**The main characteristic of this group of adopters can be defined as follows: more than any other group, this adopter category has the highest degree of opinion leadership in most systems. The main characteristics for this group of adopters are "the individual to check with" before adopting a new innovation. This adopter category is sought out by change agents as a local missionary for speeding the diffusion process. They are also able to decrease the level of uncertainty about the new innovation by adopting it. Finally, this group of adopters assist in activating the critical mass when they adopt an innovation.

Early majority: Deliberate **–** This is the most numerous adopter category, representing one-third of the members of a system. This group of adopters acts as the main linkage between very early and relatively late adopters. Their innovation adoption decision period is relatively longer than that of the innovator and early adopters.

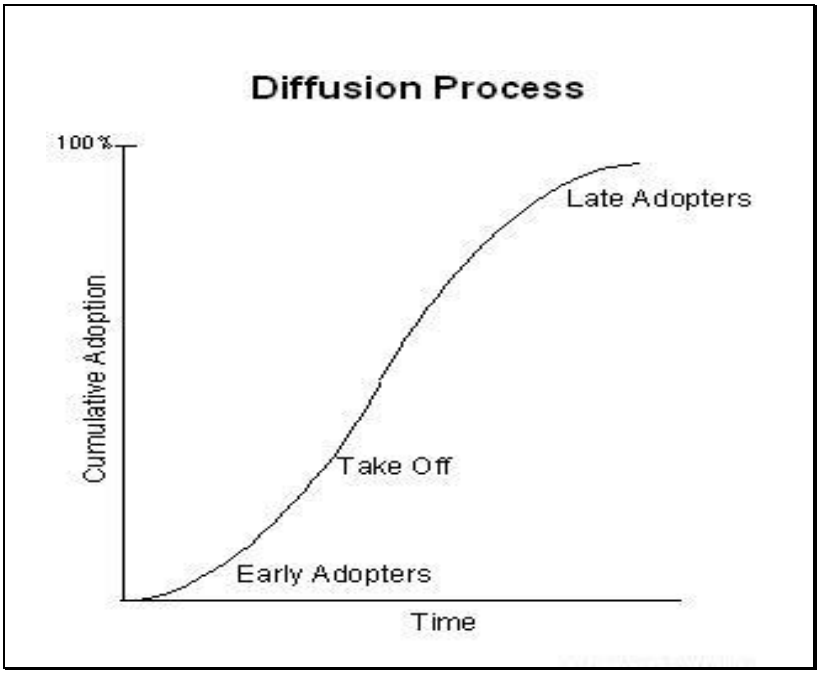
Late majority: Sceptical **-** This group forms an almost equal proportion to the early majority group (one-third). Many factors can influence their adoption decision,

such as economic necessity and/or competitive pressures from peers in the same industry. As a result of their relatively scarce resources, they need to be certain about the credibility/safe consequences for their adoption decision of the new technology.

Laggards: Traditional - This group of adopters is the last in adopting a new idea. They tend to be suspicious of innovations and change agents, and they lag far behind regarding awareness/knowledge of a new innovation. The most common excuse for them is that their resources are limited and they adopt a new technology only when they are confident about it.

It is worth noting that the separation between innovators and non-innovators takes place when the innovation is put to use within firms. Some businesses are found to adopt the new technology immediately and these firms can be considered as early adopters (Rogers, 2003). Firms that adopt innovation in later stages can be considered as late adopters (Hubbard and Hayashi, 2003). Moreover, Swanson (1994) notes that the first or early adopters of an innovation within an organisational population are viewed as innovators.

Figure 2-4: Diffusion Process. Source: (Rogers, 2003).



Inside the social system, when numbers of members start adopting a new innovation in a specific period of time, this will lead to a faster adoption rate. This also means that the adoption rate is a numerical indicator of the steepness of the adoption curve for an innovation (see Figure 2.4). Over time, innovation adoption usually draws an S shape curve, representing the rate of adoption of the innovation within the population. From this curve, the classification of adopters can easily be seen. In the beginning, there are only a few adopters, so the curve rises slowly. Over time, however, it accelerates to the mid-range of the graph, and then slows down again, forming an S-shaped curve. The rate of adoption of innovations is positively influenced by relative advantage, compatibility, trialability, and complexity, while it is negatively associated with complexity (Rogers, 2003). In the context of ICT innovation adoption, the relationship between relative advantage, compatibility, complexity and adoption decision has been widely investigated (Bradford and Florin, 2003). As shown in Table 2-7 below, several studies utilising DOI have been carried out and have consistently found that relative advantage, compatibility and complexity are key factors that could influence adoption decisions (Bradford and Florin, 2003).

Table 2-7: Examples of DOI-based studies.

Theory		Ref	Studies
DOI	**Main dependent construct(s)/ factor(s):** Implementation Success or Technology Adoption **Main independent construct(s)/ factor(s):** Compatibility of Technology, Complexity of Technology, Relative Advantage (Perceived Need for Technology)	(Armstrong and Yokum, 2001)	This study applied DOI to discuss the potential diffusion of expert systems in forecasting.
		(Grover, 1993)	This study applied DOI to empirically investigate customer based interorganisational systems (CIOS) adoption.
		(Iacovou *et al.*, 1995b)	This study applied DOI to investigate Electronic data interchange adoption among small companies. It identified three major factors that influenced the EDI adoption practices of small firms.
		(Elena *et al.*, 1999)	The study combined innovation diffusion and attitude theories in a theoretical framework to examine differences in pre-adoption and post-adoption beliefs and attitudes about the Information technology adoption process. This is because distinction is crucial in understanding and managing this process over time.
		(Bradford and Florin, 2003)	Information system and diffusion of innovation (DOI) theory were used this research in order to create a model of enterprise resource planning (ERP) implementation success.

Limitations of DOI Theory: DOI has significantly contributed to adoption and diffusion research by providing important tools that help in predicting the likelihood rate of adoption. Nevertheless, a few authors have challenged Rogers's efforts on the grounds that this theory did not present any evidence of how attitude evolves into an adoption or rejection decision (Karahanna *et al.*, 1999; Chen *et al.*, 2002). Also, studies about complex organisational technology have criticised the insufficiency of the attributes of the DOI theory in illuminating the adoption behaviour of complex organisational technologies (Prescott and Conger, 1995; Chau and Hu, 2002). For that reason, Rogers suggests that studies that use these attributes are required to elicit the major attribute of a new innovation from the respondents as a prior step to measuring these attributes as predictors of the rate of adoption (Rogers, 2003). According to Parker and Castleman (2009), this theory would have been more useful if the author had considered social contexts. They suggested that in order for further studies to investigate new innovation adoption among businesses, it would be useful to integrate DOI with other theories.

2.7 Criticism of ICT innovation adoption and diffusion research

According to Lucas *et al.* (2007), the ICT innovation adoption and diffusion research has primarily addressed the individual acceptance or rejection of systems in various organisational contexts, leaving organisational use or rejection within and between firms relatively unexplored. For instance, according to Williams (2009), it seems that a wide range of theories and theoretical constructs exist within the extant literature; however, studies to date have overwhelmingly made use of TAM and its related constructs of "*perceived usefulness*" and "*perceived ease of use*". This suggests that IS/IT adoption and diffusion research is gradually moving towards overall homogeneity, which is likely to weaken the field of technology adoption research. Added to this is the fact that the TAM model focuses on the individual level, which means that there is a need for more research considering and using new models and on a different level than the individual, such as the firm level.

Researchers limit their scope of inquiry by working within single theoretical perspectives (Wolfe, 1994). Innovation process is considered as a nonlinear and

complex process (Allen, 2000; Zappalà and Gray, 2006); thus, the implementation of a single perspective limits the scope of a researcher's inquiry and this limits the extent to which he/she can capture the innovation process (Wolfe, 1994). According to Rogers (2003) there are biases that have been inherited in the innovation adoption and diffusion studies, such as pro-innovation bias and recall problem. The adoption and diffusion research has shown bias towards assuming that a technological innovation is positive, and that innovation should be rapidly implemented and diffused by all units of a social system eventually. This bias tends to lay the "blame" for poor adoption on adopting individuals and organisations, rather than on systems or situations (Allen, 2000).

2.8 Summary

This chapter has explained the central importance of the explored theories. Korpelainen (2011) points out that many reviews have been conducted addressing ICT implementation and adoption in organisations (e.g. (Lee *et al.*, 2003; Venkatesh *et al.*, 2003; Jeyaraj *et al.*, 2006; Williams *et al.*, 2009)). The most influential adoption theories (e.g. TAM, TRA, TPB, and UTAUT) offer several systematic models that are well grounded in theory to explain individuals' intentions to adopt ICT (Korpelainen, 2011). The reasons for the popularity of TAM as the theoretical framework might be that, first, TAM is a theory specifically developed for ICT implementation and adoption research. It is a theory "owned" by the IS research community in a field in which theories are scarce (Lee *et al.*, 2003, p. 765). Despite the successful usage of TRA and TPB theories in studying ICT innovation adoption, Korpelainen (2011) argues that the main aim for creating the TPB and TRA models was to clarify some kind of human behaviour in the field of social psychology than ICT system adoption in firms. For instance, Ajzen (Ajzen and Fishbein, 1980; Ajzen, 1991) applied TRA and TPB to study, for example, weight loss, problem drinking or leisure behaviour / consumer behaviour, voting in American elections, and changing the behaviour of alcoholics. This type of human behaviour differs a great deal from human behaviour in organisational change processes. The motivational enhancers and the context of the behaviour are more or less different.

With the intention of developing the applicability of these models to explain ICT innovation adoption and diffusion, more development and extension has taken place.

For instance, TRA was extended into TPB, which was later extended to DTPB when limitations were identified by research (Al-Qeisi, 2009). Difficulties arise, however, when an attempt is made to extend and unite models. According to Korpelainen (2011) a number of important limitations in the previous literature regarding the main theories (TAM, DOI, TRA, TPB, and UTAUT) need to be considered. Firstly, there is the fact that they pay only limited attention to organisational and social factors. Korpelainen (2011) argued that the simplicity and parsimoniousness of TAM are the main reasons for its popularity, which has been achieved by leaving social and organisational factors outside the scope of the theory.

A number of extensions and combinations of TAM have attempted to react to the challenge of contextualisation by adding new independent variables, such as individual characteristics (gender, motivation etc.), situational variables (experience, training etc.), or organisational characteristics (subjective norms) (Korpelainen, 2011). Nevertheless, the extensions have not escaped criticism and have led to some further challenges. As a result of extensions and combinations, some theories have become weaker in their parsimony and clarity when they start to have too many variables. For example, the Unified Theory of Acceptance and Use of Technology (UTAUT, Venkatesh et al., 2003) has 41 independent variables for predicting intentions and eight independent variables for predicting behaviour (Bagozzi, 2007). Second, different models and independent variables may cause a theoretical confusion *"in which it is not clear which version of the many iterations of TAM is the commonly accepted one"* (Benbasat and Barki, 2007, p. 212).

To sum up, because inconclusive results are common in this field of study, researchers need to make use of the reviewed theories to understand the adoption of new ICT innovations. This review of theories has shown that:

Firstly, ontologically, theories may consider different units of analysis (see Table 2.4), typically the user (micro-level), the firm (meso-level) or the market/innovation (macro-level). Secondly, as shown in the reviewed theories, users' adoption behaviour is not a simple decision process, and there is no single theory which appears capable of handling the complexity. Therefore, its important to have a broad and comprehensive combination for a number of theories (Cao and Mokhtarian, 2005). For instance,

Konana and Balasubramanian (2005) combine factors of TRA, TPB, and TAM with economic elements (perceived financial gains) into their framework of online investing. Therefore, as suggested in previous studies, synthesising theories through the development of a comprehensive list, using each of the key constructs of the pertinent theories, can be a useful mechanism to identify the most important factors for adoption and avoid the weaknesses of using a single theory. The researcher, however, needs to ensure that the extensions/ synthesising theories, do not lead to further challenges and that synthesising theories will not cause the theory to lose its strength. Thirdly, it can be argued that the main theories pay rather limited attention to contextual factors. The factors of power relations related to ICT system use in organisations are especially neglected. These theories, for example, assume that individuals may choose independently whether to implement the system or not, but in contemporary organisations ICT implementations are harmonised and centrally coordinated, and individuals often have little say about the organisation-wide adoption of ICT (Gallivan, 2001; Lee *et al.*, 2003). Benbasat and Barki (2007) state that the use of ICT systems has changed a great deal from the early days of TAM (see also (Lyytinen and Damsgaard, 2001), and the model does not address social contexts (Korpelainen, 2011). In fact there is a call to use theories that focus on the firm level, and take into consideration organisational and environmental contexts, not only individuals. In particular, Klein and Sorra (Klein and Sorra, 1996) bemoan the absence of multi-determined, multilevel frameworks to capture the innovation adoption phenomena. A literature based evaluation of these theories' applicability to actual ICT innovation adoption behaviour has been done and different contexts (e.g. technological, organisational and environmental) are predicted to have an impact on the adoption of new ICT innovations. This research project will use the Technology, Organisation, and Environment (TOE) framework put forward by DePietro *et al*. (1990) for a number of reasons. These will be discussed in detail in the following chapter.

2.9 Conclusion

Although IS innovation adoption and diffusion research has faced much criticism, the reviewed theories have proved to be very powerful theoretical tools in predicting, explaining and increasing individual and organisational adoption of IS innovations

(Ramdani, 2008). This chapter has reviewed the relevant literature utilised to guide the foundation for the conceptual framework presented in the next chapter. The adoption and diffusion of new IS innovations (e.g. cloud computing) seems to be still understudied. Thus, further theoretical and empirical research is needed to reach more conclusive results. An important observation to be noted from this review is the ability to distinguish between three types of models. Ontologically, theories may consider different units of analysis, typically the user (micro-level), the firm (meso-level) or the market/innovation (macro-level).

By reviewing the most influential adoption theories (e.g. TAM, DOI, TRA, TPB, UTAUT), an important observation to be noted is the ability to distinguish between two types of models. On one hand, we can find models that advocate and enjoy parsimony (such as TAM (on the individual level)) but lack the comprehensiveness needed to consider them sufficient or complete. According to Williams (2009) studies wishing to produce material that is genuinely innovative should consider the use of theories/models other than TAM (and its variants) in investigating under-researched but contemporary issues such as mobile devices, and concentrate on locating their investigations within contexts other than the purely organisational. On the other hand, there are models, at the market level, such as DOI, that do not provide a suitable analytical tool to differentiate between the inherent qualities of an innovation and the capabilities, motivations, and wider environmental perspective of the adopting organisation, mainly because of the domination of the technical perspective in it (Rui, 2007). This research project will use the Technology, Organisation, and Environment (TOE) framework put forward by DePietro *et al*. (1990) for a number of reasons. These will be discussed in detail in the following chapter.

Chapter 3. Conceptual framework

3.1 Introduction

This chapter builds on the theoretical foundations established in the previous chapter. Its purpose is to develop the conceptual framework and related hypotheses based on the previous literature. These will be used as a theoretical basis for studying the factors that influence SMEs' adoption of cloud computing. It will first explain the integration between the Technology-Organisation-Environment (TOE) and the DOI framework used in this research project. It will then go on to highlight the theoretical and empirical studies of the factors that can be included within the conceptual framework. At the end, the developed hypotheses will be presented.

3.2 Organisational innovation Adoption

"*When an organisation learns to do something it did not know how to do before, and then proceeds to do it in a sustained way, a process of innovation has occurred"* (Shepard, 1967, p. 470). In fact, firms, like consumers, differ in the likelihood and speed of their adoption of new innovations. However, the process of organisational innovation is almost dissimilar to the adoption of innovations by individuals. According to Pennings and Buitendam (1987), diffusion among organisations presents special challenges. In fact, the adoption decision process in these firms would be hindered or enhanced and influenced by firms' traditions, values, and procedures. There is a need for coordination among multiple organisational stakeholders in order to make the adoption decision. Therefore, the innovation literature on individual behaviour falls short in providing insight about organisations as adopters (Pennings and Buitendam, 1987).

Technology adoption is a complex developmental process (Straub, 2009). Firms have usually tried to apply a relatively steady and predictable prototype of development through a number of cumulative and identifiable stages (Van de Ven and Poole, 1995). During these stages, firms try to gain experience to move on to the next phase of

development (Alonso-Mendo *et al.*, 2009). However, although much research has been done on the adoption of technological innovation, such as Internet technologies (Tan and Teo, 1998; Kendall, 2001), few have holistically attempted to examine the topic of the adoption stage of the diffusion process. The majority tend to be conceptual, rather than empirical, in nature. Researchers have long been calling for an increased focus on a stage-oriented approach to understand the adoption of innovations by organisations (e.g. (Klein and Sorra, 1996; Teo and Pian, 2004). In particular, Klein and Sorra (1996) bemoan the absence of multi-determined, multilevel frameworks to capture the innovation adoption phenomena and the authors suggest that researchers must move beyond single-site and qualitative case studies to analyse innovation implementation across organisations. This study aims to contribute to the existing literature by investigating the dynamics of the factors influencing cloud computing adoption, and it extensively uses a stage-oriented approach to illustrate and conceptualise the organisational usage of cloud computing services to support and facilitate business activities, processes, and operations.

3.3 The Technology-Organisation-Environment (TOE) Framework

The TOE is an organisation-level multi-perspective framework that was developed by Rocco DePietro, Edith Wiarda and Mitchell Fleischer (1990). TOE represents one segment of the innovation process, i.e. how the firm context influences the adoption and implementation of innovations (Baker, 2011). Based on this framework, the technology innovation adoption process is influenced by three aspects of an enterprise's context. The *technological context* represents the internal and external technologies related to the organisation, both technologies that are already in use at the firm, as well as those that are available in the marketplace but not currently in use (Baker, 2011). These technologies may include either equipment or practice. The *organisational context* is related to the resources and the characteristics of the firm, e.g. size and managerial structure, while, finally, the *environmental context* refers to the arena in which a firm conducts its business; it can be related to surrounding elements such as industry, competitors and the presence of technology service providers. These three contexts present both constraints and opportunities for technological innovation

(Tornatzky and Fleischer, 1990). These elements influence the firm's level of technological innovation.

The TOE framework has been examined by a number of empirical studies on various IS innovations (Table 3.1). In particular, the adoption of EDI has been studied extensively in the last decade (Zhu *et al.*, 2003). Iacovou *et al.* (1995) examined the TOE model in seven case studies, revealing the main factors for EDI adoption (perceived benefits, organisational readiness and external pressure). Also, Kuan and Chau (2001) have empirically evaluated a perception-based TOE framework using data collected from 575 firms in Hong Kong, and their study confirms the usefulness of the TOE framework for studying the adoption of IS innovations. Recent studies have focused on the adoption of e-commerce. For instance, Lertwongsatien and Wongpinunwatana (2003) have developed and empirically evaluated the TOE framework using 386 firms in Thailand. They found that a number of factors influenced the adoption of e-commerce. Scupola (2003) examined DePietro's model in seven small businesses located in Southern Italy, and she found the model to be very useful in investigating the drivers of Internet commerce adoption in SMEs. Ramdani and Kawalck (2008) examined the TOE framework in nine SMEs in the North West of England, and found that technological, organisational and environmental factors influenced the adoption of broadband. Studies of other IS innovations have also provided empirical support for the TOE framework (e.g. Fink, 1998; Thong, 1999).

Table 3-1: Examples of TOE-based studies. Asterisks denote significant factors.

IS Adoption and Context	Authors	Technological analysed variables	Organisational analysed variables	Environmental analysed variables
Open systems Firms in Hong Kong	(Chau and Tam, 1997)	Perceived Benefits Perceived barriers * Perceived importance of compliance to standards, interoperability, interconnectivity	Complexity of IT infrastructure Satisfaction with existing systems Formalisation of system development and management	Market uncertainty
E-commerce development level Firms in Shaanxi,	(Liu, 2008)	Support from technology Human capital	Management level for information* Firm size	User satisfaction*; E-commerce

China		Potential support from technology*		security*
E-Business usage Firms in developed countries	(Zhu and Kraemer, 2005)	Technology competence *	Size* International scope Financial commitment*	Competitive pressure* Regulatory support*
EDI Small firms in Hong Kong	(Kuan and Chau, 2001)	Perceived direct benefits * Perceived indirect benefits	Perceived financial cost* Perceived technical competence*	Perceived industry pressure* Perceived government pressure*
Enterprise systems SMEs in the North west of England	(Ramdani *et al.*, 2009)	Relative advantage* Compatibility Complexity Trialability* Observability	Top management support* Organisational readiness* IS experience Size*	Industry Market scope Competitive pressure External IS support
Web site Small and large firms in Portugal	(Oliveira and Martins, 2008)	Technology readiness Technology integration Security applications	Perceived benefits of electronic correspondence IT training programs access to the IT system of the firm Internet and e-mail norms	Web site competitive pressure
Communication technologies Small businesses in rural communities in the US	(Prem-kumar and Roberts, 1999)	Relative advantage* Cost Complexity Compatibility	Top management support* IT-expertise Size of the business	Competitive pressure* Vertical linkages and external support*
IS Small businesses in Singapore	(Thong, 1999)	Relative advantage Complexity Compatibility	Size* Employees' IS knowledge* Information intensity CEO's innovativeness CEO's IS knowledge	Competition

3.4 Integrating DOI and TOE to study the determinants of cloud computing adoption

At the firm level, theories such as the diffusion of innovation (Rogers, 2003) have been widely applied to studies looking at how innovations are adopted and diffused. This study, for a number of reasons, will also use the Technology, Organisation, and Environment (TOE) framework put forward by DePietro *et al.* (1990). First of all, despite the similarity in their concepts, Oliveira and Martins (2011) suggest that as the TOE framework includes the environment context, which is not included in the diffusion of innovation theory, the former is better able to explain intra-firm innovation adoption. From their point of view, the reliable empirical support and solid theoretical basis are the main advantages of the TOE framework. Rui (2007, p. 13) notes that "*compared to Rogers' (1995) innovation diffusion model, the TOE framework (or those TOE-like frameworks) overcomes the domination of the technical perspective and provides a useful analytical tool to distinguish between the inherent qualities of an innovation and the motivations, capabilities, and broader environmental context of the adopting organisation*". However, this does not mean that the technological characteristics of the innovation are not of key importance for the model. Secondly, our review of previous studies (e.g.Chong *et al.*, 2009; Oliveira and Martins, 2011) found that, typically, studies on ICT adoption at the firm level are derived from theories such as these two prominent models on innovation. Specifically for TOE, Rui (2007) suggested that other multiple perspective frameworks proposed in ICT adoption research are similar to the TOE framework, and can be considered as variants of the TOE framework in which some dimensions of the TOE are further divided. Finally, TOE has been applied successfully to numerous studies, for instance, Iacovou *et al.* (1995) and Kuan and Chau (2001). Other applications of the TOE model include studies looking at Enterprise Systems (Ramdani and Kawaiek, 2007); E-commerce (Scupola, 2003; Seyal *et al.*, 2004); EDI (Kuan and Chau, 2001); and communication technologies (Premkumar and Roberts, 1999) and the Internet (Tan and Teo, 1998). Table 3.2 summarises a few examples of TOE-based studies and outlines the main variables considered for each of the three contexts.

Table 3-2: Selection of studies combining DePietro et al. (1990) with DOI models

Theoretical model	Analysed variables	studies
TOE and DOI	CEO characteristics: CEO's innovativeness; CEO's IS knowledge. IS characteristics: relative advantage of IS; compatibility of IS; complexity of IS. Organisational characteristics: business size; Employees' IS knowledge; information intensity. Environmental characteristic: competition.	(Thong, 1999)
TOE and DOI Collaborative commerce (c-commerce)	Innovation attributes: relative advantage; compatibility; complexity. Environmental: expectations of market trends; competitive pressure. Information sharing culture: trust; information distribution; information interpretation. Organisational readiness: top management support; feasibility; project champion characteristics	(Chong *et al.*, 2009a)
TOE and DOI E-Business usage E-business impact	Technology: relative advantage; complexity; compatibility. Organisation: top management support; firm size; technology competence. Environment: competitive pressure; trading partner pressure; information intensity.	(Zhu *et al.*, 2006b)
TOE and DOI RFID	Technology: relative advantage; complexity; compatibility. Organisation: top management support; firm size; technology competence. Environment: competitive pressure; trading partner pressure; information intensity	(Wang *et al.*, 2010)

The adopting organisation not only needs to understand the technological traits and the costs of the technology, but also to identify what business activities are likely to benefit from the application of the technology. Also, it is crucial to understand the adoption processes and its facilitators and inhibitors, because this will help organisations in making decisions in the area of planning, production and distribution of their products and services. Cameron and Quinn (Cameron and Quinn, 2005) argue that the organisational domain is important because plans for any changes adopted without including organisational determinants will normally have unforeseen and usually negative consequences. In addition, other outcomes such as efficiency and satisfaction are predicated upon the perceived characteristics of the target system as an antecedent to behavioural intent to adopt and, consequently, use the system. Finally, research shows that the environmental dimension is particularly important in predicting technological innovation adoption (Damanpour and Gopalakrishnan, 1998). For instance, Zhu et al. (2003) note that e-commerce is enabled by technological development of the Internet, driven by organisational factors such as firm scope and size, and influenced by environmental factors related to customers and business partners, as well as

competitors. A summary of different ICT adoption models and variables is shown in Table 3.3.

Table 3-3: Key determinants of IT innovation adoption and diffusion

Study	ICT innovation	Variables	Main findings
(Lertwongsatien and Wongpinunwatana, 2003)	E-Commerce	Perceived Benefits, Compatibility, Size, Management Support, Existence of IT Department, Competitiveness	Increased IT assets (i.e. IT knowledge, IT capabilities) lead to an increase in organisations' likelihood of adopting.
(Martins *et al.*, 2004)	Internet as a teaching tool	Relative advantage, Compatibility, Complexity, Observability, Triability	The variables observability and trialability were found to be the two most significant predictors of adoption.
(Ramdani *et al.*, 2009)	Enterprise systems SMEs in the North West of England	Relative advantage, Compatibility, Complexity, Trialability, Observability, Top management support, Organisational readiness, IS experience, Size, Industry, Market scope, Competitive pressure, External IS support	Organisations with the following factors have more probability to implement ES. Greater top management support, a greater perceived relative advantage, a greater ability to experiment with these systems before adoption, greater organisational readiness and a larger size.
(Premkumar and Roberts, 1999)	Communication technologies SME in rural communities in the US	Relative advantage, Cost, Complexity, Compatibility, Top management support, IT-expertise, Size of the business, Competitive pressure, Vertical linkages, and external support.	Relative advantage, top management support, organisational size, external pressure and competitive pressure are important determinants in the adoption of communication technologies.
(Eder and Igbaria, 2001)	Internet technology	Earliness of adoption, top management support, organisational structure, organisational size, IT infrastructure, and IS structure	Intranet infusion is positively associated with earliness of adoption, top management support, and IT infrastructure flexibility and these effects are mediated by intranet diffusion.
(Bradford and Florin, 2003)	Enterprise resource planning (ERP)	Top management support, Training, Objectives consensus, Technical compatibility, Perceived complexity, Reengineering, and Competitive pressure.	Top management support and training are positively related to user satisfaction. Also, consensus in organisational objectives and competitive pressure are positively related with perceived organisational performance.
(Thong, 1999)	IS Small businesses in Singapore	Relative advantage, Complexity Compatibility, Size, Employees IS knowledge, Information intensity, CEO'S	Small businesses with certain CEO characteristics (innovativeness and level of IS knowledge), innovation characteristics (relative advantage, compatibility, and complexity of IS),

		innovativeness, CEO's IS knowledge, Competition	and organisational characteristics (business size and level of employees' IS knowledge) are more likely to adopt IS.
(Lin and Lin, 2008)	e-business diffusion	IS infrastructure, IS expertise, Organisational compatibility, Expected benefits of e-business, Competitive pressure, Trading partner readiness.	IS infrastructure, IS expertise, expected benefits of e-business, and competitive pressure are important factors shaping e-business diffusion
(Lai, 1997b)	ISDN implementation	Vendor involvement, compatibility, relative advantage, complexity, champion, management support, openness, centralisation, and formalization	Compatibility, relative advantage, complexity, champion, management support, openness, and formalization factors were indicative of ISDN implementation success.
(Hung *et al.*, 2003)	Wireless application protocol (WAP)	Personal innovativeness, Ease of use, Usefulness, Peer influence, External influence, Connection speed, Service costs, User satisfaction, Self-efficacy, Facilitating condition	Connection speed, service costs, user satisfaction, and personal innovativeness, ease of use, peer influence, and facilitating conditions were the critical factors influencing the adoption of WAP services.
(Mike and Chris, 2001)	Decision support system	Subjective norms, Adoption stage, Use competence, Implementation process, Organisational factors, Perceived innovation characteristics, IT diffusion	Subjective norm influences played a crucial role in assessment of the software's task-technology fit with the social needs of planning. Clients consider a perceived characteristic of innovation during the early phase of adoption and reduce their focus to relative advantage during later phases.
(Waarts *et al.*, 2002)	Enterprise resource planning (ERP) software	IT intensity, Attitude, Company IT resources, IT integration, Parent company, Industry competitiveness, Supply-side competition, Perceived advantages and, disadvantages, Compatibility.	Internal strategic force, attitudes of the firm, external factors such as competition and supplier activities are key factors at the early phases of the diffusion process of ERP.
(Kuan and Chau, 2001)	EDI Small firms in Hong Kong	Perceived direct, benefits , Perceived indirect benefits, Perceived financial cost, Perceived technical competence Perceived industry pressure, Perceived government pressure	The findings of this study show that adopter firms perceive higher government pressure, but lower industry pressure, than non-adopter firms. Also, adopter firms perceive lower financial costs and higher technical competence than non-adopter firms do.
(Zhu and Kraemer, 2005)	E-Business usage. Firms in	Technology competence, Size, International scope, Financial commitment, Competitive	Firm size, financial commitment, technology competence, competitive pressure, and regulatory support are

	developed countries	pressure, Regulatory support.	significant factors of e-business adoption.
(Liu, 2008)	E-commerce development level. Firms in Shaanxi, China	Support from technology, Human capital, Potential support from technology, Management level for information, Firm size, User satisfaction; E-commerce security.	Technology foundation, user satisfaction, management of information, EC security, and potential technology investment are important factors E-commerce development.
(Mirchandani and Motwani, 2001)	Electronic commerce (ecommerce)	Relative advantage, Compatibility, Time required to plan and implement the IS, Dependence on information, Competition, Employees' IS knowledge, Financial cost, CEO's enthusiasm toward IS.	Many factors were found to differentiate between adopters and non-adopters of electronic commerce. These included: enthusiasm of the top manager/CEO toward electronic commerce, compatibility of ecommerce with the work of the company, perceived relative advantage, and knowledge of the company's employees about computers.
(Chau and Tam, 1997)	Open systems Firms in Hong Kong	Perceived Benefits, perceived barriers, Perceived Importance of compliance to standards, interoperability, and Interconnectivity. Complexity of IT infrastructure, Satisfaction with existing systems, Formalisation of system development and management, Market uncertainty.	The study found a negative relationship between satisfaction level with current systems and open systems adoption. The study did not, however, find a significant relationship between complexity of IT infrastructure and the likelihood to adopt open systems.
(Beatty *et al.*, 2001)	Corporate Websites	Perceived benefits, compatibility (organisational and technical), complexity, and management support.	The results of this study indicate that important differences in the reasons that these organisations decided to use Web technology depending on when the organisation made the adoption decision.
(Teo *et al.*, 2009)	Electronic procurement (e-procurement)	Perceived direct benefits, Perceived indirect benefits, Perceived costs, Firm size, Top management support, Information sharing culture, Business partner influence	Firm size, top management support, perceived indirect benefits, and business partner influence are positively and significantly associated with the adoption of e-procurement.

3.5 Applying TOE to Cloud Computing Adoption

Given that cloud computing services are IT innovations to support business operations, the TOE framework is an appropriate theoretical foundation to understand the contextual factors that influence cloud computing adoption and outcomes. Although the TOE framework allows researchers to examine a broad set of contextual factors, this

research project was designed to include a manageable yet theoretically important set of factors relevant to cloud computing adoption in our research. Consistent with Ramdani (2008) and Thong (1999), the research process was designed to identify factors from prior IS innovation adoption research that employed the TOE and / or the DOI framework as a theoretical foundation. Also, it was designed to identify factors that were not included in prior TOE-based studies but which are nevertheless relevant to cloud computing. Table 3.4 outlines the definitions for each construct.

From reviewing the TOE frameworks of SMEs' adoption of IS innovations, it appears that IS innovations are highly differentiated technologies for which there is not necessarily a single adoption model (Ramdani, 2008), and different factors impact on the adoption and implementation of different IS innovations. Thus, what factors can be included in the TOE framework to study SMEs' adoption of' cloud computing? Chau & Tam (Chau and Tam, 1997) suggest extending the TOE framework to study other IS innovations. This study aims to extend the TOE framework by identifying technological, organisational and environmental factors that have an impact on SMEs' adoption of cloud computing. Based on the TOE frameworks discussed earlier, Table 3-4 presents the factors that will be included in the conceptual model of SMEs' adoption of cloud computing. Previous studies on the thirteen factors identified are summarised in the following section.

The conceptual model takes into account most of the key elements cited in the IS innovations literature (technological characteristics, organisational characteristics, and environmental characteristics) and which are most related to cloud computing. By employing a specific research strategy and research method, which will be described in the methodology chapter, the factors identified will be looked at in our preliminary empirical study. Chapter 7 will test this framework further by providing a predictive model of the factors that influence SMEs' adoption of Cloud computing.

Table 3-4: Definitions of the TOE framework constructs

Technological	Relative Advantage	"*The degree to which an innovation is perceived as being better than the idea it supersedes*" (Rogers, 2003)
	Uncertainty	The extent to which the results of using an innovation are insecure (Ostlund, 1974; Fuchs, 2005).
	Compatibility	*"The degree to which an innovation is perceived as consistent with the existing values, past experiences, and needs of potential adopters*" (Rogers, 2003)
	Complexity	*"The degree to which an innovation is perceived as relatively difficult to understand and use"* (Rogers, 2003)
	Trialability	*"The degree to which an innovation may be experimented with on a limited basis"* (Rogers, 2003)
Organisational	Size	The size of the company.
	Top management support	Devoting time to the [ICT] program in proportion to its cost and potential, reviewing plans, following up on results and facilitating the management problems involved with integrating ICT with the management process of the business (Young and Jordan, 2008).
	Innovativeness	The extent to which a client adopts innovations earlier than other members of the same social context (Rogers and Shoemaker, 1971).
	Prior technology experience	The extent of a user's experience with previous similar technologies (Heide and Weiss, 1995; Lippert and Forman, 2005).
Environmental	Competitive pressure	The degree of pressure felt by the firm from competitors within the industry (Oliveira and Martins, 2010).
	Industry	The sector to which the business belongs (Yap, 1990; Goode and Stevens, 2000).
	Market scope	The horizontal extent of a company's operations (Zhu *et al.*, 2003).
	Supplier computing support	The supplier activities that can significantly influence the probability that an innovation will be adopted (Frambach *et al.*, 1998).

3.5.1 Technological Context

In the original TOE framework, the technological context described both the internal and external technologies relevant to the firm (Rui, 2007; Oliveira and Martins, 2011). Premkumar (2003) argues that not enough studies have investigated the impact of technological characteristics. Following TOE, this research will use Rogers's innovation diffusion theory as the starting point from which to study the impact of the technological factors, which will be discussed in detail below.

Relative Advantage is taken as a central indicator for the adoption of a new IS innovation. The higher the perceived need for an innovation by an organisation, the higher the probability that it will adopt the innovation (Rogers, 2003; Lee, 2004). Moore and Benbasat (1991) demonstrated that the relative advantage construct is similar to the notion of perceived usefulness in the TAM model. The impact of relative

advantage on technology adoption has been widely investigated in previous studies (e.g. see Premkumar and King, 1994; Thong, 1999; Gibbs and Kraemer, 2004; Lee, 2004; Ramdani and Kawaiek, 2007). It has been shown that when businesses perceive a relative advantage in an innovation, then the probability of the adoption will increase (Thong, 1999; Lee, 2004). Cloud computing promises a variety of gains to companies adopting it. For example, according to Miller (2008), cloud computing can offer many advantages related to capacity, reliability, and flexibility. It considerably lowers the cost of entry for SMEs to access a vast pool of computing resources for relatively short amounts of time (Marston *et al.*, 2011). With almost instant access to hardware resources, small businesses would have a faster time to market with no upfront capital investment (Marston *et al.*, 2011). From an ICT capabilities perspective, the relative advantages of cloud computing are self-evident (Sokolov, 2009).

Uncertainty: Adoption of a new technology involves risk and uncertainty (Erumban and de Jong, 2006). Uncertainty refers to the extent to which the results of using an innovation can be guaranteed (Ostlund, 1974; Fuchs, 2005). Due to the open nature of the Internet, security risk has been recognised as a key factor hindering the use of some ICT technologies (Kalakota and Whinston, 1996). The short lifetime of a new innovation may often lead to some degree of uncertainty (Jalonen and Lehtonen, 2011). Uncertainty may signify that lack of knowledge about a particular innovation can lead to less predictable results. Consequently, the adoption decision and the associated changes may imply some risks. This is because the adoption of a new technology means getting involved in something new and, therefore, the extent of the uncertainty attached to it is also greater (Stoneman, 2001). Rogers considers uncertainty a significant barrier for innovation adoption: "*Consequences are the changes that occur in an individual or a social system as a result of the adoption or rejection of an innovation*" (Rogers, 2003, p. 436). For cloud computing, security, privacy and lock-in are among the typical concerns businesses may have (Aziz, 2010). Recognition of some concerns in cloud computing can be a possible hindrance to SMEs adopting cloud computing until uncertainties are resolved.

Compatibility: From a business perspective, there is a need for the technical and procedural requirements of the innovation to be compatible and consistent with values

and the technological requirements of the adopting organisation (Lertwongsatien and Wongpinunwatana, 2003). As such, the perceived high compatibility of the innovation with an organisation's already deployed technologies could positively affect the adoption process (Tornatzky and Fleischer, 1990). There is a large volume of published studies describing the role of compatibility, which is considered an essential determinant of IT innovation adoption (Rogers, 1983; Teo *et al.*, 1997; Premkumar and Roberts, 1999; Premkumar, 2003b; Ching and Ellis, 2004; Daylami *et al.*, 2005). For instance, in 166 small Singaporean firms, Thong (1999) found that the compatibility of the innovation had a strong influence on the adoption of IS in these businesses. Similarly, in the Zhu *et al.* (Zhu *et al.*, 2006a) study, compatibility was considered one of the most significant drivers in the post-adoption stages of innovation diffusion. Business owners are concerned that the adopted innovation is consistent with values and the technology needs for their organisations (Jungwoo, 2004). From the developer side, there is an increasing interest in compatibility, which is focused on achieving a high level of integration for the new technologies (Kamal, 2006). Consequently, it is essential for SMEs that the new innovation is consistent with their existing values and needs, since poor integration of new systems with existing ones could result in the opposite situation (Akbulut, 2003).

Complexity: Complexity refers to *"the degree to which an innovation is perceived as relatively difficult to understand and use"* (Rogers, 2003, p. 257). Rogers (2003) stated that adoption will be less likely if the innovation is considered more challenging to use. Adopting a new technology may confront SMEs with challenges in terms of changing the processes in which they interact with their business systems. New technologies have to be user-friendly and easy to use in order to increase the adoption rate (Parisot, 1995; Sahin, 2006). In many recent studies, complexity has been found to be a significant factor in the adoption decision (e.g.Thong, 1999; Tiwana and Bush, 2007; Chaudhury and Bharati, 2008; Harindranath *et al.*, 2008). In contrast to other innovation characteristics, this factor is negatively linked with the adoption probability.

Trialability: This factor has been reported as one of the most fundamental components in the process of adopting a new technology (Kendall, 2001; Rogers, 2003). This is more significant for early rather than later adopters, as the latter can benefit from

the experience of the former as an indication of how the innovation performs (Rogers, 1995). For instance, the findings of Hsbollah *et al.* (2009) suggest that trialability is the most important factor that influences the adoption of Internet and new online technology in education. In contrast, there have also been reports of this factor not being significant for innovations adoption (e.g. (Hsu *et al.*, 2007)). Dedrick and West (2003) studied the effect of organisational trials to use Linux on adoption decisions for these organisations. The findings indicated that the knowledge gained not only reduced the perceived risk of open source adoption, but also steered the organisation towards using Linux in their open source platform. According to Sahin (2006), throughout the process of the adoption decision, reinvention may take place during the trial of the new technology. This also may affect adoption rates and speeds among businesses in a positive way. For laggards there is less uncertainty, because they know from the early innovators how effective the innovation is. Therefore, for early adopters and innovators, trialabity is more significant when it comes to exploring new innovations (Rogers, 1995).

3.5.2 Organisational Context

The Organisational context was found to be an important context for innovation adoption in previous studies (e.g. Ramdani, 2008). Four main factors are included in the organisational context and these are: firm size, top management support, innovativeness and prior IT experience.

Size: The first factor that needs to be considered in the organisational context is the size of the firm. According to Rogers (2003), size is one of the most critical determinants of the innovator profile. Organisational size has long been at the heart of studies looking at IT innovation adoption and is considered to be an important predictor of ICT innovation adoption (Dholakia and Kshetri, 2004; Buonanno *et al.*, 2005; Levenburg *et al.*, 2006). However, empirical results on the correlation between them are mixed (Lee and Xia, 2006). For example, according to Annukka (2008) there are studies that report a positive correlation (Mahler and Rogers, 1999; Aguila-Obra and Padilla-Meléndez, 2006; Kamal, 2006; Ramdani and Kawaiek, 2007; Belso-Martinez, 2010), studies that report a negative correlation (Utterback, 1974; Goode and Stevens, 2000) and studies that report a non-significant correlation (Aiken *et al.*, 1980; Varun and

Goslar, 1993). It is often argued that larger firms have more resources, skills, experience and ability to survive failures than smaller firms. On the other hand, because of their size, small firms can be more innovative, they are flexible enough to adapt their actions to the quick changes in their environment (Damanpour, 1992; Jambekar and Pelc, 2002), compared to larger firms, which have multiple levels of bureaucracy and this can slow down decision-making processes (Oliveira and Martins, 2011). Finally, IT adoption often needs coordination, which may be relatively easier to achieve in small firms (Premkumar, 2003).

Top management support is also key to the successful integration of new technological innovation in organisations (Premkumar and Michael, 1995; Eder and Igbaria, 2001; Daylami *et al.*, 2005) as it can convey the importance of the innovation for the organisation to all stakeholders and, at the same time, ensure the availability of the necessary resources (Premkumar and Roberts, 1999; Daylami *et al.*, 2005). In their review of the predictors and biases in IT, Jeyaraj *et al.* (2006) found that top management support is considered the main link between individual and organisational ICT innovation adoption. Generally, top management support is essential to maintain the importance of possible change, through an articulated vision for the organisation, and by sending signals of the significance of the new technology to other members of the firm (Thong, 1999; Low *et al.*, 2011). In addition, owner involvement ensures that sufficient resources are allocated for adopting the new technologies in question (Premkumar and Potter, 1995; Annukka, 2008). Consequently, top management support is considered to have an impact on ICT innovation adoption (Thong, 1999; Stuart, 2000; Daylami *et al.*, 2005; Wilson *et al.*, 2008).

Innovativeness (being open to new products): This element is an important component in the ICT innovation adoption and diffusion that has been investigated (Rogers and Shoemaker, 1971; Leung and Wei, 1998; Lin and Jeffres, 1998). The receptiveness of an organisation toward new ideas plays a key role in the adoption decision (Lin and Jeffres, 1998; Marcati *et al.*, 2008) while, longitudinally, a history of innovativeness promotes the likelihood for further positive adoption decisions when it comes to new technological innovations (Damanpour, 1991; Marcati *et al.*, 2008). This factor can be linked to the human characteristics of the decision maker (cognitive style),

given that in small businesses the CEO is often the owner-manager (Marcati *et al.*, 2008). Generally speaking, innovativeness relates to the openness to follow new ways, and the methods by which clients process information, take decisions, and solve problems (Kirton, 2003; Marcati *et al.*, 2008). At the firm level, the receptiveness of an organisation toward new ideas plays a key role in the adoption of innovations in SMEs (Marcati *et al.*, 2008). This factor has been investigated in previous studies, such as (Midgley and Dowling, 1978; Hirschman, 1980; Rogers, 1983). It is evident from reviewing previous studies that a history of innovativeness promotes the likelihood for further positive adoption decisions for new technological innovations within firms (Damanpour, 1991; Marcati *et al.*, 2008). This finding is inconsistent with the findings of Sarrina Li (2003).

Prior technology experience: several studies have found prior experience to be important in technology adoption decisions (Igbaria *et al.*, 1995; Hunter, 1999; Dholakia and Kshetri, 2004). Consequently, the user's experience with previous similar technologies could be expected to play a facilitative role in the adoption decision. Users' recognition of prior similar experiences can be viewed on a continuum that describes the degree of linkages between present practice and past experience (Lippert and Forman, 2005). A relationship exists between a user's prior knowledge and their understanding of a new context or situation (Bandura, 1977). According to Rogers (2003), the user's adoption behaviour can be affected by the accumulated experience using new innovations. In the case of cloud computing, familiarity with technologies such as virtualisation, cluster computing or utility computing can have a direct influence upon user perceptions regarding cloud computing services. Several studies have found prior experience to be important in technology adoption decisions (e.g. Bandura, 1977; Igbaria *et al.*, 1995; Hunter, 1999; Lippert and Forman, 2005). Based on the above, prior experience could be expected to play a facilitative role in the adoption decision.

3.5.3 Environmental Context

The key factors within the environmental context are: competitive pressure, type of industry, market scope and supplier efforts and external computing support. These will be discussed in turn below.

Competitive pressure: the external environment can have a direct effect on the firm's decision. The competitive pressure faced by a firm is a strong incentive to adopt relevant new technologies (Majumdar *et al.*, 1992). Previous empirical studies have noted the importance of competitive pressure as an adoption driver (e.g. see Crook and Kumar, 1998). For instance, Leibenstein (1976) reported that competition exerts strong pressures on organisations to search for new alternatives to improve their production. In the context of small businesses, Premkumar and Roberts (1999) found that competitive pressure was an important determinant of adoption. This factor was also suggested in the outsourcing literature, where many firms outsourced their IT infrastructure to improve effectiveness (Lacity and Willcocks, 1998). Better choice of new technologies may help businesses to offer lower prices, thus enabling them to increase their market share (Majumdar *et al.*, 1992).

Industry: The industry that the firm operates within can influence its ability to adopt new ICT innovation (Jeyaraj *et al.*, 2006). According to Forman (2005), the type of industry sector may affect a firm's decision to adopt because of network externalities or learning effects. As firms in different industry sectors have different needs, it appears that some businesses in certain sectors are more likely to adopt new ICT technologies than others in different sectors (Yap, 1990; Levenburg *et al.*, 2006). More specifically, it has been reported that the industry to which a business belongs influences the business's information processing requirements, which might have an effect on the firm's adoption of new technology (Yap, 1990; Goode and Stevens, 2000). On the other hand, there are also other studies (e.g. Levy *et al.*, 2001) that suggest that the sector in which a firm operates has little influence on IS innovation adoption. In the context of cloud computing, many recent studies and global surveys used industry as an indicator for adoption, illustrating how certain sectors are adopting cloud computing services more than others (e.g. (Mimecast, 2010; VMware, 2011).

Market scope is the horizontal extent of a company's operations (Zhu *et al.*, 2003), and indicates the nature of the firm's product-market domain (Pflugheoft *et al.*, 2003). SMEs operate not only locally, but also nationally and even internationally. To span the geographically dispersed units of the organisation, SMEs are required to have an effective operational communications network which helps them to avoid lagging

behind in the current increasingly globalised world (Wilson, 2011). The IS literature suggests that the greater the business scope, the greater the demand for information technology (Dewan *et al.*, 1998; Hitt, 1999). For instance, a study by Zhu *et al.* (2006b) reported that businesses with larger global scope usually are more motivated to start and implement e-business. Businesses with a broader scope of operations have more probability to have a complex network of relations with external clients and suppliers. Yet, communication with a greater network of consumers and providers escalates the difficulty of the communication and coordination of activities and requires processing a greater amount of information (Kettinger *et al.*, 1994; Pflugheoft *et al.*, 2003). Businesses with a broader scope of operations may also require a physical presence in dispersed locations. This greater dispersion also needs an increased level of coordination and integration of activities (Kettinger *et al.*, 1994). Therefore, the availability of IS innovation can be used by small firms to reach this goal. Chopra and Meindl (2001) demonstrated that when firms expand their market reach, they incur inventory holding costs and possibly search costs (for instance, searching for consumers, trading partners, and distributors). SMEs adopting cloud services are expected to decrease external costs and make them less location dependent.

Lastly, **supplier efforts and external computing support** is "*the availability of support for implementing and using an information system*" (Premkumar and Roberts, 1999). Organisations may be more willing to try a new technology if they feel there is sufficient support (Premkumar and Roberts, 1999). Marketing activities that suppliers execute can significantly influence SMEs' adoption decisions. This may affect the diffusion process of a particular innovation. Previous research (e.g. Hultink *et al.*, 1997; Frambach *et al.*, 1998; Woodside and Biemans, 2005) has attempted to draw a connection between supplier marketing efforts and the client's adoption decision. Past research has found evidence of a connection between supplier marketing efforts and the client's adoption decision (Kwon and Zmud, 1987; Weigelt and Sarkar, 2009), with suppliers acting both as a source of knowledge and capabilities (Weigelt and Sarkar, 2009) or reassurance (Frambach and Schillewaert, 2002). Organisations may be more willing to try a new technology if they feel there is sufficient support (Premkumar and Roberts, 1999). On the other hand, there have also been reports of this factor not being significant for innovation adoption (Raymond, 1985; DeLone, 1988). For instance,

Weigelt and Sarkar (2009) suggest that a client firm may be able to develop innovation-related capabilities by tapping into the experiential learning of its supplier, which, by implication, is a potentially important source of capabilities for the client firm, potentially influencing the firm's innovation adoption. Frambach and Schillewaert (2002) highlight the importance of activities such as targeting and communication in order to reduce the perceived risk from the potential customer.

3.5.4 Cloud Computing Adoption

The concept of cloud computing is relatively new. Both clients and providers need an unambiguous understanding of the various issues involved regarding this technology (Marston *et al.*, 2011). From a cloud computing perspective, the promised benefits related to capacity, reliability, and flexibility (Miller, 2008) are expected to positively influence the relative advantage that the technology offers with respect to the organisation's propensity to adopt it. At the same time, uncertainty is expected to have a negative effect on the propensity to adopt cloud computing as there are significant concerns about security, privacy and lock-in effects (Aziz, 2010). In the case of the aggregation and resale of cloud systems, the mix of mechanisms may lead to problems with compatibility (Schubert, 2010), which could further inhibit the success of diffusion and implementation among organisations (Lai, 1997). Moreover, firms may lack confidence in a cloud computing system because it is relatively new to them (Buyya *et al.*, 2011), and it may take users a long time to understand and implement the new system. Such negative perceptions of the complexity of cloud services tend to make it diffuse slowly and in limited capacity. Consequently, the complexity of an innovation can act as a barrier to the implementation of new technology (Premkumar and King, 1994; Low *et al.*, 2011). However, decision makers may acquire prior experience with cloud computing from a user's perspective by being able to trial services within the organisational context; they need to gain experience in relation to their organisation's specific applications. Such trialling can increase confidence and help reduce uncertainty, and thus increase the potential for cloud computing to be adopted. Based on the above, we propose the following hypotheses related to the technological context and its key factors:

H1: Increased perceived relative advantage of cloud computing increases SMEs' propensity to adopt cloud computing services.

H2: Decreased perceived uncertainty of cloud computing increases SMEs' propensity to adopt cloud computing services.

H3: Increased perceived compatibility of cloud computing increases SMEs' propensity to adopt cloud computing services.

H4: Decreased perceived complexity of cloud computing increases SMEs' propensity to adopt cloud computing services.

H5: Trialling cloud services before adoption increases SMEs' propensity to adopt cloud computing services.

Firm size, top management support, innovativeness and prior IT experience are factors that belong to the organisational environment. As discussed earlier, empirical results on the correlation between them are mixed (Lee and Xia, 2006). However, it is usually suggested that smaller sized firms are more flexible in terms of changing direction (Grover and Teng, 1992). It is important for top management support to send clear signals to various parts of the organisation about the importance of a project (Larsen and McGuire, 1998), and to create a supportive climate that provides adequate resources for the adoption of new technologies (Wang *et al.*, 2010). Given that in small businesses the CEO is often the owner-manager (Marcati *et al.*, 2008), this support can be important because the implementation of cloud computing may involve the integration of resources and the re-engineering of processes (Low *et al.*, 2011). Top management support generally exists when the changes are perceived as positive for the organisation (Eder and Igbaria, 2001). At the firm level, the receptiveness of an organisation towards new ideas plays a key role in the adoption of innovations in SMEs (Marcati *et al.*, 2008). It is evident from reviewing previous studies that a history of innovativeness promotes the likelihood of further positive adoption decisions for new technological innovations within a firm (Damanpour, 1991; Marcati *et al.*, 2008). This is also expected to be the case for the adoption of cloud computing as a new ICT innovation. According to Roger (2003), users' adoption behaviour can be affected by their accumulated experience of using new innovations. In the case of cloud computing,

prior experience with technologies such as virtualisation, cluster computing or utility computing can have a direct influence upon user perceptions regarding cloud computing services.

Based on the above discussion of the organisational context, the following hypotheses are proposed:

H6: The smaller the size of the firm, the more likely it is that cloud computing will be adopted by SMEs.

H7: High top management support increases SMEs' propensity to adopt cloud computing services.

H8: The more innovative a firm is, the more likely it is to adopt cloud computing.

H9: Increased prior similar IT experience increases SME propensity to adopt cloud computing services.

When it comes to environmental factors and cloud computing, it is expected that the business' industry may affect new technology adoption (Goode and Stevens, 2000). Recent studies on cloud computing have used industry as an indicator for adoption, illustrating how certain sectors are adopting cloud computing services more than others (Mimecast, 2010; VMware, 2011). As noted earlier, a better choice of new technologies may help businesses to offer lower prices, thus enabling them to increase their market share (Majumdar *et al.*, 1992). Cloud computing is useful for SMEs as a low cost alternative to the company's internal IT costs, as well as for quick prototyping and scalable/flexible novel services. As a result, competitive pressure can play a significant role in adoption. Organisations with a broader scope of operations need ICT technologies that enhance their information processing capacity so as to enable external and internal communication and coordination (Pflugheoft *et al.*, 2003). Previous studies have reported that firms that use more advanced ICT technologies have more ability to access internal, external, and previously encountered information. Also, it allows the quick retrieval of such information, and facilitates information accessibility (Huber, 1990).The availability of ICT innovations such as cloud computing can be used by SME firms to reach this goal. Vendor involvement may also significantly contribute to the rate of the adoption and diffusion of new products (Lai, 1997). Frambach and

Schillewaert (2002) suggest that vendor actions such as targeting and communication may reduce the perceived risk from the potential customer, resulting in an increase in the rate of adoption. In addition, the marketing activities that suppliers execute can significantly influence SMEs' adoption decisions. Since cloud computing is a relatively new innovation, the level of awareness regarding this technology is also relatively low. It is therefore expected that vendor activity will be an important element to increase the adoption level among SMEs.

Finally, based on the discussion of the environmental context, we propose the following four hypotheses:

H10: Increased competitive pressure increases SME propensity to adopt cloud computing services.

H11: The industry within which SMEs operate affects their propensity to adopt cloud computing.

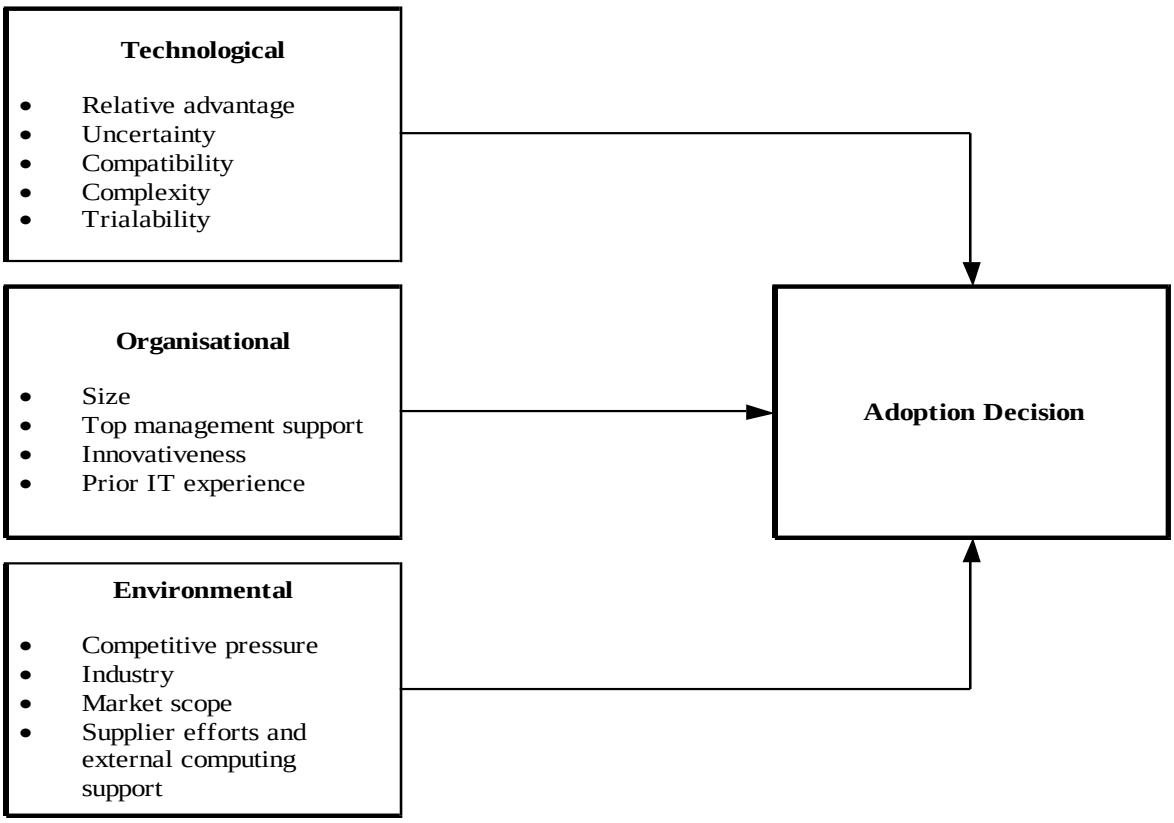
H12: SMEs with wider market scope are more likely to adopt cloud computing.

H13: Increased external computing support increases SME propensity to adopt cloud computing services.

Different approaches have been used for outcome measures in ICT innovations' adoption (Rui, 2007). (Rui, 2007) illustrated how decisions on innovation have been operationalised as either a dichotomy variable (whether the new technology is or is not adopted), or a trichotomy variable (whether the organisation is a non-adopter, potential adopter, or adopter); or a continuous variable (the extent to which the organisation intends to adopt the innovation). Ramdani (Ramdani, 2008) demonstrated that in ICT adoption studies, adoption decisions on an innovation have been operationalised as adoption decisions (e.g. Thong, 1999), degree of adoption (e.g. Premkumar and Roberts, 1999), and intention to adopt (e.g. Harrison *et al.*, 1997). Rui (2007) argues that whether a firm's adoption decision has been operationalised as a dichotomy/ tracheotomy adoption decision or an intention to adopt, they all refer to the firm's decision from not having the innovation to having it. In this research project, the dependent variable is the organisation's adoption decision, which can be defined as the

implementation of cloud computing technologies by an organisation as part of their ICT infrastructure and related services. Figure 3-1 graphically depicts the conceptual model on which this study will be based.

Figure 3-1: TOE Framework for SME adoption of on-demand computing services



Chapter 4. Research Context - SMEs and On-Demand Computing

4.1 Introduction

In an attempt to highlight the two main contexts in this research project, this chapter begins by reviewing the general characteristics and definitions of SMEs. It will provide the necessary background information on cloud computing. Although cloud computing has started to make its way into broad coverage in the commercial press, there is still no standard consensus on what exactly cloud computing is and how it relates to other similar technologies such as grid computing, software as a service (SaaS), and virtualisation and other similar technologies. In an attempt to provide a self-contained coverage of the topic under discussion, this chapter first provides an outline of the evolution of cloud computing. Then, it reviews several definitions of the term, followed by a discussion of the opportunities and challenges of cloud computing. In addition, different service delivery models and cloud deployment models, will be illustrated. Finally, it discusses the impact of cloud computing for users and companies and special issues related to cloud computing, such as service level agreements (SLA), quality of service (QoS) and important legal issues for cloud computing adoption.

4.2 Characteristics of Small and Medium-sized Enterprises

SMEs are an important component in business. It is widely recognised that SMEs make a great contribution to national and international economic development (Smallbone and Wyer, 2000), mainly because they are the main source of employment in most countries, and are a source of technological innovation and new products. Beyond the role SMEs play in employment creation, they are also an imperative element in that they provide social and economic benefits.

SME Definition: To date there has been little agreement on the definition of an SME, which may be explained by the diversity of the business carried out (Carter and Jones-Evans, 2006), or by the fact that the distinctive characteristics of different regions/ countries have led to variations in the definition (Table 4.1). In 1971, Bolton (1971) provided one of the earliest attempts to define small businesses, pointing to some of the criteria by which an SME can be identified. First, it has to be independent (not

part of a large firm). Second, it must have a simple management structure, mostly run by the business owner (Carter and Jones-Evans, 2006). Business size based on the number of the employees or annual turnover has been used in a large volume of published studies as an approach to identify SMEs.

Table 4-1: SME definitions

Region	SME Definitions
United Kingdom	**Definition**: According to Carter and Evans (Carter and Jones-Evans, 2006), the UK government tends to define SMEs as : Micro: 0-9 employees Small: 0-49 employees (including micro) Medium: 50-249 employees. **Highlights**: • According to BIS (October, 2011), in the private industry in the UK there were around 4.5 million firm at the start of 2011, an increase of 94,000 (2.1 per cent) since the beginning of 2010. • Approximately 23.4 million people are employed in these firms, and had an estimated combined annual turnover of £3,100 billion. • (SME) accounted for 99.9 per cent of all enterprises, 58.8 per cent of private sector employment and 48.8 per cent of private sector turnover
Europe	**Definition:** European Union (EU) divided SMEs into: Micro firm: number of employees not more than 10 and turnover not more than two million Euros Small firm: not more than 50 employees and turnover not more than 10 million Euros Medium sized firm: not more than 250 employees and turnover not more than 50 million Euros **Highlights:** The 20 million SMEs in the EU represent 99% of businesses, and make a great contribution to economic growth, innovation, employment and social integration (Verheugen, 2008).
United States	**Definition:** In the USA, SMEs employ fewer than 500 employees, from 1-100 considered as a small firm, and 101-500 medium sized firms (Hammer *et al.*, 2010) **Highlights**: Small and medium size businesses in the U.S. economy consider as a majority and approximately half the gross domestic product (GDP) generated by non-agricultural sectors**.**
World-wide	**Highlights:** According to United Nations industrial development organization (UNIDO): • SMEs make up over 90 % of enterprises in the world and account for between 50 and 60 % of employment (UNIDO, 2002) • "SMEs are being supported on the grounds that they make substantial contributions to productivity and, consequently, competitiveness and aggregate economic growth. In addition, SMEs are believed to be especially effective job creators and have a reputation for providing income and training opportunities as well as important basic services for disadvantaged people" (Altenburg and Eckhardt, 2006)

Characteristics of SMEs: A considerable amount of literature has investigated the characteristics of SMEs (e.g. Simpson and Docherty, 2004; Byrd, 2009). Generally,

in relation to many characteristics, smaller businesses differ from larger firms in a number of ways. Being specialised in a specific service or product, compared with larger firms, SMEs tend to have smaller market scope, or may in some cases make a single product and have a single buyer; what is more they are always attempting to reduce the cost of production (Storey, 1994; Simpson and Docherty, 2004). Yet, SMEs tend to support initiatives, usually beginning with a single person or a group of entrepreneurs (Byrd, 2009). Curran (1996) points out that a small business usually focuses on survival and independence rather than growth. However, although growth in SMEs is relatively slow, it usually tends to be incremental and steady (Bridge *et al.*, 2003).

With regard to management style in SMEs, small businesses tend to have a small management team and centralised management style. Murphy *et al.* (1996) reported that in SMEs, the manager is usually the owner of the business, and he / she has a strong influence on the firm's decisions. This means a high regard on the owner side is essential for transforming or adopting a new innovation inside the firms. The challenge that SMEs encounter regarding uneven finance supply (Pollard, 2003), and limited resources (Reid *et al.*, 1988), is just another attribute allied to this type of firm. Clearly, in SMEs, the IT infrastructure is not well-established compared to large enterprises (Beynon, 2002). The lack of well-established IT infrastructure might lead to new financial overload for the enterprise. More features of SMEs are: the centralised power, small management team, multifunctional management, flexibility, limited product range, inadequate organisational planning, and unsophisticated software or IT applications (Tetteh and Burn, 2001). Storey and Sykes (1996) suggest that small firms tend to be risky and uncertain compared to large firms. However, Durrani and Boocock (2006) argue that such an exposition is questionable because in general, motivations, constraints and uncertainties vary not only between SMEs and large firms, but also between small/small and small/medium-sized firms. This idea was also supported by Leyden and Link (2004), who point out that small businesses possess modest capital that is controlled almost entirely and directly by the owners, in addition to a modest assets base. As a result, this makes small businesses more risk-averse compared to large businesses. Table 4.2 below presents the main characteristics of SMEs.

Table 4-2: SME Characteristics

SME Characteristic	Source
Initiative: Small businesses are usually begun by a single person or a group of entrepreneurs, and therefore this type of business tends to support initiatives	(Megginson *et al.*, 1994)
Specialisation: SMEs are usually specialised in a single product and sometimes they may have only a single buyer. Compared with larger firms, they tend to have smaller market scope, and always attempt to reduce the cost of production.	(Storey, 1994; Simpson and Docherty, 2004)
Survival & growth: Small businesses usually focus on survival and independence rather than growth. Therefore, growth in SMEs is relatively slow; however, it does usually tend to be incremental and steady.	(Curran *et al.*, 1996; Bridge *et al.*, 2003)
Resources availability: SMEs have a modest resource base, a lack of economic clout and suffer from weak asset bases. They are likely to have a limited availability of resources in terms of time, money and expertise.	(Wymer and Regan, 2005; Bharati and Chaudhury, 2006)
Planning: SMEs usually have limited formal planning and control procedure mechanisms in the company.	(Chell *et al.*, 1991; Bharati and Chaudhury, 2006)
Control mechanisms: Usually the manager is the owner of the business. Control mechanisms in small businesses tend to be centralised and have a low level of formalism. The decision-making authority within a small firm is held personally by the owners.	(Chell *et al.*, 1991; Murphy *et al.*, 1996)

4.3 Cloud Computing

4.3.1 Pathway to on-demand computing

The past decade has seen the rapid development of Internet usage in many fields and industries. For a long time, Internet connection through fixed telephone lines and dial up were the main way of connecting to the Internet. Rapid adoption of fixed broadband and mobile broadband is now taking place as a result of the increased demand for high-speed Internet connections and the spread of mobile cellular networks and their wide population coverage. The difference in the speed of surfing the Internet by modem or ISDN is remarkable and was the first step towards broadband network access. The increase in speed has enabled more sophisticated and complex services (Aumueller, 2010). Stallings (2009) notes that there is an incessant inclination to offer it in a faster and cheaper way for communication and computing. Data transmission is becoming cheaper due to the growing usage of high speed wireless and fibre optic Internet. As a result, this has led to more powerful computers and clusters of computers prepared to support more complex applications. Businesses can now use web applications easily, and this creates many paths for firms to reach customers and providers (Stallings, 2009). As far as on-demand computing is concerned, high-speed

broadband network access is a key tool for this type of computing service. According to Aumueller (2010), this is because the execution of complex and integrated applications can be transferred from client computers to servers available via networks, e.g. the Internet. End-users with high-speed broadband network access experience these applications (now over the web) in the same way as a local installation, in terms of reaction time and convenience. As a result, computing has started to move toward a server-side model, which is a core element in the on-demand computing paradigm. Primarily, data centre services are considered a major tool to manage business data. Data centre facilities, which mainly include telecommunications and storage systems, have become a common and crucial aspect of most organisational operations, mainly because they aid business processes, information management, and communications functions (U.S. Environmental Protection Agency, 2007) (EPA, 2007). In other words, data-centres are designed to house hundreds to thousands of commoditised computers and associated components that provide storage and processing power. They house the applications that are accessed as services (Kurta, 2010). Research related to on-demand technologies forms a significant branch of the recent and future Internet research studies.

4.3.2 On-demand computing

ICT tools have been identified as major contributing factors for business success. Numerous studies have attempted to describe the great impact of the continued advance of technology on the business landscape, and how these technologies have helped organisations to differentiate themselves (Ritchie and Brindley, 2005; Harindranath *et al.*, 2008). During the past decades, firms have used ICT as a strategic weapon to contend with the major challenges of that period of time. However, nowadays SMEs are facing a more complex, competitive, and fast changing environment. SMEs typically deal with two types of challenge (Thinkstrategies, 2002), which can be classified as follows:

Type 1: challenges regarding being a specialist, or the service that the organisation provides. This varies according to the nature of the business that the organisation does.

Type 2: challenges regarding the IT work level, ranging from software implementation and updating, storing and privacy of data, and hardware maintenance etc.

Small businesses may feel restricted by their capability to perform some tasks of running computing services. This stems from certain limitations related to technical staff and/or adequate finance to know how to handle pending challenges (Raymond, 1985). The challenges associated with selecting, installing, maintaining, and managing information technology are particularly acute for small and mid-size organisations. Such firms often lack the resources and staff needed for planning, designing, implementing, and managing increasingly complex hardware, software, and networking equipment. In addition, the current economic crisis / downturn have resulted in making it more difficult for small and mid-size firms to justify these operating expenses (Thinkstrategies, 2002). The flexibility of small business infrastructures makes them more open to assistance from a third party (Ray and Ray, 2006). It is attractive for SMEs to adopt and use available third party computing services in order to set them free from the challenges of in-house IT, although outsourcing has its own associated challenges. Challenges that relate to IT operations usually consume a great deal of resources, effort and time to keep running them in an efficient way (Thinkstrategies, 2002). On demand computing promises a solution to this challenge, transforming the way that organisations use computing. *"A vision of the future of computing services based on the utility-computing business model has already begun to take shape. Application service providers, managed services, and hosting are an increasingly common part of the computing landscape... Clearly, there are trade-offs involved in migrating to new business models"* (Rappa, 2004, p. 41).

The increased amount of data and improved level of connectivity has encouraged ICT providers to create data centres in order to supply and host a pool of shared computing resources with dynamic load to organisations. By distributing and replicating data across servers on demand, resource utilisation has been considerably advanced (Schubert, 2010). The main aim for previous trends such as cluster, grid and now cloud computing is to provide easy access to large scale computing infrastructure in a fully virtualised manner, by enabling the pooling of resources and offering a single system

view (Buyya et al., 2011). These terms will be discussed and compared in separate sections to demonstrate their contribution to the development of cloud computing in its current form.

4.3.3 Grid computing

In the early 1990s, the term grid computing originated as a term used in an on-demand computing context to refer to the process of making computer power as easy to access as an electric power grid (Gunasekaran and Sandhu, 2010). Buyya and Venugopal (2005) define grid computing as "*a type of parallel and distributed system that enables the sharing, selection, and aggregation of geographically distributed autonomous resources dynamically at runtime depending on their availability, capability, performance, cost, and users' quality-of-service requirements*".

Table 4-3: cloud vs. grid. Source: (Vaquero et al., 2008)

Feature	Grid	Cloud
Resource sharing	Collaboration	Assigned resources are not shared
Resource Heterogeneity	Aggregation of heterogeneous resources	Aggregation of heterogeneous resources
Virtualisation	Virtualisation of data and computing resources	Virtualisation of hardware and software platform
Security	Security through credential delegations	Security through isolation
High level services	Many high level services	No high level services defined yet
Architecture	Service orientated	User chosen architecture
Software dependencies	Application domain dependent software	Application domain independent software
Platform Awareness	The client software must be grid enabled	The SP software works on a customised environment
Software workflow	Application require a predefined workflow of services	Workflow is not essential for most applications
Scalability	Nodes and sites scalability	Nodes, sites and hardware scalability
Self-management	Reconfigurability	Reconfigurability self-healing
Centralisation Degree	Decentralised control	Centralised control (until now)
Usability	Hard to manage	User friendly
Standardisation	Standardisation and interoperability	Lack of standards for cloud interoperability
User access	Access transparency for the end user	Access transparency for the end user
Payment model	Rigid	Flexible
QoS Guarantees	Limited support, often best-effort only	Limited support, focused on availability and uptime

It is not easy to differentiate between cloud computing and similar technologies such as grid computing. In fact, different studies present mixed views on what "*the grid*" is in the first instance. Schubert (2010) argued that grids may be seen "on top of", clouds, or vice versa, or may even be identical. Table 4-3 below presents a few of the differences between cloud and grid computing.

Grid computing was designed to create an innovative computing environment for businesses. *"Merged with web services and service oriented architectures, grid computing architecture pursues on-demand deployment of resources based on exactly what consumers need in terms of both quantity and quality over distributed environments"* (Hwang and Park, 2007, p.16). Nevertheless, grid computing differs from cloud computing in many respects. Perhaps the main difference is due to the provisional means of computational resource, which in clouds is commercial based and in Grids is community based. The major differences between grids and clouds were summarised by Brandic and Dustdar (2011) as follows:

- *Business Models:* While grid business models are usually based on bilateral agreements between academic institutions, the provision of resources in clouds requires more differentiated business models. At the present time, several types of business models are offered from different big players in the cloud computing field. For instance, some providers prefer to sell their own resources together with their own software services (e.g. GoogleApps, Salesforce.com), other suppliers only offer computing resources (e.g. Amazon, Tsunamic Technologies), while a third group runs a mixed approach, i.e. they allow users to create their own services, but at the same time offer their own services (Sun N1 grid, Microsoft Azure).
- *Resource Management:* Grid computing depends on batch systems, while in cloud computing the utilisation of virtualisation technologies represents the resource management solution.
- *Resource Provision Models:* For clouds, the usage of Service Level Agreements (SLAs), compliance, and trust management is essential. Grid resource provisioning models are founded on virtual organisations, where the relationships are established offline.
- *Resource Availability:* Cloud computing depends on considerable elasticity in the clouds. Challenging issues in clouds are to find the balance between wasting

resources, due to the virtualisation overhead and standby modes of devices on the one hand, and pooling of resources to facilitate efficient consumption of resources and reduced energy consumption on the other. In grid computing, resource sharing depends on the best effort approach, as sometimes there are many resources which are idle, and sometimes resources are not accessible.

4.3.4 Virtualisation

In the computing context, the creation of a virtual version from a physical entity such as network resources, hardware platforms or storage devices is known as virtualisation. Virtualisation can be viewed as the process of partitioning one physical server, called the host, into multiple virtual servers, called guests (Jeremy T. Lanman and Linos, 2011). Virtualisation helps to detach the hardware from the software layer (Aumueller, 2010). In other words, the usual goal for this technology is to hide the physical characteristics of a computing platform from the users, in its place presenting an abstract, emulated computing platform (Vouk, 2008). This emulated computing platform works as an independent system. However, it is different from the usual physical system as it can be configured on demand (Marston *et al.*, 2011). There are several benefits and limitations through the execution of a virtualised environment (IBM, 2008; Jeremy T. Lanman and Linos, 2011). Adopting virtualisation technology can assist with reducing the hardware footprint as a result of the consolidation of physical machines into virtual machines. It also assists in increasing redundancy without acquiring additional hardware. Finally, it allows for remote testing of applications by developers. On the other hand, virtualisation also has limitations such as:

- Decreased processing power for servers dedicated to high demand applications
- Inability to transfer virtual servers from one physical machine to another unless they use the same manufacturer's processor
- Increased risk of voiding license agreements that do not support virtual machines.

4.3.5 Cloud Computing

Many of the ideas in cloud computing services are not new (Marston *et al.*, 2011). According to Leimeister *et al.* (2010), various researchers refer to cloud computing as a new paradigm and emerging technology (e.g. Lyer and Henderson, 2010; Zhang *et al.*, 2010). On other hand, others (e.g. Foster *et al.*, 2008; Youseff *et al.*, 2008; Dillon *et al.*, 2010) believe it is not really a new concept, as it uses traditional computing technologies. This means that cloud computing is not a completely novel concept, but has rather quite a long history based on the advance of several technologies, especially in hardware (virtualisation, multi-core chips), Internet technologies (Web services, Web 2.0), distributed systems (Cluster computing and grid computing) (Buyya *et al.*, 2011). The main notion of these terms is time-sharing and utilising computer resources and, therefore, these technologies are considered a major enabler of the cloud computing concept.

"Cloud computing is considered as an umbrella term to describe a category of sophisticated on-demand computing services initially offered by commercial providers such as Amazon, Google and Microsoft" (Buyya *et al.*, 2011, p. 2). Cloud computing represents continuance in the development of infrastructure for the provision of computational resources as utilities (Brandic and Dustdar, 2011). Therefore, this computing model is expected to influence the way many enterprises approach IT-related services. It is also expected to be as influential as e-business (Gartner, 2008). During the last few years, the evolution of cloud computing has been considered the key emerging technology in the field of computing. However, both clients and providers need an unambiguous understanding of the various issues involved regarding this technology (Marston *et al.*, 2011). Cloud computing presents a business model for on-demand delivery of computing services; it encompasses "*pay*-per-use" services, where clients pay only for the computing services they use. This method is similar to the way in which traditional public utility services such as water, gas, electricity and the telephone are obtained (Buyya *et al.*, 2011).

Cloud computing promises to deliver tangible business benefits, often at much lower costs, as it dramatically reduces the upfront costs of computing that sometimes discourage firms, mainly small businesses, from utilising cutting-edge ICT services

(Staten, 2009). This offers them good return on the investment of their limited resources. In turn, they can focus on what truly delivers value to their customers and results in a competitive advantage. This has led to positive predictions regarding cloud computing in the next few years. For instance, According to AMI partners, over $100 billion are expected to be spend by SMEs on cloud computing by 2014, also Gartner Research predicts that worldwide spending on public IT cloud to be a $150 billion by 2014 (Marston *et al.*, 2011). In terms of ICT services, cloud computing is a key trend as it is gradually modifying the way information system services are developed, scaled, maintained and paid for. Also, it provides businesses with the computing agility needed to respond in real time to user requirements (Kim, 2009; Marston *et al.*, 2011).

Cloud service models are classified according to the computing requirements of the clients and represent different layers of the cloud computing architecture: infrastructure as a Service (IaaS), Platform as a Service (PaaS) and Software as a Service (SaaS). Also, cloud deployment models are classified according to the type of exclusive and non-exclusive method of providing cloud services to the clients as follows: public cloud, private cloud, hybrid cloud, and community clouds (Mell and Grance, 2010). Cloud-based end user services, such as email or office applications, are increasingly finding their way into daily business practices, offering new opportunities and capabilities, but equally creating new challenges for stakeholders.

4.3.6 Definition of Cloud Computing

Several studies have suggested that it is not easy to define cloud computing. Kim *et al.* (Kim *et al.*, 2009) explained that definitions of cloud computing have already changed many times and will definitely undergo further alterations. According to Aumueller (2010), due to the variation surrounding the cloud computing concept, the definition of cloud computing is the first and most difficult task of any discussion. Different definitions of cloud computing show different visions about cloud computing from the different standpoints of different stakeholders such as academics, architects, consumers, developers, engineers and managers. Cloud computing services have been defined in many different ways (see Table 4.4), typically focusing on technical and service characteristics.

Table 4-4: Cloud computing definitions

Author/Reference	Definition/Excerpt
(Buyya *et al.*, 2008)	A type of parallel and distributed system consisting of a collection of interconnected and virtualised computers that are dynamically provisioned and present as one or more unified computing resource based on service-level agreements established through negotiation between service provider and customer.
J. Kaplan (Geelan *et al.*)	A broad array of web-based services aimed at allowing users to obtain a wide range of functional capabilities on a pay-as-you-go basis that previously required tremendous hardware/software investment and professional skills to acquire.
Bill Martin (Geelan *et al.*)	Cloud computing really comes into focus only when you think about what IT always needs: a way to increase capacity or add capabilities on the fly without investing in new infrastructure, training new personnel, or licensing new software. Cloud computing encompasses any subscription-based or pay-per-use service that, in real time over the Internet, extends IT's existing capabilities.
K.Harting (Geelan *et al.*)	Cloud computing overlaps with some of the concepts of distributed, grid and utility computing, but it does have its own meaning if contextually used correctly. Cloud computing really is accessing resources and services needed to perform functions with dynamically changing needs.
Damon Edwards (Geelan *et al.*)	The "Cloud" concept is finally wrapping peoples' minds around what is possible when you leverage web-scale infrastructure (application and physical) in an on-demand way. "Managed Services", "ASP", "Grid Computing", "Software as a Service", "Platform as a Service", "Anything as a Service"… all terms that couldn't get it done. Call it a "Cloud" and everyone goes bonkers. Go Figure.
Wladawsky Berger (Geelan *et al.*)	"... The key thing we want to virtualise or hide from the user is complexity. ...with cloud computing our expectation is that all that software will be virtualised or hidden from us and taken care of by systems and /or professionals that are somewhere else – out there in the cloud".
P. McFedries (McFedries, 2008)	Cloud computing, in which not just our data but even our software resides within the cloud, and we access everything not only through our PCs but also cloud-friendly devices, such as smart phones, PDAs... the mega computer enabled by virtualisation and software as a service... this is utility computing powered by massive utility data centres.
IDC (Gens, 2008)	IDC analysts distinguish between: Cloud Services = Consumer and Business products, services and solutions that are delivered and consumed in real-time over the Internet. Cloud Computing = an emerging IT development, deployment and delivery model, *enabling* real-time delivery of products, services and solutions over the Internet (i.e. enabling cloud services).
Forrester (Ried *et al.*, 2009)	A standardized IT capability (services, software, or infrastructure) delivered via Internet technologies in a pay-per-use, self-service way.
THINKstrategies	A set of web-based tools and services which permit users to acquire computing resources and development capabilities to build or support applications, or perform specific IT functions on a pay-as-you-go basis.
Marston et al . (Marston *et al.*, 2011)	It is an information technology service model where computing services (both hardware and software) are delivered on-demand to customers over a network in a self-service fashion, independent of device and location. The resources required to provide the requisite quality-of-service levels are shared, dynamically scalable, rapidly provisioned, virtualised and released with minimal service provider interaction. Users pay for the service as an operating expense without incurring any significant initial capital expenditure, with the cloud services employing a metering system that divides the computing resource into appropriate blocks.

The U.S. Government's National Institute of Standards and Technology (NIST) offers an up-to-date definition of cloud computing. The current version of their definition is version 15, 10th July 2009, and is considered as the most comprehensive; most referred to, and widely accepted definition of cloud computing (Jäätmaa, 2010). According to the NIST: "*Cloud computing is a model for enabling convenient, on-demand network access to a shared pool of configurable computing resources (e.g. networks, servers, storage, applications, and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction*" (Mell and Grance, 2010). According to NIST, this cloud model is composed of five essential characteristics**,** three service models (IaaS, PaaS, SaaS), and four deployment models (Public cloud, Private cloud, Hybrid cloud, and community cloud, discussed in detail in the following sections). According to the definition, users can unilaterally access computing capabilities, such as server time and network storage, as needed automatically without requiring human interaction with each service supplier. Capabilities are available over the network and accessed through standard mechanisms that promote use by heterogeneous thin or thick client platforms (e.g. mobile phones, Tablets, laptops, and workstations). Capabilities can be elastically provisioned and released, in some cases automatically, to scale rapidly outward and inward, commensurate with demand. To the consumer, the capabilities available for provisioning often appear to be unlimited and can be appropriated in any quantity at any time. Finally, cloud systems automatically control and optimise resource use by leveraging a metering capability at some level of abstraction appropriate to the type of service (e.g. storage, processing, bandwidth, and active user accounts). Resource usage can be monitored, controlled, and reported, providing transparency for both the suppliers and users of the utilised service.

Vaquero *et al.* (2008) argued that it is essential to find a cohesive definition of cloud computing to draw the boundaries of the scope of the research and call attention to the possible organisational benefits. Nevertheless, there is still a lack of an entrenched and clear definition in the literature and contrasting views on cloud computing are creating confusion with other related technologies (Smith *et al.*, 2009; Jäätmaa, 2010). In the context of this work, we adopt the definition in Plummer *et al.*

(2008) as it captures concisely the key features of cloud computing from both a technical and end-user perspective. They defined cloud computing as *"a style of computing where massively scalable IT-related capabilities are provided as a service using Internet technologies to multiple external customers*" (Plummer *et al.*, 2008, p. 3).

4.3.7 Drivers for cloud computing

As discussed earlier, cloud computing is the comprehensive method of providing computing services using high speed Internet connections. Today's Internet environment has contributed directly to the shift from traditional in-house computing to cloud computing. This transition is gradually modifying the way information system services are developed, scaled, maintained and paid for (Melvin and Greer, 2009). In brief, this tendency indicates that there is a rise in the propensity for replacing in-house computing with new on-demand computing services. The results obtained from a CIO survey on business priorities and strategies reports that CIOs ranked cloud services second among the top ten technology priorities in 2010 (Misra and Mondal, 2011). A survey by Forrester's Business Technology (May 2006) about North American and European large enterprise infrastructure and data centres indicated that 80% of the overall IT budget in these enterprises goes to recurring operations and maintenance (Gillett and Yates, 2006). This makes cloud computing a strategic technology option for them. Positive market prospects are also driven by the anticipation that cloud computing may become the essential approach towards Green IT (Stanoevska-Slabeva and Wozniak, 2010).

As can be seen from Table 4.5, cloud computing reported improved attributes compared to in-house computing in different ways. For instance, when using cloud computing, businesses will have the opportunity to adopt a "pay-per-use" model for on-demand ICT scalability. In other words, it helps firms to do away with costly fixed assets such as firm-owned hardware and software.

Table 4-5: Distinguishing Attributes of Cloud Computing. Source: (Melvin and Greer, 2009)

	Traditional Computing	Cloud Computing
Acquisition model	Buy assets and build technical architecture	Buy service
Business model	Pay for fixed assets and Administrative overhead	Pay based on use
Access model	Over Internal network, to Corporate desktop	Over the Internet, to any device
Technical model	Single tenant, non-shared, static (often not shared)	Scalable, elastic, dynamic, multi-tenant

The key benefits of the cloud computing model are discussed below.

Lower IT infrastructure costs: One of the major benefits that businesses are expecting from using cloud services is cost saving (Miller, 2008). This financial benefit is expected mainly because of the usage-based pricing model. In terms of start-up organisations, using cloud services can help them to decrease their capital expenses and any hurdles to entry (Grossman and Gu, 2009). Cloud computing provides almost direct access to shared computing resources and, therefore, small and start-up businesses can launch new operations quickly with little to no upfront capital investment; this will assist with a faster time to market in many businesses (Jeremy T. Lanman and Linos, 2011; Marston *et al.*, 2011). West (2011) noted that using software from the cloud will lead to a reasonable reduction in systems maintenance and updating requirements. Clients will be able to reduce software updating and maintenance costs, by having most of the IT software, operations and functions done by a third party. In other words, there will be fewer in-house IT staff and lower costs.

Capacity and Reliability: This includes increased computing power, improved performance, unlimited storage capacity, increased data safety, and fewer maintenance issues (Miller, 2008). Most firms do not use more than half of their total ICT resource capacity (Leavitt, 2009) and, therefore, most computing suppliers try to focus on the idea of offering computing services to their clients where they can scale up their capacity on demand (Grossman and Gu, 2009). Whenever the client needs additional computing resources such as storage space, the provider can simply increase the provision accordingly in order to handle the increased business needs. Increased

reliability comes from the fact that on-demand computing usually employs systems that are extremely reliable and that provide some kind of redundancy to customers. Mainly for SMEs, a general-purpose data centre makes it easier for enterprises to scale their services and can present more availability compared to an in-house ICT infrastructure. In fact, one of the most appealing benefits of cloud computing is to scale resources up or down dynamically through software application programming interfaces **(**APIs), relying on customer load with minimal service provider interaction (Marston *et al.*, 2011).

Ease of use and flexibility: This includes instant software updates, latest version availability, easier group collaboration and universal access to documents, and removes the tether to specific devices (Miller, 2008). Perceived complexity seriously hinders the increase in adoption rates and user satisfaction. In the case of cloud computing, the operating interfaces of cloud applications look like browser web based applications or windows based applications. Both interfaces tend to be intuitive and easy to use (Melvin and Greer, 2009). Nowadays, most cloud computing suppliers offer more flexible contract terms, which encourages firms to implement cloud services as needed to expand their businesses (Leavitt, 2009). In addition to these significant characteristics of cloud computing, there is the portability and accessibility feature, as the Internet is considered the backbone of the utilisation idea, through which computing services are provided for clients through an active Internet connection. On-demand access to any application can be at any time from any location, provided the client has network access (Jeremy T. Lanman and Linos, 2011). This can assist small businesses, which have a wide market and broad horizontal company operations, such as regional or international, to decrease external costs and make them less location dependent.

4.3.8 Adoption Barriers to cloud computing

Although the benefits of adopting a cloud-centric environment provide an improved IT enterprise, cloud computing services are not without their limitations since, like any technology, this type of computing service has a distinct set of problems and challenges associated with it. In fact, cloud computing is still considered to be in the early adoption stage. Therefore, it is normal that it suffers from several issues which suppliers need to address to drive mainstream adoption. One of the most significant

current client concerns is security. With cloud computing, users take into consideration that their data and critical ICT resources will be off-premises. In this context, it is important to distinguish between security and privacy. Security is about protecting data from unauthorized access, while *privacy* refers to who is allowed to access data. Both are critical concerns for enterprises, but for slightly different reasons (Kushida *et al.*, 2010b). Another two concerns are performance and availability, as businesses need confirmation that critical services will be accessible on demand. Businesses realise that these services are supported by a complex web of interdependency, which generates concerns about the availability and performance of the service provider's systems.

4.3.9 Cloud Service Delivery Models

Cloud computing typically involves providing scalable, normally personalised, inexpensive computing resources as a service over the Internet which could be accessed in a simple and pervasive way. It simply provides shared business applications that are accessed from a web browser, while the software and data are stored on the servers. Cloud service models are classified based on the computing requirements of the clients and represent different layers of the cloud computing architecture, namely: Infrastructure as a Service (IaaS), Platform as a Service (PaaS) and Software as a Service (SaaS). This classification is grounded on the abstraction level of the capacity provided and the service model of providers. These different delivery models are known in different industries from an end-user's perspective (Marston *et al.*, 2011). Cloud computing goes beyond simply providing software as a service (SaaS); it also provides platform as a service (PaaS), and infrastructure as a service (IaaS), which gives it the potential to meet the requirements of large sectors of the market (Buyya *et al.*, 2011).

Software as a Service: This computing model allows users to access simple desktop applications such as word processing and spread-sheets as a service on the web. The application itself runs on the cloud, which means that users do not need to install and run the application on their computers, and it can be accessed on-demand at any time from any location (e.g. web browser, PDA etc.) (Dillon *et al.*, 2010; Marston *et al.*, 2011). The SaaS model organises clients' applications in a single logical environment on the SaaS cloud with the aim of achieving economies of scale and optimization in terms of speed, security, availability, disaster recovery, and maintenance (Dillon *et al.*, 2010).

Examples of SaaS include personal applications such as Gmail, TurboTax Online, Facebook and Twitter, to enterprise-level applications such as Salesforce, Netsuite or Google Apps (Marston *et al.*, 2011). For instance, salsforace.com, which relies on the SaaS model, offers business productivity applications (CRM) which are completely hosted on their servers. CRM users can access applications on demand (Buyya *et al.*, 2011).

Platform as a Service (PaaS): In the PaaS approach, cloud providers give the consumer a higher level of abstraction to deploy onto the cloud infrastructure consumer-created or acquired applications created using programming languages, operating system, web server, libraries, services, and programming language tools (Mell and Grance, 2010). In this delivery model, cloud users have the ability to develop applications directly (e.g. SaaS), using a development platform. These differences between SaaS and PaaS suggest that in general SaaS only hosts completed cloud applications, while PaaS provides a development platform that hosts both completed and in-progress cloud applications. In other words, the cloud platform presents to the developers an environment to create applications without the cost and complexity of buying and managing the underlying hardware and software layers (Buyya *et al.*, 2011). Examples of PaaS include Microsoft's Azure Services Platform, Google's App Engine, Amazon's Relational Database Services and Rackspace Cloud Sites (Dillon *et al.*, 2010; Marston *et al.*, 2011).

Infrastructure as a Service (IaaS): The virtualisation resources provided to the consumer (computing, storage, and communication) on demand are known as infrastructure as a service (Sotomayor, 2009). According to Aumueller (2010), the concept started under the term Hardware-as-a-Service (HaaS) and was later transformed to Infrastructure-as-a-Service (IaaS) to show the holistic approach for all hardware to run an IT infrastructure as a service. The basic strategy of IaaS is to set up a fixable environment where consumers are allowed to perform several activities on the server, for instance, starting and stopping it, customising it by installing software packages, attaching virtual disks to it, and configuring access permissions and firewall rules (Buyya *et al.*, 2011). Amazon's S3 storage service and EC2's computing platform,

Rackspace's Cloud Servers, Joyent and Terremark, are some prominent examples of IaaS (Dillon *et al.*, 2010; Marston *et al.*, 2011).

4.3.10 Cloud Deployment Models

Despite the fact that cloud computing has developed mainly from the appearance of public computer utilities, other deployment models, with variation in physical location and distribution, have been adopted (Mell and Grance, 2010). Cloud deployment models are classified according to the type of exclusive and non-exclusive method of providing cloud services to the clients as follows: public cloud, private cloud, hybrid cloud, and community clouds (Mell and Grance, 2010).

Public cloud: Armbrust *et al.* (2010) have defined the public cloud as a "*cloud made available in a pay-as-you-go manner to the general public*". Public cloud is sold to the public and considered a cost-effective way to deploy IT solutions. The cloud infrastructure is made available for use by general public cloud consumers and is owned by an organisation selling cloud services with its own policy, and charging model (Savu, 2011). Amazon EC2, S3, Google AppEngine, and Force.com are prominent examples of a public cloud used by many organisations of all sizes (Dillon *et al.*, 2010; Marston *et al.*, 2011).

Private cloud is an "*internal data centre of a business or other organisation, not made available to the general public*" (Armbrust *et al.*, 2010). In this deployment model, the cloud is owned or leased. The cloud infrastructure is operated solely within a single firm. It is managed by the firm or a third party regardless of whether it is located on the premises or off them (Savu, 2011). This gives a private cloud greater control over the cloud infrastructure, and is often suitable for larger installations (Buyya *et al.*, 2011; Marston *et al.*, 2011). There are many reasons that make a firm adopt this type of deployment mode. Firstly, there is the need to maximise and optimise the utilisation of existing in-house resources; secondly, users usually have concerns regarding data privacy and trust, which also makes private clouds an option for them; thirdly, organisations always need complete control over mission-critical activities that are hosted behind their network firewalls (Dillon *et al.*, 2010). This deployment model allows clients to interact with the local data centre while experiencing the same benefits

of public clouds, mainly self-service interfaces, privileged access to virtual servers, and per-usage metering and billing (Buyya *et al.*, 2011).

Community cloud: In this deployment model, computing services are shared by several organisations and they support a specific community that has shared interests (e.g. policies, requirements, values, and concerns and compliance consideration) (Mell and Grance, 2010; Marston *et al.*, 2011). The cloud infrastructure could be hosted internally (by one of the members of the community) or by a third-party vendor (Dillon *et al.*, 2010). According to Marston *et al.* (2011), as one of the biggest users of a community cloud; United States Federal Government built on Terremark's Enterprise cloud platform, it has helped the government to swiftly utilize some particular applications such as Forms.gov (for all federal forms) to the topical Cars.gov (for the so-called 'Cash for Clunkers' programme) and Flu.gov, all of which are all linked to the U.S. government's official web portal, USA.gov (Marston *et al.*, 2011).

Hybrid cloud: The cloud infrastructure is composed of two or more distinct cloud infrastructures. Firms implement the hybrid cloud model to optimise their resources to raise their core competencies by margining out peripheral business functions onto the cloud while controlling core activities in-house through private cloud (Dillon *et al.*, 2010). In other words, non-critical information is outsourced to the public cloud, while business-critical services and data are kept within the control of the organisation (Marston *et al.*, 2011).

4.3.11 ICT policy issues and the key players in cloud computing

As with any previous ICT innovation, businesses tend to consider guidelines and special issues from the research community regarding these new innovations. Issues such as security and privacy are the main concern for organisations regarding cloud computing services. Marston *et al.* (2011) highlighted the special issues in which these firms would be interested: (1) administrating and implementing a constant ICT policy across different cloud computing suppliers; (2) handling the relocation of a software subscription, which usually is the domain of the IT department, to individual departments that need the cloud application instances; and (3) initiating IT audit policies that fit with local, regional, national and international policies. According to Marston *et al.* (2011) there are many key players in the cloud industry, e.g. Google, Microsoft,

IBM and AT&T; technology providers such as Apache and AMC; "innovators" such as Amazon and Salesforce; and "enablers" such as CapGemini and RightScale.

4.3.12 Businesses and Cloud Computing

4.3.12.1 Cloud related market forecasts

A survey by Forrester's Business Technology (May 2006) about North American and European large enterprise infrastructure and data centres indicated that 80% of the overall IT budget in these enterprises goes to recurring operations and maintenance (Gillett and Yates, 2006). This makes cloud computing a strategic technology option for them. The cloud computing model is expected to influence the way many enterprises approach IT-related services. The media, as well as ICT expertise, are generally very optimistic about the opportunities cloud computing is offering for businesses. However, cloud computing is not only of interest for large businesses, but also for small and medium-sized ones too (Jain and Bhardwaj, 2010), since they tend to have limited resources in terms of time, money and expertise (Cragg and King, 1993; Wymer and Regan, 2005). Miller (2008) expected the cost advantages of cloud computing to be three to five times for business applications and more than five times for consumer applications. IDC predicts that worldwide spending on public IT cloud services will grow from $16.5 billion in 2009 to become a $55 billion business by 2014 (Gens, 2010). (Gens, 2010). In turn, this can help businesses improve the creation and delivery of IT solutions, by enabling them to access computing services more flexibly and at reduced cost (Smith *et al.*, 2009; Jain and Bhardwaj, 2010). A CIO survey on business priorities and strategies reports that CIOs ranked cloud services second among the top ten technology priorities in 2010 (Misra and Mondal, 2011). According to Gartner, cloud computing will be as influential as e-business (Gartner, 2008). This positive cloud-related market forecast comes as a result of the optimistic attitude regarding the significance and the influence of cloud computing (Stanoevska-Slabeva and Wozniak, 2010). For SMEs, cloud computing promises to deliver tangible business benefits, often at much lower cost, as they only pay for the resources needed, offering them good return on the investment of their limited resources. In turn, they can focus on what truly delivers value to their customers, resulting in a competitive advantage. Positive market

prospects are also driven by the expectation that cloud computing might become the fundamental approach towards Green IT (Stanoevska-Slabeva and Wozniak, 2010).

4.3.12.2 Impact of Cloud Computing for Users and Companies

In the past business models were largely based on a fixed cost operating model driven by large capital investments to control economies of scale. According to Hugos and Hulitizky (2010) the main source of profits usually comes from the growing quantity of products and distributing operating costs over larger and larger numbers of units sold. When demand is stable and predictable, then this model can be applied. In this case, the organisation is only required to assign labour and capital to optimise production. However, under the uncertainty of a global real-time economy and rapidly evolving consumer preferences, the capital-intensive fixed cost business model no longer works. The real-time economy of this century is composed of many smaller and rapidly evolving market segments where customers want more than just low-priced products. Companies must constantly evolve their products to respond to market needs (Hugos and Hulitzky, 2010).

At the present time, the main motivation for change is mainly driven from the cost perspective. In fact, most firms realise that capital investment in information technology is often fully under-utilised (Gomolski, 2005). Based on a survey conducted recently by Gartner Research, around two-thirds of the average corporate IT staffing budget are used in regular support and maintenance (Gomolski, 2005), and this does seem anachronistic in an age of globalisation (Marston *et al.*, 2011).

In order to cope with unpredictability, companies need to reduce their fixed costs. To survive, companies need to focus on achieving low break-even points for their operations. The more a company can turn fixed costs into variable costs, the more room for manoeuvre it gains (Hugos and Hulitzky, 2010). Firms moving to this operational model from traditional, fixed cost operating models are creating demand for products and services based on a group of related technologies like cloud computing. Cloud and virtualisation services are provided to customers on a variable cost, pay-as you-go basis determined by the number of users and their volume of transactions (Hugos and Hulitzky, 2010).

Start-ups and SMEs: these are said to be the driver of economic growth and innovation and the lifeblood of any vibrant economy (Sharma *et al.*, 2010). In particular, starting a new company is always connected to a high risk of failure. The most critical point is funding and the scaling of capital expenditure on required equipment. Today's funding of start-ups is sparser than before the financial downturn (Schubert, 2010). For start-ups, the missing inheritance infrastructure is considered an advantage. Cloud computing helps start-ups to rapidly adapt their business with new ideas, new markets and business models. In other words, cloud computing is useful for early stage start-ups, both as a low cost alternative to the company's internal IT costs, as well as for quick prototyping and scalable/flexible novel services. Cloud computing might therefore act as an accelerator for starting up a new company with modest financial commitment for IT infrastructure (Aumueller, 2010).

The same applies for SMEs that adopt cloud computing services. They do not need to have full infrastructure and therefore they can use IT resources based on pay-as-you-go models in the cloud, instead of spending a great amount of money on any further capital expenditure (Rittinghouse, 2009). According to ThinkStrategies (2002), SMEs differ from large firms in that they cannot meet the expense of hiring an adequate number of IT specialists or consultants to achieve their business objectives. Consequently, most SMEs consider their computing systems to be an annoyance more likely to disrupt their operations than support them and, perhaps, many of these firms are also discontented with the disproportionate costs of keeping their IT systems up and running. Obsolete components of existing IT-systems can be eliminated and replaced by cloud services for flexibility and scalability of future projects (Aumueller, 2010). Finally, the cloud computing idea also offers a fine option for firms in third-world countries that have been so far left behind in the IT revolution, mainly because cloud computing enables IT services for firms that would have usually lacked the resources for widespread deployment of IT services (Marston *et al.*, 2011).

Large Enterprises: Most often, large firms are more sensitive regarding the security and privacy of their information. As a result, large firms generally are less eager than small businesses to host their own data off-premises (Kushida *et al.*, 2010). This is considered a major challenge for cloud computing suppliers as they need to

work harder to provide credible guarantees that large firms' data will be secure from unauthorised access. Large enterprises have proprietary data-centres and most of them started a few years ago with server consolidation realised through virtualization. Therefore, cloud computing can be implemented via the private cloud deployment model. Large enterprises prefer this method, because control and data storage stay on the premises (Aumueller, 2010).

4.4 UK and ICT

In spite of the global financial stress in the last few years, the British economy proved to be resilient. In the UK, there were around 4.5 million private sector businesses at the start of 2011, an increase of 94,000 (2.1%) since the start of 2010. Small and medium-sized enterprises (SME) accounted for 99.9% of all enterprises (BIS, 2010). In 2009, the largest firms were still considered the pioneers in adopting new innovation. Nevertheless, SMEs were reducing the gap by increasing numbers using broadband and mobile Internet, and developing websites (ONS, 2009). Over the last decade, the year-on-year increase in the number of private sector businesses varied from one year to the next. These changes were entirely driven by SMEs, especially in the period between 2000 and 2011. For instance: the number of SMEs increased from 3.5 million to 4.5 million (31.1%) during this period, while the number of large private sector businesses decreased from 7,200 to 6,300 (-12.0%) over the same period (BIS, 2010). In terms of ICT adoption, Ritchie and Brindley (2005) claim that the value of SMEs has been recognised by governments, not only because of the significance of SMEs, but also because of their perceived creative, innovative and adaptive capabilities. As for the UK, the government attempt to raise connectivity among SMEs in the UK, where connectivity is defined as having an established website or frequently using external email. Also attempt to raise the number of SMEs ordering and paying online.

4.4.1 *ICT in the North East of England*

The North East region is the smallest of England's nine administrative regions in terms of population and, with the exception of London, is the smallest geographically. The comparatively small size of the region may be considered as an advantage for the reason that it has the potential to be more flexible and responsive in relation to government or private investment in ICT development. Nowadays, however, different

areas in the North East suffer from socio-economic deprivation and dereliction. The economic, social, technological and environmental regeneration of these areas is important to the region's continued growth and quality of life (Government_Office_for_the_North_East, 2008).

NE 1996-2005: NE 1996-2005: there was an increment from 66.5% to 70% in the working age employment percentage between 1996 and 2004, and during the period between 1996 and 2005, the number of jobs increased from 1,054,000 to 1,116,000. Business survival rates have improved by over 7% since 1993. However, during the last decade, the North East considers the slowest growing regions and levels of prosperity are now among the lowest in the country (OneNorthEast, 2006b).

Regional economic strategy 2006-2016: The attention has moved toward business as a key driver of economic growth since the North East England lags behind the UK average in the number of businesses in relation to our population size. The economy changes experienced by region over the past decade make the North East achieve good progress in terms of rising output, number of jobs, income and investment. However, the northeast economy remains lags behind the UK average on most standard measures of performance. In recent years, GVA per person in the region is approximately 80% of the UK average; this put the North East almost in the lowest in the UK league table in terms of GVA performance (OneNorthEast, 2006a).

Government and The Regional Development Agency realised that to succeed in moving towards 90% of the national average GVA per person, the North East needs to create more businesses and raise levels of productivity by around 4% to 5% of the UK average. Also, to be competitive in a growing global economy, these businesses must take advantage of increased opportunities in scientific and technological developments. An optimistic point here is that the North East has some of the best broadband coverage outside London. Rural communities, in particular, can benefit hugely from the Internet. In fact, the whole region can take more advantage of this by getting businesses and households to use information technology, in innovative and productive ways (OneNorthEast, 2006a).

In The North East of England, in the Plan Regional Spatial Strategy to 2021 (Government_Office_for_the_North_East, 2008) it has been reported that the in order to create new employment chances, influencing business location, retaining existing businesses, and extending opportunities in the region, high standard ICT facilities need to be available. Whilst the availability and use of ICT facilities, networks and applications are having a positive impact on the economy, the improvements to ICT availability are allowing people to achieve a better work-life balance through flexible working patterns, including home-working.

4.4.2 Research into ICT adoption in UK SMEs

Although the correlation between small businesses and ICT is firmly linked to UK government policy, there have been challenges with developing research in the area (Brock, 2000). Southern and Tilley (2000) argue that the main reason for this is that there is a lack of analytical simplicity on the SMEs and how they should be viewed, and this has caused a limited conceptual understanding of the relationship between SMEs and ICTs. Little is known about how small businesses are reacting to the benefits offered by ICTs, if indeed small firms see the technology as an opportunity. Also, little is known about why and how SMEs utilize ICTs, and it is frequently assumed that a technological innovation is positive. Furthermore, studying ICT innovation adoption in the context of large organisations is different from SMEs. Small enterprises are not scaled-down versions of large enterprises (Welsh *et al.*, 1982; Thong, 1999). Small firms are not a homogeneous group; they are different and have special characteristics, objectives and qualities (Beaver and Prince, 2004). Large organisations usually utilise information and communication technologies in order to harmonise and communicate between different organisational divisions and levels, whereas small firms habitually use ICT for less formal communication. SMEs adopt ICT more as useful tools to support specific organisational tasks, for instance, administration and accounting tasks, and rely on standard, off-the-shelf solutions, and on external support (Ramdani, 2008). However, as listed in Welamedage (2006), there are several reasons and requirements that enhance the success of ICT innovation diffusion among small businesses. Firstly, there is the relevance of technology in the firm; secondly, there is the integration of technology (which means the ability to match technology effectively to user needs),

while finally there is the appropriateness of technology and the capacity of the firm to capture the benefits of technology (Swann, 1993).

Chapter 5. Research Strategy and Research Method

5.1 Introduction

The primary focus of this chapter is to discuss the research design and the research methodology employed. The chapter sets the stage for presenting the results of the qualitative pilot and the quantitative study that followed.

5.2 Research Paradigms

In their major study, Burrell and Morgan clarified four sociological research paradigms based on the relationships of two key dimensions of analysis. The paradigms were meant to highlight the shared aims of perception which link the work of a set of theoreticians so that they may be conveniently seen as approaching social theory within the realms of the same issue (Burrell and Morgan, 1979, p. 23). The authors identify the subjective/objective aspect as the first principal dimension, with the second being two distinct interpretations and explanations of the character of "society". These two dimensions create four fairly distinct paradigm clusters which delineate four perspectives of the social realm founded on varying meta-theoretical suppositions concerning the nature both of science and society.

The **radical humanist** hypothesis is concerned with how to advance 'a sociology of radical change' from the perspective of subjectivism. As Burrell and Morgan (1979) stress, such a sociology concentrates on 'structural conflict, modes of domination, contradiction, emancipation, deprivation and potentiality'; these factors may lead to radical change. Moreover, it is largely anti-organization in scope. This attitude to social science is similar to that of the interpretive model, as its view of the social world would seem to be derived from both nominalism and anti-positivism (Burrell and Morgan, 1979). Theorists located within the **Radical Structuralist** paradigm advocate for a sociology of radical change from an objectivist standpoint. Whilst sharing an approach to science which has many similarities with that of functionalist theory, it is aimed at quite disparate goals. While radical humanists create their view by concentrating on 'consciousness' as the foundation of a fundamental evaluation of society, the radical structuralists highlight structural interactions within a realist social world (Burrell and Morgan, 1979).

The interpretive paradigm concurs with the views of what has been defined by Saunders *et al.* (2009) as the '*sociology of regulation.'* However, its *subjectivist* investigation of the social world means that there are often overt connections with this sociology rather than implicit ones. The interpretative model suggests that the researcher is required to comprehend the dissimilarities between humans as social beings (Saunders *et al.*, 2009). This philosophical stance is concerned with the complexity of human sense making, and it focuses on comprehending human activity from the person's own referential frame (Collis and Hussey, 2009).

In analysing the objectives of a research project, the researcher can opt for the functionalist paradigm throughout, mainly because it is the dominant paradigm for an organisational study. This paradigm is grounded in the sociology of regulation and considers its subject from an objectivist standpoint, and it also differs from the other paradigms (radical humanist, radical structuralist and interpretive paradigms) since, as mentioned, these paradigms tend to focus on radical change and are largely anti-organization in scope. Hence, these paradigms do not seem to fit the nature of this research project, which investigates the adoption of new technology in organisations. The functionalist paradigm is appropriate as it is concerned with giving cogent justifications for human affairs, and is practical and grounded in sociological positivism. Moreover, it sees relationships as tangible entities which are scientifically identifiable and measurable, and indeed this model has proven to be the key framework within which both academic sociology and studies of organisations have occurred (Burrell and Morgan, 1979). Therefore, in selecting the research paradigm, the research opted for the functionalist paradigm as an appropriate approach from which to study cloud computing adoption in SMEs.

5.2.1 Research Philosophy

Choosing an appropriate paradigm for research is a significant task, mainly because it depends on a number of issues, such as ontological assumptions, beliefs, the way to investigate reality, different approaches, answers to questions, issues related to methodology, methods and techniques for data collection, the role of values and ethics, and the perspectives and standpoint linked with the research (Al-Somali, 2011). *The importance of the choice process for the research philosophy cannot be over-*

emphasised, mainly because it will determine the research strategy and the method that will be chosen. The research philosophy assists the researcher in recognising what is being investigated (Johnson and Clark, 2006). In analysing the objectives of the research project, the researcher has opted in considering himself in the shoes of a positivist throughout the research. The philosophy of positivism is an epistemological position that relates to the philosophical stance of the natural scientist (Saunders *et al.*, 2009). In this approach, the researcher considers him/herself as an explainer of a social reality; in other words, there is a need to be objective and not be affected by the research subject (Remenyi and Williams, 1998). Collis and Hussey (2003) state a number of the characteristics of the positivist approach, the most important of which are arguably those that concern hypothesis testing and the production of quantitative data, which drive statistical analysis.

As Doolin argues, "assumptions about the nature of physical and social reality (ontology), together with assumptions about what constitutes valid knowledge (epistemology), influence what are considered acceptable methods for obtaining that knowledge (methodology)" (1996: 21). In terms of ontology and epistemology, positivist research philosophy presupposes a reality, exists "out there," driven by immutable natural laws and mechanisms (Guba, 1990).

- Ontology: Positivist researchers believe in an objectively and independently observable world, where the researcher does not consider themselves an important variable in their research, believing they are independent from that which is being researched. In this approach, research findings are usually represented quantitatively in numerical forms which speak for themselves (Mutch, 2005; Cohen *et al.*, 2011). This is in line with the aim of this research project, which is to contribute to a growing body of research on cloud computing, by developing and testing the conceptual framework quantitatively with an appropriately-sized sample.
- Epistemology explores the character of knowledge, debating what forms it can take and how it may be attained and transmitted. Positivist researchers comprehend the social world via 'predicted regularities and causal relationships' between components (Burrell and Morgan, 1979). Knowledge is also governed by the hypothetical deductive testing of theories in propositional from and

> subjected to empirical tests (falsification) under carefully controlled conditions (Guba, 1990. p.20). The validated models are used for prediction. This is the approach that will be used in this research project in order to better predict and explain SMEs' adoption. Consequently, it will contribute towards filling the gaps in the ICT adoption literature in general, and the cloud computing adoption literature relating to SMEs in particular.

According to Avison and Pries-Heje (2005), compared to positivist epistemology, interpretivist epistemology employs qualitative data collection with a very limited number of respondents. Amaratunga *et al*. (2002) point out that positivism can not only be fast and economic, it can provide a wide coverage of a range of situations, while the interpretivist paradigm requires greater recourse to data collection. Babbie (2007) highlights that the limitations placed on the researcher (e.g. time, money, personnel and ability to handle a particular technique), need to be taken into consideration when choosing the research methods and fieldwork techniques.

Also, when using the interpretivist paradigm, it is not easy to control the pace, progress and end-point of the study. In fact, positivist epistemology usually aggregates data from relatively large samples, as they may be of considerable relevance to policy decisions. In conclusion, after considering the main epistemologies, this research adopted a positivist epistemology for the explanatory part of this study. This is because technology adoption is well defined and considered to be one of most mature areas within IS research. Moreover, because of its long tradition of research, a number of theories and models have been suggested and validated to study a variety of technological innovations. In addition, a number of constructs (dependent and independent variables) are available which can be adapted to study the adoption and diffusion of new technologies (Venkatesh *et al.*, 2003). It is worth mentioning that, although this research adopted a positivist approach by seeking to clarify and envisage what occurs in the social world by looking for trends and a causal relationship between its constituent elements, this could not have been thoroughly developed without the analysis and comprehension by the researcher of the individual factors which arose in the initial empirical study. That is, while this research employed qualitative data in the initial study, it is largely quantitative in type.

5.2.2 Research Approach

In this investigation, combined elements using both inductive and deductive approaches were used. An inductive approach was used to enable more flexibility in the research design, and to examine the themes and categories that emerged from the research data. Implementing this approach enabled the researcher to move from explaining empirical observations of the real world to broad generalisations and theories and, consequently, recommendations. However, this approach may attract criticism due to the less structural nature of the research design, which may involve a degree of uncertainty (Lancaster, 2005; Saunders *et al.*, 2009). Table 5.1 presents the main differences between the deductive and inductive approach.

Table 5-1: Major differences between the Deductive and Inductive approaches. Source: Saunders *et al.* (2009)

Deductive emphases	Inductive emphases
▪ Scientific principles ▪ The need to explain causal relationships between variables ▪ Moving from theory to data ▪ The collection of quantitative data ▪ The application of controls to ensure validity of data ▪ A highly structured approach ▪ Researcher independence from what is being researched ▪ The operationalisation of concepts to ensure clarity of definition	▪ Gaining an understanding of the meanings humans attach to events ▪ A close understanding of the research context ▪ The collection of qualitative data ▪ A more flexible structure to permit changes of research emphasis as the research progresses ▪ A realisation that the researcher is part of the research process

Employing the deductive approach enhances the generalisability of the research (Saunders *et al.*, 2009). In addition, the use of structured questions and quantitative data improved the reliability and validity of the findings. According to Robson (2002), the main steps in the process of deductive research are: firstly, to deduct hypotheses from the theory. Then, the researcher needs to express these hypotheses in operational terms, proposing a relationship between two specific concepts or variables. Finally, after testing these hypotheses, the final stage examines the outcome of the inquiry, in which the researcher assesses whether the chosen theories or hypotheses are falsified or not, and states which parts of the theories and hypotheses remain un-falsified (Robson, 2002; Lancaster, 2005; Saunders *et al.*, 2009). This combined approach was used

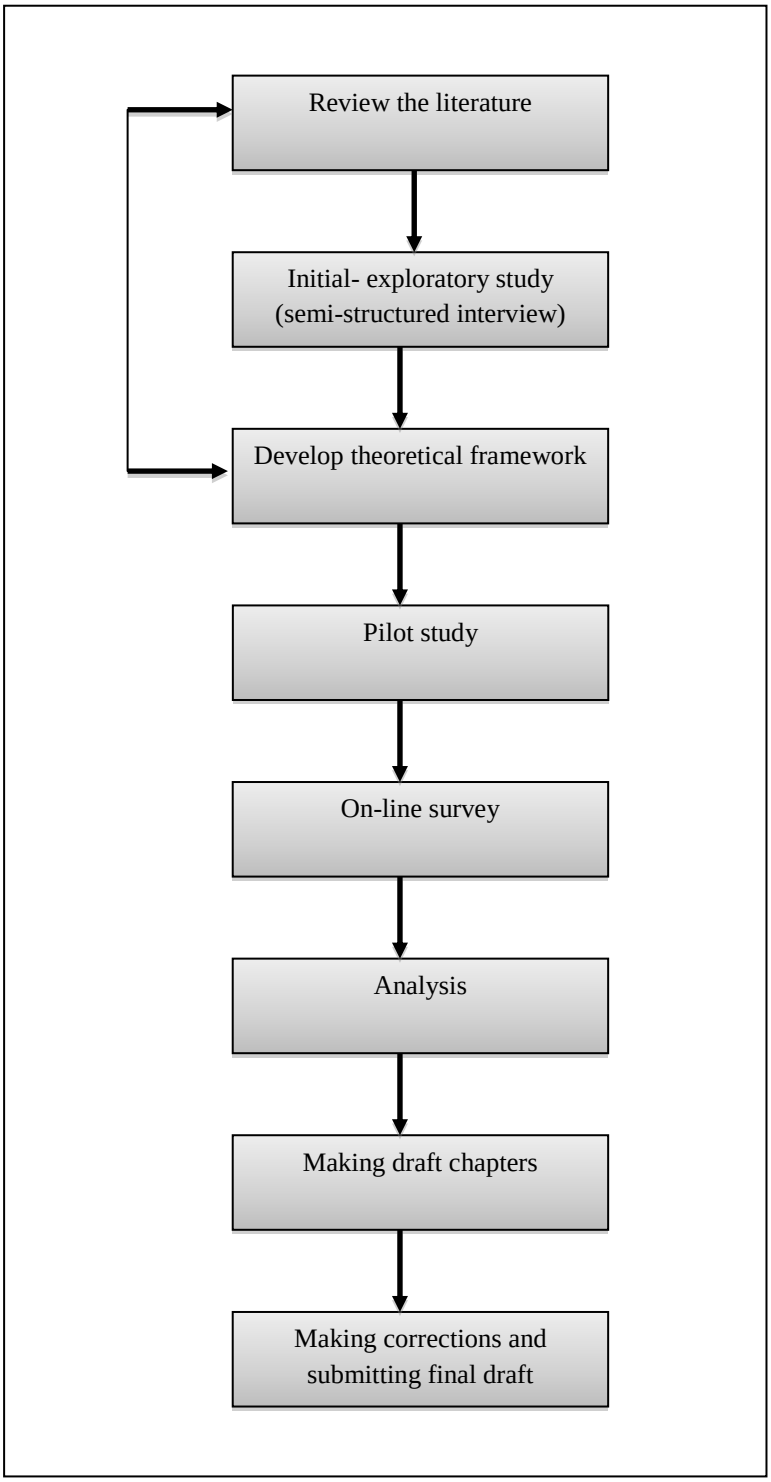
because the researcher was interested in understanding why between-group differences occurred, as well as identifying if differences were occurring between-groups.

5.2.3 Research design

The research design is essential because it links the theory and argument that informed the research and the empirical data collected (Frankfort-Nachmias and Nachmias, 2008). Research designs can be explained as organising research activity, including the collection of data in ways that are most likely to achieve the research aims (Thorpe et al., 2002). The researcher needs to ensure that the chosen design suits the particular research question. Therefore, it is best to start with the question and then choose the design (Tharenou *et al.*, 2007). In fact, research design helps the researchers to draw a general outline for the collection and analysis of the data of a study (Iacobucci and Churchill, 2009). The purpose of the research was to investigate which factor influences cloud computing adoption among SMEs, in order to understand why firms adopt cloud technologies at different rates. In order to answer the research question, a conceptual framework was formulated from existing literature in the ICT innovation adoption field. On one hand, having reviewed the literature in the ICT innovation field, it was found that extensive work has been conducted in the adoption context, suggesting that this is a mature area. On the other hand, however, what is not known is the extent to which the findings from previous studies can be generalised to other ICT innovations. Furthermore, no investigative framework exists for the research problem under study. Therefore, this study will build on existing research by developing a theoretical framework and empirically validating this framework in a particular context. The research took place in two stages, during which both exploratory and descriptive research approaches were undertaken using a cross sectional design. The first stage, which was intended for theory generation, adopted an exploratory research design, where qualitative data were collected to clarify problems, to elicit information about firms' views regarding cloud computing adoption and to construct research hypotheses for the following stage. The second stage adopted a descriptive research design which involves correlation analysis, to describe the relationship between variables. Empirical data in the form of survey research were gathered and used in the second stage to validate and determine the direction of the hypothesised relationships. Given that the

data is investigating the adoption of different ICT innovations, the results will be compared to previously published studies in the field.

Figure 5-1: Research design - Research stages



5.2.4 Research strategy

A research method can be divided into two categories: qualitative and quantitative. These two terms are used broadly in studies about business and management in order to differentiate both data collection techniques and data analysis procedures (Saunders *et al.*, 2009). Ghosh and Chopra (2003) define these two types of data as data in the form of descriptive accounts of observations or data which is classified by type, and as data which can be expressed numerically or classified by some numerical value. 'Quantitative' is generally used as a synonym for any data collection technique (for instance, questionnaire) or data analysis procedure (for instance, graphs or statistics) that produces or uses numerical data (Saunders *et al.*, 2009). On the other hand, 'qualitative' is generally used as a synonym for any data collection technique (for instance, interviews) or data analysis procedure (for instance, categorising data) that produces or uses non-numerical data (Avison and Myers, 2002; Saunders *et al.*, 2009). The survey is one of the main quantitative methods now well-accepted in the social sciences (Avison and Myers, 2002). The quantitative research approach was developed in the natural sciences to enable researchers to study natural phenomena. As a robust scientific indication of how a phenomenon works, the numbers come to represent values and levels of theoretical constructs and concepts, which can be then interpreted to draw conclusions (Avison and Pries-Heje, 2005). Potentially using different methods can result in triangulation, which can enhance the validity of the information gathered.

It was decided that mixed-method research was the best method to adopt for this investigation for a number of reasons. First of all, regarding the multiple method approach, Tashakkori and Teddlie (2010) point out that different aims in the research project can be achieved when using different methods. In turn, this can increase the confidence of the researcher by addressing the most important issues. Additionally, they suggests that applying more than one data source method to the research project enables more validation for the results, and this is called triangulation (Tashakkori and Teddlie, 2010). Qualitative and quantitative are considered different techniques and analysis procedures; each has its advantages and limitations (Saunders *et al.*, 2009). Hence, it makes sense to use different methods to balance the methods' effects. According to

Saunders *et al.* (2009, p147), this will lead to greater confidence being placed in the researcher's conclusions.

In adoption and diffusion research designs, quantitative approaches revolving around questionnaires are the dominant and most popular research method (Williams *et al.,* 2009; Wang *et al.,* 2011). However, Rogers (2003) critiques research designs applied to adoption and diffusion researches designs, where data are collected in one-go surveys of respondents. Therefore, he endorses multi-method strategies to avoid the inadequacy of the research designs. Wang *et al.* (2011, p.3) wrote that *"To broaden and enhance our understanding of the complex issues surrounding ICTs adoption and diffusion, more research should be carried out to explore other potential theories... Also, more qualitative research involving interviews, longitudinal studies, and action research would be encouraged"*.

Having both qualitative and quantitative data is thought to contribute to more robust results (Ghauri and Grønhaug, 2005). Within this study semi-structured interviews were initially carried out to identify the factors that influence cloud computing adoption among SMEs in the North East of England. According to Sarantakos (1998), in many instances, qualitative researchers employ qualitative methods in their studies to meet the criteria of quantitative research. Qualitative methods such as interviews are used in addition to quantitative methods as a preparatory step for a quantitative study, or to refine conclusions reached by means of qualitative research (Sarantakos, 1998). Also, a qualitative approach can provide more in-depth insights before running a large and costly survey, while collecting data using only the qualitative method can be problematic, as using, for instance; only semi-structured interviews can limit the generalisation of the findings (Saunders *et al.,* 2009). To overcome this, the interviews were followed by a questionnaire. The survey was conducted among SMEs in the North East of England. The survey was targeted at the key executives responsible for making the adoption decision on cloud computing services, such as business owners or CEOs who are most often involved in the decision making process.

5.3 The Unit of Analysis

One of the most significant parts of the research design is deciding on what the unit of analysis is to be, since this is highly linked with the level of data collection. Individual and organisational entities have been widely used as units of analysis for studying the acceptance of ICT innovation (Ramdani, 2008). This study intends to investigate the factors that affect the adoption decision on cloud computing services at the organisational level. Evidently, research objectives and the nature of the study control the choice of the unit of the analysis, and therefore, following the previous studies, the organisation itself was chosen as the unit of analysis.

5.4 The Research Stages

This study has progressed in three stages. Although some of the tasks carried out in this research were one off activities happening in one stage of the project, other tasks, such as the literature review recorded in stage 1, were repeated in other stages at various times. These three main stages are discussed in the section following.

5.5 Stage 1: Research design and preparation

This main research objective of this study is to study the cloud computing adoption process by SMEs in the North East of England. More specifically, the research questions aim to examine which factors, and to what extent each of these factors, influence cloud adoption decision making by SMEs. The research problem was well-defined, but, to the best of the author's knowledge, little or no research had been carried out in the area of organisational cloud computing adoption by small businesses in regions like the North East of England, which could have guided this study. Cloud computing is relatively new and there is substantial ambiguity around the adoption decision process. Moreover, the author in this research project took into consideration the fact that studies that adopt the TOE model have attracted criticism, due to the way they pick and choose from a list of attributes that have been empirically tested in other ICT innovations studies (Ramdani and Kawalek, 2007). With the purpose of exploring the impact of TOE factors on SME adoption of cloud computing services, initial empirical work using interviews as the data collection method was deemed appropriate, as these can provide the necessary flexibility needed. Also, they were chosen because

such an approach can then pave the way for a quantitative approach. Exploratory research focuses on the studying of a problem that has not been clearly defined. It provides researchers with more information on situations about which little is known (Tharenou *et al.*, 2007). In the context of the ICT adoption process, an exploratory qualitative study allows the researchers to explore in depth all the factors and the interaction of all stakeholders involved in the adoption process (Crotty, 1998; Leedy and Ormrod, 2005). It is suitable for comprehending how SMEs think and feel about cloud computing services and to add to our understanding about the decision making process related to this type of services. In addition, an exploratory qualitative study would offer the necessary flexibility to follow different discussion avenues with participants. Therefore, the main aim for this initial exploratory phase was to form better understanding about the research problem, and to find the most effective factors in relation to cloud computing adoption by organisations in the North East of England. Moreover, gaining qualitative data at this stage will be useful to provide more in-depth insights before running a large and costly survey.

Sarantakos (1998) suggested that the forms of exploratory studies refer to the reviewing of literature. In the current study, it could be argued that the literature review conducted and reported in chapter two and chapter three (i.e. literature about ICT adoption in SMEs and about the theoretical innovation adoption models) also represents the exploratory stage of this study as it was used as an input to the planning of this stage and as a rich source of concepts, theories and evidence about the phenomena. In addition to using related journal articles, databases and books, it has been recommended that other secondary resources such as annual reports, web sites and information leaflets may be used in the research project to gain more information about research problems (Walsham, 2006). Annual reports of the Department for Business, Innovation and Skills (BIS) were used as secondary data collection methods to support the information obtained in the interviews. Reports related to the North East, especially those related to the ICT adoption situation and different industry sectors, were also used.

5.6 Stage 2: Pilot Study

The important goal of this exploratory stage was to identify possible key factors in the context under investigation. Findings from the exploratory investigation aimed to

enrich the articulation of the research hypotheses and, more importantly, findings were used for the development of the survey questionnaire.

In this stage of the research project, the concentration was on meeting key people with familiarity and experience in the field of IT. The interviews were conducted using semi-structured method in order to generate discussions instead of straight questions with a yes or no response that might not provide us with enough information. It was considered that using this technique would usefully give room for open-ended replies and, therefore, introduce factors different from those included in the literature. Using semi-structured interviews helps the researcher to contact the key stakeholder directly involved in the current situation and future prospects for cloud computing adoption. Taking advantage of the freedom to explore, query and ask questions that semi-structured interviews offer, researchers can gain more information about respondents' experiences (Punch, 2005). The results from the semi-structured interviews were used to refine the initial model and to reflect the reality of cloud computing adoption within the SMEs. The results were significant in at least major two respects. They helped the researcher to articulate and clarify the research hypotheses generated from the literature, and facilitated the structuring and development of the survey in the main study.

Studies that adopt the TOE model have attracted criticism, due to the way they pick and choose from a list of attributes that have been empirically tested on other IS innovations (Ramdani, 2008). In order to avoid such bias, and in order to identify relationships among the variables that lead to the acceptance and adoption of cloud computing technologies, semi-structured interviews were used as the initial data collection method. Participants had the opportunity to discuss the factors they thought were of importance in their own cases, instead of structuring the discussion around the TOE attributes. Using Rogers's adopter categorisation on the basis of innovativeness (Rogers, 2003), fifteen cases were categorised into four main groups (Table 3). These were the service providers, SMEs that had already adopted cloud computing services (adopters), SMEs that intended to adopt cloud computing services in the next three years (prospectors) and, finally, SMEs that did not intend to adopt cloud computing services. To overcome the pro-adoption bias, this research focuses on non-adopters, prospectors, and adopters of cloud computing services. Moreover, cloud computing

providers who participated in this research project were chosen to be providers for a variety of computing services, not just cloud services.

Before the interviews took place, arrangements were made by phone and an e-mail was sent to the selected firms informing them of the goals of the study and the purpose of conducting the interviews. It is noteworthy that in an attempt to investigate the research problem in a substantive manner firms were from a wide range of business sectors, such as retailers, manufacturers and services. Investigating firms from different sectors can lead to a richer data set than companies belonging to the same sectors (Scupola, 2003). Companies were selected from the directory of companies distributed by Newcastle City Library. Companies were contacted at least two weeks before the interview and a follow up call was then given to confirm acceptance in order to ensure the correct individual had received it. In addition, a time and a place convenient for both the researcher and the participants to do the interviews was discussed and identified. The initial draft of the interview script was tested with two participants from different companies. The manuscript and the questions were revised before conducting the main interviews (see Appendix for interview script outline, partly adopted from Ramdani, 2008). Then, face-to-face interviews were conducted with key staff involved in the adoption decision making process.

Usually, due to time and business pressures, top managers are often busy and it is not easy to guarantee time with them, especially for long interviews. Nevertheless, it was important for this research project to gain information about the adoption decision process from the most key respondent in the firm in order to gain accurate information (Day and Nedungadi, 1994). In order to avoid any kind of prejudgement for the interview before the actual meeting, participants were not given the questions in advance. The interviews lasted approximately one hour. The majority of the interviews were conducted in the interviewees' offices. Interviewees were told the purpose of the interviews and that they could withdraw their consent to participate at any stage of the study without any repercussions. Interviews were recorded with the permission of the participants and transcribed immediately after the interview sessions. Transcripts were sent to the participants for refinement if needed.

The questions included the firm's background, the level of awareness of cloud services, and the impact of TOE factors on cloud computing adoption. The interview

questions focused on a more comprehensive range of issues, including technological, organisational and environmental considerations, and new questions, such as interviewees' views about the hybrid private cloud, were discussed as thoughts emerged throughout the process. In total, fifteen interviews were conducted.

The analysis stage in itself is a continuous practice, and researchers cannot simply separate the collection, reduction and analysis phases from each other (Folkestad, 2008). Data management and analysis was performed according to the procedure suggested by Miles and Huberman (1994). The process of analysis consisted of three simultaneous flows of activity: data reduction, data display and conclusion drawing/verification. By the use of data displays, the patterns and relationships between the elements of the data can be recognised. This can help the researcher to interpret the data and to draw meaning from it (Saunders *et al.*, 2009). The data obtained was summarised and simplified with the intention of condensing it (Robson, 2002; Saunders *et al.*, 2009). The data display was concerned with organising and assembling information, which finally enabled conclusions to be reached (Miles and Huberman, 1994).

5.7 Stage 3: Collecting primary data using on-line survey

The main data collection stage employed an online survey in order to test the hypotheses regarding cloud computing adoption in SMEs. There are two main types of descriptive survey research design: cross-sectional and longitudinal surveys. In a cross-sectional survey, research may be likened to a snapshot of the phenomenon of interest and data are collected at one point in time from a sample selected to describe some larger population (Pedhazur and Schmelkin, 1991). Such a survey can be used not only for the purpose of description, but also for determination of the relationship between variables at the time of the study (Babbie, 2010). In a longitudinal survey, data are collected from the same sample at several different times, with the main purpose being to study changes in the elements over time (McGivern, 2006). Longitudinal research tends to be costly and fraught with great difficulties as a result of the relatively long periods of time it takes to conduct (Pedhazur and Pedhazur-Schmelkin, 1991). In fact, a longitudinal survey requires follow-up on respondents, which makes the ability to capture a large sample size difficult if not, in certain instances, impossible (Pedhazur and Schmelkin, 1991). Moreover, longitudinal surveys often lack control samples, and

they tend to suffer from case losses, which can become a serious problem, since they will almost certainly introduce a bias in the result. In this research project, longitudinal research was not considered due to the limitation in time and funds available. Instead, a cross-sectional survey with self-completion questionnaires was deemed the most appropriate method in order to collect data. Subsequently, they were used to gather the required data on the cloud computing adoption phenomenon among SMEs, and to detect the effects of the independent variables and their hypothesised relationships on firms' cloud computing adoption. The design of the survey questionnaire was aided by the literature review and semi-structured interview responses.

5.7.1 The Use of the Questionnaire

The utilisation of empirical quantitative techniques and survey research methods appears to be the most widely used data collection strategy over other available alternatives for ICT adoption and diffusion research (Williams *et al.*, 2009). This is because the survey helps to investigate relationships between variables and to produce models of these relationships. Most especially, people perceive surveys as authoritative in general (Saunders *et al.*, 2009). It also helps to contact a sizable population in order to collect data about the same issues, most frequently by posing the same questions to all (Jankowicz, 2005). The questionnaire can be carried out either by mailing it to respondents or by personal administration (Oppenheim, 1996).

The main advantages and disadvantages of online survey compared to other survey formats, as discussed by Evans and Mathur (2005), are discussed below.

An online survey is a flexible tool to use. It can be carried out in different ways: e-mail with embedded survey; e-mail with a link to a survey URL; visit to a web site by an Internet surfer, who is then invited to participate in a survey etc. In addition, by using online surveys for respondents, instead of being annoyed at an inconvenient time with a telephone survey, the respondent can choose the convenient time to respond and have sufficient time to think about each answer. It also offers respondents more privacy and comfort in the absence of interviewers.

In general, an online survey is fairly simple for respondents to complete and for their responses to be tabulated and analysed. In addition, the cost of a questionnaire

survey is not high compared to other methods. Nowadays, with easy access to specialised online questionnaire development firms, online surveys are automatically placed into the database, and then tabulated and analysed in a coordinated, integrated manner that greatly reduces costs. As surveys are self-administered, there are no travel costs and costs related to the training of interviewers, which reduces the expense of data processing analysis (Frankfort and Nachmias, 2007). Finally, it is easy to follow-up. Owing to the low expense of sending out e-mails and the simplicity of doing so with online surveys, researchers can send out follow-up reminders in order to increase the survey response rate.

If not properly addressed, online surveys also have some potential weaknesses. Wherever Internet surveys are used, clients and researchers should pay particular attention to the extent to which the survey respondents are representative (Wilson and Laskey, 2003). Schonlau *et al.* (2002) argue that the sampling technique for online surveys is not an easy task. The main possible problem regarding sample implementation is the possibility that someone who is not serious will respond. Evans and Mathur (2005) listed the main potential weaknesses for online surveys. Firstly, some heavily criticised sample selection methods are blanket e-mailing and "volunteer" samples, as researchers will not be able to control who will be the participant that fills out the questionnaire. Usually sending email in this method to huge numbers of potential respondents may not produce the best result, as it may look like to the respondents as a spam. With "volunteer" samples, people visit web sites and proactively join and participate in the questionnaire. Participants who do not have enough online experience/expertise can be another challenge with questionnaire surveys. Secondly, although the Internet population is becoming more representative, there may still be survey difficulties due to the lack of familiarity of possible respondents with Internet protocols. Also, there are different operating systems, and many generations of web browsers. Configuration problems may occur due to monitors being of different sizes and settings, with different operating systems, and one of many generations of web browsers. This can affect the way that the questionnaire appears on the screen. Thirdly, because online surveys are self-administered and typically there is no human contact, instructions must be extremely clear. Therefore, it is important for the researcher to choose a suitable web-based tool to design the questionnaire that contains simple and

easily understood questions and instructions. Fourthly, privacy and security issues are major concerns of questionnaire surveys. Respondent privacy concerns remain important. Schonlau *et al.* (2002) demonstrated that there is limited evidence in the literature that online surveys generally obtain higher response rates than do other survey types. Currently, there are web-based tools that allow automation of most of the process of creating surveys and then emailing them to selected sample members. Although the low response rate is the main concern when adopting an on-line survey method, it provides the researcher with many facilities that enable better results.

5.7.2 Web Survey

Survey monkey is a web-based tool that offers businesses and researchers a cheap way to design and distribute surveys on-line in an easy and fixable manner. Various types of questions are provided, such as multiple and matrix choice questions, rating scales, text boxes, drop menus, and the like. It also provides researchers with control tools to ensure response validation, for instance, by making the questions required or optional, requiring a particular number of answers, or validating the text entered into an open field to ensure it meets a specified format of entry length, number, date and email addresses. In case of not meeting the criteria for a valid response, error messages in 21 different languages can be displayed, which guide the respondents to answer correctly. In an attempt to improve the response rate, the researcher is able to use the skip logic feature, which allows the creation of custom paths for different participants based on how they answer a particular question so that the participant's time is not wasted. This was the case for the on-line survey in this research project, where the potential participants could be adopters or non-adopters of cloud computing services, meaning that they were required to answer slightly different questions in the first part of the questionnaire.

Once the researcher is ready to send out the survey to the target sample, a survey link can be sent by email. More notification facilities are provided to enhance the management level of the survey and to monitor the response rate. Another handy management tool offered by Survey Monkey is that the researcher is able to restrict responses to one per IP address. For collecting survey responses, many options are available to view responses and generate reports in real time. For instance, the details of

respondents can be viewed, comments of open-ended questions can be read, different chart formats can be created and cross tabbed and responses can be filtered. The moment the data collection is completed, the researcher can get the results by downloading the data into a Microsoft Excel spread sheet format or even a CSV file (Survey-Monkey, 2012).

5.7.3 The Research Population

Population *"is the total of all elements that share some common set of the characteristics"* (Hair *et al.*, 2006, p 170). Sarantakos (1998) argued that, in quantitative research, it is important that the sample in use reflects the characteristic of the population under study and that the results drawn through the study are applicable to the whole population in order for this sample to achieve representativeness: the higher the representativeness, the higher the generalisability of the findings and, therefore, the higher the quality of the study (Sarantakos, 1998). Probability sampling is one of the common methods that have been devised for this purpose. According to Saunders *et al.* (2009), when using probability sample in order to improve the generalisations about populations from data collected; the larger the sample size, the lower the likely error in generalising to the population. Hence, probability sampling is a compromise between, on the one hand, the amount of time, money the researcher invests in collecting, checking and analysing the data and, on the other hand, the accuracy of research findings.

In the UK, SMEs represent the vast majority of all enterprises (99% according to BIS, 2010). According to the Department for Business Innovation & Skills (White, 2011) there were 119 thousand "active" enterprises in the north east region. According to statistics (Office for National Statistics - SME statistics, 2009), retail/wholesale, manufacturing, and services industry sectors form the biggest share of the market in the North East. Moreover, these sectors have great dependence on ICT innovation (Goode and Stevens, 2000). Therefore, this research project will try to focus on these industries as the main part of the target population.

5.7.4 Selection of sampling frame

Once the scope of the population was established, an attempt was made to specify a sampling frame that would provide the basis for sampling. According to Särndal *et al.* (2003), the sampling frame is the list(s) or material used to obtain observable access to the finite population of interest. This frame should help the researcher to identify and select a sample in a way that respects a given probability sampling design, and to establish contact with selected elements (by telephone, visit at home, mailed questionnaire, etc.). In cooperation with the Careers Service's Rise-Up Team in Newcastle University Career Services and Think M. (a strategic marketing and agile research consultancy in the North East of England), a sample frame was identified. Think M. provided a directory list of organisations and SMEs from different sectors (i.e. retailing, manufacturing, service, etc.) in the region. This directory contained valuable information about the background of the firms, such as business activity, telephone number, fax number and the names of the president, CEO or managing director. The directory has been used by several researchers in Newcastle University as a representative list and was found to be the appropriate sampling frame from which firms could be drawn.

5.7.5 Research sample

As Jankowicz (Jankowicz, 2005, p.202) suggests, sampling can be described as "*the deliberate choice of a number of units (companies, department, people)- the sample- who are to provide you with data from which you will draw conclusions about some large group- the population- whom these units represent*". The sample technique and sample size used in research are usually influenced by the availability of the resources (Saunders *et al.*, 2009), in particular, for a PhD researcher the limitations are generally related to financial support and time available for data collection and analysis. Therefore, in some cases where it is impracticable for the researcher to collect data from the entire population, sampling technique usage is essential. This research project adopts the formula presented by Tabachnick and Fidell (2007) for calculating sample size requirements, taking into consideration the number of independent variables to be used: $N > 50 + 8m$ (where m = number of independent variables). Given that the

research involved eleven independent variables, the number of required cases, according to the above formula, is greater than 138.

There are two common types of sampling techniques, probability sampling and non-probability sampling. Probability sampling (also known as representative sampling) offers the equivalent chance for each unit in the population to be selected. According to Saunders *et al.* (2009), this means that the researcher in this case is able to answer research questions and meet the objectives that require the researcher to estimate statistically the characteristics of the population from the sample. Consequently, probability sampling is typically associated with a survey research strategy. In cooperation with the Careers Service's Rise Up Team in Newcastle University, and Think M., the target population was identified as the following: size of the firm: 1-250 employees; region: North East; a simple random sample of 450 firms was selected using SPSS 14.0 distributed in different sectors, mainly manufacturing; wholesale and retail; businesses services and technology; and other sectors.

5.7.6 Questionnaire Design

In this research project the self–administered questionnaire technique was adopted. For that reason, it was particularly important to ensure that the questionnaire was clear and easy to handle. In an attempt to make sense to the respondent, and in order to maximize the results from the on-line survey, careful consideration was paid to the construction and flow of the questions in addition to all other minute details. In fact there is a set of issues that researchers need to take into consideration in order to improve the response rate for the survey, such as the layout, introduction and closing of the questionnaire.

As far as the layout of the questionnaire is concerned, using the design features of Survey Monkey enabled the creation of a fairly attractive layout to increase the valid responses from the participants. Evidence exists that a questionnaire's cover design can improve and influence response rate. In fact, the way the questionnaire is presented and introduced and the type of assurances given to the respondents determine whether the respondent will complete the questionnaire or not to a large extent, and whether he or she will answer the entire question (Sarantakos, 1998). Consequently, a cover page was used to introduce the respondents to the research topic and to motivate them to

participate in the study. Also, whilst simple wording and the visual appearance (if possible) of the questionnaire are important issues to make it easy to read and to fill in by the participants, and thus, increase the response rate (Dillman *et al.*, 2008; Saunders *et al.*, 2009), it has widely been suggested that a longer questionnaire will affect the response rate in a negative way (Edwards *et al.*, 2002). Therefore, the researcher aimed to avoid any unnecessary questions, and make the questionnaire as concise as possible.

Regarding the introduction and closing of the questionnaire, as Dillman *et al.* (2008) suggested, the main features of the introduction and closing of the questionnaire were taken into consideration to maximise the response rate. A summary of the main points in the covering letter was included. In an attempt to attract the interest of the respondent, the researcher used a clear and unbiased title for the topic and other parts of the questionnaire. A neutral logo or a graphic to add interest and to set the questionnaire apart (self-administrated questionnaire) is beneficial.

For this study the covering letter was enclosed with the invitation email in order to explain clearly and in detail the aim of the study to the participants, mainly because the questionnaire was self-administered, which made the letter essential for the respondent's cognizance. Moreover, in the letter, it was clearly stated that the information collected would be kept strictly confidential and used for the purpose of the study only. Also, the researcher's full contact details were clearly provided in order to enhance authenticity. Further important elements were also added, such as the possible benefits of taking part, the supervisor's contact details as a contact point for further information, and then a thank you message and the date were added for the questionnaire closing.

5.7.7 Questionnaire development process

The questionnaire used to collect the data for this study was developed with input from the literature as well as the interviews with small business owners/managers conducted during the preliminary empirical study. It is important for the questionnaire to be well-developed in order to increase the response rate and to motivate the participants to provide complete and accurate information. The questionnaire development stage needs proper planning, checking and revising. The researcher is also required to take into consideration the length of the survey questionnaire and the ease of

completion (Fayers and Hays, 2005). Researchers such as De Vaus (2002) have provided general guidelines to be taken into consideration when designing a questionnaire and suggested that a questionnaire should:

- Avoid jargon and technical terms. Instead, simple words must be used.
- Avoid using double-barrelled questions or questions with two parts that ask more than one question.
- Avoid questions that are too long.
- Ask only simple questions which respondents can answer easily.
- In multiple choice questions, ensure that all the possibilities are covered.
- Follow a natural logic and order to help respondents complete the questions step by step through thought and action, with the minimum of time and effort.

All these procedures were taken into account in order to present valid and unambiguous questions (Churchill and Iacobucci, 2009) as recommended for the process of questionnaire development adopted in this type of research. This research study utilised the closed question style in which respondents were encouraged to select the answer which best fit their opinion. This type of question was selected as a result of four key advantages summarised by Foddy (1994). Firstly, the provision of predetermined answers enables the researcher to collect standardised responses that can be meaningfully compared. Secondly, closed-end questions are quick to answer and produce answers that are much easier to code, computerise and analyse. Thirdly, they do not discriminate against the less talkative and less articulate respondents. Finally, another advantage of closed-end questions is that they present a recognition task rather than a recall task and, for this reason, respondents find them much easier (Foddy, 1994). The questionnaire covered questions about the factors identified in the preliminary empirical study, which influence the firm's willingness to adopt cloud computing

The main three parts in this questionnaire were:

Part one: this part of the questionnaire was related to basic questions about the participant, such as the level of ICT innovations adopted in the company, and different cloud computing services potentially adopted by the company. Also, questions regarding businesses' size, industry, and market scope were included.

Part two: this section contained the questions used for studying the technological, organisational and environmental factors/ measures, assessed by five Likert-type items, most of which were adopted from previous similar studies in the research field. The questions in this part were close-ended questions and addressed the following factors: relative advantage, uncertainty, geo-restriction, compatibility, trialability, top management support, prior experience, innovativeness, supplier efforts and external computing support.

Part three: the last section mainly focused on viewing the incremental adoption of cloud computing services and the usage of private and hybrid cloud services by SMEs.

Questionnaire Coding: Hair *et al.* (2006) recommend that Likert scales are the best designs when using self-administered surveys or online survey methods to collect the data. By definition, the Likert scale is an interval scale that is used to ask respondents to indicate whether they agree or disagree about a given subject by rating a series of mental beliefs or behavioural belief statements (Hair *et al.*, 2006).

The scale in the questionnaire was coded in a 5-point Likert-type scale ranging from 1 "Strongly Disagree" to 5 "Strongly Agree" as follows:

Option 5: Strongly Agree,

Option 4: Agree,

Option 3: Neutral,

Option 2: Disagree,

Option 1: Strongly Disagree.

This type of response scale has been widely used in related research. It offers the researcher a wider range of possible scores, and increases the statistical analyses that are available (Premkumar and Ramamurthy, 1995; Pallant, 2007).

5.7.1 Validity and Reliability

Valuable data presents the foundation for the information needed to achieve the objectives of the research. The main important elements with regard to dimensions or criteria of data quality are the dimensions of what researchers refer to as validity, reliability, and generalisability (Lancaster, 2005).

Validity: validity is defined as the extent to which any measuring instrument measures what it is intended to measure (Bryman and Hardy, 2004). Ghosh and Chopra (2003) summarised validity as "Absence of self-contradiction". Essentially, validation is related to the extent to which the research method describes what it is supposed to measure. There is no one clear-cut indicator of a scale's validity. Validity can be broken down into two sub-categories: content and construct validity (Churchill and Iacobucci, 2009).

Content validity: Hair *et al.* (2006) indicate that an appropriate way of measuring content validity would be to use the judgement of individuals with expertise in some aspect of the subject under study in order to comment on the wording of the items. Some items in this research project were developed for some constructs based on the exploratory interviews along with previous scales found in the literature. According to Bryman (2004), it is important to ensure that new measures should reflect the concepts they are trying to measure. In this study, the content validity of the research instrument was established through the theoretical literature review and through the extensive process of item selection and refinement in the development of the questionnaire. The items used for measuring the constructs were derived from operationalisation used in prior empirical studies, and were adapted to suit this research context, followed by pilot testing. During the pilot period, the questionnaire was distributed to academics, business consultants, top level executives and companies from the sample frame. Moreover, discussion and comment from supervisors provided a good foundation for designing the survey instrument and a number of adjustments were made to the running order of the questions and their layout. The results showed that the questionnaire covered important

aspects identified within the literature review. In sum, the items of the questionnaire were relevant from academics' and practitioners' perspectives; therefore, the questionnaire could be accepted as possessing content validity.

Construct validity is often thought to comprise two other forms of validity: convergent and discriminant validity (Bagozzi, 1980). Convergent validity assesses whether all the items measuring the construct cluster together to form a single construct. Discriminant validity assesses the level to which a concept vary from other concepts and is indicated by a measure not correlating very highly with other measures from which it have to theoretically differ (Bagozzi *et al.,* 1991). To claim that measures have construct validity, both convergence and discrimination need to be assessed. Convergent and discriminant validity were evaluated using principal component factor analysis (PCA) and the Multitrait-Multimethod Matrix. Factor Analysis: factor analysis is a statistical procedure that allows the researcher to condense a large set of variables or scale items down to a smaller, more manageable number of dimensions or factors (Pallant, 2007). PCA assists with establishing which components exist within the data and how a particular variable could add to that component (Field, 2009). Factor loadings are typically, a widely used approach to illustrate the correlation coefficients between the variables (rows) and factors (columns). The extent of the cross-loading of an item on other factors where it does not theoretically belong can be used to examine discriminant validity (Premkumar and Roberts, 1999). PCA was conducted on all items in the questionnaire. The extraction technique and Varimax rotation method were applied. In order to determine the fit between the constructs and their items, factor loadings should be greater than 0.5 and have no cross-loadings (Hair *et al.*, 2006). Most indicators loaded into their expected factor. Only one item from the compatibility construct was eliminated because of cross-loadings. Factor analysis was run once again to determine whether the factor structure remained stable. Table 5-2 demonstrates a good match between each factor and related items. Cronbach's α coefficient was used to measure the reliability. As shown in Table 5-3, all coefficients for the constructs in this study are higher than the value of 0.5.

External validity (generalisability) "*relates to the extent to which findings can be generalised to persons, setting and times as well as across types of persons, settings and*

times" (Ghauri and Grønhaug, 2005, pp. 72). One of the major drawbacks of research in this field is lack of external validity or generalisability. Because of its context specific nature, and like many previous studies (e. g. Grandon and Pearson, 2004; Lee, 2004; Ramdani, 2008), this study will not claim to be high on external validity.

Table 5-2: Factor analysis

CONSTRUCT	Factor 1	Factor2	Factor3	Factor4	Factor5	Factor6	Factor7	Factor8	Factor9
RA1	.751								
RA2	.856								
RA3	.789								
UNCERT 1		.889							
UNCERT 2		.734							
GEO1			.877						
GEO2			.926						
COMPAT 1			.727						
COMPAT 2			.516						
COMPLEX1				.755					
COMPLEX2				.852					
COMPLEX3				.827					
TRIAL1					.867				
TRIAL2					.869				
TMS1						.772			
TMS2						.855			
INNOV1							.804		
INNOV2							.837		
PRIOR								.941	
PRIOR								.928	
EX-SUP1									.749
EX-SUP1									.711
EX-SUP2									.837

Reliability is concerned with how much random error there is in the measurement. The reliability of the questionnaire is concerned with the consistency of the responses to the questions (Gill and Johnson, 2002). With the intention of testing the properties of measurement scales, the Cronbach's coefficient Alpha for these constructs were calculated using the SPSS 14.0 scale reliability measure. This statistic presents an sign

of the average correlation among all of the items that make up the scale. Values for these items range from 0 (no correlation) to 1 (maximum correlation). The higher the values, the greater the reliability. There is discussion among researchers regarding the appropriate cut-off points for reliability. Hinton (2004) has suggested four cut-off points for reliability, which include excellent reliability (0.90 and above), high reliability (0.70-0.90), moderate reliability (0.50- 0.70) and low reliability (0.50 and below). However, Cronbach's Alpha values are fairly sensitive to the number of items in the scale. In short scales, it is regular to get low Cronbach's values. In this case, it may be better to report the mean inter-item correlation for the items. Briggs and Cheek (1986) recommend an optimal range for the inter-item correlation of .2 to .4. (Pallant, 2007). The Cronbach's alpha coefficients are tabulated in Table 5-3, which illustrates the values that were estimated to examine the internal consistency of the measure. Overall, each item measuring the same dimension demonstrates an acceptable level of internal reliability ranging between .571 for the top management support construct and 0.910 for the trialabity construct. Moreover, the reliability results suggest that of the thirteen constructs, one possessed excellent reliability, seven illustrated high reliability, and two demonstrated moderate reliability.

5.7.2 Instrument Development

Data analysis will be efficient, once the level validity and reliability for measures in the research study is high. In an online survey, and in order to encourage volunteers to participate, to start and continue answering the questions, it is extremely important to have a well-designed survey (Dillman *et al.*, 2008).

To measure complex constructs, most studies usually adopt multi-item scales. According to Tharenou *et al.* (2007), in case there are no validated established or published measures of the constructs, the researcher may need to construct a new scale. Otherwise, it is more practical for a researcher to adopt validated items from previous studies, mainly due to the highly complex process of developing a new multi-item scale. ICT innovations' adoption and diffusion research has been described as one of the most mature areas in IS literature (Vishwanath and Goldhaber, 2003; Jasperson *et al.*, 2005). In an attempt to ensure validity, the author operationalised the variables in line with prior similar research. However, although to a large extent the items in the questionnaire

used in this research project were adopted from validated items in preceding studies, careful attention was still paid to ensuring a more accurate fit with the context of this study. Table 5.3 illustrates independent variables in this study and some major studies. The design of the questionnaire was based on using both five Likert scales and nominal scales. To validate the instrument, and in an attempt to improve content validity, participants in the pilot test were asked to comment on the length of the instrument, the format, and the wording of the scales.

Table 5-3: Measurement of research variables

Construct	Items	Reliability (Cronbach's alpha)
Adoption decision	1 item adopted from (Premkumar and Roberts, 1999)	
Technological		
Relative advantage	3 items adapted from (Moore and Benbasat, 1991)	.838
Uncertainty	2 items adapted from (Featherman *et al.*, 2003)	.632
Geo-restriction	2 items adapted from (Featherman *et al.*, 2003)	.832
Compatibility	3 items adapted from (Moore and Benbasat, 1991)	.812
Complexity	3 items adapted from (Moore and Benbasat, 1991)	.862
Trialability	2 items adapted from (Moore and Benbasat, 1991)	.910
Organisational		
Firm size	1 item adopted from (BIS, 2010)	Categorical
Top management support	2 items adapted from (Yap *et al.*, 1994)	.571
Innovativeness	2 items adapted from (Agarwal and Prasad, 1998)	.717
Prior similar IT experience	2 items adapted from (Lippert and Forman, 2005)	.887
Environmental		
Industry	1 item adopted from (Goode and Stevens, 2000)	Categorical
Market Scope	1 item adopted from (Buonanno *et al.*, 2005)	Categorical
External computing support	3 items adapted from (Yap et al., 1994)	.742

5.7.3 Questionnaire Pilot

After designing the questionnaire and prior to commencing the pilot study, the supervisory team, academic and research staff at Newcastle Business School was asked for advice and to comment on the suitability of the structure and the design of the questionnaire. Getting suggestions from a group of experts should enhance the validity and help to make needed alterations prior to the pilot testing (Saunders *et al.*, 2009). They were asked to comment on the questionnaire and identify any gaps or inconsistencies. Having revised the questionnaire twice, pilot testing was conducted with ten different businesses from the sample frame and this aimed to ensure that there

were no unanticipated difficulties (Alreck and Settle, 2004) and to further enhance content validity. As Bell (2005) suggested, participants were asked to provide the following information and to report about the problems they experienced, such as the time required by the participants to fully complete the questionnaire, the clarity of the instruction, if there were unclear or ambiguous questions, if there was any question which was not easy to answer, whether the layout was clear and attractive, and if they had any other comments.

The pre-test was useful in identifying problems with question wording, layout, sequence, grammar, punctuation of the questions and survey length. In addition, some questions had to be reworded to improve their clarity. For example, many participants suggested that the words "ICT, SaaS, PaaS, IaaS" are ambiguous and might not be clear for all participants. Accordingly, we provided definitions in the glossary section on the second page of the survey. Many respondents also suggested that the layout of the questionnaire should be rearranged to make it shorter and more appealing. In fact, the pre-test results supported the need for mostly close-ended questions in the survey. The time taken for the respondents to complete the questionnaire was approximately 8-10 minutes. The final questionnaire (see Appendix) was more easily read, had a better flow of questions, avoided leading or ambiguous questions and, more importantly, respondents did not have any difficulty in understanding and answering the questions. Subsequently, data collection was initiated using the final version of the questionnaire.

5.7.4 Administration and distribution of the questionnaire

Key informants are often used for reasons of efficiency. Key informants need to be individuals who possess credible sources of information about an organisation's operations, status, and who are involved in strategic activities of the firm, and willing to share their knowledge with the researcher (Tharenou *et al.*, 2007; Rubin and Babbie, 2009). According to Thong (1999), in small businesses the business owner is usually the key decision maker in the company. Therefore, because the business manager/ owner is the person who generally approves the capital expenditure, including spending on technology, and also in an attempt to get rich data regarding the considerations that affect the adoption decision, the business owner/ manager was chosen as the key informant in this research project. Of the 450 potential respondents, 306 organisations

agreed to take part in the survey, which represents a response rate of 68%. A common reason offered for refusal to participate was that they were too busy or not interested in participating in the survey. A summarised report of the research findings was offered to the respondents as an incentive for them to give a response. The message to each firm included a link for the on-line survey using Survey Monkey and a cover letter explaining the purpose of the study. To improve the validity of the response, a definition and description of certain phrases used in the questionnaire was included on the second page of the survey. The mailings were mailed to all firms in our sample frame. Both a first and second reminder, via email with a few weeks' gap in between, were sent to all firms who would like to participate in this research project. Due to the difficulty of collecting data and the low response rate from the SMEs, a final phone call was made to those businesses in order to encourage them to return the completed survey. In total the final number of responses was 197 responses. 13 of these responses were discarded and could not be used in the analysis because large sections of the questionnaires were incomplete (i.e. left blank in some questions or some parts) or had only one number on all Likert scale items, such as all ones or all fives. The final usable sample contained 184 responses.

5.7.5 Data analysis techniques

The statistical analysis undertaken included the following:

- *Hypotheses testing:* Multivariate analysis assesses the relationships among three or more variables simultaneously. There are several multivariate statistical techniques (e.g. logistic regression) (Everitt, 2003; Tharenou *et al.*, 2007). The hypothesis-testing component of the present study will use multivariate analysis techniques in order to test the hypothesised model.
- *Scale reliability testing*: most variables in the study were composed of Likert-type items. Hence, Cronbach's coefficient alpha was used to measure the consistency of the multiple-item scale. Although researchers suggest 0.7 as the accepted value for Cronbach's alpha (Hair *et al.*, 1995), a value of more than 0.6 is considered a satisfactory level (Nunnally and Bernstein, 1994).
- *Multi-collinearity tests*: multi-collinearity occurs when two (or more) independent variables are highly correlated (Pallant, 2007). The presence of multi-

collinearity can cause computational and interpretational problems (Tharenou et al., 2007). For that reason, it is recommended that the absence of multi-collinearity be investigated before regression is interpreted. Tabachnick and Fidell (2007) have suggested that if two independent variables are correlated .70 or higher, they may suffer from multi-collinearity.

- *Checking for outliers:* outliers are extreme data points that can have a disproportionate influence on the conclusions drawn from most statistical techniques (Tharenou *et al.,* 2007). In the current research, since most variables were measured with Likert 5-point scores ranging from strongly agree to strongly disagree, the threat of outliers is not a concern. If respondents answered strongly agree or strongly disagree, these response options became outliers as they are the extreme points of the scale.

5.8 Limitations of the Research Design

The most important limitation lies in the fact that the concept under investigation is a relatively new phenomenon in the computing world, and correspondingly for businesses, in particular for small and medium sized ones. Although the North East aspires to become home to innovative digital firms, the level of awareness and diffusion among SMEs in this region is quite low, and this has increased the difficulties of achieving a high response rate. Another limitation for this study is that the current research study was designed to collect data using an on-line survey; hence, the researcher was not able to acquire individuals' views in order to enhance the value of the study.

5.9 Ethical Concerns

The ethical implications of the research, which could adversely affect participants and the organisation, were carefully considered when planning for the research design and methodology. The research methodology was therefore adapted in line with suitable ethical principles. Appropriate action was taken concerning informed consent, the right of respondents to withdraw, the protection of anonymity, participator-research issues, and the personal safety of the research. Participants were also made aware that they had the opportunity to ask questions, at any time, throughout the research process. The

researcher needs to consider access and the ethical issues implied by the research design; generally, the data collection method ought not to subject participants (the research population) to discomfiture or any other material disadvantage (Saunders *et al.*, 2009).

In an attempt to ensure that the research project was characterised by privacy and confidentiality, an ethical approval from was submitted to Newcastle University Business School, and once the researcher received a notification of approval from the School, a cover letter was prepared. The cover letter clarified the aim of the research project, and explained the voluntary nature of the participation. Participants were given the right to withdraw from the research at any time and were asked to contact the researcher or the supervisory team with any enquiries. Burton (2000) claims that *"ethical concerns are present in all research designs and go beyond data collection to include analysis and publication"* (Burton, 2000, p. 299). These issues were in the forefront of the researcher's mind throughout the research process.

Chapter 6. Qualitative Study

6.1 Introduction

Using semi-structured interviews, data was collected from SMEs operating in the North East of England. The aim of this chapter is to report the piloting of the conceptual framework developed earlier on a smaller sample before carrying out a survey. The findings of this chapter aim to explore those factors that impact on the adoption of cloud computing and feed into the larger-scale quantitative study.

6.2 The Participating SMEs

To overcome the pro-adoption bias (Rogers, 2003), this study focuses on both adopters and non-adopters of cloud computing. Using Rogers's adopter categorisation, fifteen cases have been categorised into three main groups based on the extent to which an SME is relatively earlier to adopt cloud computing than others (Table 6.1).

Table 6-1: Firms taking part in the study

#	Industry	Adoption Stage	Interviewee's Position	Size
F1	IT	Provider	Operations Manager- for Cloud	130
F2	IT	Provider	Managing Director	30
F3	IT	Provider	Technical Services Director	76
F4	IT	Provider	Cloud Business Development Manager	500
F5	Education	Already adopted	Technical Director	40
F6	Financial	Already adopted	Electrical Department Manager	50
F7	Legal	Already adopted	Marketing Manager	18
F8	Business services	Already adopted	Operations Director	10
F9	Education	Prospector	Scientific Facilities Manager	6
F10	Legal	Prospector	IT Manager	170
F11	Retail	Prospector	Technical Manager	70
F12	Architecture & Planning	Prospector	Head of Project Management	220
F13	Business services	Do not intend to adopt	Key Account Manager	6
F14	Business services	Do not intend to adopt	Open Innovation Practitioner	40
F15	Services	Do not intend to adopt	Managing Director	2

The first category was services providers. Providers who participated in this research project were chosen to be providers for a variety of computing services, not just cloud services. The second category included early adopters, i.e. firms that have

already adopted and implemented cloud computing, while the third one included prospectors, i.e. firms that have not adopted cloud services yet, but intend to adopt at least one of these systems in the next 3 years. Finally, the last category included laggards: firms that have not adopted cloud computing and do not intend to adopt it in the future.

6.3 Findings & Discussion

6.3.1 Technological Context

Relative Advantage: When firms perceive a particular innovation offering a relative advantage, then it is more likely that they will adopt that innovation (Lee, 2004) (F4). To do so, though, SMEs need to have a clear understanding of the relative advantages of cloud services. In the current study, prospectors have related their late reaction to the lack of awareness about this type of service (e.g. F12). Organisations that have already adopted cloud services (F5-F6, F7) were aware of the benefits of this type of service. Prospectors justified their interest in cloud services, stating their expectation that cloud computing services could make them more effective and competent. For instance, cloud scalability and mobility could provide them with more control over their operations (F10, F11) and IT expenditure (F12). Participants (F13, F15) justified their decision not to adopt cloud services by saying that the benefits of having cloud computing systems are not clear to them, and their existing infrastructure is satisfactory to meet their business operation needs.

Uncertainty and Geo-restriction: Unlike previously studied ICT innovations (for instance Thong, 1999; Ramdani and Kawaiek, 2007) it was found that SME adoption of cloud computing services is highly dependent on the level of uncertainty. Service provider F3 confirmed that it was understandable that privacy and relinquishing total ownership are the main concerns for businesses when considering adopting cloud computing. This may be addressed by building relationships with trusted service providers. As one of the participants stated: *"Yes, for sure, I appreciate that you feel like someone else has your data, but there has to be an element of trust"* (F11). Meanwhile other participants (F13-F15) clearly expressed their concern about this type

of service: *"We sign confidentiality agreements with our clients, so security of data and trusting the whole concept of work would be a key issue for us"* (F14)**.** The majority of early adopters and prospectors (F6, F7, F9, F11) actually stated that they trusted service providers, which is of critical importance to adoption.

Much of the uncertainty around cloud computing was how data is handled and where it is stored. A new factor, geo-restriction, was identified and found to be crucial for SMEs when considering adopting cloud computing services. This is clearly reflected in the answer by F2: *"Some companies that are hugely concerned about the sensitivity of data will have concerns about: where is our data, is it in UK? Or in Europe? Is it in the USA? And sometimes, this is a big obstacle to overcome".* F6 agreed, stating that "*the confidentiality of our users' data is paramount; there's no chance we can put them at risk, or send them to another country*". Early adopters and prospectors tend to underline this point in any negotiation with service providers. Some SMEs might show no tolerance regarding this issue (F2, F4- F7, F14).

Compatibility and Complexity: SMEs expect adopted cloud services to be compatible and easy-to-use. Early adopters (F6-F8) expressed their satisfaction about the level of compatibility and complexity using cloud services. Prospectors F9, F11, and F12 expected using the new technology to be comfortable fairly soon after adoption. Cloud service providers claimed that most cloud services seem to be consistent with the firms' values and technology needs.

Trialability: In terms of the impact of the trialability, it was found to be particularly useful for the clients to try the product before implementing it, which impacted on the adoption decision. This was the case for all participants from provider, adopter and prospector groups, except for F5, who had the intention to adopt cloud services even before trying the product: *"Yes we tried it, but the intention was always there to use it. So it did not affect the adoption decision"*. Both early adopters and prospectors asserted that trialability affected their decision in a positive way. It appears that trying the technology helps reinforce the SME's choice. This was the case with early adopters, e.g. for F5, F7. From the service providers' point of view, they are prepared to allow trials for a certain period in order to help their clients decide. It is interesting to note that in all three cases of firms who do not intend to adopt cloud

services, none of them had the chance to try out the cloud computing products apart from some common web apps that are in use today.

6.3.2 Organisational Context

Organisation size: Organisation size has been shown to be a major factor in adopting ICT innovations in many previous studies. Start-ups and small businesses were found to be inclined to adopt cloud services. According to the data from the interviews (e.g. service provider F1, early adopter F6, and prospectors F9, F11), organisational size was found to be an important parameter for start-ups and small businesses; they believe that their small size enabled them to change direction quickly and to be more flexible if needed. As F9 stated: "*we are a very small group, and we are controlling our destiny, and it's easy for us to do whatever we want...so yes, we are quite eligible in that respect*". For start-up companies, using cloud computing may be attractive, because it can help avoid capital expenditure.

Top management support: Regarding top management commitment and support, findings are consistent with those of (Lertwongsatien and Wongpinunwatana, 2003; Ramdani and Kawaiek, 2007), who found that without top management support, SMEs are less likely to adopt new technologies. Service providers (F1, F2, and F4) noted that, in many cases, it was the firm's chief executive and managing director who heard about the cloud and encouraged IT staff to investigate it further. In contrast, adopters and prospectors (F6-F8) stated that it was the IT department staff who suggested the adoption of cloud computing services, which was then supported by the top management team.

Prior experience and familiarity: This factor was identified in the responses of different types of participants in this study. Apart from (F13-F15), who were neutral, and F5, who stated that this factor had nothing to do with their adoption decision as a company, service providers, adopters and prospectors agreed that using similar technologies, in particular virtualisation services, made adopters more comfortable with cloud services, as they were already familiar with these types of service: "*we had a virtual environment internally in the organisation and that was there for some time ... so yes, I guess it did affect the adoption decision.*" (F11)

6.3.3 Environmental Context

Market scope and Industry: In the context of SMEs, cloud service adoption was found to vary in different industries. According to Goode and Stevens (2000) the business sector that a company operates in is one of the factors consistently found to influence the adoption of technology. Adopters (F5-F7) and prospectors (F9, F10) mentioned that cloud services are more relevant to sectors that have high computing requirements. Regarding the market scope, it is apparent from the results that when firms operate in a wide market area, they adopt cloud services to improve their efficiency (F4, F12). For instance, F11 was considering cloud computing because it would enable them to be less location dependent.

Competitive pressure: Contrary to other ICT innovation adoption research e.g. (Grover, 1993; Crook and Kumar, 1998), competitive pressure did not affect SMEs' adoption decisions. Many participants (F2, F5, F6, F8, F9, F13, and F15) indicated that they did not consider this as a significant factor. Service provider F3 stated that SMEs have more important issues to consider when making the adoption decision beyond the competitive pressure.

Supplier computing support: In-line with previous research (DeLone, 1981; Kwon and Zmud, 1987; Gatignon and Robertson, 1989) which demonstrates the availability of external support to be positively related to adoption, in this study, the majority of participants who belong to provider, adopter and prospector groups, emphasised the importance of supplier efforts and external computing support in the decision making process. Nevertheless, adopters and prospectors noted that a supplier effort was not sufficient and needed to be extended. F13 stated that although they have attended some seminars organised by cloud providers, his firm's decision was not to adopt cloud services. F14 and F15 did not exclude the possibility of adoption, if they had the chance to know more about the nature of cloud services: *"The more information you have about anything, the more informed choice you can make"* (F15). Delone (DeLone, 1981) argues that small firms rely on external support for their IS applications. This factor has been found to play a central role, in addition to other factors as discussed in the next section.

6.4 Discussion

Table 6.2 summarise findings based on the evidence collected, while in the rest of this section we discuss the implications of our findings in relation to the three TOE contexts.

Table 6-2: Summary of findings

Factor	Support	Evident in Firm
Technological		
Relative Advantage	Supported	1-12
Uncertainty	Supported	1-4,6,10,11, 13- 15
Geo-restriction	Supported - New	1,2,4-7,10- 12, 14
Compatibility	Supported	1-4,6-8,10-13
Complexity	Supported	1- 4,6-8,10
Trialability	Supported	1- 12
Organisational		
Size (smaller, more flexible)	Supported	1,2,4,6,8-11
Top management support	Supported	1-9,11, 12
Innovativeness	Supported	1-12,15
Prior IT experience	Supported	1-5,7-11, 12
Environmental		
Market scope	Supported	2-4,6,7,10-12
Supplier computing support	Supported	1-12, 14,15
Competitive pressure	Not Supported	3-5,7-9,13,15
Industry	Supported	2,3,5-10, 12

Technological: The business benefit: New technologies are expected to bring significant benefits and value to a company, well beyond those that already-adopted technologies deliver. Therefore, relative advantage is often used as a significant indicator in the ICT innovation literature (Thong, 1999; Lee, 2004; Ramdani and Kawaiek, 2007; Chaudhury and Bharati, 2008). The client's innovativeness and self-motivation are not always enough. Therefore, awareness and understanding of these advantages is important for the adoption decision. This draws attention to the central importance of the role of supplier marketing efforts. Although in most cases in this study early adopters and prospectors tended to rely on the element of trust in the service providers, uncertainty was still a serious hindering factor for adoption. Cloud security, privacy and giving ownership are the main concerns for businesses. Moreover, the locality of the data-centre was found to be a critical issue in negotiations between SMEs and service providers. A possible explanation for this might be that SMEs have a

preference for their data to be physically stored in the UK, ensuring that cloud data-centres are subject to UK laws and legislation. An important implication arising from this is that cloud computing providers need to carefully consider the location of their data centres. Taking locality and trialability factors into consideration may lead to decreasing the level of uncertainty and the concerns of SMEs.

Organisational: Prior experience or familiarity with similar technologies such as virtualisation leads to easier decision-making processes. Consumers gain a level of comparison from previous experience with similar services, or by a contrast of the capabilities of the service with alternative services (LaTour and Peat, 1979; Anjana *et al.*, 2003). Business size was one of the organisational characteristics that Goode and Stevens (Goode and Stevens, 2000) listed as consistently associated with the adoption of technology. This factor has been found to apply equally well to large and small businesses (Raymond, 1985; Goode and Stevens, 2000). In the case of small and start-up businesses, avoiding capital expenditure encourages them and increases their willingness to adopt the cloud. This is in addition to the fact that compared to large organisations, SMEs are more flexible. The present findings seem to be inconsistent with Low *et al.* (2011), which found that large firms are more likely to adopt cloud services.

Environmental: The results of this study did not show that competitive pressure was a significant factor for adoption. As noted earlier, this might simply be related to the low rate of diffusion of cloud computing among SMEs till now. Cloud service providers could encourage small businesses in many ways. For instance, they can allow them to try the product or service before committing to it, offering their customers the opportunity to determine the level of compatibility and complexity of the product. In turn, this could help SMEs validate their choice and, therefore, reduce the perceived risks. Assuming that competitive pressure can be an engine for adoption, service providers may need to demonstrate, using relevant successful case studies, the benefits of adopting cloud computing. Consequently, this may lead to competitive pressure and the observability needed for the diffusion. It is worth noting that given that in small businesses the CEO is often the owner-manager (Thong, 1999), in that case, sales pitches should not just be targeted to IT staff, but also to the top management, for the

reason that support and commitment from the top management team makes the company more likely to adopt new technologies, and also to avoid the cases where IT managers feel that cloud computing might threaten their position. There was agreement among all participants in this study that the innovativeness of the decision-maker or whether the organisational strategy was instilled with innovation had a great impact on the willingness to adopt new technologies. The nature of the sectors may also influence, and in many cases even determine, the level of IT infrastructure needed. This may explain why cloud computing may be more attractive for certain sectors but not others. Therefore, suppliers need to understand their clients' sectors and business first.

Finally, although adopters and prospectors underlined the importance of providers' activities to make SMEs adopt cloud services, in many cases in this study, SMEs did not feel it was adequate until now. A possible explanation for this is the fact that at the moment providers recognises the changing IT industry-environment, and they are making a very active move in order to be a facilitator for cloud services. At the same time, they have a lot of investment in in-house software and hardware, which they do not want to be affected. This can create an impression among stakeholders that cloud service providers may want to protect their existing investments and maintain the status quo, as offering cloud computing services may not necessarily be in their own interest. For instance, service providers F2 and F4 stated that they will not push SMEs in a specific direction, e.g. cloud computing: *"Because we are not only a cloud computing provider, we don't try to push them down a particular route" (F2).* Consequently, more research on this topic needs to be undertaken before discussing the role service providers can play in cloud computing diffusion. This is because clients would be affected by the views of their service provider and the extent to which this provider believes in the benefits that cloud computing can bring to their business.

6.5 TOE, cloud computing and SMEs

The adoption and diffusion of IS innovation have been extensively studied, and considered to be one of the most mature areas of exploration within the IS discipline (Hirschheim, 2007; Venkatesh *et al.*, 2007; Williams *et al.*, 2009). The dominant paradigm in studying IT innovation adoption involves identifying contingency factors that facilitate or hinder the adoption decisions in organisations (Fichman, 2004;

Troshani *et al.*, 2011). Given that technology adoption is complex and context-sensitive, different factors for the technological, organisational, and environmental context can vary across different innovations (Baker, 2011; Troshani *et al.*, 2011). Cloud computing is still an emerging set of technologies and business models. Discussions of Cloud computing have not reached the level of clarity or shared conceptions of more mature areas of computing (Kushida *et al.*, 2010). Based on TOE, this study offers evidence for this as cloud computing adoption was found to be influenced by different types of factors beyond the technological and organisational contexts. TOE has proven to be sufficiently holistic to capture cloud computing adoption. Among the initial 13 TOE factors the researcher found evidence for 12 of them, to warrant supporting the proposition that they are significant. The researcher also added a new factor which may prove to be of increasing importance as ICT infrastructures become more interconnected, albeit also more geographically dispersed. The effect of geo-restriction could be potentially generalised and extend TOE as a facet of trust and the role of trust is examined in more detail in future studies. The nature of cloud computing should also offer enough scope to generalise findings beyond the geographical area considered and to SMEs in other regions and even countries as cloud computing transcends boundaries and regional ICT infrastructure is not considered a major obstacle for the adoption process. Still relevant skills and supplier support can make a difference and should be considered when translating findings to other regions. Finally, participating SMEs were not considered to be special cases and the opportunities and challenges identified would have been expected to broadly apply to the majority of SMEs.

6.6 Conclusion of Qualitative Pilot Study (Stage 2)

"Computing services on-Demand" is gradually modifying the way information system services are developed, scaled, maintained and paid for. Previous trends such as virtualisation and outsourcing may be considered as the initiation point for cloud computing ideas. Nevertheless, the novelty of cloud computing is the comprehensive method of providing computing services using high speed Internet connections (Leimeister *et al.*, 2010; Yadav and Zeng Wen, 2010). This qualitative study is a first attempt to explore and develop an SME cloud computing adoption model that was theoretically grounded in the TOE framework. By adopting the TOE framework the first stage of this study has shown that the three contexts of this framework (technological,

organisational, and environmental) are connected to each other. The main factors that were identified as playing a significant role in SME adoption of cloud services were: relative advantage, uncertainty, geo-restriction, compatibility, complexity, trialability, size, top management support, prior experience, innovativeness, industry, market scope, supplier efforts and external computing support. In contrast, this stage did not find enough evidence that competitive pressure was a significant determinant of cloud computing adoption.

These preliminary findings have important implications and great value to the research community, managers and ICT providers, in terms of formulating better strategies for cloud computing adoption. For service providers, using the research model in this study can assist in increasing their understanding of why some SMEs choose to adopt cloud computing services, while seemingly similar ones facing similar market conditions do not. On the other hand, however, cloud computing providers may need to improve their interaction with SMEs who are involved in the cloud computing experience, in an effort to create a healthy environment for cloud computing adoption, and to remove any vagueness surrounding this type of technology. Providers may need to clarify their position and stance when it comes to offering in-house services versus cloud services, which in turn can affect clients' confidence. Prospectors appear to be willing to adopt cloud computing services despite security concerns, as they rely on the element of trust. Nevertheless, providers need to be aware of common concerns that SMEs experience when they make their adoption decision, such as locality, and trialability. All these points can play a role in spreading a sense of trust and relief among SMEs to encourage adoption. In turn, this will lead to the diffusion of cloud computing. Giving the SMEs the chance to try the products before actual use would increase awareness of cloud services. Also, an SME will be able to assess the services before the actual use, regarding the compatibility with its existing systems and to evaluate the complexity level. Finally, since prospectors and most of the clients who are already adopting cloud services have stressed the importance of the physical location of the data centre, providers can take this point into consideration when choosing the place for their data centre, and also in their negotiations with the potential customers.

Chapter 7. Quantitative Study

7.1 Introduction

This chapter discusses the results of the testing of the hypotheses put forward in relation to the conceptual framework discussed in the previous chapters. It then reflects upon the findings, comparing them to the relevant literature. Before proceeding to present the results and the findings, it will first outline a few additional aspects of the quantitative study undertaken in stage 3 of the overall research design.

7.2 Participant Information

Adopters versus Non-adopters: The questionnaire opened with a question on whether participating SMEs are adopters or non-adopters of cloud services. This is a dichotomous variable indicating mere adoption versus non-adoption. The 185 collected cases include 145 adopters, representing 78.8% of the cases, and 39 non-adopters, representing 21.2%, as shown in the Table below.

Table 7-1: Adopters versus Non-adopters

Measure	Frequency	%
SME type:		
Adopter	145	78.8
Non-adopter	39	21.2

Current level of IS adoption among SMEs: In order to determine the level of ICT adoption by SMEs, the respondents were asked about the current level of IS employed in their businesses. ICT classifications in studies for Laudon and Laudon (2009) were used. The results are presented in Table 7.2.

Table 7-2: ICT classification

ICT classification	**Count**	**Percent %**
Basic Internet services (email and web)	133	83.2
Web site with simple e-commerce functions	78	42.4
Web site with advanced e-commerce functions	39	21.2
Transaction Processing Systems such as: Payroll, Order Tracking, etc.	62	33.7
Decision-Support Systems such as: Sales region analysis, cost analysis, etc.	39	21.2
Management Information Systems such as: Sales management, inventory control, etc.	60	32.6
Executive Support Systems such as: profit planning, Manpower planning, etc.	24	13.0

It seems that SMEs tend to adopt simple ICT infrastructure such as basic Internet services (email and web), which are more valuable to them on an operational than a strategic level. In turn this could be potentially interpreted as being in line with Brown and Lockett's (2004) study, which suggests that SMEs are more comfortable with low complexity ICT applications, and try to avoid the more complex applications. This is not surprising because SMEs always lack ICT skills in their workforce (Spectrum, 1997). Parida et al. (2010) argued that SMEs do not adopt some complex ICT services because they are unfeasible or may not suit the simple nature of their specific business. In fact, ICT providers used to target large firms as they usually had adequate resources and were willing to pay for more complex ICT services. Their products are often too expensive and too complex for SME users. Supposing that SMEs successfully managed to develop their own system, either a simple or complex ICT application will, usually, continue to need updating and the maintenance required for this application over time will cause a problem for this small business, in particular if they already suffer from a lack of technologically skilled staff. In fact, for them systems such as those that tend to feature at the advanced end of the scale may not even be necessary. For instance, only 24 firms, representing 13% percent of the respondents, used advanced ICT, such as Executive Support Systems.

SMEs sample description according to the size and years since establishment

Table 7-3 presents the composition of the sample according to the size, based on number of employees, years since establishment, market scope and industry. In summary, most businesses fell into the micro-size (1-9 employees), were relatively well established (the vast majority passing the 3-year threshold) and had a regional or national focus.

More specifically, the category 1-9 employees represented 63.6%, 10-49 employees represented 19.6% and 16.8% accounted for firms with more than 50 employees. This is in line with what one would expect in a region like the North East. Among them, 15.8% were start-up firms, while the majority of participant firms had been established for more than one year. More than half of the firms sampled had been established for more than five years (53%). This is of interest as companies that have been established for some time would be expected to spend less money on technology

(Storey, 1994) and those that are newer would be expected to be investing more (Levy *et al.*, 2001). In the case of cloud computing adoption, it is expected to be attractive for start-up companies as they have no legacy infrastructure and can make decisions on investment without worrying about prior investments. This would also be line with some literature which argues that cloud computing might act as an accelerator for starting up a new company with modest financial commitment for IT infrastructure (Aumueller, 2010).

Table 7-3: Characteristics of participant firms (n=184)

Measure	Frequency	%	Non-Adopter	%	Adopter	%
Firm Size:						
1-9 Employees	117	63.6	31	26.5	86	73.5
10-49 Employees	36	19.6	5	13.9	31	86.1
50-250 Employees	31	16.8	3	9.7	28	90.3
Established:						
Less than a year ago	29	15.8	3	10.3	26	89.7
1-5 years ago	57	31.1	11	19.2	46	80.8
More than 5 years ago	98	53.0	25	25.5	73	74.5
Market scope:						
Local	18	9.8	6	33.3	12	66.6
Regional	40	21.9	11	27.5	29	72.5
National	61	33.3	14	22.9	47	77.1
International	64	35.0	8	12.5	57	87.5
Industry:						
Manufacturing and retail	33	17.5	8	24.3	25	75.7
Business services	49	26.8	11	22.4	38	77.5
Technology	62	33.9	14	22.5	48	77.4
Other	40	21.9	6	15.0	34	85.0
SME type:						
Adopter	145	78.8				
Non-adopter	39	21.2				

Those that reported having an international scope also reported significantly higher adoption than other groups, such as those with a local scope. This is in line with the findings of the pilot study, which found SMEs with wide market scope to be more likely to adopt cloud computing services, as it helps them to be less location dependent. Participating companies were trading in various industries (technology, business services, manufacturing and retail, and others). The majority of respondents were from the technology sector, representing 33.9% of the sample. The technology sector, understandably, was the industry most involved in adopting cloud computing services. This result may explain the relatively good correlation between levels of awareness and

adoption decisions for new innovation technology. Finally, those in manufacturing and retailing were among the minority groups, representing only 17.5% of the sample.

7.3 Logistic regression

Regression analysis is used as a common method of analysing and describing the relationship between a response variable and one or more explanatory variables (Jank and Shmueli, 2010). Logistic regression helps to predict the probabilities of decision making and measures how well the independent variables explain the dependent variable (Pallant, 2007). In view of the research objectives for this research project, it was considered that binary logistic regression would be an appropriate analysis method for analysing and predicting SMEs' choice behaviour. This is mainly because it helps to analyse the dependency of a dichotomous variable from other independent variables. Usually, the dichotomous variable is an event that can occur or not. In this case this event refers to whether a company decides to adopt cloud computing (coded as 1) or not (coded as 0). It is worth mentioning the successful usage of these types of regression models in previous ICT innovation adoption studies, e.g., Enterprise systems adoption (Ramdani, 2008), and E-business adoption (Zhu *et al.*, 2003). In this type of model one estimates the probability of an event occurring. The equation can be written as:

$$Prob(event) = \frac{1}{1 + e^{-z}}$$

For a single independent variable this is:

$$z = b_0 + b_1 x_1$$

While for multiple independent variables this becomes:

$$z = b_0 + b_1 x_1 + b_2 x_2 + \cdots . b_n x_n$$

where b_0 and b_1, b_2, are coefficients estimated from the data, x_1, x_2, are the independent variables, n is the number of independent variables and e is the base of natural logarithms (2.781).In this situation z is the dependent variable showing whether SMEs will adopt or not adopt cloud computing. The independent variables denoted by x

are: relative advantage, uncertainty, geo-restriction, compatibility, complexity, trialability, size, top management support, prior experience, innovativeness, industry, market scope, supplier efforts and external computing support. Table 7.4 shows the results of the logistic regression. The predictors that were found to be statistically significant were relative advantage, uncertainty, innovativeness and external computing support.

Table 7-4 Logistic Regression

Variables	B	Standard. error S.E.	Wald	Df	Significance	Exp (B)	95% C.I. for EXP(B) Lower	Upper
Relative Advantage	.978	.396	6.108	1	.013*	2.658	1.224	5.773
Uncertainty	-.731	.294	6.182	1	.013*	.482	.271	.857
Geo-restriction	-.060	.228	.069	1	.793	.942	.603	1.471
Compatibility	.683	.460	2.203	1	.138	1.979	.804	4.874
Complexity	-.096	.429	.050	1	.822	.908	.392	2.104
Trialability	-.192	.312	.381	1	.537	.825	.448	1.520
Top management support	-.134	.291	.213	1	.644	.874	.495	1.546
Innovativeness	.682	.303	5.054	1	.025*	1.978	1.091	3.584
Prior similar IT experience	.221	.260	.727	1	.394	1.248	.750	2.076
External computing support	-.787	.377	4.347	1	.037*	.455	.217	.954
Size	1.398	.752	3.455	1	.063	4.046	.927	17.665
Industry	.434	.603	.519	1	.471	1.544	.474	5.030
Market scope	-.491	.482	1.039	1	.308	.612	.238	1.573
Constant	-.172	2.197	.006	1	.938	.842		
C2 Hosmer & Lemeshow	7.101							
Initial -2 Log likelihood	175.537							
-2 Log likelihood	130.323							
Cox & Snell R^2	0.234							
Nagelkerke R^2	0.363							

** =p<0.05, Variables are significant at the 0.05 level of significance.*

***=p<0.01, Variables are significant at the 0.01 level of significance.*

+= Test is not significant at 0.05 level of significance.

7.4 Model Fit Statistics

The table above shows the output of binary logistic regression. Results show that relative advantage, uncertainty, innovativeness and external computing support are significant with p values of 0.013, 0.013, 0.025 and 0.037 respectively.

Therefore, the results suggest that these factors are related to the organisational likelihood to adopt cloud computing. In order to find the goodness of fit (Hair and Anderson, 2010) and to measure the strength of association between independent and dependent variables, statistical tests including the Log Likelihood statistic and the, Cox and Snell R^2 and Nagelkerke R^2 were used.

The Log Likelihood statistic shows the amount of unexplained variation in the dataset. A lower value of log likelihood statistic indicates the better fit of the model (Field, 2005). The 2 LL of the null model was higher than the research model (175.537). A lower r value of research model (130.323) suggest that the research model explained the dependent variable better with independent variables included in the model compared to the null model excluding independent variables.

The result of Hosmer-Lemeshow test shown in the table 7-4 also provides enough support for the model (526). For the Hosmer-Lemeshow Goodness of Fit Test, a significance value less than .05 indicates poor goodness of fit. In this study the chi-square value for the Hosmer-Lemeshow test is 7.101 with p = .526. This result indicates a better goodness of fit for the model.

Table 7-4 shows complete information regarding the usefulness of the model. **The Cox & Snell R Square and the Nagelkerke** R Square values present an indication about the variation in the dependent variable explained by the model. In this model, the two values are .234 and .363, suggesting that between 23.4 per cent and 36.3 per cent of the variability in whether SMEs would adopt cloud computing is explained by these variables. This value is in line with previous work (e. g. Premkumar, 2003, Ramdani 2008).

7.5 Multicollinearity

To check for the existence of first order correlations, the Pearson Product Moment Correlation (Pearson R) among the independent variables is illustrated as shown in Table 7-5.

Table 7-5: Correlation Matrix

	RA	UNC	GEO	COMP	COMPLX	TRIAL	TMS	INNOV	PRIOR	EXSUP	SIZE	INDSTR	SCOPE
CONSTANT													
RA	1												
UNC	129	1											
GEO	-.081	.231**	1										
COMP	.634**	.042	-.092	1									
COMPLX	.593**	.114	-.091	.591**	1								
TRIAL	.315**	.334**	.252**	.379**	.320**	1							
TMS	-.145	.013	.137	-.052	-.155*	.126	1						
INNOV	.365**	.196**	-.007	.492**	.380**	.365**	-.055	1					
PRIOR	-.049	.104	.071	.049	-.155*	.073	.226**	-.018	1				
EX_SUP	.194*	.260**	.227**	.220**	.071	.464**	.129	.257**	.180*	1			
SIZE	.031	-.036	-.072	.035	-.003	-.040	-.026	-.014	.041	-.005	1		
INDSTR	-.055	.050	.010	-.025	-.042	.002	.238**	.088	-.028	.084	.038	1	
SCOPE	.178*	.078	-.050	.230**	.130	.145	.034	.184*	.042	.177*	-.120	.094	1

* correlation significant at the 0.05 level of significance (2-tailed)

** correlation significant at the 0.01 level of significance (2-tailed).

It has been suggested by Cohen *et al.* (2002) that a correlation coefficient above 0.9 is a cause of concern of multicollinearity. In this model, the correlation coefficients are highest at 0.634. Therefore, multicollinearity does not appear to be a problem. Because Pearson R highlights first order correlations only, there may exist more subtle forms of correlations. Alternative techniques are used to test for multicollinearity. Both the Variance Inflation Factor (VIF) and Tolerance statistics of the variables were examined, as shown in Table 7-6 below. It has been suggested that very small tolerance values (much below 0.1) or large variance inflation factor values (above 10) indicate high collinearity (Hair *et al.*, 2006). From the analysis, all of the variables have a tolerance value above 0.1 and VIF below 10. This suggests that no threat of multicollinearity (including its subtlest form) exists in this model.

Table 7-6: Collinearity Statistics

Independent Variables	Collinearity Statistics	
	Tolerance	VIF
Relative Advantage	.539	1.857
Uncertainty	.830	1.205
Geo restriction	.757	1.320
Compatibility	.449	2.225
Complexibility	.458	2.182
Trialability	.666	1.503
Top Management	.701	1.427
Innovativeness	.893	1.120
Prior IT Experience	.711	1.407
Industry	.645	1.550
Market Scope	.649	1.540
Supplier Effort	.670	1.492

7.6 Predictive Accuracy of the Model

Given a set of predictors, Hair and Anderson (2010) argue that the main objective of logistic regression is to achieve the highest prediction accuracy of the outcome of the dependent variable. Compared to other similar techniques, the logistic model requires fewer assumptions to produce high predictive accuracy. In an attempt to assess the predictive accuracy of the logistic regression model, a classification Table was used. It can be seen from the data in Table 7.7 that the observed value of the overall accuracy rate was 80.6%.

For adopters, the model correctly predicted 94% of adopters' cases and 30.6% of the cases for non-adopters.

Table 7-7: Classification

Observed			Predicted		
			Adoption		Percentage Correct
			Non-adopted	Adopted	
	Adoption	Non-adopted	11	25	30.6%
		Adopted	8	126	94.0%
	Overall Percentage				80.6%

7.7 Findings and Discussion

Returning to the hypotheses posed in this paper, there is evidence for the importance of perceived compatibility, trialabity, perceived top management support and innovativeness in SMEs' adoption decisions regarding cloud computing services. Table 7.8 offers a summary of the accepted and rejected hypotheses.

Table 7-8: Summary of hypotheses

Technological	
H1: Relative advantage	Accepted
H2: Uncertainty	Accepted
H3: Geo-restriction	Rejected
H4: Compatibility	Rejected
H5: Complexity	Rejected
H6: Trialability	Rejected
Organisational	
H7: Size	Rejected
H8: Top management support	Rejected
H9: Innovativeness	Accepted
H10: Prior similar IT experience	Rejected
Environmental	
H11: Industry	Rejected
H12: Market scope	Rejected
H13: External computing support	Accepted

7.7.1 Technological context

This study provides evidence that perceived relative advantage was positively associated with the adoption decision on cloud computing and was significant (p=0.05 in the research model). This outcome corroborates the results of a great deal of the previous work in this field, such as (Premkumar and Roberts, 1999; Nelson, 2003; Dedrick and West, 2004; Gibbs and Kraemer, 2004; Wu and Lee, 2005; Anand and Kulshreshtha, 2007). However, it disagrees with the results of other published studies (Chau and Tam, 1997), which showed that adopters and non-adopters are not significantly different in their beliefs about the benefits of new IT systems. In fact, it corresponds to the dominant argument regarding the significance of relative advantage in understanding SMEs' adoption of new ICT innovations. When firms perceive that an innovation offers a relative advantage, then it is more likely that they will adopt that innovation (Lee, 2004). However, these relative advantages need to be clear for SMEs. It can therefore be assumed that small firms need to perceive cloud services as new a computing model that could increase their profitability before they will take a positive adoption decision. Given that most of applications that were reported as adopted tended to be those on the basic end of the spectrum it may be that participants did not believe that these applications would actually offer them a competitive advantage. Instead they may be more pragmatically looking at reliable and flexible ICT services to underpin their daily operations (e.g. adopting a cloud-based email system).

The uncertainty factor was expected to be a significant obstacle for an adoption decision, owing to the reputation of cloud computing regarding security and privacy concerns. Indeed this was found to be the case in our analysis. In some cases, firms may seek out suppliers that have more security and continuity expertise than they do because they have no ability in-house to adequately assess the security of a sophisticated offering (Heiser and Nicolett, 2008). Nevertheless, cloud computing services, such as SaaS, can be intangible to clients as web-based applications may be used online in place of direct installation on computers in-house. The challenges involved in this aspect include clients' concerns about security and connectivity issues, such as systems failure or Internet disconnection. These issues cause SMEs to be uncertain whether to adopt cloud computing.

As a result, a clear implication of this uncertainty in the prevention of cloud computing adoption has been identified in this analysis.

Compatibility and complexity were not found to be significant factors for predicting cloud computing adoption in this study. Regarding compatibility, this finding differs from some published studies (Thong, 1999), which suggested that compatibility is an essential attributes of the IS innovation, and that small businesses will be more likely to adopt them if they are compatible with existing work practices. Rogers (2003) maintains that a rapid adoption rate for technology usually occurs if organisations recognise the compatibility of the innovation with their needs and existing practice. For that reason, decision makers prefer to ensure that new ICT services are compatible with individuals' job responsibility and value systems. However, the insignificance of compatibility might be because SMEs do not worry about integrating their applications either because their systems are relatively easy to integrate with cloud computing, or because they expect them to just replace existing stand-alone systems, like-to-like. For the latter integration is not a significant issue as such a system can function in a self-contained manner. Another possible explanation for this finding is that compatibility may have significant effects during the post-adoption stage. The extent to which the innovation is consistent with the values, experience, and needs of potential adopters may not be clear enough in the pre-adoption stage. Adopters may understand how a new IS innovation can be made more effective and compatible after they are adopted. This finding is in agreement with the findings in (Zhu *et al.*, 2006a; Zhai, 2011), which showed that compatibility of IS innovation has a significant effect during the post-adoption phase of the adoption process.

The present findings are consistent with past research which did not report complexity as a significant factor for SMEs' decision making when it comes the adoption of new technologies (e.g. Kendall, 2001; Ramdani and Kawalek, 2008). However, the result from this analysis regarding complexity is inconsistent with those of (Grover, 1993; Thong, 1999), which suggest that businesses may be less likely to adopt an innovation or technology, if it requires a high level of new skills by members of the organisation. This result may be explained by the fact that SMEs do not worry about how easy these systems

are to operate since cloud services are becoming easier to adopt, implement and use. In fact, the main idea of cloud computing is based on delivering all the functionality of existing information technology services and enabling new functionalities that were hitherto unfeasible in a simple manner (Staten, 2009). Given the nature of the adopted cloud-based application it may be that adoption actually reduced complexity for the organisation as its hardware and often software support is undertaken by the cloud solution vendor. In other words, cloud computing acts as an IT outsourcing mechanism.

Trialability was not found to be a significant predictor of adoption either. As shown in the Fujitsu report 2010, cloud services could be adopted on a workload-by-workload basis. When firms start adoption process, they usually need to run trials on less-sensitive workloads (most commonly, test and development, websites and PC applications) (Fujitsu, 2010). In fact, familiarity with technologies such as virtualisation, cluster computing or utility computing can have a direct influence upon user perceptions regarding cloud computing services, and trialability may not be important because they may have prior adequate experience of how things would work in the cloud. Consequently, trialability is not as important as other factors. In addition, given that cloud-based systems are often available for a quick demonstration, it may be that SMEs find them easy to trial, especially when compared with traditional business computing systems that are more involved. This could in turn suggest that considerably more effort from the providers' side is required in order to encourage SMEs to try cloud services, not just to try cloud services but to trial them for long enough to observe how it can potentially affect their business performance.

7.7.2 Organisational context

According to Rogers (2003), size is one of the most critical determinants of the innovator profile. As discussed earlier in chapter three, organisational size has long been at the heart of studies looking at IT innovation adoption and is considered to be an important predictor of ICT innovation adoption (Jeyaraj *et al.*, 2006; Lee and Xia, 2006). However, empirical results on the correlation between them have been mixed and are not clear yet (Lee and Xia, 2006). For example, according to Annukka (Annukka, 2008) there are studies that report a positive correlation (Mahler and Rogers, 1999; Aguila-Obra and Padilla-

Meléndez, 2006; Kamal, 2006; Ramdani and Kawaiek, 2007; Belso-Martinez, 2010), studies that report a negative correlation (Utterback, 1974; Goode and Stevens, 2000) and studies that report a non-significant correlation (Aiken *et al.*, 1980; Varun and Goslar, 1993). In this study, firm size was not found to be the significant predicting factor for cloud computing adoption. Given the relative homogeneity of the sample and the types of applications adopted, this may suggest that they have relatively similar IT requirements and consequently it is not a matter of size as such.

Regarding top management support, it is interesting to note that this factor turned out to be statistically insignificant Typically, SMEs' manager / owner support is essential to assign the resources needed for adoption; however, an owner will possibly not be involved in the critical evaluation for making the adoption decision. This result is in line with (Thong *et al.*, 1993; Seyal *et al.*, 2004), but in contrast with the findings of (Tan and Teo, 1998).

When it comes to the last organisational context factor, i.e. innovativeness, this was found to be a significant factor when it came to cloud computing adoption by SMEs. This finding can be explained in part by the large costs required for managing and implementing increasingly complex hardware, software and network equipment and the associated time costs. In turn this will also act as a distraction from their core business. Innovative businesses would also need to have an agile organisation structure and IT infrastructure to underpin their innovative nature. In addition they would also be more receptive to trying new solutions that offer higher performance. As previously reported by (Thong and Yap, 1995; Kirton, 2003), firms with a tendency for innovativeness would prefer solutions that change the structure in which the dilemma is entrenched; that is, a new method or innovation that has not been tried out may be risky. This result is consistent with those of other studies (Hirschman, 1980; Goldsmith *et al.*, 1995; Kirton, 2003) and suggests that innovativeness as a factor supports the belief that it increases the tendency towards or possibility of new innovation adoption.

7.7.3 Environmental context

Under the category "environmental factors", this quantitative study shows that market scope is not a significant factor in the adoption of cloud computing by SMEs in the North East of England. This result differs from some published studies (e.g. Zhu *et al.*, 2003; Anand and Kulshreshtha, 2007); however, it is consistent with those of Ramdani and Kawalek (2008). Cloud computing can be understood in the context of an overall businesses strategy based on agility and responsiveness. It offers massive market scale, lower operating costs and the lease of starting new services (Microsoft, 2010). According to Hugos and Hulitzky (2010) the real value of cloud computing is the way in which it can be used to support an overall strategy designed to create agility for the businesses. This strategy emphasises the ability to make continuous incremental changes and adjustments in operating procedures so the company can respond as new business conditions unfold. It also emphasises continued exploration of new business opportunities along with rapid growth into new markets, when it is sensed that they will be profitable. This means that ideas can be more readily converted into reality by individuals or organisations, regardless of their size. It seems possible that SMEs cannot yet perceive the facilities provided by cloud computing as an operational communications network. Given that initiative is a key characteristic of SMEs (Byrd and Megginson, 2008), it is highly important to be aware of how these favourable facilities can be exploited. Finally, it is worth pointing out that most of the participating companies reported a local or regional scope (about 75%), which could also suggest that the scale and functionality that cloud computing can potentially provide may not be a critical factor for them. This may in turn explain why the firm's type of industry was not found to be a significant factor either. A possible explanation for the insignificance of this factor might be that most participants in this study belonged to industries that heavily use ICT innovations and, therefore, the differences between adopters and non-adopters was not easily determined. Nonetheless, this finding is in agreement with findings in Thong (1999), which showed an insignificant association between industry sector and IT innovation adoption.

External computing support is another environmental stimulator. Many studies (e.g. DeLone, 1981; Kwon and Zmud, 1987; Gatignon and Robertson, 1989; Scupola, 2003) have demonstrated that the availability of supplier efforts and external support are positively related to adoption. The results of this study show that in the context of SMEs in the region, external computing support, which is also interpreted as support from the cloud supplier, significantly and negatively affected the adoption of cloud computing services. It is rather surprising that the more external support is available the less likely SMEs may be to adopt cloud computing. One explanation could be that when suppliers aim to offer support they are negatively perceived as focusing on the sales rather the needs of the SMEs. This could put SMEs in a defensive position and they are therefore sceptical when it comes to external support. On the other hand, another possible explanation for this is that suppliers do not expend enough effort to make SMEs feel that their support was a key reason for their adoption decision, so that their decision to adopt was fully based on the provider's sense of initiative. This rather contradictory result may be due to the amount of investment that providers currently have in in-house software and hardware, which they do not want to be affected. Therefore, they will not push SMEs in a specific direction, such as cloud computing.

7.8 Discussion

While cloud computing is considered an important ICT innovation that can provide strategic and operational advantages, it has yet to see significant rates of adoption among SMEs. Therefore, there is a requirement to understand what factors influence cloud computing adoption in the small businesses. Based on the TOE theoretical framework, this study developed and validated a research framework to study the influential contextual factors on cloud computing adoption in SMEs.

The study obtained several key findings and implications about the determinants of cloud computing adoption in the SMEs. Organisations' adoption of cloud computing in the north east of England depends on the organisation's technological, organizational, and environmental contexts. New technologies are expected to bring significant benefits and value to a company, well beyond those that already-adopted technologies deliver. Adoption

of new technology is sometimes postponed for the reason that the firm is not fully aware of the potential benefits of adopting these innovations. As discussed earlier, the client's innovativeness and self-motivation are not always enough. Therefore, awareness and understanding of these advantages is important for the adoption decision. Relative advantage and uncertainty were observed to have a significant influence on cloud computing adoption in the SMEs. This implies that managers should evaluate the potential benefits of cloud computing, and increase their awareness about these services in order to decrease the level of uncertainty. Cloud security, privacy and giving ownership are the main concerns for businesses. An important implication arising from this is that cloud computing providers need to work on providing a reliable and secure environment in the most scalable, cost-effective, and convincing manner. This is true especially in the early stages of cloud computing, when providers are yet to prove themselves to be "battle-ready" (Marston *et al.*, 2011). Also, a major concern when signing up for and using cloud services that run from a different country is that this might lead to a loss of privacy for a client's data, because of different privacy legislation applying to those in our country. Therefore, governments may need to consider revision to this legislation related to data protection, e.g. legislation coordination between countries regarding cloud computing services.

In the organisational context, the innovativeness of the firm on cloud computing adoption determines the importance of these factors in explaining firms' innovative behaviour. This finding that firm innovativeness has a strong impact on cloud computing adoption leads to some important implications for service providers in their efforts to better understand their customers and formulate marketing strategies. Hence, a more extensive study including other factors, together with the role of firm innovativeness, should yield better predictions for future researchers.

Finally, the results indicate that external computing support plays an important role, and activities that suppliers execute can significantly influence SMEs' adoption decisions in many ways. Supplier marketing activity can significantly influence the probability that an innovation will be adopted by organizations (Frambach *et al.*, 1998), and will help to lower the level of uncertainty regarding cloud services. Computing service providers always try to offer innovative forms of IT support to their customers to satisfy their needs for efficiency,

cost reduction and flexibility. In the past, in the traditional in-house method, equipment had to be obtained and investments had to be made in human capital to establish, manage, and operate the hardware and embedded software involved with generating IT services. Computing service providers used to have a lot of investment in in-house software and hardware, which makes the change quite difficult for them. Nowadays, providers recognise the changing IT industry-environment, and they are making a very active move in order to be a facilitator for cloud services. Supplier efforts and the external computing support laid out in this research project have a great influence not only from an academic position, but also on practical business issues. Both the user and supplier perspective of cloud computing services, therefore, should be considered. This is because clients would be affected by the views of their service provider and the extent to which this provider believes in the benefits that cloud computing can bring to their business. Cloud computing providers may need to improve their interaction with SMEs who are involved in the cloud computing experience, in an effort to create a healthy environment for cloud computing adoption, and to remove any vagueness surrounding this type of technology. Providers may need to clarify their position and stance when it comes to offering in-house services versus cloud services, which in turn could affect clients' confidence.

Chapter 8. Conclusion

8.1 Introduction

This study has been an attempt to explore and develop an SME cloud computing adoption model that is theoretically grounded in the TOE framework. A validated conceptual model was developed in order to examine the influence of twelve contextual factors on cloud computing adoption in SMEs in the North East of England. By adopting the TOE framework, the results of this research support the idea that more than one context can be responsible for the decision to adopt a new ICT innovation by SMEs (i.e. in this study: technological and organisational and environmental contexts).Moreover, cloud computing adoption is influenced by different types of factors and, therefore, is not exclusive to one context. As a result, this thesis provides additional support with respect to the applicability of the TOE framework in investigating ICT innovation adoption among SMEs.

8.2 Revising the Research Objectives

Objective 1: To develop a conceptual framework that can be used to study firms' adoption of cloud computing services.

The TOE framework and DOI were proposed to examine the adoption of cloud computing in SMEs. TOE represents one segment of the innovation process, i.e. how the firm context influences the adoption and implementation of innovations (Baker, 2011). Based on this framework, the technology innovation adoption process is influenced by three aspects of an enterprise's context. At the firm level also, theories such as diffusion of innovation (Rogers, 2003) have been widely applied to studies looking at how innovations are adopted and diffused. However, the adopting organisation not only needs to understand the technological traits and the costs of the technology, but also needs to be able to identify what business activities are likely to benefit from the application of the technology, in other words, how the innovation can be managed. In addition, understanding the adoption processes, its facilitators and inhibitors is crucial, because it will help organisations in

making decisions in the area of planning, production and distribution of their products and services. Cameron and Quinn (2005) argue that the organisational domain is important because plans for any changes adopted without including organisational determinants will normally have unforeseen and usually negative consequences. Also, other outcomes such as efficiency and satisfaction, are predicated upon the perceived characteristics of the target system as antecedent to behavioural intent to adopt and, consequently, to use the system. Finally, research shows that the environmental dimension is particularly important in predicting technological innovation adoption (Damanpour and Gopalakrishnan, 1998). For instance, Zhu et al. (2003) note that e-commerce is supported by technological development of the Internet, driven by some factors related to the organisation itself, such as firm scope and size, and influenced by environmental factors related to customers, business partners, as well as competitors. Compared to other IT, cloud computing is an increasingly important trend in information and communication technologies, offering the potential to improve the reliability and scalability of IT systems. The diffusion of cloud computing can potentially change the way business information systems are developed, scaled up, maintained and paid for. A conceptual framework was proposed to study firms' adoption of cloud computing services and the developed hypotheses were outlined. The model combines three main variable categories that can influence the adoption of IT innovations in organisations, namely, technological characteristics, organisational characteristics, and environmental characteristics.

Objective 2: To empirically validate the conceptual framework qualitatively and ensure its validity.

In chapter six a preliminary empirical study was conducted to test the conceptual framework developed earlier on a smaller sample of SMEs before carrying out a larger quantitative approach revolving around a survey. Based on TOE, this study suggests that cloud computing adoption decision is influenced by different types of factors beyond the technological and organisational contexts. Among the initial 13 TOE factors evidence was found for 12 of them, which warrants supporting the proposition that they are significant. This study also added a new factor (geo-restriction), which may prove to be of increasing

importance as ICT infrastructures become more interconnected, albeit also more geographically dispersed. The effect of geo-restriction could be potentially generalised and extend TOE as a facet of trust and the role of trust is examined in more detail in future studies. The main factors that were identified as playing a significant role in SME adoption of cloud services were: relative advantage, uncertainty, geo-restriction, compatibility, trialability, size, top management support, prior experience, innovativeness, industry, market scope, supplier efforts and external computing support. In contrast, this stage did not find enough evidence that competitive pressure was a significant determinant of cloud computing adoption.

Objective 3: To identify the factors which encourage or limit the adoption of cloud computing by SMEs by testing the conceptual framework quantitatively with an appropriately sized sample.

Objective 4: To discuss the perception of SMEs and influential factors that relate to cloud computing adoption within SMEs in a way that it can be applied to and practically used by the research community, managers and ICT providers who are interested in the swift adoption of new technologies.

The Logistic regression technique was used to test the research hypotheses. The result of statistical analysis on the data revealed that four out of the twelve hypotheses developed are supported. By adopting the TOE framework, this found that more than one context can be responsible for the decision to adopt a new ICT innovation by SMEs (i.e. in this study: technological, organisational and environmental contexts). As a result, the present research project support the applicability of the TOE framework in investigating ICT innovation adoption among SMEs. Four factors (namely relative advantage, uncertainty, innovativeness and external computing support) were found to be significant determinants of cloud computing adoption, but eight variables (compatibility, complexity, geo-restriction, trialability, firm size, prior IT experience, industry sector, and market scope) were found to be insignificant factors of cloud computing adoption.

8.3 Theoretical contributions

This study contributes to the ICT technology adoption literature, by studying cloud computing adoption in SMEs. Looking at SMEs' adoption of new IS innovations can help to enrich knowledge and understanding of the innovation adoption process in this era of rapid development of new technologies. Consequently, this study has been an attempt to explore and develop an SME cloud computing adoption model that is theoretically grounded in the TOE framework. A validated conceptual model was developed in order to examine the influence of twelve contextual factors on cloud computing adoption in SMEs in the North East of England.

This model builds on the existing literature on IS innovation adoption and diffusion, which argues that the decision to adopt cloud computing is a function of a variety of factors. The model adds new insights to the literature, and provides the insights for future research. To the best of our knowledge, this is among the first studies to look at the adoption of cloud computing in the context of small businesses. The nature of cloud computing should also offer enough scope to generalise findings beyond the geographical area considered and to SMEs in other regions and even countries, as cloud computing transcends boundaries and regional ICT infrastructure is not considered a major obstacle for the adoption process. Still, relevant skills and supplier support can make a difference and should be considered when translating findings to other regions. Participating SMEs were not considered to be special cases and the opportunities and challenges identified would be expected to broadly apply to the majority of SMEs.

Previous research has not differentiated between pre-adoption and post-adoption phases. This study, however, furthers our understanding of the pre-adoption factors, which are found to be different from factors affecting previously studied ICT innovations. Also, previous studies on innovation adoption in general have primarily explored technological factors (e. g. Moore and Benbasat, 1991; Rogers, 2003), or have focused on the effect of organisational factors on the adoption and diffusion of IS innovations, including top management support (e.g. Rai and Howard, 1994), organisational size (e.g. Grover and Teng, 1992). In fact, this study adopts a broad perspective on cloud computing and answers

the call by Zhu and Kraemer (2005, p. 63), who suggest that there is a need to adopt a "generic" theory such as the TOE framework for studying technology diffusion.

Consequently, this research add to a growing body of literature on organisational innovation adoption by examining the effects of three key elements on the following distinct dimensions of cloud computing adoption. These three elements are 1) technology characteristics (relative advantage, uncertainty, geo-restriction, compatibility, and trialability), 2) organisational factors (size, top management support, prior experience, innovativeness) and 3) environmental determinants (industry, market scope, supplier efforts and external computing support).

The conceptual model takes into account most of the key elements cited in the literature to explain a firm's adoption of ICT innovations. It is to be noted that this study did not intend to pick and choose from a list of factors that have been empirically tested and validated as having influenced the adoption of innovations.

Therefore, this study commenced with an initial qualitative research design to empirically validate the conceptual framework and ensure its applicability. It is important to note that this model produced after the initial qualitative study should be seen as exploratory and not a prescriptive framework.

The current work builds upon the technology–organisation–environment (TOE) framework developed by DePietro *et al.* (1990), and extends it by incorporating cloud computing -specific (1) constructs that represent unique characteristics of cloud computing such as geo-restriction. Earlier studies have not pointed out the significance of this factor in the adoption of other IS innovations. In the preliminary qualitative study, it was found that this factor is crucial for SMEs when considering adopting cloud computing services. Early adopters and prospectors tend to underline this point in any negotiation with service providers. Some SMEs might show no tolerance regarding this issue (see chapter 6). This was absent from this stream of literature (e.g. Low *et al.*, 2011). Therefore, this study has gone some way towards enhancing our understanding of by adding this dimension to the debate.

8.4 Practical contributions

8.4.1 Implications for technology consultants and software vendors

This study also leads to important practical implications for technology consultants and software vendors. SMEs represent the majority of businesses in most economies, and consequently represent an important market segment for software vendors or service providers. Brown & Lockett (2004) stress that provider's play important role in adoption and that it quite clear when the firm and community intermediaries are aware of each other's respective input and a working relationship is established.

Organisations that fail in diffusing an innovation may become influential negative opinion leaders (Leonard-Barton, 1988). Vendors and mediating institutions should, therefore, be more focused on identifying appropriate role models, learn about the specific problems these organisations face, understand organisational characteristics and take a more proactive role to promote successful diffusion in these organisations. Understanding factors impacting on organisations' adoption of cloud computing technologies will enable technology consultants to design strategies for the widespread adoption of cloud computing.

Cloud computing providers may need to improve their interaction with SMEs who are involved in the cloud computing experience, in an effort to create a healthy environment for cloud computing adoption, and to remove any vagueness surrounding this type of technology.

Promotional efforts and other influential tactics can lead to faster and more integrated adoption (Iacovou *et al.*, 1995). The take-up of new IS innovations is sometimes delayed because owners/managers of SMEs are unaware of the potential benefits of adopting these technologies. The client's innovativeness and self-motivation are not always enough. Therefore, awareness and understanding of these advantages is important for the adoption decision. This draws attention to the central importance of the role of supplier marketing efforts. In the initial study in this research project (see chapter 6), prospectors related their

late reaction to the lack of awareness about this type of services. Therefore, it is essential for software vendors to devise a strategy that actively communicates the benefits of cloud computing through promotional tactics (promotional seminars, workshops, presentations and on-site visits).

It is essential for technology consultants and vendors to reduce the feeling of uncertainty regarding cloud computing adoption. Much of the uncertainty around cloud computing has been about how data is handled. Understandably, privacy and relinquishing total ownership are the main concerns for businesses when considering adopting cloud computing. Recognition of some concerns in cloud computing could be a possible hindrance to SMEs adopting cloud computing until uncertainties are resolved. Providers need to work on providing reliable and secure environments in the most scalable, cost-effective, and convincing manner. This will provide a supportive business environment. 24/7 technical support for cloud services should be offered by suppliers so that users have less concern about their data which is stored remotely away from their own premises.

Finally, although adopters and prospectors underlined the importance of providers' activities in making SMEs adopt cloud services, in many cases of this study; SMEs did not feel they were adequate until now. A possible explanation for this is the fact that at the moment providers recognises the changing IT industry-environment, and they are taking a very active role in order to be a facilitator for cloud services. At the same time, they have a lot of investments in in-house software and hardware, which they do not want to be affected. This can lead to an impression among stakeholders that cloud service providers themselves have no clear stance or vision about cloud computing. Consequently, more research on this topic needs to be undertaken before discussing the role service providers can play in cloud computing diffusion, since clients would be affected by the views of their service provider and the extent to which this provider believes in the benefits that cloud computing can bring to their business.

To put it briefly, for service providers, using the research model in this study can assist in increasing their understanding of why some SMEs choose to adopt/ not to adopt

cloud computing services. On the other hand, however, cloud computing providers may need to improve their interaction with SMEs who are involved in the cloud computing experience, in an effort to create a healthy environment for cloud computing adoption, and to remove any vagueness surrounding this type of technology. Providers may need to clarify their position and stance when it comes to offering in-house services versus cloud services, which in turn can affect clients' confidence. Supplier marketing activity can have great effect on the chance that an innovation will be used by firms (Frambach *et al.*, 1998), and this will help to lower the level of uncertainty regarding cloud services.

8.4.2 Implications for Managers

A rapidly developing and uncertain environment represents a key challenge within which business leaders make decisions. The issues which influence choices fluctuate with time; consequences are not yet known when choices are made, and frequently there is an extended period between the choice itself and when its outcomes become clear (Fishera *et al.*, 2000). Recent studies can be used by managers to improve their decision making process in such an environment. The proposed model in this research project may help managers to evaluate possible adoption and increase their awareness about factors that influence results. Given the nature of the collected data, managerial implications can be derived which could be set as guidelines for the adoption of cloud computing.

Firstly, as shown by the empirical analysis, relative advantage and uncertainty are important technological factors in SMEs' adoption of cloud computing. This implies that managers should evaluate the potential benefits of cloud computing, and increase their awareness about these services in order to decrease the level of uncertainty. Organisation managers could use the information about relative advantage and uncertainty and their instrument explained in this research project, as a road map to evaluate and plan their technology adoption and implementation; that is, they can identify how cloud computing can enable them to accomplish tasks more quickly, increase productivity, and give them greater control over their work.

The findings also provide a set of valid and reliable measurements for evaluating external computing support. The measurements developed in this research captured various activities associated with choosing a service provider. Firms can use the measurement to identify the strengths and weaknesses for the potential services providers. From a managerial standpoint, managers must pay great attention to their choice of cloud service provider. Both security and reliability are of great importance in adopting these advanced technologies. Chosen providers must provide technical and organisational support to promote a favourable environment to infuse cloud computing and reduce uncertainties around technical and organisational changes. Moreover, managers need to assess the appropriateness of adopting cloud services, taking into account their firm's size. Research findings also suggest that the computing support given by the provider is significant for the type of cloud computing adopted. This suggests that companies need to attempt to gain all possible support from the supplier during the different adoption stages, from the early stage (related to awareness about the new technology), until the full implementation and actual use stages.

According to Frambach *et al.* (1998, p.164), "For suppliers it is important to achieve a certain level of adoption of the innovation in order to get the innovation accepted in different social systems (e.g. different industries) through interaction and contamination effects." Managers should seek all possible assistance from the supplier regarding the adoption, and should also play the major role in this issue to guarantee adequate support from the supplier side to ensure the successful implementation of the new computing services. Given that suppliers will attempt to be more active in marketing the innovation and communicating its properties to the adopters, managers should seek all possible assistance from the supplier for adoption.

Finally, given its integrative approach, the proposed framework may be better positioned to help organisations with cloud computing adoption ambitions carry out in-depth analyses of the cloud computing resources and capabilities that they might be considering. A research instrument can be developed to assess the company's situation. Subsequently, the outcome recommendation from this assessment can be used to evaluate

their strengths or weaknesses and the manner in which the adopted capabilities can enhance or minimise these in strengthening their competitive position. Furthermore, the experience gained by using this model to evaluate the possible adoption of one technology, e.g. cloud computing, can then lead organisation managers to use it for other technologies, and improve their insight in balancing specific decisions concerning adoption in the future. Finally, this study may assist managers in developing practices which assess the risks involved in adopting cloud services. Managers may benefit from developing a set of specifications which cover all the aspects of their security needs, including legal issues, physical security, policy concerns and technical factors.

In general, the advantage of the TOE framework is that it can include many factors from different contexts, when other models may not. Other advantages are that it presents information in an easy to understand format, and it is based on reliable empirical support and a solid theoretical basis. Therefore, the TOE model has the potential to enable SME managers to practise decision making. The research model in this study can be used to provide managers with insight which helps them in their decision making processes.

A number of possible future studies could relate to developing practices for evaluating the risks caused by in using cloud services and comparing offerings from different suppliers to select the best supplier(s) for a particular project (Marston *et al.*, 2011). The security check-list has to include all aspects of security requirements, including legal issues, physical security, policy issues and technical issues (Catteddu, 2010).

8.4.3 Implications for government and policy makers

The study finds that the regulatory environment is an important factor that influences the tendency of organisations to adopt cloud computing. Cloud computing adoption requires the existence of appropriate government policies and regulations. In the North East of England, in the Plan Regional Spatial Strategy to 2021 it has been reported that the availability of high level standard ICT facilities is important for retaining existing

businesses, creating new employment, influencing business location, and expanding opportunities in the northeast region.

Cloud computing growth and development could involve government reviewing its policies and incentives in promoting the adoption of technology among SMEs. As noted above in Chapter 4, the British government has taken various measures to refine and enhance business processes and to raise connectivity among SMEs. In fact, the research model can help maximise the potential benefits of the British government's ICT implementation effort by providing an understanding of the factors that influence the adoption and implementation of ICT technologies such as cloud computing. In fact, the financial crisis in 2008 saw a decline in the availability of government support to business (Van, 2012). Therefore, cloud computing can be seen as a chance to enable SMEs to reduce the cost of their IT operations.

A major concern when signing up for and using cloud services that run from a different country is that it would lead to a loss of privacy for clients' data, because of different privacy legislation applying to those in our country. Therefore, governments may need to consider revising this legislation related to data protection, e.g. legislation coordination between countries regarding cloud computing services.

Taking all the above into account, this study presents some useful information for organisations, technology consultants, vendors and policy makers. Therefore, this research is viewed as being relevant to the current era of rapid developments of cloud computing technologies. Finally, the above discussion on the contributions and implications of this research has led to the achievement of the fourth, and final, objective of this research, which was to provide guidelines to policy makers, technology vendors and practitioners in implementing and accelerating cloud computing development and utilisation among SMEs.

8.5 Study Limitations and Future Research Directions

This study expands our knowledge about the ICT innovation adoption among SMEs. However, although this study has fulfilled its aim and objectives, it is thought that there are

many areas for additional studies and empirical research, given the limitations of the research. I must say that this piece of research represents only a tiny fraction of the vast knowledge about ICT innovation adoption but it may be considered as an important contribution in the pursuit of fulfilling the knowledge about ICT technology adoption in SMEs, cloud computing services in particular. However, as noted earlier, there has not been much research done on cloud computing in SMEs and much more can be discovered, especially the process in which different size enterprises adopt new technologies such as cloud computing. Notwithstanding the fact the this piece of work has focused mainly on the factors that affect cloud computing adoption among SMEs, certain areas that need further research have emerged. Future research could build on this study by examining cloud computing adoption in different sectors and industries and in different countries in both a qualitative and quantitative way. More specific details about research limitation and Future Research Directions are as follows:

On a geographical dimension, this study was primarily limited to the Northeast of England. Therefore, it may not be appropriate to generalise to the whole population of the SMEs in this country or any other country. For this reason, further empirical investigations in different regions and countries are needed. The methodology that has been chosen to achieve the research objectives was limited to two methods of data collection (semi structured interviews, and the online questionnaire survey), due to a number of constraints outlined in the methodology chapter, in particular, for a PhD researcher the limited time available and cost constraints imposed upon the study. Future research could build on this study by examining cloud computing adoption in different sectors and industries in both a qualitative and quantitative way. Given that SMEs are pervasive in all economies this will call for a careful selection of samples that can help provide a representative picture of cloud computing. In addition, since this study focused on SMEs active industries, future research on other industries is also suggested, which simultaneously with this research can present more valid model of cloud computing adoption. Also a replication of this research on different industries would provide data for comparison.

For instance, in the qualitative study, this study adopted a semi-structured interview data collection method to explore the decision-making process of SMEs. Although this approach is useful in delving into business-related decision analysis, other approaches could also be implemented. Focus groups can be organised for owner/managers to discuss issues related to the currently adopted IS innovations. This will not only highlight the factors that impact on the adoption of new IS innovation, but also probe further into the reasons behind the adoption of the new technologies. Also, future studies could consider interviewing different stakeholders (e.g. top managers, staff in the IT department, end users etc.) within the same firm in the form of case studies. Our sample was limited to one or two companies per sector. Having more participants per sector could better represent trends within each sector and allow for more reliable comparisons.

Though our online survey investigation of the model of cloud computing adoption provided findings on the cloud computing adoption among SMEs, further research is needed to complete our understanding of this subject. Large-scale, longitudinal research would be preferable for addressing this issue. In fact, the diffusion of innovation is a socialisation process that occurs over time, in which member attitudes toward the desirability of various behaviours are developed as time passes (Zmud, 1982). Therefore, there is no way to avoid including time when diffusion is studied. However, such a research project requires much financial investment and human effort. Factors influencing the adoption of a particular technology at a particular phase may change over time through other phases. It would also be interesting to look at a firm's performance pre/post adoption of new ICT innovations. Besides, Cloud computing is relatively new, future studies should incorporate this measure after a while that the number of managers/ SMEs familiar to cloud computing reaches a critical mass.

The focus of the research model has been on the relationships among constructs identified in this study. The variables included are not intended to be comprehensive. They were selected as representing the key factors potentially affecting SMEs' adoption of cloud computing. The findings should be viewed with caution as other potentially important factors (e. g. individual characteristics) have been excluded. In his article Straub (2009)

demonstrates that innovation adoption is a complex, inherently social, developmental process; individuals construct unique yet malleable perceptions of technology that have an effect on their adoption decisions. Successfully facilitating technology implementation, therefore, have to address cognitive, emotional, and contextual concerns. Adding these elements as a new context in the TOE theory would add to the ability of the TOE framework to predict the willingness of SMEs to adopt new technologies.

Baker (2011) suggested other possibilities for using the TOE model. For instance, one area of interest to researchers is inter-organisational adoption. The TOE framework has been used to study the adoption of inter-organisational systems, but only from the perspective of a single focal firm. Extant research does not examine how decisions are made when multiple firms collectively have to reach a decision about a new system. How do the multiple firms' multiple technological contexts influence adoption? How do the multiple firms' multiple organisational contexts influence adoption? Is the environmental context viewed differently by different firms? Does the position of a firm in the value chain cause it to view new technologies differently from its value chain partners? Exploration and investigation of each of these questions would allow researchers to extend the TOE framework in ways that would increase its explanatory power or possibly reveal its limits. Such research would also provide actionable insights for practitioners in an age of increasing organisational interconnectedness.

Contrary to the call for a more unifying model, it has been argued that IS innovations are highly differentiated technologies for which there should not be a single adoption model (Ramdani, 2008). Therefore, researchers in this area are encouraged to use different theories (Williams *et al.*, 2009; Wang *et al.*, 2011) to describe and predict individual and firms acceptance of different IS innovations such as smart applications, GSM (global system for mobile communications). Furthermore, more research is needed to introduce new theories that could add to a growing body of literature on research into IS innovation adoption/diffusion. A number of possible future studies could relate to developing practices for evaluating the risks involved in using cloud services and comparing offerings from different suppliers to decide on the best provider(s) for a particular project (Marston *et al.*,

2011). The security check-list should include all aspects of security requirements, including legal issues, physical security, policy issues and technical issues (Catteddu, 2010).

Allen (2000) points out that IS research will improve in the future if a wider and clearer research picture of the technology innovation process is developed. As Allen (2000) notes, there are a number of ideas which need to be further developed and explored concerning technological development, such as the fact that it occurs in competitive contexts, it is not predetermined by technical requirements, and it is generally hard to alter over time. Allen (2000) also maintains that the idea of 'community-based definitions of technological problems', and their interface with obligations over time, suggests a potential comparison for collating various IS research work. ICT systems, as one of the current central technology-intensive developments, can progress the debate on technological innovation, even as we attempt to comprehend IT in organizations.

Though this study includes important variables, other studies could focus on variables such as the cultural implications for cloud computing, the organisational view of technology adoption and the governmental role in cloud computing implementation support. There is an on-going debate about the differences in the use of technology across different countries. Organisational culture could be strongly associated with technology adoption in general, and cloud computing in particular. Largely, cloud computing adoption is related to many issues regarding security to regulatory issues to cultural beliefs about technology. These mean that each country has a slightly different point of view about specific technology adoption. This research has touched upon the geo-restriction issue for adoption; however, further work needs to examine the cultural implications of cloud computing adoption. The effect of geo-restriction could be potentially generalised and extend the TOE as a facet of trust; the role of trust needs to be examined in more detail in future studies. Notwithstanding the fact that this research project has focused mainly on cloud computing adoption among SMEs in the NE of England, this research model could be applied by other researchers and may also provide strong theoretical foundations for further studies on IS innovation adoption. Further exploration is needed on how start-ups, SMEs and large organisations are affected by the adoption of cloud computing and/or other

IS innovation in different sectors. The individual, social, cultural and religious aspects of technology adoption and SME performance also need further investigation.

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APPENDIX

OUTLINE OF SEMI-STRUCTURED INTERVIEW SCRIPT

Firm Background:

1. Can you please tell us about your firm's background? (Number of employees/ main services industry/ Years since establishment…)
2. What are the main challenges / benefits of running your IT operations on-premises?
3. Why has your firm decided to use / not to use cloud computing services?

Level of IS Innovations adoption & Use in the Firm:

4. What IS innovations has your business adopted?
5. What was the process of selecting these IS innovations?
6. What IS innovations does your business need? Why?
7. How effective do you think your business is in exploiting new IS innovations?
8. What challenges do you think SMEs are confronted with in the adoption of new IS innovations? Why?
9. What cloud computing service does your firm use (or think about using)? (i.e., Email application, CRM, Data storage, CPU usage, etc.)?
10. To what extent do you feel your firm is aware of cloud computing?

Impact of TOE Factors on Cloud Computing Adoption:

If we classify these factors into 3 groups (Technological, Organisational and Environmental):

11. What technological factors do you think may impact the adoption of cloud computing in your firm? Why?
12. What is the impact of (relative advantage, uncertainty, compatibility, complexity, and trialability) on the adoption of cloud computing?
13. What organisational factors do you think may impact the adoption of cloud computing in your firm? Why?
14. What is the impact of (firm size, top management support, innovativeness, and prior IT experience) on the adoption of cloud computing?
15. What environmental factors do you think may impact the adoption of cloud computing in your firm? Why?

16. What is the impact of (competitive pressure, industry, market scope, Supplier efforts and external computing support) on the adoption of cloud computing?

CLOUD COMPUTING SURVEY

Many thanks for taking a few minutes to answer this questionnaire. This study is concerned with cloud computing adoption by Small and Medium Enterprises (SMEs). More specifically, the research aims to investigate the factors affecting the adoption decision of cloud services within SMEs.

In return for their contributions:

• Participants will receive a summary of the research findings once analysed, and will be invited to a workshop where the final research results will be presented.

• To thank you for your time and effort, all participants will be entered into a draw for an iPod Nano.

All information provided will be strictly confidential (individuals will not be identified) and will be purely used for academic purposes.

I would like to thank you very much in advance for kindly agreeing to participate in this survey.

If you have any questions about this study or the questionnaire please contact me using the information below:

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GLOSSARY OF TECHNICAL TERMS USED IN THE QUESTIONNAIRE

The following terms are used in this survey. Please see below the adopted definitions in the context of this study

ICT: Information and Communication Technology

Small to Medium-sized Enterprises (SME): micro-firms with fewer than 10 employees; small firms with 10-49 employees; and medium-sized firms with 50-249 employees (DTI, 2004).

Cloud Software as a Service (SaaS): The capability provided to the consumer is to use the provider's applications running on a cloud infrastructure. The applications are accessible from various client devices through a thin client interface such as a web browser (e.g., web-based email). The consumer does not manage or control the underlying cloud infrastructure including network, servers, operating systems, storage, or even individual application capabilities, with the possible exception of limited user-specific application configuration settings.

Cloud Platform as a Service (PaaS): The capability provided to the consumer is to deploy onto the cloud infrastructure consumer-created

Or acquired applications created using programming languages and tools supported by the provider. The consumer does not manage or control the underlying cloud infrastructure including network, servers, operating systems, or storage, but has control over the deployed applications and possibly application hosting environment configurations.

Cloud Infrastructure as a Service (IaaS): The capability provided to the consumer is to provision processing, storage, networks, and other fundamental computing resources where the consumer is able to deploy and run arbitrary software, which can include operating systems and applications. The consumer does not manage or control the underlying cloud infrastructure but has control over operating systems; storage, deployed applications, and possibly limited control of select networking components (e.g., host firewalls).

A. Personal Information

Name (optional):

What is your email address (optional):

What is your position in your company:

B. Company Information

Company Name (optional):

What is the size of your company?

In what year was your firm established?

In which industry does your firm operate?

- Technology
- Energy
- Legal and professional services
- Education
- Manufacturing
- Government
- Retail
- Financial service
- Healthcare
- Other (please specify):

What is the market scope for your firm?

- Local
- Regional
- National
- International

C. Cloud Computing Adoption

Which of the following phrases best describes your firms' situation?

- We have already adopted some cloud services
- We intend to adopt cloud services in the next 3 years
- We don't intend to adopt any cloud services for the foreseeable future

What "Information Systems Applications" has your firm adopted?

- Basic Internet services (email and web)
- Web site with simple ecommerce functions
- Web site with advanced ecommerce functions
- Transaction Processing Systems such as: Payroll, Order Tracking, etc...
- Decision-Support Systems such as: Sales region analysis, cost analysis, etc...
- Management Information Systems such as: Sales management, inventory control, etc...
- Executive Support Systems such as: profit planning, Manpower planning, etc...
- Other (please specify)

Has your firm adopted or considers adopting any cloud computing services from those listed below?

- Individual software packages
- Infrastructure services such as storage, network capacity etc
- A complete operating system and software package available via cloud services
- Security services in the cloud
- N/A
- Other (please specify)

Which of the following cloud computing types has your firm adopted or considers adopting?

- Public cloud
- Private cloud
- Hybrid cloud
- N/A

D. Cloud Computing Adoption Factors

Scales:

5. Strongly Agree
4. Generally Agree
3. Neutral
2. Generally Disagree
1. Strongly Disagree

Technological					
Relative advantage					
1. Using cloud computing services enables us to accomplish tasks more quickly.	1	2	3	4	5
2. Using cloud computing services gives us greater control over our work.	1	2	3	4	5
3. Using cloud computing services increases our productivity.	1	2	3	4	5
Uncertainty					
1. Cloud computing services might not perform well and create problems with our IT operations.	1	2	3	4	5
2. Cloud computing services servers may not perform well and may not support our IT operations effectively.	1	2	3	4	5
Privacy risk due to geo-restriction					
1. Our signing up for and using cloud services that run from a different country would lead to a loss of privacy for us, because of different privacy legislation applying to those in our country.	1	2	3	4	5
2. Due to differences in legislation, we might lose control of our data if we used cloud computing services provided from a supplier hosting data outside my country.	1	2	3	4	5
Compatibility					
1. Using cloud computing services is compatible with all aspects of our work.	1	2	3	4	5
2. Using cloud computing services fits well with the way we like to work.	1	2	3	4	5
3. Using cloud computing services fits into our work style.	1	2	3	4	5
Complexity					
1. We believe that it is easy to get cloud computing services to do what we want them to do.	1	2	3	4	5
2. Overall, we believe that cloud computing services are easy to use.	1	2	3	4	5
3. Learning to operate cloud computing services is easy for me.	1	2	3	4	5
Trialability					
1. Before deciding whether to use any cloud computing service applications, we were able to properly try them out.	1	2	3	4	5
2. We were permitted to use cloud computing services on a trial basis long enough to see what it could do.	1	2	3	4	5
Organisational					
Top management support					
1. It is not essential for the top management team to be involved in reviewing a consultant's cloud computing recommendations.	1	2	3	4	5
2. The top management team has nothing to do with the cloud computing adoption project monitoring.	1	2	3	4	5
Innovativeness					

1. If we heard about a new information technology, we would look for ways to experiment with it.	1	2	3	4	5
2. Among our peers, we are usually the first to try out new information technologies.	1	2	3	4	5
Prior similar technology experience					
1. Overall, our firm has extensive technical knowledge about technologies similar to cloud computing.	1	2	3	4	5
2. Cloud computing services were a familiar type of technology to use.	1	2	3	4	5
Environmental					
External support					
1. It is necessary to have adequate technical support before cloud computing adoption.	1	2	3	4	5
2. It is necessary to have adequate technical support after cloud computing services adoption.	1	2	3	4	5
3. We believe that a good relationship with other parties will be crucial.	1	2	3	4	5

Do you have any other comments?

Thank you