An Online Collaboration Framework for Small and Medium Sized Enterprises in the United Kingdom Construction Sector

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List of Abbreviations

ACAP	Absorptive Capacity
AEC	Architecture, Engineering and Construction
API	Application program interface
APM	Association for Project Management
BaaS	Business as a Service
BERR	Business, Enterprise and Regulatory Reform
BIM	Building Information Modelling
BIS	Department for Business, Innovation and Skills
CACCIS	Context-Aware Cloud Computing Information System
CAD	Computer Aided Design
CAID	Context-Aware Information Delivery
CapEx	Capital Expenditure
CCS	Crown Commercial Service
CEO	Chief Executive Officer
CIC	Computer Integrated Construction
CIE	Construction Industry Enterprise
CIOB	Chartered Institute of Building
CMM	Capability Maturity Model
CMMI	Capability Maturity Model Integration
CRM	Customer Relationship Management
CSMEs	Construction small and medium-sized enterprises
DDoS	Distributed Denial of Service
DOI	Diffusion of Innovations
DTI	Department of Trade and Industry
EaaS	Everything as a Service
EC	European Commission
EDI	Electronic Data Interchange
ENISA	European Network and Information Security Agency
ERP	Enterprise Resource Planning
ESS	Enterprise Systems Success (Model)
FBI	Federal Bureau of Investigation
HRM	Human Resource Management
IaaS	Infrastructure as a Service
IBM	International Business Machines (Company)
ICT	Information and Communications Technology
IDS	Intrusion detection System
IDT	Innovation Diffusion Theory
IEC	International Electro technical Commission
IS	Information Systems
ISO	International Standards Organisation
ISP	Internet Service Provider
IT	Information Technology
KM	Knowledge Management
LCM	Lifecycle Management
MM	Motivation Model
MoD	Ministry of Defence
MPCU	Model of PC Utilisation
NIST	National Institute of Standards and Technology
OpEx	Operational Expenditure

PaaS	Cloud Platform as a Service
PEST	Political, Economic, Social, and Technological (analysis)
PM	Prime Minister
QA	Quality Assurance
R&D	Research and Development
RFID	Radio Frequency Identification
SaaS	Software as a Service
SCT	Social Cognitive Theory
SD	System Dynamics
SLA	Service Level Agreement
SMEs	Small and medium-sized enterprises
TAM	Technology Acceptance Model
TOE	Technology, Organisation, Environment (Framework)
TPB	Theory of Planned Behaviour
TQM	Total Quality Management
TRA	Theory of Reasoned Action
TVH	True Value Homes
UDI	User-Driven Innovation
VCSEs	Voluntary, Community and Social Enterprises
WWW	World Wide Web
XaaS	Anything as a Service

Abstract

More than 99% of the UK construction sector includes businesses that are defined within the category of SMEs (Small and Medium Sized Enterprises). Of these, most are categorised as micro-businesses that have less than ten employees (Department for Business, Innovation & Skills, Business Population Estimates for UK and the Regions, 2015). Therefore, it is an essential part of the construction sector that requires attention. A large part of their business depends on collaboration and partnering with other businesses. Online technologies are the latest trend to achieve innovative collaboration. Such technologies could improve the collaboration methods within construction SMEs and make them more competitive in the marketplace. By minimising the cost of their hardware and software systems, this will provide them with greater security and accessibility, thereby helping construction SMEs to focus more towards their core business and enhance productivity.

This research has sought to achieve the aim of developing a collaboration framework specifically for construction SMEs based on online technologies. The objectives that were followed included reviewing the associated literature with regards to differences between SMEs and larger enterprises in the construction industry, assessment and evaluation of the related literature in connection with success factors in the construction industry, observation and inspection of the attributes of exiting online technologies and their prospective advantages for collaboration working, identification and recognition of the current collaboration issues occurred within the construction industry, examining the key requirements pertaining to effective collaboration within construction SMEs and, finally, to develop a collaboration framework for construction SMEs based on online technologies.

A total of 17 interviews were carried out and the interviewees were selected carefully from several different construction SMEs, ensuring that a variety of SME sizes were selected to identify various associated issues that may occur within the construction SMEs regardless of their sizes. The extracted information from all interviews confirmed numerous aspects that caused similar issues within the associated companies regardless of their sizes. The gathered data, along with the related literature review, helped to achieve the aim and objectives of this research and to develop the final framework.

Dedication

This thesis is dedicated to my parents Hassan and Shohreh, who have given me the courage and support not only during my PhD, but in every step of my life.

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First and Foremost, I would like to thank my supervisor, Mr David Baldry, for the patient guidance, encouragement and advice he has provided throughout my time as his student. It has been an honour for me to be his student and I have been extremely lucky to have a supervisor who cared so much about my work, and who responded to my questions so thoroughly and promptly. I would also like to thank all the members of staff at the University of Salford who helped me throughout this research study.

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1 Introduction

In terms of innovation and renewal, the construction industry has long been recognised as traditional and conformist. This has caused the industry to lag behind, falling short of most other industry sectors. Indeed the rate of innovation appears to be falling further and further behind. (Lassen et al., 2010).

The contextual conditions which characterise the construction industry can mainly be defined as a low tech industry (below 2% annual investment in R&D), with low levels of expenditure on activities associated with innovation (OECD, 2000; Seaden and Manseau, 2001; Reichstein et al., 2005). Furthermore, the industry structure creates a strong interdependence between the different supply network partners (suppliers, manufacturers, retail, architects, and construction contractors) which can often become an obstruction for innovation (Lassen et al.,2010).

This is especially the case when introducing new initiatives to the industry, be it a new product, process, or market development, the conservation characteristics associated with the construction industry create distinct barriers. Several initiatives have been launched to improve the performance and image of the construction industry, for example partnering, digital construction, re-valuing construction, etc. (Bejder et al., 2008). These initiatives have each created significant value for individual firms, but none has focused on addressing the fundamental problem of creating a more systematised approach to continuous activities of innovation in the industry. Such an approach will indeed have to directly address the distinct contextual characteristics of the construction industry and their effect on the ability to be innovative.

The use of information and communication technologies (ICT) can improve business competitiveness, and has provided genuine advantages for small and medium sized enterprises (SMEs, firms with one to 250 employees (DTI, 2004)), enabling them to compete with large firms (Swash, 1998; Bayo-Moriones and Lera-Lo´pez, 2007). In the UK, SMEs represent the vast majority of all enterprises, 99.9% according to BIS (2008), a figure which is not uncharacteristic for almost all countries. Despite their importance, limited research has studied the adoption, implementation and usage of ICT in the small enterprises within the UK context (Shiels et al., 2003; Harindranath et al., 2008). In traditional IT environments, increasingly the complex management issue of software, hardware and networking equipment require specialist staff for implementing

and maintaining IT services (Thinkstrategies, 2002). Some of the promised benefits of Cloud Computing can be very appealing to SMEs, which need to maximise the return on their investment and still remain competitive in an ever-demanding business environment. 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. If SMEs have access to scalable technologies, they could potentially deliver products and services that in the past only large enterprises could deliver, levelling the competitive arena.

Professional organisations get status, they improve their chances of promotion, they tie into a network of fellow professionals, they are sent regular information and their understanding of the key issues in their profession is kept fresh. But in truth much more of the value that professional bodies provide goes unnoticed. It is easy to take this work for granted.

The true value of professional bodies can only really be gauged when we consider a world without them. So while nobody claims professional bodies are perfect, I suggest as you read you consider this: Who would fill the gap if they were not there?

Professional bodies, certainly in construction, are today far more important to the future of their professions and the welfare of the nation than they have been for a very long while. The opportunities and challenges facing UK construction professions are great. Professional bodies have a crucial role to play in making sure their members are able to seize the opportunities and squarely meet the challenges.

According to Construction Industry Training Board (2013), the swell in global construction is immense, pumped up by emerging nations rapidly building the infrastructure they need to take them from predominantly under-developed economies to industrial nations. This is generating fantastic opportunities both at home and abroad for UK professionals as these nations seek to service the demand.

The aim of the research is to develop an online collaboration framework for Construction SMEs. In examining the issue, the areas that have come to the fore include the importance of SMEs (Small and Medium Sized Enterprises) in the construction industry and the significance of collaboration between them, and why online technology is important to facilitate industry collaboration.

1.1 Research Background

The rapid evolution in the modern business market demands that competition is at its highest level, resulting in products and skills becoming obsolete (Wiley and Hobokem 2011). SMEs are usually less advantaged with such levels of competition due to limited resources that have restricted SMEs from accessing the new technologies of IT services. SMEs play a vital role for economies by offering a large amount of employment (European Commission, 2005). To survive, SMEs need to find and implement new strategic ideas at an even faster rate to gain a competitive advantage over their rivals within the global market. "The need to quickly respond to business demands is imperative in this new age. Waiting six to eight weeks for a new server deployment is unacceptable." (Primus, 2011). A new strategy should enable SMEs to incorporate new technologies, reduce costs, develop process innovation, and enhance speed of implementation.

A developed IT infrastructure can remove some of the barriers to global competition, allowing SMEs to be more efficient and competitive, as well as providing a degree of flexibility. Mainly for SMEs, online technologies have the potential to play a major role in addressing inefficiencies and will make a fundamental contribution to the growth and competitiveness of these organisations.

In recent years there has been a considerable increase in usage of ICT in the industry (Adair, 2006). The introduction of ICT has allowed collaborative working to become part of the industry's daily practices. It has already been described how important it is for the future success of the industry, to recognise the difficulties of introducing collaborative working This research aims to demonstrate how a more strategic approach to use ICT systems for collaboration between construction SMEs, and beyond is achievable through the latest development of online technologies and Cloud Computing.

Cloud computing is simply a new term to describe the advantages of using computing as a utility. It has the ability to transform a huge part of the IT industry, making software even more accessible as a service (Armbrust et al., 2009). Developers with innovative ideas for new Internet services no longer require the substantial investment in hardware to set up their service or manpower costs to operate it. There is no need to worry about over-provisioning for a service where the popularity does not match the developers predictions, therefore wasting costly resources or under-provisioning for an

idea that may become hugely popular, and so missing out on potential customers and profits.

Whatever the cause of obvious resistance to an industry strategy of continual improvement, it is nevertheless commonly observed that SMEs are likely to expand the industry trend and be less technically innovative than large enterprises (Abbott et al., 2006). Although a widespread amount of literature exists on the subject of innovation delivery by construction companies, it tends to concentrate on big businesses, and the experience of SMEs in this area has gone largely unreported whilst there are some notable exceptions (Abbott et al., 2006; Manley, 2006; Manley, 2008a).

Usually SMEs do not have a reasonable size of ICT department or financial resources, and so they are unlikely to have access to the latest innovative IT architectures and necessary equipment. Cloud computing seems to be the answer to a lot of their business obligations, whilst at the same time preventing unaffordable IT maintenance expenses. Cloud Computing offers them advanced IT support for their market activities so they will stay updated with new technologies (Dimitrakos, 2010). Cloud Computing is a new IT end user delivery platform that intend to supply high availability and simple access (Li et al., 2009; Marta et al. 2011; Sheng-Yuan et al. 2010). According to National Institute of Standards and Technology (NIST) definition of Cloud Computing (NIST, 2011), this technology is composed of five vital elements: On-demand self-service, Broad network access, Resource pooling, Rapid elasticity, Measured Service; three service models: Cloud Software as a Service (SaaS), Cloud Platform as a Service (PaaS), Cloud Infrastructure as a Service (IaaS); and, four deployment models: Private cloud, Community cloud, Public cloud and Hybrid cloud. Key enabling technologies include: (1) fast wide-area networks, (2) powerful, inexpensive server computers, and (3) high-performance virtualization for commodity hardware."

Political, Economic, Social, and Technological analysis - or PEST analysis - is a strategic tool for learning more about market development or rejection, business situations, business possibilities and the routes for actions and procedures. This equipment gives SMEs a general idea of the various elements that have to be analysed for their business plan development.

Furthermore, Cloud Computing, its services and arranged models, give small and medium sized companies the opportunity to purchase high level solutions at an affordable price. This will be based on the companies personal requirements to access

infrastructure, platform and software over the Internet, without the obligation of having to own the services themselves (Dillon et al., 2010). Normally, some of the Cloud related programs that are mainly used by SMEs are web-based projects, such as file sharing and e-mail facility. SMEs are beginning to understand that Cloud Computing can have substantial advantages and are prepared to look at a complete transformation to cloud technologies (Chien et al., 2010; Sultan, 2011).

Cloud Computing was invented for business purposes in 2007 by industry giants such as Google and Amazon. Cloud Computing technology and resources are based in various regional data centres, actively amended and modified to be the most efficient and effective, thereby ensuring huge savings in costs as well as increased production levels. The Cloud model is supplied to end users (individuals, SMEs and large companies) on the basis of pay-per-use for the services with which warranties are given by the providers in the form of customized Service Level Agreements (SLAs) (Yang et al., 2009). This alters the influence of computing with regard to public utility supplies such as water or gas. It is a thoughtful paradigm adjustment for the IT industry as well as every other field (Marta et al., 2011).

From the perspective of an SME, the advantages of Cloud-based technologies are: low set up fees, low cost for infrequent applications, simplifying management tasks, expansion of projects and equipments and quick innovation (TechRepublic et al., 2009). Therefore, helping businesses to obtain the advantages of Cloud Computing, by learning and using its potential for additional improvement, stops troublesome alteration of business practices (Skilton, 2010). Pay-per-use and high functionality of computing related proposals (Dimitrakos, 2010) would allow businesses to encourage innovation and increase their competitiveness (Chen et al., 2011).

From a consumer's perspective (Nair et al., 2010), the Cloud Computing facility model provides major cost reduction, enhanced and improved understanding and usage of IT facilities, quicker return on investment, elimination of barriers to increased business, and a more powerful and durable infrastructure, leading to better business stability. Cloud Computing facilities create vital opportunities for SMEs to collaborate and produce new competitive advantages in the present digital business environment (Petrakou et al., 2011).

The appealing significance of Cloud Computing is based on its power to offer SME entrepreneurs, instant savings on their expenditure and enhanced productivity. Including cloud based facilities as part of their IT plans offers an enhanced approach to

their business. According to Tumer (2010), Cloud Computing can be a major part of future innovations by adding significantly increased development of their assets and services in the international market, producing robust environments with powerful foundations.

Research is necessary in helping Construction SMEs appreciate and understand the positive impacts of using Cloud Computing Technology, and the positive outcomes that will result on their deliverable work and activities. This research study will contribute towards meeting this requisite by developing a collaboration framework for Construction SMEs.

1.2 Aim

The aim of this research is to develop a validated collaboration framework specifically for construction SMEs based on the utilisation of online technologies.

1.3 Objectives

To achieve the aim of this research, the following objectives need to be achieved:

- To critically review the associated literature with regards to differences between SMEs and larger enterprises in the United Kingdom construction industry;
- To critically review the associated literature with regards to performance factors in the construction industry;
- To examine the features of exiting online technologies and their potential benefits to collaboration working;
- To identify and assess the current collaboration arrangements which occur within the construction industry;
- To examine the key requirements pertaining to effective collaboration within construction SMEs;
- To seek to develop and validate a collaboration framework for construction SMEs based on online technologies.

1.4 Thesis Structure

This thesis is presented in 6 chapters, and a summary of what is included in each chapter follows:

In chapter 2, a literature review has been carried out, and some of the related literature in the field of construction and particularly construction SMEs has been reviewed (see section 2.3). This includes success factors (see section 2.2) in the construction industry and also collaboration and management in this industry have been reviewed (see section 2.5 and 2.6). Additionally, the existing online technologies and the associated literature have been reviewed (see section 2.4). In chapter 3, online technologies and construction SMEs have been brought together. In this chapter the existing technologies for collaboration in the construction industry (see section 3.1 and 3.2), and more specifically in construction SMEs (see section 3.6) have been reviewed in the existing literature, and some of the existing technological issues (see section 3.8) and adoption complexities (see section 3.10) have been analysed. Different approaches in academic research have been discussed, and a qualitative and inductive approach has been chosen. Also, the sample data and models have been described (see section 4.15 and 4.16). In chapter 5, starts by rigorous analyses of collected data (see sections 5.1 and 5.3), and presenting the data to describe different dimensions and optimisation techniques (see section 5.2) for collaboration in construction SMEs. Then the findings are discussed and a framework for online collaboration in construction SMEs is proposed (see section 5.6). Finally, in chapter 6 aim and objectives of this research are reviewed (see section 6.1) and limitations and contributions are described (see section 6.2 and 6.3), and some of the avenues for future research are recommended (see section 6.4).

2 Literature Review

The purpose of this chapter is to review the literature associated with Online Technologies, Organisational Collaboration and Construction SMEs definitions, history and concepts that subsequently can achieve the first three objectives of this research.

2.1 The Construction Industry

In terms of innovation and renewal, the construction industry has long been recognised as traditionalist and conservative, This has caused the industry to lag behind, falling short of most other industry sectors, and indeed appears to be falling even further behind (Lassen et al., 2010) . The industry structure creates a strong interdependence between the different supply network partners (suppliers, manufacturers, retail, architects and construction contractors) and often becomes a hindrance for innovation (Lassen et al., 2010). Especially, in the case of introducing new initiatives in the industry, be it a new product, process, or market development and such characteristics pose distinct barriers. Several initiatives have been launched to improve the performance and image of the construction industry, such as, e.g. partnering, digital construction, re-valuing construction, etc. (Bejder et al., 2008). These initiatives have demonstrated to be of major value for individual firms, but none has focused on addressing the fundamental problem of creating a more systematised approach to continuous activities of innovation in the industry. Such an approach will indeed have to directly address the distinct contextual characteristics of the construction industry, and their effect on the ability to be innovative.

During recent years of research conducted within the field of innovation, focus has been placed upon the user-driven innovation (UDI), both empirically and theoretically for companies to increase the level of innovation and market capabilities (von Hippel, 1988; Chesbrough, 2003; Baldwin et al., 2006). The UDI approach has mainly been applied by companies with direct linkages to end-users, and under such circumstances the approach has proven to be highly successful. The current situation in the construction industry demonstrates a lack of user knowledge, as companies rarely have explicit knowledge of how their products and services are in fact used by their end-users, and in continuance of this, which needs, desires, wishes, values, and practices the end-users have. As such the UDI approach is not directly applicable to the construction industry without further developments. The UDI approach has been expanded from

mere considerations of classifying different kinds of users, to now also defining characteristics of UDI on different levels. Characteristics, enablers, and disablers for UDI have been defined on single actor level (Kristensson et al., 2008; Park, 2007; Kleinsmann and Valkenbourg, 2008), on project level (Kleinsmann and Valkenbourg, 2008), and on an entire company level (Spina et al., 2002; Prahalad and Ramaswamy, 2004). However, there is still a lack of characteristics defined for UDI on a network level.

2.2 Success Factors in the Construction Industry

In the previous section, some of the specific aspects of the construction industry were discussed and the associated literature was reviewed. In this section the key success factors in this industry will be assessed.

2.2.1 Leadership

A vital metric of Distributed Leadership is getting an extensive collection of related workers involved in tactical decision-making (Chartered Institute of Personnel Development, 2014; Cope et al., 2011; Gronn, 2002; Spillane and Diamond, 2007a). This combined business preparation enables enterprises to carry out a systematic and detailed evaluation of business opportunities and risks, as well as influencing larger buying and ownership from staff (Coldren, 2007; Cope et al., 2011; Halverson, 2007).

In addition, the majority of Distributed Leadership studies state that individuals who directly contribute to tactics, plans and schemes within their organisation, must frequently communicate and keep in regular contact with each other (Bolden, 2011; Carmeli et al., 2011; Cope et al., 2011; Currie and Lockett, 2011; Gronn, 2002; Soriano and Martínez, 2007; Spillane and Diamond, 2007a). This allows commanding structures are in place to utilise the skills and knowledge of staff members.

It is also essential for the main staff members to be involved in cooperative and joint decision-making (Bolden, 2011; Carson et al., 2007; Mehra et al., 2006; Nicolaides et al., 2014; Soriano and Martínez, 2007; Spillane and Diamond, 2007b). This allows all organisational leaders to have the chance of influencing necessary and key business decisions.

Distributed Leadership could include a complex configuration which may not follow a firm hierarchical structure. It is recommended (Coldren, 2007; Cope et al., 2011; Diamond, 2007; Halverson, 2007; Spillane and Diamond, 2007b; Thorpe et al., 2011)

that to prevent lack of data, there must be valuable and systematic methods in place to share knowledge between staff and leaders. Literature states that ongoing forums for joint agreement, such as employees meetings, are mainly effective in doing this (Coldren, 2007; Halverson, 2007; Spillane and Diamond, 2007b).

The key activities that are effective in sharing of information between leaders and employees include:

- Usual employees meetings (Coldren, 2007; Halverson, 2007; Soriano and Martínez, 2007);
- Developing groups which assign employees with specialist expertise (Coldren, 2007; Hallett, 2007; Halverson, 2007; Spillane and Diamond, 2007b);
- Setting-up cross-sectional groups (Bergman et al., 2012);
- Developing innovative tools to gather data from employees (Coldren, 2007; Halverson, 2007; Spillane and Diamond, 2007b);
- Producing a casual culture of data sharing (Coldren, 2007; Halverson, 2007).

Distributed Leadership often requires non-management employees to undertake leadership duties. To carry out these responsibilities effectively, people must achieve both practical experiences in leadership as well as being trained and taught by more experienced employees (Chartered Institute of Personnel Development, 2014; Cope et al., 2011; Sheppard et al., 2010).

Methods to develop new leaders include:

- Enabling junior employees to engage in brief leadership roles (Chartered Institute of Personnel Development, 2014; Cope et al., 2011), such as project manager positions;
- Allocating senior employees as trainers to junior employees or allowing staff to take on their seniors' duties temporarily (Janson et al., 2009; Kempster and Cope, 2010);
- Arranging official training for junior employees on leadership tactics (CEML, 2002; Kempster and Cope, 2010);

- Granting official or unplanned rewards for carrying out extra duties for employees (Hoch, 2013);
- Regularly making employees with expert knowledge and skills, accountable for leading others in assignments that need such skills and knowledge (Chartered Institute of Personnel Development, 2014; Coldren, 2007; Cope et al., 2011; Halverson, 2007);
- Persuading senior employees to supply informal direction to junior employees on how to lead others (CEML, 2002; Stephen Kempster and Jason Cope, 2010).

While lots of SMEs undoubtedly take advantage of executive and leadership development, one general discovery from SMEs is that there is usually not enough time available for anything other than operational duties (Gareno et al., 2005). So it is totally comprehensible that most learning in SMEs of any kind happens outside a formal tutoring location (Eraut 2000; Billett 2001) with SME directors being seen to extensively learn from clients and sellers, even if this is not acknowledged as learning by the directors themselves because it is part of practice and valued relations (Doyle and Hughes, 2004; Gold et al 2007).

When it comes to the topic of appropriate condition of leadership learning activities, one factor that is particularly essential is the attitude directors and leaders have towards the expansion of activities within the organisation. It has continuously been acknowledged that the majority of SME leaders are not worried about growth, but rather with survival (Gray 2002). As a result of their size and ability to affect their situations, they are not able to plan strategically, or reflect on the methods in which their businesses might develop (Gareno et al., 2005). A recent systematic review of literature relating to the measurement of performance in SMEs, appears to reiterate this matter. They found that shortage of time for anything other than operational duties prevented a move to more long term direction and the adoption of more logical measures of performance. Their lack of time to carry out a proper analysis of performance, even if models are employed, usually means implementation tended to be incomplete or incorrect.

Therefore, growth and development in the SME sector is mostly seen from the viewpoint of capital growth or employment generation, which is seen as unsuitable, and mislaid when managers wish to merge their businesses and survive (Gareno et al., 2005).

CEML (2002) believes that failure to connect with SME life is unlikely to lead to effective management and leadership growth. There is a necessity to acknowledge each SME director as an independent case, each with his/her own experiences and valued paths. Devins and Gold (2002) mention that it can be achieved by adopting a social constructionist method that allows an understanding of the uniqueness of the SME and the workings of social processes in a specific time and place, that would give growth to local versions of certainty and truth (Gergen, 1994). It is these local versions which create the SME world, and set the boundaries of what is feasible. Any effort to move past such boundaries is not likely to be accepted. However, by sensitive consideration of the abnormalities of regular understandings, new ideas can be introduced to inspire movements and to challenge the self-imposed limits. Successful completions of new performances allow the construction of new meanings which expand the boundaries of the SME world (Bosumafi and Gold, 2006).

As Toor and Ofori (2008) state, leadership is long-term, visionary, and purpose oriented, and seeks to achieve innovation and adaptation, while management is short-term, narrow, and task-focused, and aims to obtain control and stability. Similarly, leaders and managers undertake different functions, apply different conceptualizations and approaches to work, exercise different problem-solving methods, and demonstrate different attitudes owing to their different enthusiasms. Though, particularly in the construction industry, importance of managerial functionalism reduces the boundaries between management and leadership (Chan, 2008).

2.2.2 Innovation

Creativity is perceived as being extremely significant for innovation and economic success (Andari et al. 2007; Huggins and Clifton 2011; Cooke and De Propris 2011). Organisations in the creative industries, such as design, publishing, software or the arts, are usually seen as specifically innovative (DCMS 2001; Miles and Green 2008; Bakshi and McVittie 2009; Müller et al. 2009).

Furthermore, creativity is not limited to particular industries, and research has suggested that creative occupations may also be key drivers of innovation (Vinodrai 2006; Bakshi et al. 2008; Cunningham and Higgs 2009; Cunningham 2010; Lee and Drever 2012). Creative workers ‘embedded’ in other sectors, such as designers in manufacturing, may be part of the innovation strategy of firms (Cunningham and Higgs 2009; Cunningham 2011). Firms may site the innovative aspects of their activity in cities, to take advantage

of the specialised labour markets, inputs and exchanges of knowledge they offer (Duranton and Puga 2001). Yet a second gap in the literature relates to the link between creative occupations and innovation.

Both the leadership science literature (Anderson and Schaan, 2001; O'Farrell and Miller, 2002) and the construction leadership literature (Blackley and Shepard, 1996; Koivu and Mantyla, 2000) state that the performance of SMEs is substandard in adopting and executing innovations and this is mainly obvious in the case of information and communication technologies (ICTs) which need specific organisational knowledge for effective functioning and performance levels (Markus and Robey, 1988; Sauer, 1993 in Whyte et al., 2002).

Contractors can use ICTs for their incorporation, collaboration, knowledge management, procurement, site management and method development activities (Sarshar and Isikdag, 2004). However, regardless of the obvious benefits that ICT offers, construction enterprises in particular are slow to utilise their prospective advantages (Egbu and Botterill, 2002). The building construction sector spends little in ICTs, as opposed to the other industries such as financial services and manufacturing (Construction Industry Board, 1998).

The vibrant background of IT often leads to innovations being developed that have the ability to make vast differences in organisational competitiveness. As a result, organisations must take risk into consideration when investing in new technologies (L. Willcocks, V. Graeser, 2001). Jiang and Klein (1999) believed that risks are characteristically connected with the viability of an IT project and the eventual payoffs (i.e., the possibilities of not completing projects on time or using the initially allocated budget). The evaluation of risk during the validation process could allow leaders to prepare for any incidents that may take place (K. Lyytinen, M. Keil, 2000). Consideration of possible risks persuades leaders to recognise those conclusions that may unfavourably change behavioural, structural and strategic views within the enterprise, before they actually get utilised (R.L. Kumar, 2002).

Habitually, the UK construction sector has been transaction-oriented, with projects being achieved by successfully bidding for and carrying out tasks (Briscoe and Dainty, 2005). However, the construction sector is changing direction from this classic design–bid–build process, to a new innovation feasibility and performance-based method, in which contracts are assigned based on elements such as knowledge, intellectual

resources and expertise (Khalfin et al, 2007; Reason and Bradbury, 2001). As the construction sector is becoming increasingly competitive, both the organisations and their members of staff must have the potential to learn quickly and have the ability to incorporate and apply these new found skills to business developments, practices, and regular activities (Reason and Bradbury, 2001; Daghfous, 2004). This method will enhance the overall innovation and competitiveness of the enterprise in construction markets, where an expression of innovative organisational abilities is now necessary (Mathews et al, 2000).

The vibrant potential of an enterprise to acknowledge the significance of new external information, incorporate it and utilise it is absolutely vital in maintaining competitive benefits as well as innovation (Cohen and Levinthal, 1990), particularly in rapidly changing market situations such as the construction market for public procurement. Absorptive capacity (ACAP) is what essentially allows an enterprise to obtain, use, change and execute necessary data, significant for the development of a knowledge-sharing culture and to the company's operations (Cohen and Levinthal, 1990). ACAP '…increases a firm's potential to achieve and maintain a competitive benefit' (Zahra and George, 2002, p 185). It also allows the company to become accustomed to the changing market situations. Jones (2006), along with Zahra and George (2002), mention that the study of ACAP in enterprises is insufficient because of a shortage of explanation at an operational level within these enterprises.

The construction industry is exceptionally unpredictable and wide-ranging. In order to enhance effectiveness and competitiveness, it is necessary for the industry to have the vibrant potential to learn quickly. As well as the ability to incorporate, modify and utilise this new knowledge in their everyday business developments (Jones, 2006; Daghfous. 2004).

Vibrant potential can be interpreted as 'the company's capability to incorporate, construct and reconfigure internal and external skills to acknowledge fast changing atmospheres' (Teece et al, 1997, p 509). ACAP can be defined as a vibrant potential that is based on 'the formation and utilisation of knowledge that adds to enhanced competitive benefit' (Jones, 2006, p 357). Jones (2001, 2006), illustrates absorptive capacity as the skill to learn and solve issues, where the status quo and path reliance are tested, as is the position in the construction sector.

2.2.3 Collaboration

Collaborative technologies, described as, a mixture of technologies that together produce a single shared boundary between two or more interested people, can have great capability to promote the necessary collaborative working in the Architecture, Engineering and Construction (AEC) field. This allows them to take part in an innovative process in which they share their collective knowledge, skills and understanding, in an environment of trust, directness, sincerity, mutual admiration and respect, that together deliver the best results,to their general goal (Rezgui, 2011). This is encouraged by the Government Construction Strategy (2011), discussing that Architecture, Engineering and Construction sector 'has not fully taken advantage of the full potential offered by digital technology' (Cabinet-Office, 2011). This comprehensive plan intended to reduce the cost in the sector's duties up to 20% at the end of the UK parliament in 2016. One of the remarkable goals within this file was the intention of using full collaborative Building Information Modelling (BIM) as a minimum for projects by 2016 (Whyte et al., 2011).

Previous research discusses that large Architectural, Engineering and Construction (AEC) enterprises adopt budding collaborative technologies, that often fail to gain full advantage from their functioning and performances (Gladwell, 2001; Brandon et al, 2005; Wilkinson, 2005; eBusiness W@tch, 2007; Rezgui, 2011). Unlike other technologies, collaborative technologies are quite complex with regards to collaboration across a whole project life-cycle, and the success of functioning and performance. Not only one, but all those organisations involved in the project life-cycle, need to be in a position to take full advantage of collaboration. The overall picture of the AEC field is that of a pyramid, with control being in the hands of the large organisations, supported by a large base of SMEs. It is obvious these SMEs play a major role in supporting the larger enterprises. This would imply that only by developing an understanding of the SMEs' requirements, and the use of collaborative technology, effective, collaborative conditions will occur and highlights the significance of how end-users collaborate.

It is encouraging that some main UK construction enterprises have already started to learn about benefits that they would achieve by using collaboration technologies. Though, the literature review stated that 80% to 90% of IT firms in the UK do not meet their performance goals (eBusiness W@tch, 2006; Alshawi, 2007). This can be partially accredited to confirming that most SMEs which are major players in supporting the large construction enterprises fall behind (Maguire et al., 2007; Stokes and Wilson,

2006). In reality, the use of collaboration technologies stays low amongst 99% of firms in the UK construction sector normally referred to as SMEs. The logic behind this is found to be hardly ever technical. Concentrating too much on technical problems and underrating or undervaluing the organisational elements have been brought up in other research efforts (Laudon and Laudon, 2000; Clegg et al., 2001; Kuruppuarachchi et al., 2002; Wilkinson, 2005; Shelbourn et al., 2007). Amending the IT life cycle, by adding a new phase to evaluate the IT knowledge and skills of enterprises prior to the beginning of functioning and performance, fails to apply the operational prospects for SMEs at project organisational level, because the majority of SMEs are still at the first level. It can be stated that the advantages of collaborative atmospheres are not yet proven industry wide (Barbour 2003; Allen et al, 2005; Wilkinson, 2005; eBusiness W@tch, 2006; Hassan et al. 2007; Erdogan et. al, 2010).

This implies the issue of what are the most suitable working atmospheres available to match the SMEs in the construction field. The construction reports push for collaboration methods as one solution to this issue, i.e. to improve functionality and performance levels and while there is a growing awareness levelled at the significance of the incorporation of IT in business environments, previous research linked to the implementation of IT based collaboration seems to be focussed at the very large enterprises, with little consideration directed towards SMEs. Given that SMEs deliver 52% of the construction sector's projects duties, in financial terms (DETR, 2000), it is perceived logically that they are major players in supporting large construction enterprises. As a result, SMEs good performance levels and survival in the industry is crucial.

Collaboration atmospheres, functionality and performances need a determined viewpoint on collaboration, as well as IT. Even though collaboration is hard to set up, even as a soft subject, regardless of the associated IT. Each IT development is a source of resistance and uncertainty on its own, unless great awareness is given while it is being introduced to the enterprise. Concentrating too much on technical elements could result in technically exceptional systems which are incompatible with the organisation's configuration, background and goals since it does not acknowledge how the new technology assists with working methods, organisational structure, occupational design and active processes (Laudon and Laudon, 2000; Clegg et al., 2001). Tanyer (2004) and classifies the limitations recognised for computer integrated construction (CIC) under following six headings:

- Industry related issues linked to the incompatibility within the industry structure;
- Organisational based issues such as willingness of the organisation for the new technology, cultural issues, individuals' issues, conflicts during various processes and technologies between organisations collaborating on a project;
- Project related issues including doubts and worries as well as risks during project processes, various project information management systems created for separate projects;
- Technology based issues regarding coordination and management of information (data admission authorities, data modification authorities, database transactions), data exchange standards;
- Legal related issues surrounding ownership of data, insurance, protection and security requirements;
- End-user related issues including usability problems and training requirements.

Many research projects on collaboration atmosphere developments in construction state similar boundaries. Alshawi and Ingirige (2003) recognised security matters, cultural difficulties, legal issues, inability of digital and remote conferences to replace face-to-face meetings and not being incorporated in a common database for Web-based project management tools, as major obstacles. Nitithamyong & Skibniewski (2004) acknowledged issues related to data rights and collaborative development. Ruikar et al. (2005) acknowledged security problems, multiple-supplier difficulties, cost related problems, cultural difficulties, legal matters, connectivity issues and technology related problems as limitations to project extranet supported collaboration atmospheres.

In this regard, the fact that many major UK construction businesses have already begun to teach and deliver collaboration technologies, is extremely motivational. Large construction enterprises adopting up-and-coming collaboration technologies, normally fail in gaining all the advantages from their developments (Gladwell, 2001; Brandon et al, 2005; Wilkinson, 2005; Alshawi, 2007; Shelbourn et al. 2007).

Barbour (2002) discovered that, on average, 2% of projects in 2001 were managed using project collaboration techniques, with the usage more notable within larger organisations. A year later, Barbour (2003) stated that 13% claimed their groups used such technology. In 2004, it was proposed by the IT Construction Forum that 34% said

that they used project extranets to experience web-based collaboration. The DTI benchmarking study (2004) discovered that 17% of construction businesses claim to be extranet users. However, usage between SMEs stayed low (Wilkinson, 2005; eBusiness W@tch, 2006). A 2004 survey of more than 800 associates of the National Federation of Builders which represents over 3,000 SMEs discovered that only 3% of respondents had used project collaboration techniques. While it is hard to obtain trustworthy, steady and stable statistical data, it can be presumed that collaboration technologies had begun to gain reliability and integrity between many leading organisations.

2.2.4 Knowledge Management

Hylton (2002) stated that SMEs require knowledge equally as much as larger organisations. The reasons mentioned are that over recent years there have been very significant and ongoing changes in the global market, with ever increasing pressure on enterprises to compete for revenue. There needs to be an increased awareness by SMEs to understand how this is managed. Innovation is key to expansion. and the ability to grow products quickly. With this awareness, has to be strong leadership, with an understanding based on the universal economy. SMEs must be in a position to be aware of, and exploit their strengths,to sustain and gain the most returns. There is a wealth of knowledge available on the market relating to knowledge management techniques.

Increasing concern of knowledge management is normally aimed at very large international firms and there is little shown towards the small and medium sized enterprises (SMEs); and even less at construction-based companies

Information Technology is becoming more and more critical to Knowledge Management in construction firms (Egbu & Botterill, 2002). Many companies use IT in one way or another to manage their knowledge and information. In general, IT is used mainly to store and convey basic kinds of knowledge and information. In addition, IT can also be used to support collaboration and cooperation between people, and as method and practice to help the transfer of information, knowledge and perception between project teams, allowing the expansion of new knowledge for innovation. The construction industry has been slow to identify the advantages of IT as a key communication device (Egbu et al., 2001). Research (Egbu & Botterill, 2002) has proven that the most commonly used techniques and technologies in construction enterprises are: telephone, Internet, files and reports. Face-to-face gatherings and communication with the supply chain is the second most important element. While

construction enterprises spend more in some features of IT, such as the Internet, greater stress is put on the more predictable methods for obtaining, developing, sharing and storing data. IT should be perceived less in its ability to store plain data and more on its capability to support collaboration and teamwork between individuals (Egbu & Botterill, 2002). Dougherty (1999) discusses that IT should be perceived as a utensil to support the processes of Knowledge Management in enterprises.

When there is communication between unspoken, plain and clear understanding, and awareness, new knowledge and understanding, awareness and innovation can repeatedly come into sight (Ingirige et al., 2002). Knowledge is quickly becoming the most significant section of almost all firms, and enterprises in the construction industry are exactly the same.

The capability to run and make the most of understanding and awareness will be the major basis of competitive benefit for the construction field of the future. Knowledge management could assist SMEs expand for the future and have more reliable business training and preparations, making them less exposed to the financial phases of the industry. Knowledge sharing will reduce the loss of awareness and understanding that will result in the event of a simple transfer of unspoken knowledge to open and clear types. McDermott (1999) discusses that IT facilities alone will not be able to successfully carry out conversion of understanding and awareness, unless other specific factors such as belief, trust, direct contact, time to interrelate between applicants and formation of a common language are prepared and ready. Sketched above are the various scenarios that SMEs need to take into consideration in order to obtain understanding and awareness. To facilitate bringing knowledge management to its next stage, SMEs must look into their work practices and methods and then integrate the knowledge achievement method into it. Furthermore, SMEs must also be able to recognise their foundation of understanding and awareness to be able to obtain it. For SMEs to develop knowledge management facilities, investment on teaching, learning, training, infrastructure and communications must be enhanced and improved. Finally, SMEs should accept and take on the methods, rules, procedures and training styles of the larger enterprises and, as with these enterprises, SMEs must resolve their differences and move towards encompassing the current unspoken understanding and awareness that exists in the larger organisations.

In general, the management techniques of smaller companies are straightforward and clear-cut. It is motivational, innovative, and shows originality of services to enhance

business ideas. The few management policies and regulations are usually relaxed and management of the business is normally based on the proprietor's particular supervision. Official rules and regulations do not usually exist in SMEs (Daft, 2007).. Furthermore, in lots of smaller companies, the directors occupy a central role (Bridge et al., 2003). In such an atmosphere, it is not unusual for stages of business arrangements and executive duties to be restricted to one individual (Culkin and Smith, 2000). This focus would indicate these individuals are specifically accountable for the identification of the Knowledge Management-related advantages which assist and help the company's performance levels though; the performance of SMEs' routine business and need particularly close consideration (Hofer and Charan, 1984). This usually leads to scenarios where managing directors do not have enough time for tactical problems. This, combined with financial resources and skills limitations (Bridge et al., 2003), frequently results in most understanding and awareness retained in the minds of the directors and senior management instead of being actually stored or shared via alternative planning and understanding (Wong and Aspinwall, 2004).

Previous research on Knowledge Management in SMEs has identified many differences compared to larger companies. The majority of SMEs have no open and clear rule aimed at tactical Knowledge Management, and they normally treat Knowledge Management on a performance level (i.e. tools and devices) (McAdam and Reid, 2001). SMEs usually put more stress on the management of unspoken knowledge than larger companies (Corso et al., 2003) do. The SME sector seems to be less sophisticated in terms of knowledge development, having a more mechanistic approach to this idea and relying less on public relations (McAdam and Reid, 2001). Managers in smaller companies even seem to avoid leakage of knowledge from the firm and in this manner stop knowledge sharing (Beijerse, 2000). Hutchinson and Quintas (2008) discovered that specific developments and practices are applied within SMEs, stating that they do understand knowledge management, but it mostly takes place in an unofficial way. Since resources are limited in SMEs, understanding and awareness are likely to be the outcome of secondary sets of information (e.g. trade papers, division research, conferences and expert magazines) or from personal contacts (Egbu et al., 2005). Knowledge achievement activities in SMEs are focused on a few people, mainly managers, who have to split their concentration over multiple responsibilities (Lowik et al., 2012). Furthermore, as methodical knowledge search and development will be more costly compared to unofficial gatherings with suppliers or buyers; there is a huge

possibility that SMEs will prefer the second option (Cegarra-Navarro and Martínez-Conesa, 2007).

2.2.5 Decision Making

Improving the decision making of SMEs is a major factor in enhancing their flexibility (Wedawatta et al., 2010). Underwood (2008) recognised the necessity for a toolkit which would enable SMEs to make improved business decisions that relate to difficulties in their business, and those associated with changes in the current business climate, and how managers of SMEs withstand these changes and difficulties. The role of individual planners and tactical decision makers in creating a change strategy is absolutely vital, and strategic results cannot be obtained without the importance and influence of such roles (Das 2001).

The work of Sparrow (2001) and Scarbrough (2003) show that innovation processes in SMEs are facilitated by cohesion between Knowledge Management (KM) and Human Resource Management (HRM). The functional distinction between Knowledge Management and Human Resource Management is rare in SMEs, because of the centrality of the manager in the organisation of activity at ground level, and his role in strategic decision-making (Sparrow, 2001).

2.2.6 Risk Management

Many writers such as Perry and Hayes (1985), Flanagan and Norman (1993), Turner (1999) and Zou et al. (2006) have stated that to facilitate reaching the project goals with regards to time, cost and quality, companies have to develop and exercise a risk management method. Researches carried out by Cooke-Davies (2002) and Voetsch et al. (2004) clearly mentioned that business accomplishment is mainly dependent upon the support of the firm's risk management practice; and Rounds and Segner (2011) illustrated it as one of the most skilled fields and vital systems that assists individuals to accomplish successful projects.

Specialised associations in the UK construction industry such as the British Standard Institute (British Standard (BS) 31100, 2008) have analysed risk management as one of the major fields of business management practice and have introduced planned and controlled standards to fit risk management within enterprises.

Considering the features available within small and medium sized enterprises (SMEs), the development and operation of risk management can be a difficult task which needs a

broad range of expertise and resources. The Association for Project Management (APM) (2013) believed that resources to help and assist risk management development and its ongoing application are impractical for SMEs, and outside their potential abilities and budget.

The construction industry in the UK supplies about 7% of gross domestic manufactured goods and is one of the leading fields within the UK economy with 10% of overall employment (Department for Business Innovation and Skills (BIS), 2013). The field includes contracting and sub-contracting firms, architects, engineering specialists, quantity surveyors, manufacturers and sellers, and has the capability of acquiring a broad variety of projects in building, manufacturing, trading, distant organisations, configurations and developed plants which ensure substantial job opportunities.

Regardless of the variety and significance of the construction sector with its natural risks, Risk Management has only been applicable and functional over the past several years (Rounds and Segner, 2011) and its status in contrast with other sectors is not really strong (Chartered Institute of Building (CIOB), 2010).

All firms need to implement a risk management plan and tactics to recognise, evaluate and eliminate risks (Verbano and Venturini 2013). SMEs have to practice risk management more so than larger enterprises. Enduring resource restrictions, the absence of risk strategy management could have devastating effects, ultimately bankruptcy of a company (Raghavan, 2005) However, in order for SMEs to remain innovative and increase success, there has to be an element of risk involved with their projects (Vargas-Hernandez, 2011). SME directors have to regard Risk Management as an essential part of business management to keep projects practical, feasible and profitable (Yeo and Lai, 2014).

Akintoye and MacLeod (1997), Lyons and Skitmore (2004), Simu (2006) and Kuang (2011) observed the influence of projects' attributes on risk management functioning and performance in construction organisations. They explained that, in the construction sector which is organised around Project-based companies, the time obligation is linked with a range of risk detection and analysis factors. Akintoye and MacLeod (1997) assessed that firms in the construction field rarely perform official Risk Management because of the projects' just-in-time features and attributes. Additionally, Lyons and Skitmore (2004), based on a survey in the Queensland construction engineering sector, stated the "organisation issue" as the major element that stops construction firms from

performing risk management. They discovered both time limitations, and restrictions to devoted resources, as extra obstacles to Risk Management approval and implementation. Mubarak (2010) and Hwang et al. (2014) also reiterated that the growth and expansion of a risk management framework is a lengthy practice which occasionally does not match projects' specified finances.

The latest research within the perspective of developing countries stated that the limits to understanding the Risk Management practice, inadequate skills and insufficient data are the main considerable tests which influence the functioning and performance of Risk Management in the construction field (Kim and Bajaj, 2000; Frimpong et al., 2003; Kikwasi, 2011; Chileshe and Kikwasi, 2013; Hwang et al., 2014). Though, in comparison, "time, assets and capitals boundaries" were rated least significant. Kim and Bajaj (2000) and Frimpong et al. (2003) stated that the low level of awareness and expertise with methods, practices and failure to identify the advantages of the process, were the most significant elements which influence the acceptance and implementation of Risk Management. Debrah and Ofri (2005) discussed that based on the total number of people who work for small and medium sized enterprises in the field of manufacturing and engineering; they particularly suffer from shortage of services to offer and supply Risk Management instructions. This combined with the failure to provide a comprehensive and full approach for Risk Management in standard, expert and specialised main parts, which results in perception, awareness and development of Risk Management, more difficult (Kikwasi, 2011).

2.2.7 Scope Management

Project managers must have clear focus and concentration towards managing scope. Harrington & McNellis, (2006) state that one of the most frequent causes for project breakdown is the failure to fully explain or effectively deal with scopes.

Experienced project managers realise that thorough scope management is critical to complete projects on time using the allocated finances. An extension and change in scope, that doesn't consist of relevant modifications to project cost or timeline, could have the consequences of delay in project completion, or going over the allocated financial budget. Baca (2005), mentions that scope adjustments bring interruption and disorder to the project results and conclusions. Mochal (2004) discussed that without scope adjustment management, projects ultimately deliver more tasks than were initially

settled, arranged, planned and financed for. Furthermore, projects may face additional unnecessary issues.

Hill, J., Miller, B., Weiner, S. and Colihan, J. (2010) state that the reason for the change management is to make sure that no unintentional or unofficial changes are added to the project scope (which naturally impacts some adjustments in designed plans, expenditure, timetable, or resource deployment and operation), and that any amendments required necessary will go through a fairly official assessment and authorisation process including appropriate stages of internal and client collaboration, before any alterations are implemented.

Harrington & McNellis (2006) note that project scope management allows a project to concentrate only on the tasks necessary for its successful completion. The course of action recognises and turns aside tasks that are placed outside the scope, including procedures for essentially significant and positive primary scope, and recognising, allowing, and supervising alterations to scope. This is carried out to make sure the project will function and perform within its positioned boundaries effectively and efficiently. But in majority of situations, during project operations it will be necessary to make adjustments on project scope. Harrington & McNellis (2006) state that scope alterations are normally likely to take place over the duration of a project and if adjustments are necessary, there needs to be plain and comprehensive practices to accept them.

Scope alterations need to be filed and assessed by the project financial supporters and shareholders for evidence. Richman (2006) states that project scope organisation and leadership consists of the practices and movements necessary to make sure that the project has all the main initial tasks, and only the assigned deliverables, in order to finish the project effectively and efficiently. He added that project scope leadership consists of scope preparation, scope explanation, and generation of a list of all tasks involved in the job, as well as scope confirmation and scope direction.

Project scope describes what is or is not incorporated in the job, and determines what must be added or removed as the project is carried out. Schwalbe (2010) mentions that scope refers to all the tasks included in generating the commodities of the project and the procedures used to generate them. And project scope leadership includes the procedures included in determining, organising and managing what task is or is not added in a project. It makes sure that the project panel and shareholders have the same

perception and awareness of what results the project will create and what actions the project group will take in order to develop them. Scope management is useful for preventing unnecessary setbacks within projects as a result of constantly rising scopes and uncontrollable lists of request tasks.

For leading and reviewing the ongoing tasks, the project manager must be certain of what is, and is not to be included within the project deliverables. Heldman (2011) discusses that project scope leadership needs to be clear in explaining and managing what is, and what is not part of the tasks. This is considered alongside the project management preparation, the project scope declaration, and a generated list of all tasks involved in the job. Schwalbe (2014) mentions that project managers cannot complete a successful task of leading the scope, if they do not first complete a successful task of gathering the necessary elements and explaining scope as well as authenticating and confirming all aspects of it.

Heldman (2011) states that explaining, authenticating, confirming and managing scope would include; a well-defined provision of requested deliverables and necessities of the outcomes within the project; producing a project scope leadership preparation; confirming requirements using in-depth methods and managing alterations to these procedures.

Kerzner (2013) mentions that scope alterations can take place at any stage in the project life cycle. Scope alterations happen based on the fact that at the beginning of a project, most people cannot fully explain the tasks and expectations for the final outcome.

As the project progresses, the allocated team gain more understanding that allows scope alterations. Jones, Snyder, Stackpole & Lambert (2011) state that scope alteration is an ordinary action on projects, implying there is no problem in making amendments throughout the lifecycle of the project. Anderson, Molenaar & Schexnayder (2007, P. 110) discuss that "while leading a project to the calculated approximation is the aim of every project leader, scope alterations are occasionally inevitable". Schwalbe (2014) mentions that project scope leadership includes managing alterations to the project scope while maintaining project objectives, plans and tactics in mind.

For the project scope to be altered there needs to be an initial adjustment and modification demand. The adjustment demand must be filed and accepted by all individuals who have any connections and involvements in the project. Harrington, & McNellis (2006) clarify this by saying that everyone within the project team who is

influenced by the project (e.g., clients, internal staff, external colleagues, financial supporters, enterprises) should be incorporated in the procedure of reassessing the scope and then accepting any amendments that are going to take place on the primary project scope. Having all influenced individuals take part in this procedure will ensure the new project scope is acceptable.

Harrington & McNellis (2006) discuss that participation is essential to the accomplishment of this procedure, and particular assistance is necessary from the project leader and financial supporters. The leader should manage this procedure to make sure that the scope is appropriately explained throughout the preparation stage of the project life cycle. Anderson, Molenaar, & Schexnayder (2007) state that in project scope leadership any alternation in scope must be filed and approved. A scope alternation should be a completed form which is significant to the amendment recognition process thus developing a standard procedure for scope amendment that will enable project leaders to demonstrate directness, unambiguousness, liability and responsibility.

Harrington & McNellis (2006) believe that people asking for scope alterations must file their justifications on an amendment and modification application form. The alteration necessities must be checked throughout frequently held project gatherings, and kept in a main secure database or record, with specific consideration given to how adjustment impacts the extents of expenditure, timetable, functionality and operation. The project group must file alterations in project scope, so there will be valid explanations of why the original arrangement was followed-up particularly to the project financial supporters.

Cox (2013) recommends that with scope leadership, as well as modification and amendment files, project leaders will be able to steer clear of risky projects with every rising scope, and uncontrollable lists of desired outcomes. This record explains what is or is not incorporated in the new project scope, and manages what gets added or removed as the project is carried out. People asking for a project scope alteration must file any new preferred factor by completing an amendments and modifications application form. Influential evaluations are normally integrated with the demand. So all involved group members can discover extra expenditure, timetable, functionality, operation, and other features developed from the modifications. The project leader and financial supporters will use the data in their reassessment for either accepting or refusing the modification demands. Project shareholders may decline any demands they

believe are unreasonable for the project, but they should offer appropriate consideration to every demand, particularly those raised by clients or business employees (Harrington & McNellis, 2006).

Furthermore, Cox (2013) discusses that scope leadership allows direct procedures to deal with elements that may cause any project alteration throughout the project life-cycle. Project amendments and modifications that influence scope consist of: 1) necessities: the eventual goals of the project; 2) Restrictions: Boundaries such as time, finances, resource reliance, trade, authorities, directorial, industrial and management restrictions; 3) Hypotheses: Declarations that are measured as formal truthful evidences for arranging and preparing intentions but need confirmation; for instance, a software project might presume a new system will not need a full-time database supervisor after development is finalised and 4) Safety threats: any trading or practical element that has logical prospective to influence the project (or its presumptions); main risk features consist of: possibility of happening, influence, justification movement, and unpredictable scenario.

2.2.8 Sustainable Procurement

The theory behind sustainable procurement emphasises on the significance of liability and accountability of a firm, for performances outside its own restricted borders (Meehan and Bryde 2011).

During the past several years, efforts to develop ideas for sustainable procurement designs into the construction sector have begun to emerge. The UK government approach for sustainable construction, mentions procurement as one of the major factors for gaining an improved sustainability action (Department for Business Enterprise & Regulatory Reform 2008).

In the development of the scheme, a number of drivers are mentioned that create the trading scenario for sustainable procurement. These consist of the overall worth of the investment, status and character based matters, market segregation, directions and rules (Department of Trade and Industry, 2013). The influence of these elements on particular construction enterprises may differ hugely. Examples of some justifications for these differences for certain elements, are discussed below.

Value for money is recommended as a major concept for sustainable procurement, as the enhanced and greater use of entire life estimation approaches, this decreases the

general cost during the life of the constructed facility. The overall worth of the entire life expenditure may not be apparent to the construction firm or, in different scenarios, the customer. The advantage of, for instance, decreased operational expenditures of a constructed facility may not be seen by the constructor, as they are not the consumer. In most cases, the buyer is not the customer, adding another level of disengagement between the constructor and the purchaser. This could be made even greater by bearing in mind end of life expenditures, as the consumers at the end of life may not even be the same as the proposed and scheduled consumers at the construction phase. This may emphasize the necessity for major alterations to current business frameworks with the aim of adopting a long standing method.

Though transformation to a long-standing method may not be the main concern of construction enterprises, of more concern, is how, and with what resources, finance for construction projects is supported. Although any changes to this financial approach is not likely to be the main concern for construction enterprises, this is a key element that can have impacts and should influence the mind-set of those who are in a position to consider this concern

Brand status and character has already been considered in broad terms. It is stated that the major predominant companies are hugely influential in the ecological and populace influence of their entire supply chain which specifically applies to enterprises with well established brands such as clothing firms (Koplin, Seuring et al. 2007; Seuring and Müller 2008).The influence lies heavily on brand image. If consumers agree to use construction enterprises that are able to demonstrate good evidence of a fully sustainable supply chain, and show accountability to customers, financial supporters and stake holders, and apply this to a brand image that will be influential for construction enterprises.

Market segregation may have a substantial part to play in motivating firms to accept and undertake sustainable procurement preparations. If an organisation gains the advantage to promote itself as having a fully sustainable supply chain, it might be able to acquire business from consumers who appreciate this aspect and wish to do the same. Similarly, this benefit relies hugely on the significant value added by customers to sustainability and their enthusiasm and motivation to pay for the acknowledged advantages. It has been recommended that accepting and taking on sustainable construction preparations may offer a competitive benefit, but the degree to which this is perceived and acknowledged is not yet known (Tan, Shen et al. 2011).As the government has given

their assurance to procure more sustainably in the future via the sustainable procurement movement scheme, it would propose that in any case there is a market for this in government financed projects. Customers' needs may take part in a vital position here. It is stated that purchasers are putting specific necessities into contracts for ecological movements, for instance (Sterner 2002).

In a study in which questionnaires were given to commercial managers within a certain contracting firm, Wood and Ellis (2005) mentioned that with high opinion and regards to associative partnership in construction, there were scenarios where awareness, understanding, practices and skills, were optimistic and encouraging. Relationships from time to time were purely based on factors that caused a change in the cost of activities, even when there were acknowledged advantages in an alteration to the new method. This practice appears to be conflicting, in that a tactic with acknowledged advantages is not engaged, or the progression to the new tactic is slow. One rationale for this may be the tendency to do nothing. or to remain unchanged within the enterprise (Meehan and Bryde 2011). This grows from the establishment of a regular practice within an enterprise. As companies try to preserve a sense of consistency and dependability, processes become routine, resulting in the implementation of change becoming more difficult, as it relies on a sudden change or disruption from the current practice (Meehan and Bryde 2011).

An additional purpose may be that the occupied members of staff sense that other strains loaded on them oblige them to come up with thoughts that do not come into line with a sustainable procurement plan. This could specify that there is imbalance and inconsistency between strains on staff and they find the growth of these to be pushing them towards preserving the more conventional method. Such clash of motivation and encouragement could be an extra obstacle to sustainable procurement. This can be in spite of the reality that a lot of enterprises are filing sustainable procurement tactics and practices in their yearly account statements (eg. Morgan Sindall 2010). It would be fascinating to figure out to what degree these rules and regulations actually impact the procurement choices within a firm. The main business concerns are possibly reliant on various contradictory strains, and the way in which such strains are connected will be main factor to the ultimate choices made.

A procurement method may fundamentally be a more secure framework with minimum risks if the key contractor presumes the design process and the construction of the tasks, as well as accepting a maximum price limit stated in design plan (Rowlinson et al.,

2010). The method would decrease potential challenges generated by the consumer in the future and propose an incentive to the contractor in order to establish significantly important services by take on board their knowledge and skills in the design and construction approaches to increase construction capability (Chan et al., 2007).With this in mind, the contractor would receive bonuses for their development and progression attempts and inspiration on both the design and construction performances. This kind of bonus consists of joint saving between the customer and the chief contractors as well as sub-contractors. Three consistent and solid tools and methods that have been arranged in place comprise of the gain share and pain share agreement, the project disagreement declaration and ruling scheme, and the support and advertising of a collaborative field atmosphere.

2.2.9 Strategic Planning

Andersen's empirical study (Andersen, 2000) supplies proof that tactical preparation and forecasting (that reiterates factors of the predictable tactical leadership procedure) is linked with higher functionality and operation in all the manufacturing, engineering and trading atmospheres researched. The operational impact of tactical preparation does not differ considerably between the various manufacturing, engineering and trading teams. Therefore, tactical scheme is a vital operational influence in all industrial situations, and increases financial operation as well as organisational novelty, originality and modernisation. Song (2011) states that the experimental facts imply that more tactical preparation and more new product growth and expansion projects, result in improved and enhanced organisational operations. Even though tactical preparation is a procedure and method for predicting ecological instability and confusion, the valid and rational processes, normally approved in the literature, are not adequate to impact operation and functionality. Agility in choices and options is required to alter performance and functionality problems, such as goods and facilities or their manufacturing and to alter cost related difficulties, such as financial assets to facilitate influence on monetary operation (Rudd et all, 2008).

Studies have constantly revealed that the majority of SMEs do not get involved in tactical preparation (e.g., Robinson & Pearce 1984; Sexton & van Auken 1985; Berman, Gordon & Sussman 1997; Orser, Hogarth-Scott & Riding 2000; Sandberg, Robinson & Pearce 2001; Beaver 2003). This is in conflict with much of the tactical creative studies which state that organisations must continuously prepare for the future to deliver their projects effectively and efficiently (Ennis 1998). Therefore, SME directors have been

blamed for being tactically narrow-minded and not having the long-lasting mind-set as to where their enterprise is moving towards (Mazzarol 2004, p.1). The issue is that by disregarding tactical preparations, SMEs might not obtain their complete operation and expansion prospective, and their continued existence and endurance may face a risk (Berry 1998). As a result, significant study attempts have been carried out on discovering obstacles that hold back preparations in order that these could be dealt with, or else to reduce the level of severity to persuade and motivate tactical arrangements and preparations in SMEs.

Regardless of their numerous added advantages, SMEs are known to face a vast number of unsuccessful ratios as well as below average degrees of functioning and operations (Jocumsen 2004). To make sure continuous and persistent growth and expansion of the field, it is significantly important to learn and appreciate why some SMEs are more successful than others. Broad reassessments of existing research studies into SMEs (e.g., Lurie 1987; Schwenk & Shrader 1993; Miller & Cardinal 1994; Hormozi, Sutton, McMinn & Lucio 2002) mention that the statement "with other conditions remaining the same; other things being equal" is a major decisive factor of business accomplishment which plays a huge part in the existence or non-existence of tactical preparation.

Tactical preparation is associated with the arrangement of long-standing managerial and authoritative aims and objectives within the enterprise, the growth, progression, expansion, functioning and performance of preparations to obtain these aims and objectives, and the distribution, sharing or recreation of required facilities and services for learning and appreciating these aims and objectives (Stonehouse & Pemberton 2002; O'Regan & Ghobadian 2004). In a realistic and sensible manner, tactical preparation is related to ambitious and driven benefits. This is summed up by Ohmae (1983 in O'Regan & Ghobadian, 2002, p.664) who discussed that the principle and rational behind tactical preparation is to allow a business to achieve as systematic and productive as possible, a viable and continual advantage over its rivals.

This is re-confirmed in the experimental and practical research. Regarding functioning and operations, tactical preparation is normally more widespread in better operating SMEs. For instance, SMEs that are involved in tactical preparations (compared to those that do not) are more likely to be those that gain more advanced and top levels of sales, return on investments, and additional advantage on revenue as well as staff numbers

increasing (Bracker, Keats & Pearson 1988; Berman et al. 1997; Carland & Carland 2003; Gibson & Casser 2005).

Additionally, SMEs that are involved in tactical preparations are most probably those firms that are also more inventive and modernised, that have more recently patented materials and creations, that utilise new procedures, practices and leadership techniques and expertise, and that reach global expansion (Upton, Teal & Felan 2001; Beaver & Prince 2002; Stewart 2002; Gibbons & O'Connor 2005). Possibly most significantly, SMEs that take on tactical preparations face less chances of being unsuccessful (i.e., involuntarily wound up) (Gaskill, van Auken & Manning 1993; Perry 2001).

Although it is undoubtedly accurate that SME functionality and operational accomplishment is the outcome of more than tactical preparations alone, results usually back up the argument that there are, all things considered, massive benefits to preparation than non-preparation. Though, considering all the proof, it is well identified that tactical preparations is uncommon or missing in most of SMEs. In actual fact, SMEs have a tendency to adjust towards temporary and instant performance levels instead of long-standing tactical difficulties, and managerial duties are inclined towards being unprompted rather than practical (Jones 1982; Gaskill, van Auken & Manning 1993; Brouthers, Andriessen & Nicolaes 1998; Stonehouse & Pemberton 2002; Mazzarol 2004). In SMEs that allege to prepare, preparations are often informal and instinctive rather than officially printed in black and white, and offer little foundation regarding which business functionality and operations could be considered, calculated, evaluated or examined (Kelmar & Noy 1990).

The basis and rational behind why some SMEs carry out tactical preparations whereas others do not, is usually unspoken and not well perceived (O'Regan & Ghobadian 2002). Therefore, the power of studies to give details and clarify the shortage or absence of tactical preparations in SMEs has concentrated on recognising and discovering the obstacles that put off or stop preparations. For instance, Robinson and Pearce (1984) mentioned that a shortage of time and specific knowledge and skills, insufficient awareness of the preparation procedures, or unwillingness to share tactical preparations with members of staff and external specialists are disadvantageous to understanding tactical preparations in small enterprises. Others have suggested that ecological ambiguity or instability (Shrader, Mulford & Blackburn 1989; Matthews & Scott 1995; Yusuf & Saffu 2005), dimension and range of business (Stonehouse & Pemberton 2002), nature and form of production sector (Shrader, Mulford & Blackburn 1989),

internal functioning and performance obstacles (O'Regan & Ghobadian 2002) and production life-cycle of growth and progression (Berry 1998) could be considered for what Sexton and van Auken (1982) expressed as the deficiency stage of tactical preparation in SMEs.

As mentioned by Volberda et al. (2010) tactical leadership derived from long-standing predictions, allows the firm to presume upcoming scenarios, situations and choices. The phrase Plan is strongly connected to the goals that it pursues. Kotler and Keller (2007) believe that plan and scheme must state the simple initiative of what is the best direction to gain the company's expected objectives. The significance of plan and scheme for advance and modernised inventions, growth, expansion and rivalry of enterprises have been reiterated by a vast number of researches in recent years, e.g. Glaister (2008), Skokan (2010), Volberda et al. (2010), David (2013).

Based on business plan, scheme growth and developments, we could usually split enterprises (including both SMEs and large companies) into three categories (Šebestová, Nováková 2013):

- Firms that have a well-organised and thoroughly printed initial tactical file (business plan). Such a file takes care of significant sections within companies, such as human resources, market studies, investigations, aims, objectives, growth and expansion of manufactured goods, modernised and original inventions, skills, knowledge and expertise regarding development and future additional facilities, logistics, level of excellence, atmospheres and surroundings, financial plans and statements, funding and repayments, time plan, risk assessments, etc. In-depth tactical file must include significant contemporary leadership styles, methods and practices. The planned and tactical file consists of upcoming phase of no less than three years and is regularly measured up, evaluated and updated against factual scenarios (at least once a year).

- Enterprises often have a planned and tactical file created in printed but brief structure, with inadequate explanations in all significant sections. A vast number of companies quickly, and for a short space of time point out just undertaking assignment, operation, mental image and some basic but incomplete planned and tactical matters, such as development, operation, promotion, advertising or funding; though other significant area remain outright.

- Enterprises that have no printed planned and tactical file. It is under no circumstances plain and simple to understand if the scheme is held in mind of major leaders (e.g. unaccompanied freelance business individuals); some parts are within the foundation of company's culture or happen to be completely absent or missing.

Enterprises that do not maintain printed plan and scheme are regrettably still the most occupied set (Pawliczek et al. 2011). But it is precisely tactical business leadership that has the ability to offer an enterprise the added benefits in rivalry with other firms. Johnson and Scholes (2006) propose that the business scheme and plan must supply certain significant business rivalry benefits.

Advantages of establishing tactical leadership in small and medium-sized companies as illustrated Analoui and Karami (2003) in the following aspects. They

- Assist in allowing to realise the existing circumstance in which the firm is placed,
- offer a simple and plain perspective of the mental image, undertaking assignments of the firm,
- decide the advantages and disadvantages, reiterating those that are tactically significant for the firm's movements,
- Assist towards finalising the most precise and accurate objectives of the enterprise,
- Allow the firm be more dynamic and active,
- Help and assist the organisation to be able to organise everyday and unusual issues,
- Develop an environment for management of information and data sharing in the company,
- Assess ecological matters and the related alterations,
- Help and assist the commencement of moral principles and commercial social duties in the planned and tactical procedures.

Andersen's empirical study (Andersen, 2000, p. 196) offers proof that tactical preparations (that reiterate factors of the predictable planned and tactical leadership procedures) are linked with more advanced functionality and operations in all the manufacturing, engineering and trading atmospheres that have been researched for. The operation and functionality consequences of tactical preparations do not differ massively between the diverse manufacturing, engineering and trading teams. Therefore, tactical preparation is a significant functionality and operation element in all organisational situations and scenarios, and improves both financial operation and industrial modernised and original invention. As mentioned by Song (2011) the experimental proof proposes that more tactical preparation and more new projects involving manufactured goods result in enhanced functionality and operations within companies. While tactical preparation is a method and practice for predicting ecological disorders and instabilities, the reasonable and rational subsequent approaches normally found in the research is not adequate to impact functionality and operational levels. Resilience in management is necessary to alter functionality related matters, such as manufactured goods and additional facilities or their manufacturing and to alter monetary matters, such as assets and fitting and adjusting with the purpose of creating certain influences on monetary operations (Rudd et all, 2008). We acknowledge and take into consideration these observations and also look within firms for further plan, scheme and tactical information.

A vast number of managers in SMEs are certain that genuine and innovative executives do not take advantage of any prepared sets of tactics (Posner, 1985). Alternatively, it is believed that they take advantage of their restricted time assets more practically and successfully for functionality, performance or marketing movements. Furthermore, official preparation is normally limited to large organisations and as a result not conveyable to the necessities of the quick growing, dynamic and amenably and responsively arranged and designed SMEs. From an innovative executive's point of view, three main goals are stated against the use of tactical procedures in SMEs (Esser, Höfner, Kirsch and Wieselhuber, 1985; Füglistaller, Frey and Halter, 2003):

- Planned and tactical tools restrict the resilience and the capability for spontaneity;
- It is better to use the restricted time assets for performance, marketing or research and development duties instead of plan and scheme growth and expansion methods and procedures;

- Planned and tactical leadership is too overbearing.

At the same time, these writers recognise that particularly during the periods of rising ecological movements and ambiguity, it is significant to remain knowledgeable about business aims, objectives and their achievements and accomplishments frequently, hence observing and examining tactical growth and progression as a forthcoming asset. In this regard, the major advantage of tactical preparations remains in the inevitability of potential upcoming cases and situations. While most of recognised plan and tactical ideas and thoughts have been created for large enterprises that normally present a higher point of understanding for active issues, and therefore assign more assets to this matter, some of these ideas, thoughts and tools, also seem to be appropriate for functioning and performance in SMEs. A particular plan and approach idea for SMEs though has to contribute towards their distinctive situations, scenarios and issues (Wirth, 1995).

SMEs' distinctive features involve both issues and prospects for planning and tactical growth and progression in SMEs (Füglistaller et al., 2003). For instance, contrasted to large enterprises, SMEs are inclined to offer restricted variety of goods in a restricted number of marketplaces, taking advantage of market infiltration, tactics and plans involving growth and expansion of manufactured goods, rather than tactics or plans involving growth and expansions of the actual market. In addition, based on the fact that SMEs primarily function in a narrow percentage of marketplaces with a restricted number of manufactured goods or additional facilities - frequently even within an identified market gap - they normally do not have the funds to access main facility units that are able to carry out complicated market examinations and investigations (Johnson & Scholes, 1997). Furthermore, they normally have inferior available facilities as well as inferior entitlements to use labour and monetary resources. Consequently, specifically up to a solid and crucial measurement, the request and claim of official preparation means are normally unavailable (Karagozoglu & Lindell, 1998). The most significant and vital achievement and accomplishment element for a small company director is time. In the end, this has a powerful impact on the effects of any advanced and improved movement examination and review of the innovative executive? (e.g., Delmar & Shane, 2003). Moreover, the procedure and practice of tactical management in SMEs is often based on understanding, knowledge, skills, instinct and perception, or purely on assumptions (Welter, 2003).

Preparation approaches in SMEs do not always occur in an extremely complicated or official approach. It frequently happens as an indication of tactical assessment and

philosophy (Ohmae 1982). In this regard, Bracker and Pearson (1986) illustrate SMEs' preparation movements as varying from a shapeless and unofficial method to a more prepared, planned and official method. As a result, it has yet to be discovered and identified whether SMEs do not prepare tactically whatsoever, or whether they just do not prepare in an official way. Beside these points, Welter (2003) mentions that it is the conditions and excellent levels of preparation, as opposed to tactical approaches. that are significantly responsible.In actual fact, preparation in SMEs appears to be almost shapeless, infrequent, constantly changing and most of the time unofficial .This proposes an almost general type of assessing and evaluating by the original inventions executives, which may represent a signature and mark on the enterprise for a long-standing future. The main managerial procedure that could be pragmatic and practical, in actuality frequently departs and varies significantly from the most favourable logical image. To link this to the primary description of tactical leaderships and preparations in this procedure, executives of original inventions may get involved too much in unofficial tactical leaderships to support the growth and expansion of mental images while disregarding and abandoning the most significant areas of preparations (Reschke 2005).

Furthermore, it appears logical and realistic to presume that each kind of preparation, whether it is official or unofficial, optimistically and completely impacts industrial and commercial achievements and accomplishments. The functioning and performance of tactical preparation, hence, appears to be positive and constructive regardless of firm size, even though an optimistic and encouraging association between growing firm size and the functioning and performance of tactical leadership tools seems to be present (Haake, 1987). This discovery is possibly related and linked with the rising necessity to decrease ambiguity regarding a firm's position in its surroundings and the mounting capabilities to deal with situations that are determined by only physical processes.

Based on these statements, it may be presumed that individuals' beliefs in the majority of SMEs are considered to be tactical and purposeful, though a mindful or official tactical procedure mainly occurs within the leading individuals who are associated with of a small number of staff members. Based on the generally approved perspective that tactics restrict an SME's scope of movements too much, thus decreasing its resilience, a lot of SMEs still do not take advantage of any printed tactical preparations (Pleitner, 1986). Furthermore, there are other rationales that could clarify why SMEs decline and reject to get involved in official tactical preparations, such as inadequate understanding

and awareness, disbelief, refusal of external help and support, conventional assessments, being afraid of fundamental alteration, high expenses and shortage of time or excessive leadership (Scharpe, 1992; Robinson & Pearce, 1984). As a result, Gibb and Scott (1985) believe that tactical learning and understanding as well as the participations and contributions of the original invention executives counterbalance the shortage of official tactical preparations as a product of tactical leadership. The level of an original invention executive's tactical direction therefore appears to be a major element for the tactical concentration of the organisation (Mazzarol, 2003).

2.3 Small and Medium Sized Enterprises (SMEs)

SME is the known abbreviation for Small and Medium Sized Enterprises.

According to Department for Business, Innovation & Skills, Business Population Estimates for UK and the Regions, at the beginning of 2015, there were 5.4 million businesses in the UK. More than 99% of these were Small and Medium Sized Enterprises (SMEs). Of these, most were defined as micro-businesses, that of having less than ten employees (Department for Business, Innovation & Skills, Business Population Estimates for UK and the Regions, 2015).

A rough calculation carried out by The Office for National Statistics states that SMEs produce approximately £35 of gross value added to the UK financial system for every £100 of turnover, though at the same time, larger enterprises produce around £24 (Office for National Statistics, Annual Business Survey, 2013).

Central government pays almost £45 billion every year on materials and facilities prepared and served by private sector enterprises. Over £12.1 billion of this is approximated to be achieved by SMEs. The government classifies an SME as a unit occupied in economic movements that (European Commission, 2015):

- hires less than 250 individuals; and
- has an annual turnover of less than or equal to 50 million euros (£39 million); or
- has a balance sheet total of less than or equal to 43 million euros (£33 million)

The government's classification consists of the majority of voluntary, community and social enterprise (VCSE) organisations.

The government does not have the knowledge of how many SMEs were offered straight government contracts in 2014-15. The Cabinet Office's Crown Commercial Service (CCS) gathered information from larger organisations about spending with SMEs within their supply chains. Though, there are uncertain aspects in the obtained information so it is not feasible to be certain of the definite number of SMEs operating for the government, nor the kinds of SMEs implicated.

In November 2010, the government declared an ambition for 25% of government acquisitions to reach SMEs by 2015 (Minister for the Cabinet Office, Summit for small business speech, November 2010, available at: www.gov.uk/government/news/plans-to-open-up-government-to-small-businesses).

This was part of a number of evaluations proposed to help SMEs in the UK expand and to enhance ventures across Britain. In February 2011, at a tactical supplier meeting regarding SMEs, the Prime Minister supported and reiterated this obligation, stating:

"We need to make the [procurement] system more open to new providers, more competitive between suppliers … helping us tackle waste, control public spending and boost enterprise and growth. It will also help us modernise our public services, opening them up to the forces of competition and innovation, and give our great charities and social enterprises the opportunity to deliver services too" (Prime Minister, PM's speech at the Strategic Supplier Summit, February 2011, available at: www.gov.uk/government/speeches/pms-speech-at-the-strategic-supplier-summit).

Government allocated a target for SME expenditure for the first time in 2010, but the aim to enhance the government's use of SMEs is not new. Over the past few decades, government has continuously stated related plans to improve access to public sector acquisition for SMEs. It predicts their contribution will show the way to better value for money via improved rivalry and advance originality. Government had also attempted to follow spending with SMEs before 2010. In 2005, the government carried out a survey of an illustrated example of public figures. It used data gathered from this illustration to calculate approximately, that, as a percentage of total contract value, it gave 22% of its business to SMEs in 2004-05. This approximation does not include spending by the National Health Service and the Ministry of Defence (MoD) (Small Business Service, Access to public procurement for small and medium enterprises: progress report – December 2005, available at: www.bipsolutions.com/docstore/pdf/12111.pdf).

According to Iacovou, C., Benbasat, I. and Dexter, A. (1995) and IDC (1999), the main reason SMEs adopt IT is to improve their overall level of rivalry. As a result, SMEs could feel the pressure when they recognise more and more firms in the industry implementing various technologies to unravel the tactical issues created by the incompatibility of systems, particularly if it is their business associates, rivals or larger trading co-workers. As a consequence, SMEs will sense the stress and the requirement to adapt to the Information system incorporated atmospheres to keep up with the high intensity levels of competition in the marketplace.

Iacovou, C. (1995) mentions that the major cause that drives SMEs to accept and implement "IS" based technologies is to obtain a competitive improvement and benefit.

As a result of the above statements, Themistocleous, M. (2002) established that initially, because of SMEs' lack of overall resources, SMEs' enthusiasms to roll to accepting and implementing integration facilities, is mainly achieved from external strengths. This is different from large organisations, as their inspiration mainly rises up from their tactical, monetary, executive and administrative requirements.

Secondly, according to Tagliavini, M., Faverio, P., Ravarini, A., Pigni, F. and Buonanno, G. (2002) the different incorporation requirements between SMEs and large enterprises may be based on their different corporate complexity. The understanding of corporate complexity here is defined by whether the form and state of being a complex enterprise is linked to their acceptance and implementation of integration technologies. After decades of various technological acquirements, organisations have been left with various systems stretched throughout numerous units. Though, the number of systems to be handled (i.e. various systems) is not the same between SMEs and large enterprises. For example, SMEs may only have a few systems, whilst large companies may have a lot. Hence, some SMEs (with only 10 members of staff or less which are known as Micro companies) may find it unproductive to accept and implement integration technologies based on the fact that there are not a lot of various systems within the firms.

As a result of this, accepting and implementing integration technologies to assist SMEs' IS integration, will only improve and enhance their assets and funds or maintenance expenses, but add difficulty and complications to their current functioning and performances, unless there are some additional tempting and appealing motivations.

For instance, an SME's trading associates might need them to do so, or heavy demands from the government might lead them to proceed. As for larger enterprises, since they are relatively different companies and include more complications as opposed to SMEs (e.g. with lots of different systems within the enterprise), accepting and implementing numerous integration technologies may support them to fix their integration issues, improve and enhance effectiveness, and accelerate operations, etc.

According to Cragg, P., King, M. and Hussin, H. (2002), Cragg, P. B. and Zinatelli, N. (1995) and Iacovou, C., Benbasat, I. and Dexter, A. (1995) based on the fact that SMEs' have insufficient assets, funds, capitals, inadequate awareness, insufficient knowledge of 'accessing and using IS, and numerous other limitations, small businesses usually need to deal with more intense threats in IS execution and operation and the practice of information technology than large enterprises.

Hence, Chang, L. and Powell, P. (1998) and Thong, J. Y. L. (1999) discuss that directors in SMEs have been described as having hesitations about the acceptance, implementation and practice of information systems. Nevertheless, these hesitations have not constantly prevented the advantages, and accomplishments such companies can gain from IS. At the beginning, SMEs were most likely to practice IS as tools to mechanise their basic directorial operations, e.g. financing and recorded control, etc.

However, Pollard, C. E. and Hayne, S. C. (1998) acknowledge the recent increase in literature dealing with the difficulty of using IS for a competitive benefit within SMEs. According to Lin, B., Vassar, J. and Clark, L. (1993), the mounting attention in the tactical practice of IS by SMEs is derived from three elements: (a) the growing acceptance and implementation of IS and its efficient and valuable practice by rivals, (b) a reduction in the overall charges and rates of IS that it is available and accessible to SMEs, and (c) the capability for IS to let SMEs cover their size from their external associates. As a result of these points, some SMEs have focused on the acceptance and implementation of integration skills and expertise, as a new tactic to enhance their overall level of rivalry.

Most of the workforce is employed by SMEs. Statistics for 2008 published by the BIS (previously BERR) Small Business Service (SBS) Statistics Unit show that out of 4.8 million businesses in the UK, 99.9% were SMEs. In the UK, sections 382 and 465 of the Companies Act 2006 define an SME for the purpose of accounting requirements. According to this,

a small company is one that has a turnover of not more than £6.5 million, a balance sheet total of not more than £3.26 million and not more than 50 employees. A medium-sized company has a turnover of not more than £25.9 million, a balance sheet total of not more than £12.9 million and not more than 250 employees.

About 98.2% of the construction sector includes businesses that are defined within this SME category (Construction Statistics Annual, 2007). Therefore, it is an essential part of construction sector that requires attention. A massive part of their business depends on collaboration and partnering with other businesses. How successful or not the collaboration is, would depend on the collaborative arrangements between the companies. These arrangements should be able to resolve the issues associated with such collaboration by allowing partners to expand resource and provide quick and flexible access to external resources.

Research has proven that some SMEs take advantage from cooperation of their innovation processes, while others experience significant concerns. The positive effects include increased turnover, higher profit rates, and expansion of the product range (De Jong and Vermeulen, 2006).

However, SMEs often find it difficult to create and take advantage of inter-organisational innovation projects. One of the reasons is that smaller companies cannot enforce their determination upon others (Batterink et al., 2010). The sharing of the results is therefore a major issue for them. In addition, typically for SMEs, knowledge may accidentally spill over to other organisations. Finally, inter-organisational innovation projects may involve organisations with various cultural backgrounds, consequently leading to coordination problems. These normally increase proportionally to the number and diversity of the organisations involved. Hence, it is vital for a hub firm, especially an SME, to be well informed of the potential drawbacks of cooperation within networks, so as to mitigate these via suitable coordination mechanisms. In their study of 164 Austrian SMEs, Hoffmann and Schlosser (2001) showed that coordination (such as a precise definition of rights and duties) is a key success factor of cooperative arrangements. However, SMEs often lack the capacity to fulfil such key success factors for successful coordination and network management (Hoffmann and Schlosser, 2001).

Currently a Cloud Computing based innovation for collaboration within SMEs could be a major innovation to increase productivity. The reason Cloud Computing Based innovation for collaboration is recommended is because all different SMEs can

contribute regardless of what operating systems they use. Everything will be based on a Cloud Computing platform accessible from any operating systems without requirements to use various programming languages for editing and sharing knowledge.

2.4 Online Collaboration Technologies

In previous sections construction industry and SMEs were discussed in detail. Additionally, some of the major success factors in this industry were reviewed based on the existing literature. In this section, online technologies will be discussed. Furthermore, the online collaboration technologies and the existing platforms will be reviewed and discussed.

2.4.1 Online Technologies and Collaboration Systems

Regardless of the extensive recognition and approval of Internet practice in business and commercial atmospheres, the degree of Internet applications still differs greatly within small and medium sized companies (SMEs). While some SMEs profit from fast Internet expansion, trading over the Internet, or taking advantage of new commercial frameworks, others do not have the same apprehensions. Current justifications of these variations depend on enterprise or marketplace features as is regularly observed in the wide spread of original invention frameworks (NERA, 1998 and Forrester Research, 1998). Such frameworks, though, do not sufficiently regard the features of the innovation, and how it influences enterprises' inspirations and enthusiasms for acceptance of changes. In the field of information and communication technology (ICT) implementation and acceptance, this hole has been focused on via the notion of planned and tactical exercise, which integrates elements from widely spreading of frameworks with the ones linked to the system features (Antonelli, 1989) of information and communication technologies (Preissl, 1995).

As an advance modern development, the Internet is established according to telecommunications and computer skills and expertise, bringing about elaborate and detailed features with regards to its structure and performance. In developing a new connection to the Internet, new consumers need to accept a number of associated new technologies (LaRose and Hoag, 1996). Based on these features, and to its primary foundation, the Internet is anticipated to have a wide spreading direction that varies from those practised with previous telecommunication developments (Kavassalis et al., 1996). Furthermore, dissimilar to conventional electronic data interchange (EDI), Internet implementations and acceptance prevents practical periods during which users

are bound by the terms of a contract, based on the fact that elements surrounding internet drafts and proposed standards comply with the rules within the public domains.

In addition, Internet implementation and acceptance does not need hugh investments or a sophisticated preceding telecommunication framework. These new features have created new options for SMEs to invest in Internet-based facilities and software and appear to suggest a distinctive number of elements in the implementations and acceptance behaviour (EITO, 1999).

The idea of tactical advantages of Internet software and services, attempts to connect Internet applications, with the tactical freedom of options and convenience that it produces for the enterprise. Moreover, the idea identifies the tactical advantages of using Internet to improve and enhance the practice of management over the constrained and obligated associations and the interfaces used in connection between consumers and the enterprise, which are also related to the firm's strategy.

First, if one considers the establishment of a website that runs particular applications, it does not necessarily assume pre-existing business relationships, but instead makes possible new strategic opportunities with potential customers or business partners (Barling and Stark, 1998). In this respect, the establishment of a website presence requires some strategic considerations, with respect to the extent it should be utilized to engage in different forms of on-line business activities. Furthermore, the design of a website reflects the extent to which particular business functions are integrated with its Internet activities (Turban et al., 1999).

Furthermore, strategic factors to adopt Internet services and software are related to particular desired functionalities that should improve the long-term market positioning of the firm within its immediate business environment. Decisions to opt for selling via the Internet, for example, indicate at least that the management team of a particular firm is aware of new ways of organizing business activities via the Internet.

Additionally, the particular form of website presence enables companies to define the boundaries between customers or business partners and their own business. They define, for example, the terms of use of restricted areas on their website by particular user groups (Emmanouilides and Hammond, 2000). Establishing a website presence is therefore different from communicating via email, where control over use is somewhat relegated to individual corporate users. In general, the establishment of website presence represents a more strategic use of the Internet technology, compared to other

Internet activities. Moreover, when establishing an Internet connection a firm takes partial control over the interface through which they communicate with their clients. Different Internet-based media, such as a web interface versus email, allow varying degrees of control over this interface.

To further examine the notion of strategic use, it is first necessary to categorize the relative importance of this motivation compared to other motivations for adopting Internet services and products. Previous studies in the area of SME adoption of ICTs suggest that the motivations for adoption are based on opportunistic reasons, i.e. those relating to cost. In particular, managers in SMEs have identified the time and effort to incorporate telecommunications in their business as principal barriers to adoption of information technology (Chappell and Feindt, 2000). Furthermore, limited capital has also been used to explain a relative lack of investment in ICTs by SMEs (La Rovere, 1996). Given the evidence provided by these studies, it can therefore be proposed that SMEs will be more opportunistic in their adoption of Internet-based e-commerce services and software.

Thus far the strategic uses of the Internet have been described but the discussion has yet to touch upon the possible factors that can be used to explain why some firms recognize these assets and are able to take advantage of them, while others do not. In defining strategic use in the context of information and communication technology adoption, Preissl (1995) proposes that the environment of the firm will define the communication requirements, communication prerequisites, structures of competition and support and incentives that will in turn create incentives for strategic adoption. This model is modified here, eliminating the ‘communication prerequisites’ factor as it is concerned with compatibility issues which the Internet solves to a large extent. Definitions of the three factors are as follows:

Communication requirements: These requirements are shaped by the modes of communication. There are a number of channels through which communication can take place: formal or informal, technology-based or personal channels. Strategic use of the Internet is related to the need to communicate with business partners, competitors, and potential customers.

Intensity of competition: The actions of competitors affect strategic use. Fierce competition increases strategic use in a way that entrepreneurs look earlier for improved

methods of production and communication and investment opportunities to (re-) gain competitive advantage.

Support and incentives: Based on the existence of external support and incentives, users become earlier aware of the potential of new technologies.

Support and incentives can be provided by business partners, government programs, or Internet Service Providers (ISPs).

2.4.2 Support for Adoption

In literature, it has been has been recognized that SMEs are rarely aware of their needs with respect to the adoption of advanced telecommunications (Gillespie and Williams, 1988). As a result some of their needs are not effectively translated into demand, because these needs remain unrecognized. These needs might be due to factors internal to the firm, as well as cost or other factors of the supply environment. In other words, the actual pattern of usage of advanced telecommunications by SMEs might, in effect, provide only a partial guide to their external or 'objectively' defined needs. Incentives and support can actually facilitate the adoption of advanced telecommunications by SMEs in making them aware of the potential of the new technology. Recent studies have found a relationship between strategic use of advanced telecommunications and user awareness (NERA, 1998). The level of awareness increases the extent of strategic use of the Internet. This awareness can be fostered, for example, by government support programs but also by aggressive support of an Internet Service Provider.

2.4.3 Sector and Size Differences

In the literature, the effect of size on Internet adoption is still debated. While some propose that with further diffusion size-differences will become less important (Choi et al., 1997), others demonstrate that differences still exist (Chappell and Feindt, 2000), while still others debate the validity of the results (EITO, 2000). Studies have shown that differences are, however, visible in the extent of adoption of electronic data interchange (EDI) or personal computer (PC) penetration. In the United Kingdom, for example, in medium-sized companies (between 100–250 employees) PC penetration has nearly reached the saturation point. This compares to micro-enterprises (between 1–9 employees) where only less than two fifths own a computer (Chappell and Feindt, 2000). Therefore it can be proposed that strategic use of Internet-based services and software is more likely in larger SMEs.

The adoption of the Internet by SMEs seems to be not only affected by size, apparently industry characteristics are also important. As shown empirically, SMEs in knowledge intensive industries have been more inclined to adopt Internet services and products. Furthermore, technology-intensive manufacturing and service sectors have been at the forefront of utilizing Internet services and products compared to more traditional business sectors, such as retailing or cloth manufacturing (Chappell and Feindt, 2000). The question therefore is the extent to which the levels of Internet usage are related to industry specific patterns of adoption. It can be predicted that there is a relationship between sector-specific processes of adoption and Internet usage.

In the past few years, group work and collaboration using online environments, has become an important research topic because of the interconnectivity enabled by the Internet, and more specifically, the World Wide Web (WWW). An important area within group collaboration is the current research on communities of practice. Liedka (1999) describes communities of practice as ‘‘individuals united in action’’ (p.5). Communities of practice, employ active participation and decision-making by individuals, as opposed to separated decision-making that is present in traditional organisations (Collier & Esteban, 1999). This approach gleans creative and effective solutions from the communities' participants that are essential for organisations if they are to survive in environments of continuous change. Communities of practice are the sum of both stakeholder interest and the development of individuals within the community. Authoritarian management is replaced by self-management and ownership of work (Collier & Esteban, 1999). The learning that evolves from these communities is collaborative, in which the collaborative knowledge of the community is greater than any individual knowledge. Communities of practice also emphasize process development over market development or product development (Liedka, 1999).

Virtual communities use networked technology, especially the Internet, to establish collaboration across geographical barriers and time zones. In comparison to traditional communities, virtual communities in cyberspace differ in several respects (Palloff & Pratt, 1999). Traditional communities are place-based and have membership according to norms. Group dynamics often override individual expression. There is a distinct border between membership and differentiation, that is, it is clearly defined who is a member and who is not.

In contrast, virtual communities exist according to identification to an idea or task, rather than place. They are organized around an activity, and they are formed as a need

arises (Squire & Johnson, 2000). Squire and Johnson (2000) also note that virtual communities do not need formal boundaries, they can be fluid. Because the members cannot see each other, norms do not dominate as much as in traditional communities, thus allowing for greater individual control. In other words, the Internet, or the WWW, becomes the ‘‘place’’ for the community; thus networked communication has increased the parameters of what is known as a community (Palloff & Pratt, 1999).

Palloff and Pratt (1999) describe several steps in constructing a virtual community. First, one needs to define clearly the community’s purpose and create a gathering place for the group. Subsequently, the participants in the group should promote leadership from within the group, as well as define norms or a code of conduct. This allows community members to resolve conflicts by themselves. In addition, a range of member roles should be established, plus facilitation of subgroups.

Both virtual communities and communities of practice have life cycles. Palloff and Pratt (1999) outline the following five stages with respect to the life cycle of community development, whether the community is traditional or virtual: ‘‘forming, norming, storming, performing, and adjourning.’’ ‘‘Storming’’ refers to conflict that is an inherent and necessary part of all workgroup evolution. Haythornthwaite, Kazmer, and Robins (2000) refer to these temporal stages of community development as initial bonding, early membership, and late membership. Palloff and Pratt delineate the phases of building a virtual community as follows:

(1) the initial (testing the waters) phase, (2) the conflict phase, (3) the intimacy and work phase, plus (4) the termination phase. Seufert (2000) focuses on learning within a community and divides it into four phases: (1) content, (2) intention, (3) contracting, and (4) settlement. These phases are also based on time. Thus, in communities of practice and virtual communities, language, practices, customs, and resources develop over time (Squire & Johnson, 2000).

Communities of practice comprise social arrangements in which individuals learn by participating in activities. They include the members, which consist of both experts and novices. In addition, communities of practice also include the artefacts, which are the products, technology, media, and processes that are created by its members. Constructivist techniques (e.g., collaboration, facilitation, and ill-structured problems) enable learning to take place in communities of practice. Communities of practice differ from traditional learning environments because the learning takes place in the actual

situation, including the social environment. This means novices and experts, as well as novice movement to expertise, are important aspects of communities of practice.

Virtual communities are networked communities that bridge time zones and geographical locations. Networked technologies, especially the Internet, allow these virtual communities to exist.

2.4.4 Cloud Computing

Today's internet, built upon ubiquitous connectivity, low-cost processing capacity, open standards and loosely coupled information technology (IT) infrastructure, has been widely recognised as a tremendous enabler for business collaboration (Chen et al., 2007). In the global marketplace, the internet is a tool by which businesses may uncover additional opportunities and is viewed as a requirement to develop a technology-driven competitive advantage (Liu and Orban, 2008). The internet-based Cloud Computing model, while intangible in context, offers a means by which technologically savvy organisations may leverage previously unavailable tangible IT capacity, for a fraction of the traditional resource commitment. Synthesizing from several sources, Cloud Computing may be defined as a connectivity-facilitated virtualized resource (e.g. software, infrastructure, or platforms) that is dynamically reconfigurable to support various degrees of organisational need, which allows for optimized systems utilization (IBM, 2009; IBM Global Technology Services, 2010; Vaquero et al., 2008).

Cloud Computing assures to transform the delivery of vital computing services as well as offering all different users, additional advantages. These advantages could be from clarified administration tasks for project leaders to instant access to huge processing authority for desktop users. Nevertheless, to obtain the entire advantages, a full devotion to Cloud computing is essential including a requirement for users to adjust business methods and approaches to computing services. as well as the clearly understandable systems changes (Khajeh-Hosseini et al., 2010; Marston et al., 2011; Chang, 2015). As a result, an assessment of a Cloud Computing project must keep in mind the overall advantages and disadvantages to the organisation in the form of its environment, in addition to technical considerations. This is especially important for newly formed services and logical experts to offer the organisations that implement Cloud computing, the facility to complete their projects quicker and with improved quality, as well as making certain that all the staff and clients concerned are pleased with the type of services that have been used.

Recent developments in the field of cloud computing have immensely changed the mode of computing as well as the concept of computing resources. In a cloud based computing infrastructure, the resources are normally in someone else's premise or network and accessed remotely by the cloud users (Petre, 2012; Ogigau-Neamtiu, 2012; Singh & jangwal, 2012).

Processing is done remotely implying the fact that the data and other elements from a person need to be transmitted to the cloud infrastructure or server for processing; and the output is returned upon completion of required processing. In some cases, it might be required, or at least possible, for a person to store data on remote cloud servers. These give the following three sensitive states or scenarios that are of particular concern within the operational context of Cloud Computing:

- The transmission of personal sensitive data to the cloud server,
- The transmission of data from the cloud server to clients' computers and
- The storage of clients' personal data in cloud servers which are remote server not owned by the clients.

All the above three states of Cloud Computing are severely prone to security breach that makes the research and investigation within the security aspects of Cloud Computing practice an imperative one. There have been a number of different blends that are being used in the Cloud Computing realm, but the core concept remains the same – the infrastructure, or roughly speaking, the resources remain somewhere else with someone else's ownership and the users 'rent' it for the time they use the infrastructure (Bisong & Rahman, 2011; Rashmi, Sahoo & Mehfuz, 2013; Qaisar & Khawaja, 2012). In some cases, stored sensitive data at remote cloud servers are also to be counted.

Security has been at the core of safe computing practices. When it is possible for any unwanted party to 'sneak' on any private computers by means of different ways of 'hacking'; the provision of widening the scope to access someone's personal data by means of Cloud Computing eventually raises further security concerns. Cloud Computing cannot eliminate this widened scope due to its nature and approach. As a result, security has always been an issue with Cloud Computing practices. Robustness of security and a secured computing infrastructure is not a one-off effort, it is rather ongoing – this makes it essential to analyse and realize the state-of-the-art of the Cloud Computing security as a mandatory practice. Cloud is mainly categorized as private

cloud, community cloud, public cloud and hybrid cloud (Ogigau-Neamtiu, 2012; Singh & jangwal, 2012; Rashmi et al., 2013; Qaisar & Khawaja, 2012; Kuyoro, Ibikunle & Awodele, 2011; Suresh & Prasad, 2012; Youssef, 2012) - the discussion in this paper assumes only one category of cloud exists which is public cloud; as this assumption will well satisfy all the characteristics of any other type of cloud. Due to its diversified potentiality, the approach to Cloud Computing is being thought to be as the 5th utility to join the league of existing utilities water, electricity, gas and telephone (Buyya, Yeo, Venugopal, Broberg & Brandic, 2009) rather than being just another service.

2.4.4.1 Definition of Cloud Computing

Cloud Computing is a new model of computing that is widely being utilized in today's industry and society (Hartig, 2008). According to Hartig, Cloud Computing is a recent concept and one of the latest computer industry buzzwords. Hartig specifies that the concept is derived from the imagery of the Internet Cloud, in which the imagery of a cloud is traditionally used to represent the Internet or some large networked environment. The idea illustrated in the imagery is that client data and applications are stored and accessed somewhere out there (Hosch, 2009). As such, one definition offered for Cloud Computing is the ‘‘virtualization of resources that maintains and manages itself (Hartig, 2008). To simplify the concept, Cloud Computing can be defined as simply the sharing and use of applications and resources of a network environment to get work done without concern about ownership and management of the network's resources and applications. With Cloud Computing, computer resources for getting work done and their data are no longer stored on one's personal computer, but are hosted elsewhere to be made accessible in any location and at any time.

Cloud Computing is the latest trend to outsource some or complete IT operations to run a business from the public Cloud that provides a flexible and highly scalable technology platform for an organisation's business operations (Armbrust et al., 2010; Badger et al., 2011; Catteddu and Hogben, 2009). It lowers IT costs and provides organisations with the people and expertise to create a "pre-integrated suite" of software applications. Various analysts' reports predict billions of dollars in revenue from Cloud Computing (Gartner Press Release, 2010; Reuters, 2011)

Cloud computing has many advantages as Nuria Lloret Romero (2012) point out these include:

- Cost reduction. Ability to increase or decrease the consumption of hardware or software resources immediately and in some cases automatically.
- Scalability. “Pay as you go” allowing a more efficient control of expenditures.
- Lower investment, reduced risk. Immediate access to the improvements in the resource proposed (hardware and software) and debugging.
- Support included. Enjoyment of the most advanced security procedures, availability and performance of providers with experience and knowledge in this type of service.
- Greater security and accessibility. Access to resources from any geographical point and the ability to test and evaluate resources at no cost.

Nuria Lloret Romero (2012) argues that the drawbacks are actually the same as those encountered by institutions that have information hosted outside of the entity. Whereas, in the case of hard-copy document files at the enterprise level, this fear disappeared years ago. Given the benefits of cost reduction in infrastructure management and security, in the case of digital data, there is still a huge fear of putting our information in the hands of third parties. These fears arise from issues such as confidentiality, theft, loss etc. yet people are increasingly more likely to do what they fear most now that the use of Web 2.0 and social networks has become so widespread. There is nothing more sensitive than banking or personal data, yet this data is stored in servers over which we have no domain or ownership.

An institution might take the decision to progressively move towards cloud computing by uploading applications which are not very sensitive such as: messaging, the booking of rooms, meeting management, the liquidation of costs, and holiday management. Following this learning process, more valuable information involving the corpus of the institution, i.e. “Business intelligence” might be uploaded to the cloud.

By accessing services through the cloud, the elements related to their business could be bought on a pay-and-go basis, without the requirement to purchase whole ERP, finance or CRM sets (Sharif, A.M. 2010). Instead there will be a joint process from software and hardware sellers, and a relationship is then started directly with the middle-man: the Cloud Computing provider.

The term Cloud Computing is rather a concept which is a generalised meaning evolved from distributed and grid computing. Cloud Computing is described as the offspring of distributed and grid computing by some authors (Che, Duan, Zhang & Fan, 2011). The straightforward meaning of Cloud Computing refers to the features and scenarios where total computing could be done by using someone else's network where ownership of hardware and soft resources are of external parties. In general practice, the dispersive nature of the resources that are considered to be the 'cloud' to the users are essentially in the form of distributed computing; though this is not apparent or by its definition of Cloud Computing, do not essentially have to be apparent to the users.

In recent years, the cloud has evolved in two broad perspectives – to rent the infrastructure in cloud, or to rent any specific service in the cloud. Where the former deals with the hardware and software usage on the cloud, the latter one is confined only with the "soft" products or services from the cloud service and infrastructure providers. The computing world has been introduced with a number of terminologies like SaaS (Software as a Service), PaaS (Platform as a Service) and IaaS (Infrastructure as a Service) with the evolution of Cloud Computing. As discussed earlier, the term "Cloud Computing" is rather a concept, so are the terminologies to define different blends of Cloud Computing. At its core essence, Cloud Computing is nothing but a specialized form of grid and distributed computing, which varies in terms of infrastructure, services, deployment and geographic dispersion (Hashizume et al. 2013; Westphall et al., 2011; Hamlen, Kantarcioglu, Khan, & Thuraisingham, 2010). In a universal sense, within the context of computer networks, infrastructure could be thought of as the hardware as well as their alignment, where platform is the operating system which acts as the platform for the software (Singh & Jangwal, 2012; Lee, 2012).

Thus the concept of cloud based services is hierarchically built from bottom to top in the order of IaaS, PaaS and SaaS. This is merely the level of abstraction that defines the extent to which an end-user could "borrow" the resources ranging from infrastructure to software - the core concern of security and the style of computing are not affected by this level of abstraction. As a result, security is to be considered within any form of Cloud Computing (Bisong & Rahman, 2011), regardless of hierarchy and level of abstraction. Virtualization is an inevitable technology that is highly coupled with the concept of Cloud Computing (Buyya et al., 2009; Ogigau-Neamtiu, 2012; Hashizume et al. 2013; Kim, 2009; Mosher, 2011; Atayero & Feyisetan, 2011; Zissis & Lekkas, 2012) -it is the virtualization technology that complements cloud services especially in the

form of PaaS and SaaS, where one physical infrastructure contains services or platforms to deliver a number of cloud users simultaneously. This leads to the addition of total security aspects of virtualization technology, on top of the existing security concerns and issues of Cloud Computing.

Security is the most prioritized aspect for any form of computing, making it an obvious expectation that security issues are crucial for the cloud environment as well. As the Cloud Computing approach could be associated with having users' sensitive data stored both at clients' end as well as in cloud servers, identity management and authentication are very crucial in Cloud Computing (Kim & Hong, 2012; Emam, 2013; Han, Susilo & Mu, 2013; Yassin, Jin, Ibrahim, Qiang & Zou, 2012). Verification of eligible users' credentials, and protecting those credentials are part of main security issues in the cloud - violation in these areas could lead to undetected security breaches (Kumar, 2012) at least to some extent for some period. A potential authentication scenario for a cloud infrastructure is illustrated in the "Figure 1".

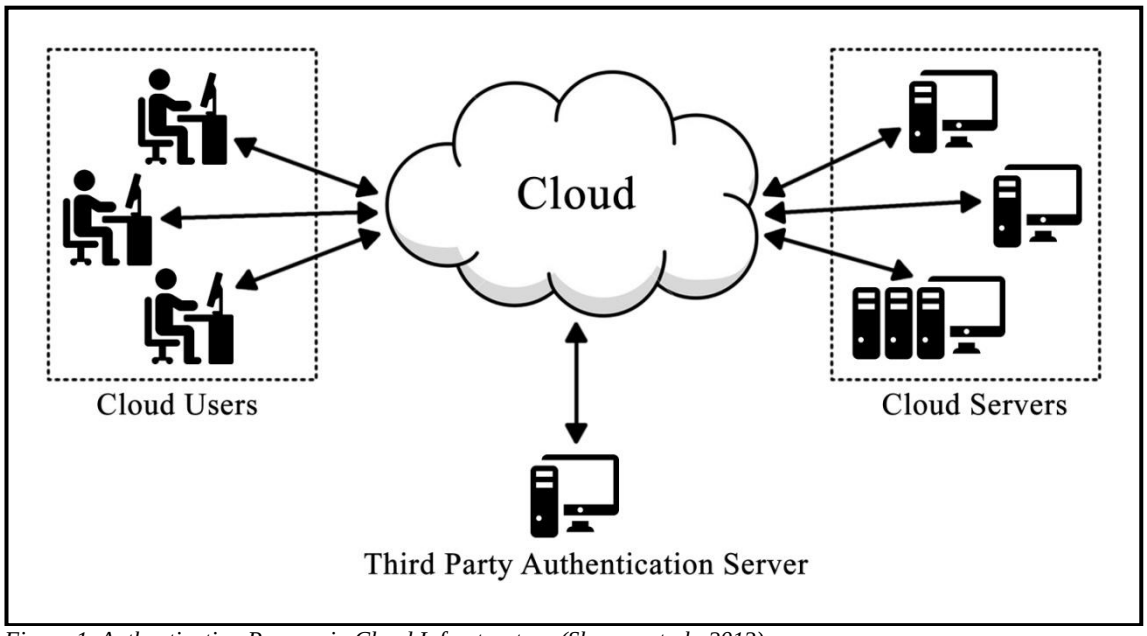

Figure 1. Authentication Process in Cloud Infrastructure (Sharma et al., 2013)

The illustration presented in "Figure 1" conveys that the authentication for the cloud users can be done either by the cloud service provider, or the service provider can outsource the identity management and authentication service to third party specialists (Gonzalez, Miers, Redigolo, Simplicio, Carvalho, Naslund & Pourzandi, 2012; Sharma & Mittal, 2013). In the latter ,the cloud service provider is required to have collaboration with the third party authentication specialist – the collaboration between the cloud service provider and the third party authentication specialist, during the

authentication process of cloud users, is done essentially through cloud. This feature adds performance overheads and security issues to the cloud context, as the message passing between third party authentication management authority, and the cloud service provider as part of collaboration, might essentially be done through cloud infrastructure. As discussed earlier, the total authentication process, and how they are carried out - regardless of the involvement of third party authentication specialists - is transparent to cloud users. The illustration on the authentication scenario presented above is a fairly simple one - if geographically dispersed servers are deployed by the cloud service providers, then the total authentication process might be far more complex in terms of security, underlying algorithm, as well as performance level. Whatever the level of complexity, the introduction of third party authentication and identity management specialist into any cloud architecture, should have only one goal; and the goal is to strengthen the robustness of security in the concerned area which the cloud service provider itself is not capable of to deploy or offer.

Cloud Computing will be adopted by firms that are likely to use a more hybrid process on the premise of, "public" cloud and "private" cloud services where appropriate (Goscinski and Brock, 2010). The concept of private Cloud Computing involves firms deploying key enabling technologies, such as virtualisation and multi-tenant applications, to create their own private cloud database. Individual business units then pay the IT department for using industrialised or standardised services in line with agreed chargeback mechanisms. For many firms, this approach is less threatening than an overall move to the public cloud and should make it easier to hand individual services over to trade partner providers in future (Tuncay, 2010). Moreover, Cloud Computing is a new business model wrapped around new technologies, such as virtualisation, applications (Software as a Service (SaaS)), platform (Platform as a Service (PaaS)), and hardware (Infrastructure as a Service (IaaS)) (Goscinski and Brock, 2010).

Everything as a Service (XaaS or EaaS) is a critical perception for Cloud Computing to implement its key enabling technologies (fast wide-area network; powerful, inexpensive server and high-performance virtualization). XaaS aims to make the available resources consumable, so that it could help businesses take advantage of Cloud Computing. Cloud-oriented Service Solutions could play an important part in transforming enterprise systems, contributing to cost reduction, agile deployment of services,

expanded flexibility and improved productivity. (The Customize windows blog, by Abhishek, 2011)

This XaaS principle can also be extended to the Business level (Business as a Service (BaaS)). IBM Global Business Services explained: "BaaS provides six key enablers (Speed and adaptability; Scalability/ elasticity; Cost flexibility; Analytics; Focus/ strategic alignment and Collaboration) that can fundamentally change an industry or expand the horizon of what is possible in business model innovation" (IBM Global Business Services Datasheet, 2011).

2.4.4.2 Security Concerns on Cloud

Cloud Computing comes with numerous possibilities and challenges simultaneously. Of the challenges, security is considered to be a critical barrier for Cloud Computing in its path to success (Khorshed, Ali & Wasimi, 2012). The security challenges for the Cloud Computing approach are somewhat dynamic and extensive. Data location is a crucial factor in Cloud Computing security (Teneyuca, 2011). Location transparency is one of the prominent flexibilities for Cloud Computing, considered to be a security threat. At the same time – without knowing the specific location of data storage, the provision of the data protection act for some regional areas might be severely affected and violated. Cloud users' personal data security is thus a crucial concern in a Cloud Computing environment (Joint, Baker & Eccles, 2009; Ismail, 2011; King & Raja, 2012). In terms of customers' personal or business data security, the strategic policies of the cloud providers are of upmost significance (Joint & Baker, 2011), as just technical security is inadequate to address the problem. Trust is another problem which raises security concerns of using the cloud service (Ryan & Falvy, 2012) for the reason that it is directly related to the credibility and authenticity of the cloud service providers. Establishing trust may become the key to creating a successful Cloud Computing environment. The provision of a trust model is essential in Cloud Computing as this is a common interest area for all stakeholders for any given Cloud Computing scenario. Trust in cloud might be dependent on a number of factors among which some are automation management, human factors, processes and policies (Abbadi & Martin, 2011). To a great extent trust in cloud is not a technical security issue, but it is the most influential soft factor that is driven by security issues inherent in Cloud Computing. Cyberattacks and the data in transit similarly apply to cloud based services - some threats in this category are man-in-the-middle attack, phishing, eavesdropping, sniffing and other similar attacks. DDoS (Distributed Denial of Service) attack is one common

yet major attack for Cloud Computing infrastructure (Dou, Chen & Chen, 2013). The well-known DDoS attack can be a potential problem for Cloud Computing, and there should be no exception to the option of being able to mitigate this. The security of the virtual machine will define the integrity and level of security of a cloud environment to a great extent (Rakhmi, Sahoo & Mehfuz, 2013; Agarwal & Agarwal, 2011). Accounting & authentication, as well as using encryption, falls within the practice of safe computing - they can be justly considered as part of security concerns for Cloud Computing (Lee, 2012; Ogigau-Neamtiu, 2012; Singh & Jangwal, 2012). However, it is important to distinguish between risk and security concerns in this regard. For example, vendor lock-in might be considered as one of the possible risks in cloud based services which do not essentially have to be related to security aspects. On the contrary, using a specific type of operating system (e.g. opensource vs. proprietary) might pose security threats and concerns which, of course, is a security risk. Other examples of business risks of Cloud Computing could be licensing issues, service unavailability, provider's business discontinuity, which do not fall within the security concerns from a technical viewpoint. Thus, in Cloud Computing context, a security concern is always some type of risk, but any risk cannot be blindly judged to be a security concern. Allocation of responsibilities among the parties involved in a Cloud Computing infrastructure may result in experiencing inconsistency, which makes security vulnerable and at risk. Like any other network scenario, the provision of insider-attack remains as a valid threat for Cloud Computing (Ogigau-Neamtiu, 2012). Any security tools or other kinds of software used in a cloud environment might have security loopholes which in turn would pose security risks to the cloud infrastructure itself. The problem with third party APIs as well as spammers are threats to the cloud environment (Bisong & Rahman, 2011; Singh & Jangwal, 2012).

As Cloud Computing normally means using public networks and subsequently putting the transmitting data exposed to the world, cyber-attacks in any form are anticipated for Cloud Computing. The existing contemporary cloud based services have been found to suffer from vulnerability issues, the possibility of security loopholes that could be exploited by an attacker. Security and privacy are both concerns in Cloud Computing due to the nature of such a computing approach (Bisong & Rahman, 2011). The approach taken by Cloud Computing has made it prone to both information security and network security issues (Rakhmi, Sahoo & Mehfuz, 2013; Qaisar & Khawaja, 2012). Third party relationship may emerge as a risk for the cloud environment, along with other security threats inherent in infrastructural and virtual machine aspects (Hashizume

et al., 2013). Factors like software bugs, social engineering, and human errors make the security for cloud a dynamically challenging one (Kim, 2009). Intrusion detection is the most important role in seamless network monitoring to reduce security risks. If the contemporary IDSs (Intrusion detection Systems) are inefficient, the resultant consequence might be an undetected security breach for cloud environment (Westphall et al., 2011).

The factors from which the security threat might be introduced into a cloud environment are numerous, ranging from database, virtual servers, and network to operating systems, load balancing, memory management and concurrency control (Hamlen et al., 2010). Data segregation and session hijacking are two potential and unavoidable security threats for cloud users. One of the challenges for Cloud Computing is in its level of abstraction as well as dynamism in scalability, which results in poorly defined security or infrastructural boundary. Privacy and its underlying concept might significantly vary in different regions and thus may lead toa security breach for cloud services in specific contexts and scenarios (Chen & Zhao, 2012). Data loss and various botnets can come into action to breach security of cloud servers, besides multi-tenancy model, that is also a feature that needs attention (Kuyoro et al., 2011; Ogigau-Neamtiu, 2012) when it comes to security. Security in the data-centres of cloud providers are also within the interests of security issues, as a single physical server would hold many clients' data (Okuhara, Shiozaki & Suzuki, 2010), making it a common shared platform in terms of physical server or operating system. The storage security at the cloud service providers data centres are also directly linked with the security of the cloud services (Mircea, 2012). All the traditional security risks are thus applicable with an added degree of potency in a cloud infrastructure, which makes the ongoing success of Cloud Computing quite a challenging one. Confidentiality, availability and integrity are the generalized categories into which the security concerns of a cloud environment falls. Threats for a cloud infrastructure are applicable both to data and infrastructure (Agarwal & Agarwal, 2011).

Different modes of data transfer and communication means (e.g. satellite communication) may need to be taken into account. Huge amounts of data transfer is a common anticipation in a cloud environment, the communication technology used, along with the security concerns of the adapted communication technology, also becomes a security concern for the Cloud Computing approach.

The dissemination nature of some communication technology is a core concern in this regard (Celesti, Fazio, Villari & Puliafito, 2012). The Cloud environment is associated with both physical and virtual resources and they pose different levels of security issues - having no sophisticated authentication mechanism to fully address the security threats, is an existing problem for Cloud Computing. It has mainly resulted in the situations where grid computing has been taken as an embedded part of Cloud Computing (Casola, Cuomo, Rak & Villano, 2013). As the virtualized resources are highly coupled with a cloud infrastructure, intrusion related security concerns are of utmost priority as part of security issues. Arbitrary intermittent intrusion needs to be monitored in the operational context of a Cloud Computing infrastructure where the severity of possibility for a virtual machine to be compromised is to be taken into account (Arshad, Townsend & Xu, 2013). Some authors have argued that using Internet technologies is not a must for Cloud Computing (Khorshed et al., 2012) - but the cost efficiency and globalization trends will enforce and motivate almost all the businesses to admit Internet and associated technologies to be the ultimate means towards Cloud Computing approach. As a result, total Internet related security concerns are anticipated to be automatically added on top of the cloud-specific security issues. Bringing portability is one of the means to make cloud services flexible. The portability of cloud services would also be associated with security concerns. Cloud portability enables the cloud users to switch among different cloud service providers without being affected with the necessity to change the ways to accomplish tasks in different ways. It is a clear provision on bargaining power for the cloud users; but at the same time, the security issues with cloud portability are to be counted. Cloud portability might bring severe degree of API based security threats (Petcu, Macariu, Panica & Craciun, 2013).

The wide transition to mobile computing practices in recent years, has made it imperative to include mobile computing and its associated technologies as an essential part of Cloud Computing. Resource , as well as other constraints of mobile computing, are barriers to Cloud Computing. The demand of huge data processing is a problem for mobile end-user devices which has been further complemented by the security concerns of mobile Cloud Computing. For mobile Cloud Computing, the device level limitations has inspired researchers to suggest the inclusion of another level of cloud termed as ‘mobile cloud’ to aid the processing of the specific computing and processing for mobile computing devices (Fernando, Loke & Rahayu, 2013). The earlier explained broadcast nature of satellite communication and related security issues are equally applicable to the mobile Cloud Computing due to its being wireless communication.

Besides, the addition of mobile cloud into the perspective would add another cloud with all its security issues for a service provider having both mobile cloud and conventional cloud. The addition of mobile cloud in the scenario would boost performance, but it would also add another layer of security issue not only to the mobile cloud users, but also to the total infrastructure of the cloud service provider. The hierarchical arrangement of Cloud Computing facilitates different level of extensibility for the cloud users with varying degree of associated security issues (Che et al., 2011). Security issues for Cloud Computing are described by some authors, as an obvious one, due to its nature. In a business model, the risks for the consumers are related to and dependent on the relevant approaches and policies of the cloud service providers the consumers are dealing with.

Using cloud products or services may lead to security concerns for the consumers if they are not well aware with the type and particulars of the products or services they are to procure, or to use in a cloud environment; this is also related to the cloud providers' identity and reliability. One of the inherent problems in this context is that the consumers might normally be unable to identify or foresee all the risks involved in the specific cloud transaction they are dealing with, or involved in (Svantesson & Clarke, 2010).

2.5 Collaboration within the Construction Industry

Knowledge sharing is one of very important business aspects and is considered one of the core competencies in knowledge management (Pasher and Ronan, 2011; Liu, 2008). The critical result of knowledge sharing is the formation of new knowledge and innovation that will significantly improve organisational performance (Al-Hawamdeh, 2003). Therefore, there is need to understand the factors influencing knowledge sharing activities and examines the knowledge sharing behaviour in SMEs because of their contribution to economic growth.

Anson, P. B. (2018) states that study of the dynamic patterns of behaviour has recently achieved the interest of scholars studying the investments in Research and Development of enterprises as well as setting up and arrangement of collaborative agreements. Anson, P. B. (2018) argues that continual cooperative behaviour and determination in R&D implement a positive effect on innovation performance.

According to Anson, P. B. (2018), that perseverance in both activities permits enterprises to surpass competitors, because R&D investments contributes to external

innovation activities not only because it builds the base of knowledge that is required for enterprises to be able to acknowledge the value, understand, develop and utilise existing new knowledge from the external environment (Cohen and Levinthal, 1990), but also because it generates certain knowledge that may not be easily operated or provide advantages outside the enterprise or copied by rivals (Dierickx and Cool, 1989).

Based on the form of behaviour of enterprises being persistent in R&D, it is argued that they are provided with a extensive knowledge and they have collective abilities and a major technological base (Peters, 2009; Raymond et al., 2010). Thus, it appears that enterprises being persistent in R&D are going to be able to instigate a greater number of innovations (Peters, 2009).

Surprisingly, although extant research has acknowledged that investments in R&D could potentiate the establishment of collaborative agreements, the literature has no analysed the impact on innovation performance that persistence in these two activities have, both individually and jointly.

A common problem in introducing knowledge sharing in SMEs is the lack of clarity about which types of methods should be taken into consideration (Fink and Ploder, 2009). Wong and Aspinwall (2004) indicated that SMEs generally lack a proper understanding of knowledge sharing and is slow in adopting formal and systematic knowledge sharing practice. This is because most of the SMEs feel that it is not feasible to establish a formal system for codifying, organising and storing knowledge since they are always busy with their daily routines (Wong and Aspinwall, 2004).

They tend to focus more to company survival lead to poorly documented knowledge which creates problems when their key resource leaving (Debowski, 2006). Although there were many researches about knowledge sharing, few of them focused on SMEs. Most previous studies on knowledge sharing have been confined mainly to the public sectors or large private companies (Fathi et al. 2011). Because of the discernible absence of studies examines knowledge sharing in SMEs context, so it is necessary to deep research on knowledge sharing in SMEs in order to formulate a model that could be used to promote knowledge sharing that fits with the SMEs environment (Eze et al., 2013).

There are many studies regarding knowledge sharing factors and collectively, these studies have identified a number of factors that are believed to influence knowledge sharing behaviour. The researchers acknowledge the factors that influence knowledge

sharing was through individual psychological, social, organizational cultural and technological factors (En, 2012; Eugene, 2010; Habeeba, 2010; Fong et al., 2011; Hislop, 2009). According to Liu (2008) and Henriks (1999), ICT gets more important as a prominent tool for facilitating knowledge sharing due to information technology improvement and knowledge transmission. Although knowledge sharing gets more important due to the technology improvement and recognised as the most factor in facilitating knowledge sharing by researchers, however the human factors still remain the key success in knowledge sharing (Liu, 2008; Al-Hawamdeh, 2003). According to Chatzoglou and Vraimaki (2009) the most important determinant factor to influence knowledge sharing behaviour is from an individual perspective. The results of previous studies indicated that individual psychology has a positive effect towards knowledge sharing behaviour. For instance, the finding of several studies found that trust (En, 2011; Eze et al. , 2013, Fathi et al., 2011), self-efficacy (Al-Qadhi, 2013; Zhang and Ng, 2012; Jolaee, 2012), attitude (En, 2011; Wu and Zhu, 2012; Zhang and Ng, 2012) and enjoyment (Wu and Zhu, 2012; Anitha, 2006) are critical success factors for knowledge sharing.

Akintoye and Main (2007) state that in the UK, Construction Industry Enterprises have a positive perspective about collaboration and are involved in collaboration relationships for construction developments. According to their research study, factor analysis shows that the principal reasons why contractors are engaged in collaborative relationships are for risk sharing, access to innovation and technology, response to market, resource efficiency and client requirements. The major success elements are commitment of sufficient resources from the partners, equity of relationship, identification of the significance of non-financial benefits and clarity of objectives while the main failure aspects are lack of trust and consolation as well as lack of business experience (Akintoye and Main, 2007).

The construction sector is a huge and compound field of the UK economy, adding to £103 billion in economic output in 2014, and covering a broad variety of products, facilities and expertise (BIS 2013; Rhodes 2015). Innovation in the industry is not constantly profit-based, but it is impacted by arrays of governmental potentials such as general policies, government rules, construction criterion, market and economical situations and the public opinion for the environment (Dale 2007; Lizarralde et al., 2015). Therefore, enterprises are required to find methods to change their practices and technologies based on these external demands. This process may not be effortlessly put

into practice because of the high number of enterprises engaged in construction tasks, and the low degrees of modernisation and resilience to adapt.

Construction enterprises hardly ever innovate in confinement, but in collaboration with other enterprises, clients or suppliers, and in cooperation with innovation associates such as universities (Hauser 2010). This is difficult as the field is also defined by high degrees of sub-contracting, self-servicing and the production of many small and micro sized businesses (BIS 2013). Based on this, enterprises must tackle, control and make use of the innovative competences of various firms by interconnecting the resources in a network so that they depend on each other to the least extent practicable.

2.6 Management within the Construction Industry

There are different management disciplines which are used within the construction industry. In this section Total Quality Management and Life Cycle Management within construction industry are discussed in more depth and the associated literature will be reviewed.

2.6.1 Total Quality Management

A review of the essential elements of Total Quality Management (TQM) exposed a lack of practical application of the processes within the construction industry. The main factors included a lack of adequate budget, failure to plan adequately for quality, inadequate training at all levels except for top or senior management positions, and little recognition given to those who strive for quality improvement on their projects (Haupt and Whiteman, 2004).

Pheng and Teo (2004) envisage that there is a general resistance to implementation of TQM in the construction industry. The main reasons of this reluctance are; Product Diversity, Organisational Stability, and Misconception of the Cost of Quality. Sommerville, Stocks and Robertson (1999) support the uniqueness of the construction industry and specify a set of barriers which might prevent the organisations from taking full advantage of the adoption of holistic TQM including product differentiation, organisational stability, change (reluctance to change), contractual relationships, and teamwork and management behaviour.

Likewise, indicating the differences of construction industry and manufacturing, Arditi and Gunaydin (1997) state that quality control procedures which are effective in a mass production industry are not considered suitable for the construction. Accordingly Kubal

(1994) suggests that the concept of quality control should be changed from "controlling quality" to "controlling management for quality" in construction, which would result in utilising an integrated quality control system, based upon the current industry experience and standards. Pheng and Teo (2004) showed that the majority of construction organisations in the UK are reluctant to implement TQM because they feel that ISO 9000 series is enough and therefore they do not want to impose more "cultural shock" to their employees. In addition, Love et al. (2000) state that organisations in the construction industry have refrained implementing TQM practices because they feel that the short term benefits are relatively nominal, also it is common for these firms to consider TQM as a synonym to quality assurance (QA). Furthermore, Haupt and Whiteman (2004) point out the historical reluctance of the construction industry to implement change. According to them, construction companies are intended to implement just those aspects of total quality management programs which will provide them with competitive advantage and lead to an improved financial performance. According to Kubal (1994) the construction industry presents a unique situation for a quality management programme due to the disintegration of site management and office management teams. Furthermore, uniqueness of every project, due to different management structures and different internal and external customer requirements, necessitate that the quality management programme be tailored individually and specifically to each project. Pheng and Ke-Wei (1996) indicate that many of Crosby's approaches to quality, fit the construction industry well. According to them, Crosby's quality definition - conformance to requirements - could be adapted to the construction industry as simply conforming to drawings and specifications. Generally, construction process can be broken down into three main phases: planning and design phase (pre-construction), construction phase, and maintenance and operation phase (commissioning). Hellard (1993) argues that establishing the project s requirements must always be considered at the first phase in the overall process of building.

Appointing a committed team of main contractor and subcontractors to the quality process and developing a true quality attitude are the initial important steps in developing the quality in the construction process. In other words, selection of the team must reflect the quality attitude of the work (Pheng and Ke-Wei, 1996). Chileshe (2004) suggests a four-phase implementation process for TQM; start up, transition, consolidation, maturity and refocusing. In addition, Pheng and Ke-Wei (1996) outline a more detailed process for TQM implementing construction projects as follows:

- Obtaining the client commitment to quality;
- Generating awareness, educating the staff and changing the attitude;
- Developing a process approach towards TQM;
- Preparing project quality plans for all levels of work;
- Establishing organisation and management bodies;
- Instituting continuous improvement;
- Promoting staff participation and contribution using quality control circles and incentive programmes;
- Reviewing quality plans and measure performance.

Shammas-Toma, Seymour and Clark (1998) show that generally there is a poor and insufficient coordination, collaboration, and communication system within the construction process. However, undertaking an effective QA system in the process can provide a remedy for some of the coordination problems. Clearly implementation and development guidelines of a TQM programme must be set out in accordance to the organisational needs and requirements. Collard (1993) suggests that a successful total quality programme is derived from certain principles. According to him, implementation process is characterised by six fundamental requirements, based on the concept that people are the heart of a successful programme. These requirements are; top management commitment, attitude change, continuous improvement, strengthened supervision, extensive training and recognition of performance. Arditi and Gunaydin (1997) indicate that the project's quality requirements should be established at the inception stage of the construction process. They refer to the project requirements as the key factors that define quality in the process of construction. In "Figure 2", the generally accepted elements of TQM and construction industry specific factors that affect quality of the construction project's process are illustrated (Arditi and Gunaydin, 1997).

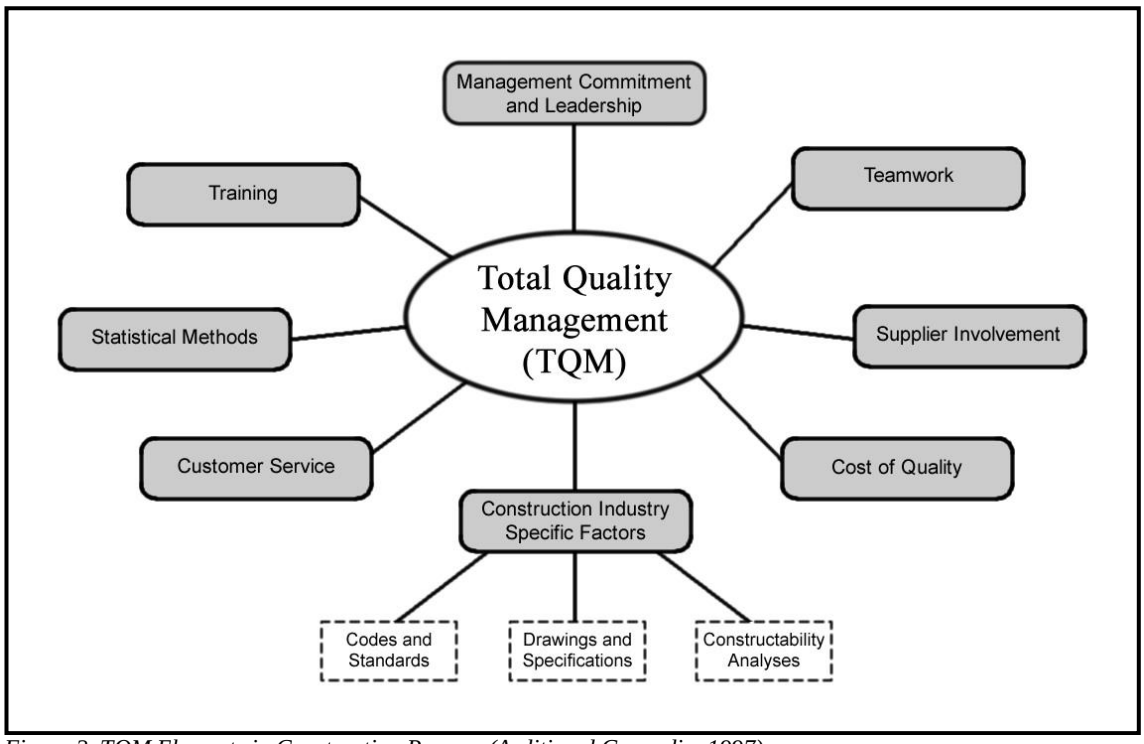

Figure 2. TQM Elements in Construction Process (Arditi and Gunaydin, 1997)

2.6.2 Lifecycle Management

It is believed that Lifecycle Management (LCM) in the construction industry can reduce the life-cycle cost of projects and improve the service to owners (Xie and Simon 2006). Construction project management is traditionally separated into several independent and contiguous phases, e.g. planning, design, construction, commissioning, etc, and they are implemented respectively with almost no communication or interaction between participants in each phase (Gransberg and Ellicott 1997). This leads to many problems. For example, due to lack of communication and collaboration between designers and constructors, most of designs need to be modified or reworked during construction due to its unfeasibility; otherwise, these changes cannot be effectively supported by design personnel in that after a design is finished and then transferred to constructors, design personnel's tasks are over in the traditional project management method. As a result, time or cost overruns often occur and the rights (e.g. normal completion time, cost, etc) of owners are not guaranteed (Ellicott 1994). The application of the LCM approach helps to solve these problems. LCM integrates each phase of project management from planning, to close-out, making information sharing and coordination possible between owners, consultants, designers, contractors, etc (ISO 2002; Teresko 2004). All parties can communicate and collaborate with each other in real-time. On one hand, this makes the holistic operation processes consistent and ensures a reasonable construction time

and cost; on the other hand, it enables the owners' interests to be protected due to their ideas receiving due attention from other parties involved.

The effective implementation of LCM in construction projects relies strongly on a visual communication and collaboration information platform (Fraser, M. and Dutta, S. 2008; Garetti 2004) as information sharing is the key to implementing LCM (Schilli and Dai 2006). An effective information platform is needed to gather project information (Gross and Fleisch 2004) and furnish relevant information (from planning to decommissioning) to each participant (Krause and Kind 1998). At the same time, this allows information to be open, transparent, and otherwise easy to understand, especially for complex projects. However, no such information platform exists in the construction industry. Often, many shop drawings and Gantt charts provided by different parties are needed to conduct the LCM of construction projects, as all parties, including owners, consultants, designers, contractors, etc, need them to discuss and make decisions on the planning, design, procurement, construction, commissioning, and decommissioning of projects. Due to the increasing complexity of projects, a great deal of information is needed (Love et al. 2002; Lee et al. 2006). This is usually provided in the form of 2D (dimensions) drawings that cannot be easily understood by each party. For example, owners find it difficult to understand the drawings provided by designers, while designers often cannot completely master the ideas of owners. As a result, the target of "information sharing" is rarely realised in the current LCM of construction projects.

Life Cycle Management (LCM) has been developed as a business approach for managing the total life cycle of products and services (Garetti 2004; Kovacs et al. 2006). Its potential application in the construction industry has also been examined in recent years and various project life cycle approaches have been discussed, e.g. control-oriented models, quality-oriented models, risk-oriented models, etc., (Bonnal et al. 2002). In addition, it has been noted that, owing to the different characteristics of projects or industries, the phases of project life cycle are different from each other. As a result, it has been proposed that the available life cycle phases of Conceptual, Planning, Testing, Implementation and Closure (Kerzner 2001) should be applied to projects.

Planning includes conception design, preliminary evaluation, etc.; Design involves initial design and detailed design; Utilization refers to the owners' or tenants' use or operation of buildings; and Decommissioning consists of demolition and recycle of buildings or material.

2.7 Company Culture and Technology Adoption

In the previous sections, some of the management techniques within the construction industry were discussed. However, it should be noted that complex phenomena such as technology adoption is also associated with organisational culture within the company. Hence, in this section company culture and technology adoption will be discussed in more details, and the associated literature will be reviewed.

2.7.1 ICT Innovation Adoption

Innovation has been defined as "the generation, development, and adaptation of novel ideas on the part of the firm" (Damanpour, 1991). This type of innovation, from an IT perspective, refers to a new practice or operational scheme (Lind and Zmud, 1991; Annukka, 2008). ICT can influence firm productivity (Caldeira and Ward, 2003; Oliveira and Martins, 2011) and as a result there are a large number of published studies which have considered the adoption and diffusion of ICT-based innovations. Several theoretical and empirical studies have examined ICT innovation adoption, and many theories have been tested (Rui, 2007; Oliveira and Martins, 2011). For user adoption, a number of models have been proposed in information systems research. The main aim for these models was to decide what aspects influence user adoption and usage behaviour within organisations (Ndubisi and Jantan, 2003). Examples of key theories applied to study the adoption of ICT innovation and adoption in previous research, include the following: theory of planned behaviour (Harrison et al., 1997); innovation diffusion theory (IDT) (Cragg and King, 1993); theory of reasoned action (Elena et al., 1999); technology acceptance model (Grandon and Pearson, 2004).

Ontologically, theories may consider different units of analysis, typically the user (micro-level), the firm (meso-level) or the market/innovation (macro-level). Given that SMEs are the focus of our work, we turn our attention in the rest of the literature review to the meso-level, i.e. the organisational-level ICT innovation adoption process. At the firm level, theories such as diffusion of innovation (Rogers, 2003) have been widely applied to studies looking at how innovations are adopted and diffused.

Oliveira and Martins (2011) suggest that as the technology, organisation and environment (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 power of the technical perspective and provides a useful analytical tool to differentiate between the natural qualities of an innovation and the motivations, capabilities, and broader environmental context of the adopting organisation". Still, this does not mean that the technological characteristics of the innovation are not of key importance for the model.

A 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; Kuan and Chau, 2001). Other applications of the TOE model include studies looking at enterprise systems (Ramdani and Kawalek, 2008); e-commerce (Scupola, 2003; Seyal et al., 2004); EDI (Kuan and Chau, 2001); communication technologies (Premkumar and Roberts, 1999); and internet (Tan and Teo, 1998).

2.7.2 The Capability Maturity Model for Software Systems

In 1986, the Software Engineering organisation (SEITM) with support from the MITRE Company started developing a progression maturity framework that would help firms advance their software processes (Humphrey 2002). This attempt was commenced in response to a demand to provide the Federal Government of the US with a technique for evaluating the capability of their software contractors. In June 1987, the SEI released a short report of the software process maturity framework (Humphrey 1987a) and, in 1987, an introductory maturity questionnaire (Humphrey 1987b).

As a result of skill and knowledge in using the software process maturity framework and the maturity questionnaire for identifying problems and improving processes, the SEI made official the theory as the Capability Maturity Model for Software (Software CMM).Version 1.0 of the model was issued in 1991 (Paulk et al. 1991;Weber et al. 1991). The Software CMM has since been replaced with the CMM Integration (CMMI) model, but it encouraged many other standards and frameworks, including the Systems Security Engineering CMM (Hefner 1997). It was also one of the main aspects in the

development of ISO/IEC 15504 (Process Assessment), especially Part 7 on the assessment of organisational maturity (ISO 2008).

The Software CMM had a remarkable influence on the software society. It is anticipated that billions of dollars were spent on CMM-based improvement (Emam and Goldenson1999). Many research reports have been issued on its influence on efficiency, productivity, and quality (Krasner 2001; Clark 2000; Harter, Krishnan, and Slaughter 2000), and its maturity levels have been inserted in various cost models such as COCOMO II (Boehm 2000).

The basic argument regarding the SEI's work on software process maturity is that the quality of a software product is largely established by the quality of the software development and frequent update processes applied to construct it. The configuration of the software process maturity framework is based on total quality management (TQM) standards that have been in place for almost a hundred years.

In recent times, the TQM theories have been broadened from manufacturing procedures to service and engineering design systems. The software process can be described as a set of movements, techniques and performances that people use to develop and sustain software and the associated products. As an organisation matures, the software process gets better described and more steadily implemented within the institute. This will result in higher-quality software, increased efficiency and improved software project management. This is an adaptation of the Deming chain reaction shown in "Figure 3". Perhaps the most vital element to state in this sequence reaction is that process improvement and quality management should influence business objectives and goals.

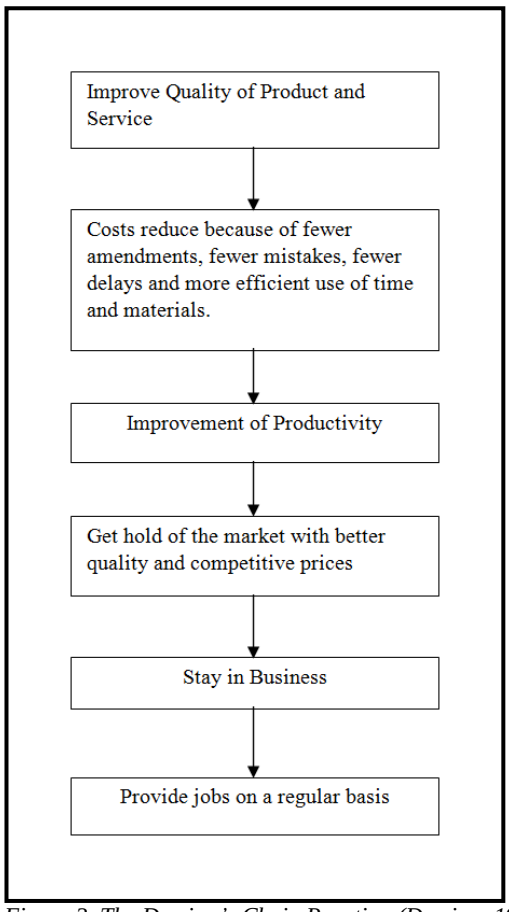

Figure 3. The Deming's Chain Reaction (Deming, 1990)

The Software CMM became accustomed towards TQM theories for software organisations. The model creates a project management and engineering base for organisational learning and management. Watts Humphrey adapted Philip Crosby's quality management maturity grid for his development work at IBM (Humphrey 2002), and the maturity configuration resulted in the software process maturity framework that became the Software CMM.

Philip B. Crosby (1979) describes five advanced stages in adopting quality practices. The quality management maturity grid applies five stages to six measurement categories in subjectively rating an organisation's quality operation. These five stages are:

- Uncertainty: Management is puzzled and indifferent regarding quality as a management tool.
- Awakening: Management is starting to realise that quality management can assist.
- Enlightenment: The decision is made to really perform an official quality improvement program.

- Wisdom: The enterprise has the opportunity to make changes everlasting (things are mainly quiet and people are not sure why they used to have difficulties).
- Certainty: Quality management is considered an extremely fundamental part of enterprise management.

The six measurement categories are:

- Management perception and behaviour: It is defined as "no knowledge of quality as a management tool" at indecision and "a vital part of the enterprise system" at certainty.
- Quality enterprise position: It is described as hidden at indecision and a major concern at certainty.
- Managing Problems: Dealt with whilst they happen at indecision and prevented at certainty.
- Cost of quality as percent of sales: It is defined as 20 percent at indecision and 2.5 percent at certainty.
- Quality enhancement tasks: It is identified as no arranged activities at indecision and a regular and constant activity at certainty.
- Outline of company quality position: It is described as "we are not sure why we have difficulties with quality" at indecision and "we know why we do not have problems with quality" at certainty.

The maturity stages include clear development priorities, direction for choosing those few enhancement tasks that will be the most helpful if designed instantly.

This is essential because most software enterprises can only concentrate on a few process improvement actions at a time. Many firms have made the mistake of discovering several required improvements, then falling short of acting on any of them because they were pressurised by the volume and difficulty of the requirement. The approach Watts Humphrey (Radice et al. 1985) supplied in the maturity framework was a recognition of the "fundamental few" problems at each maturity level that require to be fixed first. It was viewed that tested projects had many connections in their underlying issues. Targeting frequent problems in a reliable style was considered to be an effective method of building organisational capability, although it was identified that

certain projects would have unique requirements that would also have to be dealt with as part of an improvement program.

At Level 1, the first level, the software process is identified as ad hoc, and sometimes even disordered. Few processes are described, and success depends on personal attempts of individuals. “Ad hoc” is sometimes used as a criticism, but ad hoc simply means “special.” The problem with ad hoc processes is that it is hard to envisage performance or learn from experience when everything is new and unique. Level 1 is described by the failure to assure the requirements for Level 2, yet there is one unspoken requirement: If an enterprise does not create software, the model is inappropriate (and the enterprise could be classified as a Level 0 enterprise).

At Level 2, the repeatable level, vital project management procedures are created to keep hold of expenditure, timetable, and functionality. The required process regulation is in place to repeat earlier successes on projects with related applications. The focus at Level 2 does not clearly include the engineering processes, because the main issues Level 1 enterprises have to deal with are managerial problems, and not technical ones (DOD 1988). Engineering procedures are designed and followed at Level 2, but they are not explained in detail—or even stated in some versions of the model.

At Level 3, the clear level, the software procedures for both management and engineering performances are formally acknowledged and incorporated into a set of standard software processes for the enterprise. Projects use an approved and modified version of the firm’s set of standard software procedures for building and sustaining the software. The engineering processes are first plainly stated at Level 3, but they must be put into practice at Level 1 if the enterprise is making software, even if those engineering procedures are ad hoc and performed in variable modes. The importance of Level 3, however, is on organisational learning via process meaning and enhancement.

At Level 4, the managed level, detailed events of the software procedures and product quality are gathered. Both the software process and products are quantitatively acknowledged and managed. This suggests statistical thinking (Britz et al. 1996) and evidence-based management (Pfeffer and Sutton 2006), although these phrases were not used in the early formulations of the model. It also should be stated that events and examination take place at all levels of the model, although it comes to the front position at Levels 4 and 5.

At Level 5, the efficiency improvement level, process enhancement will continue taking place by feedback from the process and from original thoughts and technologies. Applying statistical thinking allows the enterprise to learn about process potential and corroborate when there are statistically major differences in action as the process is changed. In the 1987 framework, this level was described as the optimised level, but it was renamed in early 1988 to the optimising level because the constant process enhancement activities never end. The serious concepts of organisational maturity therefore include a concentration on organisational change and revolution to identify general project issue, an emphasis on management rather than engineering procedures, and fixing the major issues disrupting success.

2.7.3 Technology, Organisation and Environment Framework

The Technology, Organisation and Environment Framework (TOE) is a multi-perspective framework that was developed by Rocco DePietro, Edith Wiarda and Mitchell Fleischer (DePietro et al., 1990). The TOE framework is an organisation-level theory. It represents one section 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:

- Technological context, which 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.
- Organisational context, which is related to the resources and the characteristics of the firm, e.g. size and managerial structure.
- Environmental context, which 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, p. 154). These elements influence the firm's level of technological innovation. These three key constructs are illustrated in "Figure 4", and will be discussed in detail below.

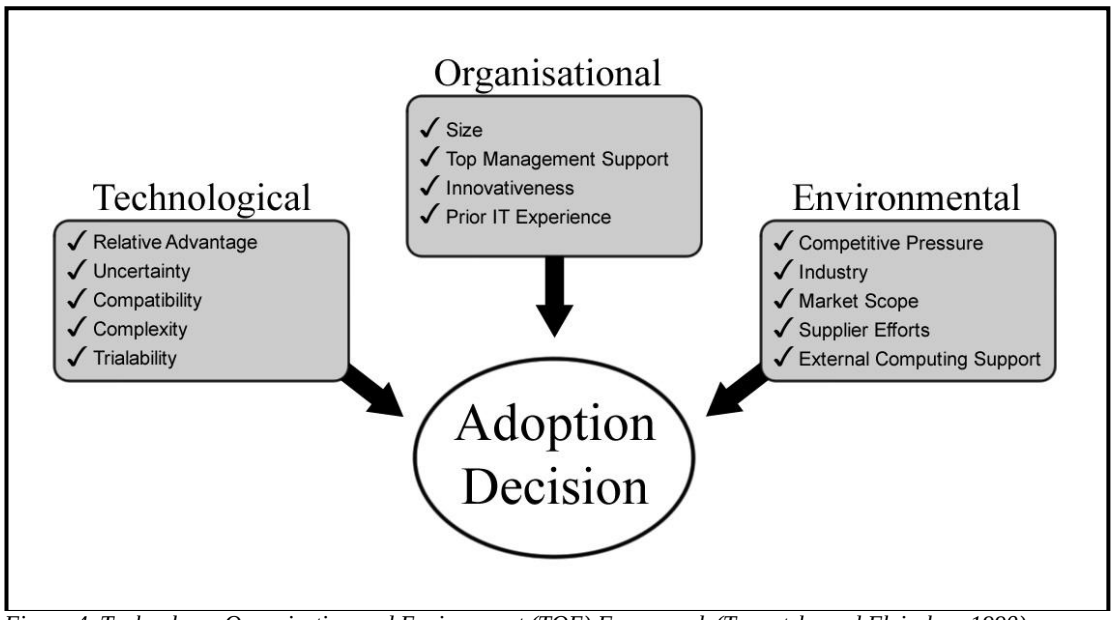

Figure 4. Technology, Organisation and Environment (TOE) Framework (Tornatzky and Fleischer, 1990)

2.7.3.1 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 there are not enough studies that have investigated the impact of technological characteristics. Following TOE, this research will embark from Rogers' IDT, to study the impact of the technological factors. According to Stuart (2000), in the field of innovation diffusion, Rogers' theory is one of the most commonly used.

Relative Advantage: it is taken as a central indicator to the adoption of new IS innovation. The impact of relative advantage on technology adoption has been widely investigated in previous studies (e.g. see Premkumar and King, 1994; Iacovou et al., 1995; Thong, 1999; Gibbs and Kraemer, 2004; Lee, 2004; Ramdani and Kawalek, 2008). It has been shown that when businesses perceive a relative advantage in an innovation, then the probability of the adoption will increase (Thong et al., 1994; 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 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 almost apparent (Sokolov, 2009).

Uncertainty: 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.

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: there is a large volume of published studies describing the role of compatibility, and they consider it as an essential determinant of IT innovation adoption (Rogers, 2003; Teo et al., 1997; Premkumar and Roberts, 1999; Premkumar, 2003; Ching and Ellis, 2004; Daylami et al., 2005; Zhu et al., 2006). For instance, in 166 small Singaporean firms, Thong (1999) found that compatibility of the innovation had a strong influence on the adoption of IS in these businesses. Similarly, in the Zhu et al. (2006) study, compatibility was considered as 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 principles and the technology requirements for their organisations (Lee, 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.

Complexity: Rogers (2003, p. 230) stated that adoption will be less likely if the innovation is considered as being 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 element in the adoption decision (e.g. 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: a number of studies have found that trialability is one of the most important mechanisms in the process of adopting a new technology (Rogers, 2003; Kendall, 2001; Martins et al., 2004; Ramdani and Kawalek, 2007, 2008). For instance, the findings of Hsbollah and Idris (2009) and Jeyaraj et al. (2006), suggest that trialability is the most important factor that influences the adoption of Internet and new online technology in education. 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, trialability is more significant when it comes to exploring new innovations (Rogers, 2003).

2.7.3.2 Organisational Context

Some of the organisational factors such as size, support and expertise have been highlighted in TOE framework. In this section, such factors are reviewed and discussed in more details.

Size: 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 (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 (2008) there are studies that report a positive correlation (Mahler and Rogers, 1999; Aguila-Obra and Padilla- Mele´ndez, 2006; Kamal, 2006; Ramdani and Kawalek, 2007, 2008; 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: it has been shown that technology innovation adoption can be influenced by top management support and attitudes towards change (Premkumar and Michael, 1995; Eder and Igbaria, 2001; 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 as the main link between individual and organisational ICT innovation adoption. Generally, top management support is vital 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 the 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; Daylami et al., 2005; Wilson et al., 2008).

Innovativeness: 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). On 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). This factor has been investigated in previous studies such as Midgley and Dowling (1978), Hirschman (1980) and Rogers (2003). 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 firm (Damanpour, 1991; Marcati et al., 2008).

Prior IT experience: users' recognition of prior similar experiences can be observed 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 Roger 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 (Bandura, 1977; Igbaria et al., 1995; Hunter, 1999; Kuan and Chau, 2001; Lippert and

Forman, 2005). Consequently, prior experience could be expected to play a facilitative role in the adoption decision.

2.7.3.3 Environmental Context

Environmental factors such as competition, industry and market place have been highlighted in TOE framework. In this section, such factors are reviewed and discussed in more details.

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). Prior empirical studies have noted the importance of competitive pressure as an adoption driver (e.g. see Grover, 1993; Iacovou et al., 1995; Crook and Kumar, 1998). For example, 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 being able to increase their market share (Majumdar et al., 1992).

Industry: according to Levenburg et al. (2006) the adoption of IS innovation by a firm can be influenced by the industry in which the firm operates. More specifically, it has been reported that the industry to which a business belonged 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 statistics 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). Therefore, the industry sector could potentially be a significant factor in new technology adoption.

Market scope: it has been identified as the horizontal extent of a company's operations (Zhu et al., 2003). SMEs operate not only locally, but also nationally and even internationally. 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 maybe 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.

Supplier effort and external computing support: 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. 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.

2.8 Summary

In this chapter, various literatures were reviewed to enhance the overall existing knowledge of main aspects within this research. The reviewed literatures were regarding online technologies used for collaboration, UK SMEs and the construction sector. In the next chapter, there will be a major focus on the existing methods of collaboration within the UK construction SMEs, what current technological adoptions have taken place in various construction SMEs and how effective and efficient they have proven to be. Another significant aspect that would be discussed is about employees' desire to adapt to new innovative systems and online technologies that may be utilised in their workplace.

The purpose of this literature review is to track the ongoing innovations and technology related concepts within Construction SMEs (Small and Medium Sized Enterprises), highlight the key definitions and properties, review and evaluate the strengths and weaknesses of current collaboration approaches within construction SMEs with focus on identifying their current lack of innovativeness within their collaboration system.

Online collaboration is a new model of communication and collaboration that is used extensively in today's industry and society, and is one of the latest industry buzzwords.

To simplify this concept, online collaboration can be defined as the sharing, and use of applications and resources of a network environment, with the advantage of being able to complete jobs without any concerns regarding the ownership and management of the network's resources and applications. With Cloud Computing, computer resources and personal data for an individual to work, are no longer stored on their personal computer, the resources and data is hosted elsewhere to be made accessible at any time and from any location.

In the UK, Construction Industry Enterprises have a positive perception about collaboration and are involved in collaboration relationships for construction developments. According to their research study, factor analysis shows that the major reasons why contractors are engaged in collaborative relationships are for risk sharing, access to innovation and technology, response to market, resource efficiency and client requirements. The main success factors are commitment of sufficient resources from the partners, equity of relationship, identification of the significance of non-financial benefits and clarity of objectives, while the main failure aspects are lack of trust and consolation as well as lack of business experience.

About 98.2% of the construction sector includes businesses that are defined within this SME category (Construction Statistics Annual, 2007). Therefore, it is an essential part of construction sector that requires attention. A massive part of their business depends on collaboration and partnering with other businesses. How successful or not the collaboration is, would depend on the collaborative arrangements between the companies. These arrangements should be able to resolve the issues associated with such collaboration by allowing partners to expand resource and provide quick and flexible access to external resources.

The TOE (technology, organisation and environment) framework is an organisation-level theory. It represents one section 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 including "Technological context", "Organisational context" and "Environmental context". These three contexts present both constraints and opportunities for technological innovation (Tornatzky and Fleischer, 1990, p. 154). These elements influence the firm's level of technological innovation.

3 Online Collaboration within Construction SMEs

The construction industry is often associated with fragmentation, complexities and non-integrated environments. The significant challenge for construction projects is to integrate, support and facilitate a multidisciplinary team of stakeholders working with supply chain parties and project stakeholders on achieving the common goals of a project. They must work collaboratively to improve the productivity and effectiveness of construction management and to ensure the efficient utilisation of resources in order to guarantee the success of construction projects in achieving their specific objectives. These specific objectives mostly concern completing the project within the required time and cost whilst ensuring its quality and safety. For several years, the construction industry has made considerable efforts within an increasingly competitive market to implement techniques, technologies and tools that can reduce project duration and cost along with improving productivity, efficiency and effectiveness. It should be noted that clients within the dynamic construction industry are requesting better value of money, higher quality, shorter construction cycle times and access to up-to-date information. Moreover, they require such information to be produced at any point in both the project life cycle and construction supply chain (O'Brien et al., 2011; Aziz et al., 2006).

Although a variety of technological advancements have arisen within the construction industry (Anumba et al., 2008 and 2006; Sze-wing et al., 2008; Acar et al., 2005), there are still many challenges in existing construction processes resulting from poor access to the right information at the right time for effective decision-making and from a general communication breakdown between project participants.

This could contribute to a lack of collaboration and integration both within the construction supply chain and between project stakeholders (Xuan et al., 2007; Peansupap et al., 2006; Kondratova et al., 2003).

Quality, quantity and timing of information are significant elements in construction projects which can either hamper or assist the successful consequences for project objectives (Garza et al., 1998). Moreover, according to Anumba et al. (2008), construction is an information-intensive industry since information delivery is the key to better management within the construction supply chain including the implementation of construction projects. Also, it is vital for cost savings, efficient and effective decision

making and a key to success. Modern project management approaches and tools have been evolved in order to overcome problems in construction management. The use of project management tools in construction management has been widely known (Milosevic, 2003). All of these techniques and tools are key facilitators for efficient and effective collaboration among construction industry parties.

In order to overcome the mobile and information-intensive nature of construction projects, their unstructured and dynamic nature, along with the difficulties and hazards existing within the construction industry, will necessitate the use of intelligent solutions such as adapting Cloud Computing to support the construction industry. As stated by Goscinski and Brock (2010), Cloud Computing is a new business model wrapped around new technologies, such as virtualisation, applications (Software as a Service (SaaS)), platforms (Platform as a Service (PaaS)) and hardware (Infrastructure as a Service (IaaS)). Therefore, this research effort is to discover the concepts and benefits of applying and incorporating a context-aware approach to the use of Cloud Computing within the construction industry.

3.1 Construction Collaboration Tools

Since the early 2000's, many researchers have sought to implement techniques, technologies and tools which reduce project duration and cost whilst improving quality, productivity, efficiency and effectiveness. Within the dynamic construction industry, clients, as a significant part of the construction supply chain, are requesting better value for money, higher-quality products, shorter construction periods and access to valid and up-to-date information at any time in the project life cycle (O'Brien et al., 2011). As asserted by Barthelmess (2003), collaboration in a project requires those involved to communicate and be aware of one another's activities. Moreover, collaboration requires successful and efficient sharing of knowledge, negotiation, coordination and management of activities (Lang et al., 2002). On the other hand, the unstructured, dynamic and complicated nature of projects, their difficulties, threats and risks, are associated with the construction industry. Thus, in order to overcome the mobile and information intensive nature of construction projects, the use of creative and intelligent ways of collaboration will be necessary. Consequently, Cloud Computing is a potentially significant tool to support the construction industry and its currently available collaboration tools, such as desktop PCs, internet networks, tablets, smart phones and laptops. Therefore, this research will propose the development of a context-aware construction collaboration tool (Application) for the successful effective

implementation of Cloud Computing in the construction industry that could be utilized by the supply chain parties and project stakeholders. The next part of this research will present the various concepts, definitions, delivery models and types of Cloud Computing.

3.2 Context-Aware Construction Collaboration Tools

Information communication technologies (ICT) are reaching their main target of developing an environment in which anyone can easily access any information they may need at any time and from anywhere (Cloud Computing). On the other hand, the cost reduction of information delivery has drawn the construction industry into an ocean of unmanageable amounts of information (both useful and useless). Therefore, it is important to provide useful information, merely for a specified user, at a given time and according to the user's context (context-awareness). On the other hand, the adaptation of information communication technologies (ICT) and tools in the construction industry is slower compared to other industries. Aziz et al. (2006) asserted that there is limited application of context-aware technology in the construction industry. Furthermore, there are valuable opportunities via evolving the significant enabling technologies of CAID (Context-Aware Information Delivery).

Additionally, Aziz et al. (2009) identified some of the enabling technologies for CAID which were classified into location-based services, ubiquitous computing, sensor networks, Radio Frequency Identification (RFID) and profiling technologies.

Awareness of a user’s context (such as their role, task, preferences, location and site conditions, etc.) in mobile construction applications, will enhance the effectiveness of project delivery by providing information and services relevant to a particular context (Fathi et al., 2009). Therefore, awareness of a user’s context could provide efficient and effective information, communication and services throughout the entire construction supply chain to enhance the success of construction projects.

Architectural System of Context-Aware Cloud Computing Information System (CACCIS), besides the characteristics of great fragmentation, similar information is exchanged, processed, manipulated and disseminated throughout the construction industry Consequently, drawings are redrawn, lists are re-entered, quantities are recounted and materials are ripped out and replaced unnecessarily etc. These examples of unproductive workflows will all be contributors to a decline in productivity.

Therefore, the significant objective is to enhance the early coordination and communications, along with improving collaboration by bringing the parties within the construction project supply chain together much earlier, in much the same way that design/build brought the architect and contractor together at the project's onset, so that any modification one party makes will affect the entire process of the construction project; thus, creating constant communication and efficiencies. Therefore, it is hoped that by proposing this cloud-based model (an openly shared collaborative tool), all project stakeholders and supply chain parties, including the design team members, owner, architects, contractors, suppliers, engineers and consultants, will be able to collaborate more accurately and efficiently than in traditional approaches and processes. Implementation of this system will result in enhanced productivity, efficiency and effectiveness within the construction industry.

The construction sector is fragmented, project based (and therefore mobile/temporary) with many types of information needed by so many different stakeholders (Betts, 1999), including clients, regulatory authorities, consultants, contractors and the supply chain.

Information flow serves as the backbone for all successful projects across the construction sector. Construction small and medium-sized enterprises (CSMEs) are an important part of the UK construction sector to absorb collaboration - supporting technologies such as Cloud Computing, that has the ability to provide a platform for cloud collaboration tools, facilitating transfer of information and data in digital format, using digital devices such as smart phones, tablets and laptops on construction sites. The aim is to provide accessibility to information to improve productivity. Productivity is defined as a ratio of a measure of output, to a measure of some, or all, of the resources used to produce this output (Grimes, 2007). Productivity improvement is an increase in the ratio of produced goods or services in relation to resources utilised (Pekuri et al., 2011).

The research investigates the use of system dynamics (SD) methodology as a modelling and analysis tool in order to identify the key drivers in the absorption of Cloud Computing in CSMEs. The aim is to determine how system dynamics (SD) can improve management of information flow leading to improved productivity, using Cloud Computing technology and cloud collaboration tools for CSMEs. The focus is at the production stage on the construction site. System dynamics is a tool that can be used to address the complexity in the management of information flow on construction sites. Consideration is given to information flow through the value chain, from the design

team, to the speciality contractor, focusing upon the speciality contractor. Most research has been concerned with information flow between the design team and the main contractor, whereas with specialisation and the out-sourcing of work packages, the role of specialist contractors is increasingly important in the information flow process.

3.3 Information Mobility

Information and data moves from the design offices, through to the construction site, needs to be accessed by construction personnel to carry out relevant construction activities. The site is concerned with converting the design into production processes, which involve a plethora of different skills and trades. Whilst the overall process is interdependent, each of the specialty contractors is focussed on their work package.

Each specialist requires different information to fulfil their work package, with the overall goal of the main contractor to co-ordinate such information and data. The specialty contractors care about safety, delivery on time, within budget, to ensure the work package is profitable. Computer Aided Design (CAD) and Building Information Modelling (BIM) has meant that design is more dynamic, with faster reaction times on projects. The speciality contractor must deal with change orders, materials delivery, and resource availability. However, there is generally a scarcity of information and data on construction sites (Chen and Kamara, 2008). The information and data is frequently of variable degrees of intensity and diversity with variability in accuracy. The research has focussed on project information which includes models, drawings, emails, mark-ups, submittals, transmittals, images, contracts, specifications, change orders and other documentation that are created in the course of designing, building and operating facilities.

On-time and accurate information provided during the production stage reduces errors, rework and delays, reducing the likelihood of contractual claims, disputes, and the requirement for change orders. Timely information and communication also contributes towards improved health and safety on construction sites (HSE, 2002). It helps in completing projects on time, with reduced costs and improved quality (Titus and Bröchner, 2005). Moreover, information in real time about external factors that influence production, such as inclement weather, or a significant design change being proposed by the client and design team, can help to forward plan activities, so that to minimise disruption to production.

There is a need to manage the complexity of information flow on construction sites from the perspective of all the stakeholders in the production and delivery chain. The characteristic of this research is that it takes a bottom-up approach, viewing production from the site team. Collaboration-enabling technologies have the ability to provide a platform for software collaboration tools that can improve information mobility and the information and data transfer. Information mobility is about ensuring seamless exchange of information in the right version, in the appropriate format and with the required level of reliability, accessed by the right people, at the right time.

The users are as important to information mobility as the technology; mobility will depend on the user's motivation, whether they can afford to use it, and if they have the ability to do so (Peters, 2004). Collaboration between all organisations involved in a project has become a fundamental requirement in construction. Effective collaboration strategies provide document access across any endpoint, deepen connections with partners and increase productivity.

3.4 Construction Small and Medium-Sized Enterprises

"Figure 5" shows that small and medium-sized enterprises (SMEs) in the UK account for 99.8 % of all businesses, 60 % of employment and 47 % of turnover. Construction SMEs are 18.12 % of all SME businesses, with 85 % of employment and 73 % of turnover in the UK construction sector (BIS, 2014).

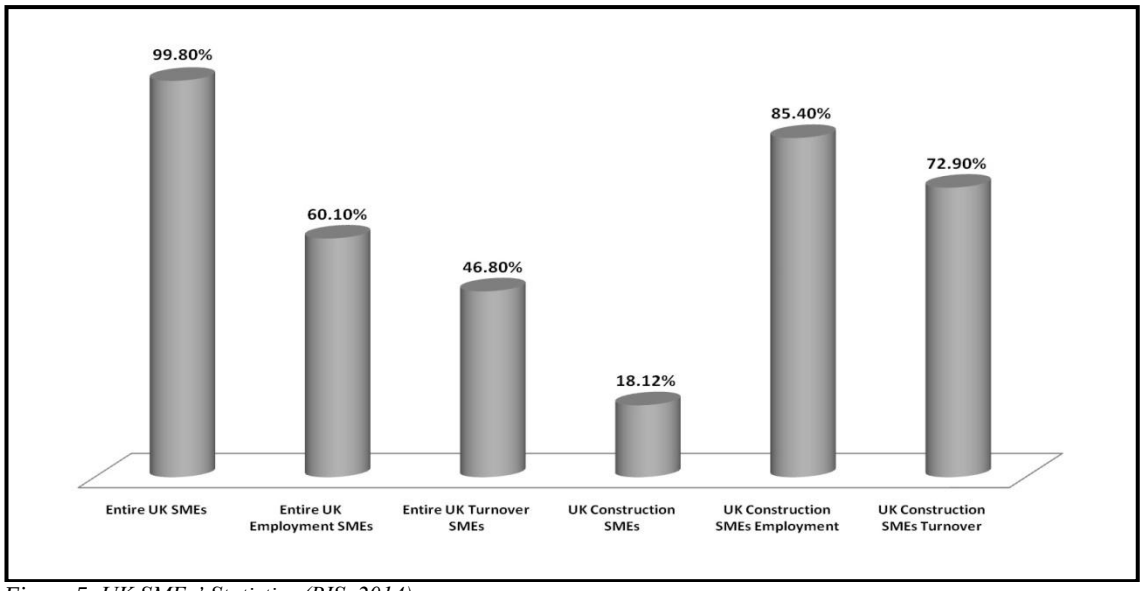

Figure 5. UK SMEs' Statistics (BIS, 2014)

Table 1 shows the European Commission (2005) definition of an SME according to number of employees and annual turnover of a business.

Enterprise Category	Max Headcount (Annual Work Unit)	Max Annual Turnover	Max Annual Balance Sheet
Medium	250	€ 50 m	€ 43 m
Small	50	€ 10 m	€ 10 m
Micro	10	€ 2 m	€ 2 m

Table 1. Definition of SMEs (European Commission, 2005)

In a small firm, the productive activity represents the heart of the organisation (Di Tommaso and Dubbini, 2000). This led this research to focus on the firm's productive capacity and capability on the construction site. Sexton and Barret (2003a) identified various challenges and characteristics for small construction firms:

- Limited staff capacity as well as capability restricting their ability to undertake necessary research and development (R&D);
- Limited time and resources for external interaction that results in restricted flow and amount of information;
- Mostly dominated by single owner or small team who may use inappropriate strategies and skills; and facing difficulty in maintaining an adequate cash flow that results in limited scope for capital or on-going investment in innovation activity.

To the list can be added two further factors, firstly, the lack of systems and procedures with feedback loops providing real-time information on performance and productivity. Secondly, lack of formal organisational structures in CSMEs, which means the lack of systems integration across the business. CSMEs work on both small and large projects as main contractors, sub-contractors, or specialty contractors. Large projects involving work packages that are outsourced to specialty contractors. Large organisations outsource to reduce overheads (Langford and Male, 1992), leading to an increase in number of specialist contractors. Such an increase requires more information and document management with increased integration across all the stakeholders, including consultants and contractors. This can be achieved through increased information mobility especially in the house-building sector that involves a lot of specialist contractors working on a single generic product.

3.5 Cloud Computing and the Construction SMEs

The US National Institute of Standards and Technology (NIST) define Cloud Computing as: "A model for enabling ubiquitous, 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, 2011, p. 2)

Cloud Computing is a general term for anything that includes providing hosted services over the internet (Beach et al., 2013). Everything in Cloud Computing is treated as a service i.e. (XaaS) e.g. SaaS (Software as a Service), PaaS (Platform as a Service) and IaaS (Infrastructure as a Service). At the Infrastructure layer, processing, storage, networks, and other fundamental computing resources are defined as standardized services over the network. Cloud providers' clients can deploy and run operating systems and software for their underlying infrastructure. The middle layer, i.e. PaaS provides abstractions and services for developing, testing, deploying, hosting, and maintaining applications in the integrated development environment. The application layer provides a complete application set of SaaS. The user interface layer at the top enables seamless interaction with all the underlying XaaS layers (Pallis, 2010).

Cloud Computing is not a new technology but rather it is the combination of already existing computing paradigms such as grid computing and virtualization. Cloud Computing is considered as an innovation, because it offers a new method of computing by integrating the already existing technologies (Innovation, 2013). Similar to other innovations, in addition to costs and benefits of adopting Cloud Computing there are other factors that influence the decision to adopt Cloud Computing. Technology adoption is one of the biggest research streams in Information System (IS) field; and many different models and theories try to explain the factors that influence the adoption of new technologies. So far not many studies investigated the adoption process of Cloud Computing. Among these studies few of them focused on the adoption of Cloud Computing by SMEs. Majority of the studies in this field try to introduce Cloud Computing; and to determine the pros and cons of using Cloud Computing.

Although the underlying concept of Cloud Computing dates back to 1950s (when mainframes were accessed by users from different terminals), it was during late 1990s when Cloud Computing started to become a buzz word; and companies gained a better understanding of Cloud Computing (EzeCastle Integration, 2012). The diffusion of Cloud Computing has many advantages at both micro and macro level. At micro level the diffusion of cloud is advantageous for SMEs. At macro level, it is beneficial for the

economy and environment. Below, these potential advantages will be discussed in more details.

3.6 SMEs and Cloud Computing

The size and structure of SMEs gives them some advantages including fast communication between employees and their managers and their ability to rapidly implement and execute decision. But in most cases these companies face many disadvantages. Most of the challenges that SMEs face are due to their lack of access to enough resources (Welsh & Wite, 1981). These resources include but not limited to financial and human resources. This limitation makes SMEs weaker than large companies in terms of financing, planning, control, training and also information technologies (Bilili & Raymond, 1993). Keeping cost under control is one the biggest challenges that SMEs faces. (Communications News, 2008) It is not feasible for SMEs to spend a significant amount of money on their Information Technology (IT). In addition to their high cost, IT projects usually involve a high risk of failure too. About 20 percent of IT projects are cancelled before completion and less than a third are finished on time and within budget with expected functionality (Kappelman, McKeeman, & Zhang, 2006). Overall SMEs have low tolerance in bearing costs and risks that are involved in IT investment.

Different studies have been conducted to investigate how to improve SMEs' operational efficiencies; and help them grow larger. For example, a strategy which has been proven to enhance SMEs' ability to compete against larger companies is the use of appropriate Information and Communication Technologies (ICT) (Tan, Chong, Lin, & Eze, 2009). Although adopting new technologies help SMEs gain competitive advantage, it usually involves high cost. These costs are fixed costs (such as hardware, software, storage, licensing etc.), operating costs (such as cost of operation, maintenance, systems upgrade, etc.) and training costs. Moreover in many cases IT projects involve cost overruns (Jorgensen & Molokken-ostvold, 2006; Whittaker, 1999).

Cloud Computing, as a new computing paradigm, offers many advantages to companies, especially smaller ones. Flexibility, scalability, and reduced cost are just some of many advantages that Cloud Computing offer to SMEs. Detailed explanation of Cloud Computing's advantages will be discussed later in literature review section (section 3.1.3). Cloud Computing enhances companies' competitive advantage (Throng, 2010). It also enables SMEs to access sophisticated technologies without spending

significant amounts of money. These advantages help SMEs grow larger and become more efficient, productive and innovative, by allowing SMEs to focus on their core business. This is applicable to both start-ups and already existing companies.

It should also be noted that cloud providers are specialized in providing IT services; therefore the service provided by these companies is better than the service that is delivered by IT department of SMEs. Relying on massive, centralized data centers, results in achieving economies of scale (Ryan, Merchant, & Falvey, 2011). Cloud's security measures are implemented on large scale, which makes it much cheaper. This is another result of levering economies of scale (Cattehhu & Massonet, 2009).

3.7 Economy and Cloud Computing

As it is briefly mentioned in the introduction, SMEs are very important players of each market. Although they are not powerful enough to individually affect the economy, overall their effect on the economy is considerable. Moreover, smaller firms are the source of many innovations. Acs & Audretsch (1988) found that in comparison to larger firms, the correlation between the number of patents and rate of production innovation is much higher for smaller companies. Also, many of the giant players of today's market started their businesses as small companies some of the good examples are Ford, Microsoft and Boeing (Acs, Morck, Shaver, & Yeung, 1997).

The above mentioned factors make SMEs vital for economies. Acceptance and usage of any beneficial technology by SMEs have a positive influence on the economy as a whole. Since Cloud Computing help SMEs save money and become more efficient and productive, its widespread usage also has a direct impact on the economy. The economy which consists of more innovative, efficient and productive businesses, is at more of an advantage than the economy in which businesses are neither successful nor productive. Moreover, the economies of scale always result in better use of resources; therefore an economy in which IT services operate on economies of scale, uses resources more efficiently. It is another indirect advantage of cloud for the economy.

Cloud service is not offered to the public; it is exclusively offered to one particular organisation.

Consumers of this type of cloud are different units and departments of that specific organisation. In this deployment model, the underlying infrastructure of the cloud can be owned (or leased), operated and managed by the organisation itself, by a third party

or by both. Depending on the company, the underlying infrastructure of the cloud can be on or off-premises (Mell & Grance, 2011). In this deployment model of Cloud Computing, any legal consequence of misusing the information by cloud providers can be prevented (Kim, 2011).

Similar to private cloud, community cloud is exclusively offering service to a specific unit. But unlike private cloud this unit is not comprised of one specific company, rather a group of organisation in a community which shares a set of similar concerns such as mission, security requirements, policy, and compliance consideration, etc. is using this type of cloud (Mell & Grance, 2011). The ownership, management and operation of the cloud can be dedicated to one or more companies in the community; and in some cases it is outsourced to a third party. Similar to private cloud the infrastructure can be on or off-premises. In comparison to private cloud this deployment model brings economies of scale and equilibrium to the community (Dillon, Wu, & Chang, 2010).

Third deployment model of Cloud Computing is public cloud. Nowadays, public cloud is the most common deployment model. It offers the service to the general public. Cloud providers have the full ownership of the infrastructure; and they have their own rules, policies, and pricing models. Public cloud providers can be businesses, academic or government organisations. The service is offered to the general public for use. The physical infrastructure of the cloud provider is on-premises of cloud providers. Some of the well-known public cloud providers are Amazon, Google, IBM and Microsoft (Grossman, 2009).

Finally, hybrid cloud is the combination of two or more previously explained models (private, community and public cloud). Different types of clouds are combined and bound together by standardized technologies and techniques that enable the portability of data and applications between different types of cloud (Mell & Grance, 2011). One of the main reasons for using hybrid cloud is to enhance the core competencies of the organisations. Companies are able to outsource their non-core activities to a public cloud provider, while managing their core activities using their on-premises private cloud. In such a way, organisations can maintain their cost and security at a reasonable level; but at the same time there are some issues regarding standardization and interoperability of clouds which should be considered (Grossman, 2009).

A study conducted by Gartner, reports that by the end of 2016 the value of global cloud industry will reach $148.8 billion (Jones, 2010). European Union (EU) prioritised the

support of Cloud Computing, which positively supports the fact that experts are optimist about the future of Cloud Computing (Bajenaru, 2010). The reason behind this success is linked to the benefits that Cloud Computing brings for individuals and organisations.

Cloud Computing has many advantages for companies. Cloud Computing allows organisations to save money; become more productive; increase their operational efficiencies and effectiveness; and concentrate on their core businesses instead of non-core activities such as maintaining and upgrading systems. These are just some of the advantages of using Cloud Computing. In this section I will discuss in more detail some of the benefits of Cloud Computing for organisations.

One of the characteristic of Cloud Computing which differentiates it from other types of computing is its payment model, which is a utility-based payment model. Utility-based payment model is a pay-as-you-go method, which involves minimal initial investment. This model correlates companies' payments to the actual resource they use. In other words companies, pay only for the amount of service and resources they use. It converts the companies' capital expenditure (CapEx) into operational expenditure (OpEx) (Creeger, 2009). Traditionally companies had to forecast their peak demand; and according to that forecast, invest in infrastructure (CapEx). Using Cloud Computing, companies are not required to invest in, or manage infrastructure. Eliminating the capital expenditure is beneficial for both start-ups and already existing companies. Start-ups tend to be very cost conscious. Cloud Computing help start-ups manage their costs more effectively. Cloud Computing is also advantageous for companies operating now. Based on their system analysts forecast, these companies already invested in some infrastructure. Incorrect forecast wastes their investment. Cloud Computing provides companies with the opportunity to use their existing infrastructure (as a private cloud) to perform their core business activities; and use public cloud for their non-core activities. The conversion of CapEx to OpEx is specifically important for smaller firms.

Another beneficial characteristic of Cloud Computing is its on-demand self-service characteristic. It makes Cloud Computing more flexible than other computing paradigms. Unlike traditional models of computing, Cloud Computing is location independent, which means customers are able to access and use the service wherever they have access to the network. Using Cloud Computing is also device independent, which means the service is able to function on a wide variety of devices regardless of the local hardware on which the software is used. As long as users can connect to the network through a browser, they are able to use the service. Being location and device

independent increases the flexibility of Cloud Computing in comparison to traditional forms of computing such as on-premises deployment. This flexibility in turn, increases the productivity and efficiency of the companies by letting them perform their job remotely.

Another main advantage of Cloud Computing is its ability to scale up and down. The majority of companies different demands which may vary over time, along with their need for computing services. When estimating how much resources are needed, firms tend to make provision for their peak times (Armbrust, et al., 2010), however, when the company is not operating at peak level, these resources lie idle. Not using computing resources to their maximum capacity is wasting money. The scalability of Cloud Computing significantly reduces resource idle time, and gives companies the option to use resources that fit their current level of demand. Should this demand increase, they can instantly scale up their resources that are dynamically released to customers with minimal human interaction (Marston et al., 2011)

Maintaining internal applications and data centres is a stressful and costly procedure which can be reduced or eliminated by using Cloud Computing (Clark, 2009). Cloud Computing helps SMEs use the most state of the art technologies, without being responsible for operating and maintaining the technology. Outsourcing company's IT to cloud providers significantly reduces the complexity of using computing resources, because customers do not need to be concerned about upgrading or maintaining the technology. The service provided by cloud providers is accessible over the network and it takes negligible amount of time and effort for customers to deploy and use the system.

Cloud Computing allows SMEs to focus more on their core business and innovation (Ashford, 2008). All the resources, time and effort that should had been allocated to the companies' IT department; can now be spent on other important areas of the business. SMEs, whose main business is not related to IT, do not need to be concerned about maintaining or upgrading their Information Systems (IS). Rather they can work on their core business; and increase the efficiency and productivity of their companies. It also allows them to become more innovative; and find new ways of doing business.

3.8 Issues Regarding Usage of Cloud Computing

Although Cloud Computing has many advantages, there is also the potential risk of problems. There are different opinions about the potential risks of using cloud. Some argue these concerns are legitimate, while others may say these concerns are not valid.

Some of the main issues with Cloud Computing which have been extensively discussed by scholars and researchers are cloud's security, reliability and privacy and ownership of data. According to Sultan and Tan et al. (2009) security and reliability are two main concerns about services offered by Cloud Computing (Sultan, 2011; Tan, Chong, Lin, & Eze, 2009). In addition to these issues, there are also some other barriers for companies specifically SMEs preventing them from adopting Cloud Computing.

The first and the most commonly discussed issue about Cloud Computing is the concern about security of the cloud. Security of the cloud refers to many issues such as privacy, confidentiality and auditability of the cloud (Zhang, Cheng, & Boutaba, 2010; Khan, Zhang, Khan, & Chen, 2011). Other researchers argue that security-related issues of Cloud Computing are related to third parties' access to their data; or the issues regarding the data transmission and data storage (Subashini & Kavitha, 2011). Hackers are also a big threat to the security of information that is transmitted to and from cloud (Kim, 2011). Identity theft is another main security-related issue that companies face (Chorafas, 2011). However, according to a survey done by Federal Bureau of Investigation (FBI), on origins of information security risks, disgruntled employees were the number one reason behind security breaches.

There are different perspectives about the security of the cloud. In a study conducted by Repschlaeger et al. (2012) managers of thirty companies participated in a survey. The finding of their survey show that 83% of managers ranked security and compliance as high importance. Some believe the cloud is not secure, while others believe it is more secure than other types of computing. Security issues that are discussed by opponents of Cloud Computing are security issues related to the cloud providers' resources, application security, data transmission security (e.g. network infrastructure security) and data storage security (server security) (Subashini & Kavitha, 2011). In 2008, IDC conducted a survey on 244 IT executives about Cloud Computing.

Unlike previous studies about the security of the cloud, another study conducted by European Network and Information Security Agency (ENISA) suggests that because of the fact that cloud providers are specialized in creating data centres and security measures, they can provide better security than small companies who want to manage their own security (2009).

They believe cloud providers offer up-to-date security measures to their data centres. Also because of the backup versions that they have, they can also take care of emergency problems if some happens.

Current businesses are so reliant on their Information Systems, that in many cases the service operation below 99.99% is not acceptable for them. Reliability of the service is another concern about Cloud Computing services which depends on many factors. When continuity of a service is guaranteed, the service is considered as being reliable. Also a reliable system performs in the planned way. A reliable system should be available and operate without any failure, under specific conditions.

Customer lock-in is the next issue with Cloud Computing. Customer lock-in is the instance where a customer who is using Cloud Computing cannot easily switch to another provider. There is no standardised format among cloud providers in storing data. Usually the format in which the customers' data are stored in the providers' data centres is unique to that specific provider. Therefore customers cannot easily transfer their data to another cloud provider. If they want to switch to another provider, they should change the format of the data; which may result in the loss or damage to the data. Customer lock-in forces customers to stay with the same cloud provider, even if they are not satisfied with the service they receive. The customer lock-in situation is favourable towards the cloud providers.

Factors Influencing the Adoption of Cloud Computing by SMEs

Other less discussed concerns about Cloud Computing is as follows:

- The place where data is stored, which may produce legal consequences;
- Who accesses the data;
- Cloud providers' compliance with the Service Level Agreement (SLA);
- Complexity of the system;

One way to overcome the problems just discussed, is to create a set of rules and policies that address these concerns (Subashini & Kavitha, 2011). A good Service Level Agreement (SLA) addresses these problems. A comprehensive SLA includes both threats and opportunities of the service. Some argue that the security and privacy of the data should be equally distributed amongst parties that are involved. Developing new standardized and open technologies and programming languages create new business

models for cloud providers, which improves cloud providers' value chain (Mohammad, Altman, & Hwang, 2009). Also, proposing standard rules and policies regarding the format of data, significantly reduces the risk of customer lock-in. In summary, I believe for SMEs the advantages of using Cloud Computing significantly outweigh the disadvantages of Cloud Computing. A good SLA can minimize the risks that are involved with Cloud Computing services.

Many studies try to define what Cloud Computing is. They mainly try to improve the reader's understanding and knowledge about Cloud Computing. (Grossman, 2009; Youseff, Butrico, & Da Silva, 2008). Some other researchers aim to investigate the concept of Cloud Computing by studying only one type of Cloud Computing, for example Infrastructure-as-a-Service (Bhardwaj, Jain, & Jain, 2010; Kim, 2011; Repschlaeger et al. 2012).

Diffusion of technologies is one of the interesting areas of research; however diffusion of Cloud Computing has not yet received much attention from researchers. (Peiris et al. 2011) conducted a research about this topic, in which they tried to develop a model that not only considers the financial aspects of Cloud Computing, but also other business initiatives such as IT governance structures, IT operational control structures, and technical architectureal requirements.

Taylor and Hunsinger (2011) conducted a research about the acceptance and usage of Google Docs in a university setting. In order to complete their study they used the Theory of Planned Behaviour. In order to collect data, they conducted interviews and surveys. After running regression analysis they found out that attitude, subjective norm, and perceived behavioural control are factors that significantly influence the students' acceptance and usage of Google Docs. According to this study, the person's emotional response are the factors that significantly influence the students' intention to use Google Docs.

Many countries such as Australia, Japan, Malaysia, Taiwan etc., significantly invested on cloud-related projects. This is another reason that makes research about Cloud Computing so compelling (Lin & Yen, 2011). Despite its importance, few researchers have studied the adoption process of Cloud Computing. This number is even less for studies which main focus is on Small and Medium-sized Enterprises. Therefore, there is no doubt that this area of research is appropriate and persisting. The results of this study

will significantly contribute to the field of study; and will be valuable for both practitioners and researchers.

Current market is characterized as being very competitive. Therefore, for companies who want to survive, it is essential to adopt innovations. As it has been mentioned previously, one of the most state-of-the-art technologies that assist companies gain competitive advantage is Cloud Computing. Cloud Computing allows companies to access the most advanced technologies over a network (e.g. Internet). If companies switch to Cloud Computing, they can save time, energy and money. These resources can then be spent in other value-adding areas of their business. It makes companies more efficient and productive which is particularly true for SMEs.

If several companies switch to Cloud Computing this will create far greater levels of efficiency for the company, and in turn the economy and the environment. Cloud providers specialize in offering IT services; therefore they can accomplish IT-related tasks quicker, and more economically by spending fewer resources. Furthermore, offering any service on a larger scale brings in economies of scale which result in more efficient operations.

Economies consisting of more efficient and innovative companies are certainly at more of an advantage than those which are comprised of inefficient companies. Widespread usage of Cloud Computing will reduce the number of data centres; because individual companies do not need to have their own data centres. Data centres that are operating by cloud providers, consume resources in a more efficient manner than small data centres. Cloud Computing is based on virtualization, which results in less power consumption. It is one way to achieve environmental sustainability.

Cloud Computing is still in its early stages of diffusion; therefore studying its adoption process is very useful. It helps cloud providers recognize the factors that influence the decision to adopt Cloud Computing. In a study conducted by Marston et al. (2011) a research agenda about Cloud Computing is proposed. One of the topics that have been proposed in this study is research about technology adoption and implementation (Marston et al. 2011). Practitioners and researchers agree that diffusion of an innovation in the market depends on different factors. During the last five decades, scholars have tried to determine the factors that influence the diffusion process of different technologies. Many different theories and models have been proposed to study the process of adopting new technologies. The eight major theories of this field are Theory

of Reasoned Action (TRA) (Ajzen & Fishbein, 1980), the Technology Acceptance Model (TAM) (Davis, 1989; Davis F. , 1986), the Motivation Model (MM) (Davis, Bagozzi, & Warshaw, 1992), the Theory of Planned Behavior (TPB) (Azjen, 1985, 1991), the Combined TAM and TPB (c-TAM-TPB) (Taylor & Todd, 1995), the Model of PC Utilization (MPCU) (Thompson, Higgins, & Howell, 1991), Diffusion of Innovations (DOI) (Rogers, 1962) and Social Cognitive Theory (SCT) (Compeau & Higgins, 1995).

Types of innovation decision depend on two factors: the degree of voluntariness; and the person responsible for decision making. Optional decision making is the one in which one person who is distinguishable from others in a social system, makes the decision. In collective decision making, decision is made by all individuals in a social system. Finally, in authority decision making, few people makes decisions on behalf of the whole social system (Diffusion of Innovations, 2012).

3.9 Decision Maker's Innovativeness

Innovativeness is defined as "the level of decision makers' preference to try solutions that have not been tried out; and therefore are risky" (Thong & Yap, 1995). Levels of innovativeness range from a person's ability to improve, or perform tasks in a different way to his/her best ability per. I believe decision makers who prefer to perform the tasks differently are more innovative; and hence they usually adopt new technologies. Therefore it is hypothesized that companies whose decision makers more innovative are more likely to adopt cloud are computing. Hypothesis 4 is related to the decision maker's innovativeness.

3.9.1 Employee's Cloud Knowledge

Similar to decision maker's cloud knowledge, employees' knowledge about Cloud Computing is defined as "Employees' knowledge about Cloud Computing". Employees' knowledge of Cloud Computing is not directly measured; rather decision makers who participated in this research ranked their employee's IS knowledge. I believe a company whose employees have more knowledge about innovation face less resistance against adoption of new technologies. There are also some empirical evidence that shows the positive relationship between employees' IS knowledge and the decision to adopt IS (Thong, 1999).

3.9.2 Information Intensity

According to Thong (1999), information intensity is defined as “the degree to which information is present in the product or service of a business”. Companies in different sectors have different information intensity, for example financial brokers need to have access to most current information.

3.9.3 Relative Advantage

Rogers (2003) defined relative advantage as “the degree to which an innovation is perceived as being better than the idea it supersedes”. In this research relative advantage is defined as “The degree to which decision makers perceive Cloud Computing as being better than other computing paradigms”. Many studies which have investigated the diffusion process of innovations found relative advantage to be a significant determinant; therefore it is crucial to study this concept in the context of Cloud Computing, and raises the question of whether being advantageous would actually influence the decision-making process of the adoption of Cloud Computing. An advantageous technology is the one that enables companies to perform their tasks quicker, easier and more efficiently. Moreover it improves the quality, productivity and performance of the company. Because of the above mentioned reasons, relative advantage has a positive influence on adoption of Cloud Computing.

3.9.4 Complexity

Complexity is another factor adapted from Rogers (2003). He defined complexity as “the degree to which an innovation is perceived as relatively difficult to understand and use”. In the context of Cloud Computing, complexity is defined as “the degree to which Cloud Computing is perceived as being relatively difficult to understand and use”. To be more specific, a technology that is difficult to understand, and use is considered to be complex. Furthermore, a technology is considered to be complex if it takes too much time and effort to be learnt; or if the user should spend too much time to perform its normal duties.

3.9.5 Compatibility

According to literature, compatibility is one of the three concepts which significantly influence the adoption rate of innovation. The definition of Cloud Computing proposed by Rogers, is modified based on the context of Cloud Computing. In this research, compatibility is defined as “the degree to which Cloud Computing is perceived as consistent with the existing values, past experience, and needs of companies”. Also in

this research, compatibility is defined as compatibility with norms and culture of the organisation, in addition to compatibility with technical aspects of the work environment. Cloud Computing has a high level of compatibility with work environment and that will have a positive impact on the adoption of Cloud Computing.

3.9.6 Trial Ability

Consistent with Rogers' definition of trial ability, this research defines this concept as "The degree to which Cloud Computing may be experimented on a limited basis". Although in many researches that used DOI, trial ability is not an influential factor; in the context of Cloud Computing it perhaps makes a difference. The majority of the current cloud providers, such as Microsoft, IBM, Amazon etc. offer a trial version of their service. I believe, the opportunity to try and experiment Cloud Computing on a trial basis positively influences the adoption of Cloud Computing.

3.9.7 Cost

In this study cost of Cloud Computing is defined as "the degree to which decision makers perceive the total cost of using Cloud Computing, lower than other computing paradigms". As it has already been mentioned, cloud providers claim that their service significantly decreases the SMEs total IS cost. Total cost includes fixed costs such as initial investment, variable costs such as systems maintenance and upgrade, and training costs. Therefore the low cost of obtaining the service increases the likelihood of adoption of Cloud Computing.

3.9.8 Security and Privacy

In the context of Cloud Computing, security and privacy is defined as "The degree to which Cloud Computing is perceived as being more secure than other computing paradigms". Cloud providers claim that they are able to protect companies' data more securely than the companies themselves. Security is defined as the security of the service, data centres and media. This concept also takes into account, the privacy and confidentiality of the companies' data. Higher levels of security and privacy will most certainly have a positive influence on the adoption of Cloud Computing.

Contemporary collaboration activities within construction industry enterprises rely massively on modern and innovative information communication technologies (ICT) in order to enhance the level of their productivity. About 98.2% of the construction sector includes businesses that are defined within SME (Small and Medium Sized Enterprises) category. Therefore, it is an essential part of the construction sector that requires

attention and a massive part of their business depends on collaboration and partnering with other businesses. “Cloud” is a technology which refers to the use of virtual servers where users may access stored data through an Internet connection. Providing access in this manner is frequently referred to as using cloud-based or web-based services. Moving to the cloud can mean anything from increasing data capacity without having to invest in additional IT infrastructure, to licensing a new generation of subscription-based and web-viewable software. Using the cloud in the construction industry has strong appeal because of the constant change of workers and frequent setup of new jobsite locations. Many workers need better access to company data to aid timely, well-supported decision making and reporting, while working in the field. The main focus of this chapter is a comprehensive review of the relationship between cloud computing and Collaboration within Construction SMEs, by reviewing the literature on Cloud Computing, Construction Industry, Collaboration and SMEs. As a continuation from the previous chapter, the first half of this chapter reviews the literature that connects Cloud Computing Technology and Innovativeness to SMEs and the construction industry. The second half of the chapter reviews literature on importance of Effective and Efficient Collaboration within Construction SMEs.

3.10 Technological Innovation Adoptions by SMEs

“Cloud” is a technological word that has varying definitions. According to some, it refers to the use of virtual servers where users access stored data through an Internet connection. Providing access in this way is frequently referred to as using cloud-based or web-based services. Others refer to the cloud as including any application that is used outside of a company’s firewall. “Moving to the cloud” can mean anything from increasing data capacity without having to invest in additional IT infrastructure to licensing a new generation of subscription-based and web-viewable software.

Using the cloud in the construction industry has strong appeal because of the constant change of workers and frequent setup of new jobsite locations. Many workers need better access to company data to aid well-timed, well-supported decision making and reporting, whilst working in the field. Conversely, the main office balances the necessity to bill and pay invoices, produce financial reports, process payroll, and plan logistic, alongside the demand for offsite workers to access and update information to support these functions, no matter their location. Traditional client/server software solutions provide users access to this information from designated locations. But cloud technology has opened up new possibilities allowing instant connections beyond

traditional preconfigured office sites. It is now possible with the cloud to tap into back-office information and reporting functionality from any location in a very secure way - wherever one can access the Internet.

Construction companies are uniquely positioned to benefit from the cloud's ability to provide greater freedom and ease to access information anytime and anywhere from satellite offices, job sites or customer locations that span across the globe.

One example is True Value Homes (TVH), a large construction enterprise with many locations. TVH has seen instant benefits after transitioning to the cloud and giving employees with the proper credentials access to applications through a secure, web-based environment. Before TVH moved to the cloud, they were running operations for seventeen sites, and employees could only update project information and perform system-dependent tasks at TVH's corporate office. As a result, TVH saw a heavy influx of paperwork that was hand-carried into the corporate office for processing and approval. Today, TVH uses the cloud to provide information and system access for its five hundred users through new web-based applications. "We want to make sure that our employees get the best out of their workplace," Arun Nehru, TVH's director, said. "What we are telling employees is that [wherever you need to work], the applications are accessible from office, home, or outside. They need not come to [the] office to work." (Insulation Outlook, 2012).

The importance of context has been emphasised in the IS (Information Systems) literature (e.g., Avgerou, 2001): "It could be argued that all information systems studies are contextual, as they address issues of technology implementation and use within organisational rather than in a laboratory setting. Therefore, by the nature of the object of its study, information systems research considers a changing entity within its environment." (Avgerou, 2001, p. 44). However, conceptualisations of the term context differ amongst studies. With regard to the boundaries of contextualise studies, three levels of context may be identified (Avgerou, 2001):

- Organisation;
- Organisation's environment;
- National and international environment;

Early IS research focused largely on intra-organisational IT innovation, and the contextual factors were therefore usually considered within the boundaries of an

organisation (e.g., Ein-Dor and Segev, 1978; Raymond, 1990). A number of IS studies have extended the focus beyond the single organisation, and also considered aspects of the organisation's environment, highlighting the existence of competitive pressures on organisations. Increasingly, national and international aspects have also been introduced in research on IT innovations (Avgerou, 2001).

Several frameworks and models have been employed to capture the contextual influences on IS. A number of studies have adapted the technology, organisation and environment (TOE) framework by Tornatzky and Fleischer (1990) to explain IT innovation (e.g., Chau and Tam, 1997; Zhu and Kraemer, 2005; Zhu et al., 2006), as well as technological system adoption and implementation (e.g., Kouki et al., 2006; Pan and Jang, 2008; Kouki and Pellerin, 2010).

The TOE framework defines three elements of a firm's context influencing the process of adoption and implementation of technological innovation: organisational context, technological context, and environmental context. These three contextual dimensions are as follows:

Characteristics of the organisational context typically include; firm size, centralisation and formalisation, complexity of managerial structure, quality of human resources, the amount of slack resources, decision making, and internal communication.

The environmental context represents the arena in which a firm conducts its business, such as industry, competitors, access to recourses supplied by others, and governmental regulations.

Characteristics of the technological context are defined in terms of all internal and external technologies relevant to the firm. The technological context is considered separately from the rest of the context in order to focus attention on influences of the technology on the adoption and implementation process (Tornatzky and Fleischer, 1990).

Important for the focus of this study, the TOE framework has been tested and validated by studies on IT adoption and assimilation in SMEs (e.g., Thong, 1999; Iacovou et al., 1995; Kuan and Chau, 2001; Scupola, 2003; Raymond et al., 2005). Also several studies investigating Enterprise Resource Planning (ERP) adoption in SMEs have employed the framework (e.g., Ramdani and Kawalek, 2007; Raymond and Uwizeyemungu, 2007; Ramdani et al., 2009; Poba-Nzaou and Raymond, 2011). These

studies successfully utilized the framework to organize selected contextual factors, and found it to be a relevant framework that can be used to study SMEs' adoption of enterprise systems (Ramdani and Kawalek, 2007).

Based on the successful use of the TOE framework in former research, I have adopted the framework in my research. I organise the SME characteristics according to the three contextual dimensions of the TOE framework. The following section presents a review of literature to identify characteristics which typify the SME context, and that could potentially influence implementation of a Cloud Computing based collaboration framework.

3.10.1 Contextual Influences in SMEs

This section introduces an overview of relevant literature on contextual influences in SMEs.

SME context originate from reference disciplines within organisational research (e.g., management, organisational design, and organisational behaviour), I perceived it valuable to review studies investigating the influence of SME characteristics on various organisational initiatives. In this, rather than aiming for a comprehensive review, I focused on identifying frequently cited studies used as references for illustrating distinguishing characteristics of the SME context.

Two studies were identified to be particularly relevant, as they provide a comprehensive overview of inherent characteristics distinguishing SMEs from large enterprises. The studies explore the SME context with relation to Total Quality Management (TQM) (Ghobadian and Gallear, 1997) and Knowledge Management (KM) (Wong and Aspinwall, 2004).

The study by Ghobadian and Gallear (1997) explored the differences between large enterprises and SMEs, and analyzed the relationship between the SME characteristics and TQM practices. Based on a literature review, the authors compiled an extensive list of issues distinguishing SMEs from large enterprises, grouped into six areas: structure, procedures, behaviour, processes, people, and contacts. The influence of these issues on TQM implementation practices was investigated through four exploratory case studies, resulting in a framework for successful implementation of TQM in SMEs.

In the study characterising KM in a small business environment, Wong and Aspinwall (2004) looked at specific SME characteristics and the key problems and issues

associated with KM. Inspired by Ghobadian and Gallear (1997), based on a literature review the authors proposed a list of SME characteristics which can have an influence on the implementation of KM. The characteristics were classified into six groups: ownership and management; structure; culture and behaviour; systems, processes and procedures; human resources; customs and market. This conceptual paper concludes that recognition of these elements is crucial in order to provide a compatible KM approach for SMEs.

Several studies have investigated various factors affecting IT/IS adoption in SMEs (e.g., Thong and Yap, 1995; Thong, 1999; Sharma, 2009), such as CEO characteristics, employees' IS knowledge, information intensity, and competition. The studies have identified several barriers to IT adoption in SMEs, including resource constraints (Blili and Raymond, 1993; Cragg and King, 1993; Levy and Powell, 2000; Thong, 2001), limited internal IT/IS expertise (Blili and Raymond, 1993; Cragg and King, 1993; Cragg and Zinatelli, 1995; Iacovou et al., 1995; Fink, 1998; Levy and Powell, 2000; Thong, 2001), and limited IS knowledge (Cragg and King, 1993; Cragg and Zinatelli, 1995; Levy and Powell, 2000).

Among the aforementioned studies on IT/IS adoption, the study by Blili and Raymond (1993) stands out in terms of its coverage of SME characteristics and its emphasis on the importance of SME environment specificity. The authors investigated the threats and opportunities of SMEs during IT adoption, and developed a schematic summary of the unique SME characteristics with respect to strategic information systems. The SME specificity features were classified into five areas: environmental specificity, organisational specificity, decisional specificity, psycho-sociological specificity, and information systems specificity. The study provides a framework for analyzing the threats and opportunities formed by IT in SMEs.

3.10.2 Overview of SME Characteristics

Based on the literature review, Table 1 lists the identified SME characteristics that could potentially influence on Cloud Computing based collaboration framework implementation. The overview is largely based on four summative studies which are found to bear particularly relevant for the purpose of this thesis (i.e., Blili and Raymond, 1993; Ghobadian and Gallear, 1997, Gable and Stewart, 1999; Wong and Aspinwall, 2004). The SME characteristics are grouped according to the three contextual dimensions of the TOE framework: Organisational Characteristics,

Environmental Characteristics, and Technological Characteristics. Selected key references are included for each characteristic.

SME Characteristics	Selected References
Organisational Characteristics:	
Resources • Modest financial resources • Limited human capital • Limited resources for employees' training	Blili and Raymond 1993, Ghobadian and Gallear 1997, Gable and Stewart 1999, Bernroider and Koch 2000, Levy and Powell 2000, Thong 2001, Wong and Aspinwall 2004, Raymond and Uwizeyemungu 2007
Ownership, management, and decision making • Owner is the CEO • Time constraints of owner-managers • Top management highly visible and active • Few layers of management • Centralised decision-making • Short-term decision-making cycle • Intuitive decision process	Blili and Raymond 1993, Ghobadian and Gallear 1997, Gable and Stewart 1999, Wong and Aspinwall 2004
Structure • Simpler, flatter, and less complex structure • Flexible structure and information flows • Single-sited • Organic structure • Limited and unclear division of activities • Low degree of employees' specialisation	Blili and Raymond 1993, Ghobadian and Gallear 1997, Gable and Stewart 1999, Wong and Aspinwall 2004
Culture • Unified culture • Few interest groups • Common corporate mindset • Low resistance to change • Organic and fluid culture • Influenced by owner-managers	Ghobadian and Gallear 1997, Wong and Aspinwall 2004
Processes and procedures • Smaller and less complicated processes • More flexible and adaptable processes • Informal rules and procedures • Low degree of standardization and formalisation	Ghobadian and Gallear 1997, Wong and Aspinwall 2004
Environmental Characteristics:	
Market, customers • Mostly local and regional market • Normally dependent on a small customer base • Affected by powerful partners in their supply chain	Blili and Raymond 1993, Ghobadian and Gallear 1997, Wong and Aspinwall 2004, Seethamraju and Seethamraju 2008
Uncertainty • High level of environmental uncertainty • Uncertain and unstable environment	Blili and Raymond 1993, Gable and Stewart 1999, Seethamraju and Seethamraju 2008
Technological Characteristics:	
IT technical expertise • Limited IT/IS in-house technical expertise • Emphasis on packaged applications • Greater reliance on third party	Raymond 1985, Blili and Raymond 1993, Cragg and Zinatelli 1995, Iacovou et al. 1995, Fink 1998, Gable and Stewart 1999, Levy and Powell 2000, Thong 2001, Shiau et al. 2009, Chang and Hung 2010
IS function, IS complexity • IS function in its earlier stages • Subordinated to the accounting function	Blili and Raymond 1993, Gable and Stewart 1999

Table 2. SME Characteristics

The detailed descriptions below are based on references mentioned on Table 2.

3.10.3 Organisational Characteristics

Due to financial and human resource constraints of SMEs, they are most likely to develop and manage their own IS, however, SMEs are reported to invest less in employee training than the larger enterprises, who usually have the financial resources to develop custom made training and educational training programs. Therefore, there is a level of risk attached to SMEs managing their own IS. They will have limited control over the information resources, and are likely to rely on third parties such as vendors and consultants to solve any issues they cannot due to lack of in house expertise

The research on selection of innovative IT systems shows that affordable cost and short implementation time are among the most important selection criteria in SMEs. With limited resources available, the enterprises were less disposed to the adoption of a newly developed digital system, and financial constraints were identified as the main cause of non-adoption of such innovative systems among SMEs.

The CEOs of SMEs are usually owners who have the ultimate power of control, and commonly oversee every aspect of the business. Often they are the only ones with responsibility for and access to the information needed, to identify the opportunities of using IT for strategic or competitive purposes. The owner-managers usually do not have enough time to reflect on strategic issues, as they are busy with day to day operations and their attention is more on core business operations.

Decision-making in SMEs has been reported as generally centralised with fewer layers of management and decision makers. The centralised decision-making implies that the CEO can either be the main obstruction, or the main catalyst for change. Furthermore, the decision-making cycle is usually short-term. In addition, the decision process in SMEs has been found to be more intuitive and based on experience, as a limited number of formal information and decision models are employed.

Compared to large enterprises, SMEs in general have been reported as having a simpler, flatter, and less complex structure. A simpler structure facilitates a change initiative across the organisation. As a result of a flat structure in SMEs, the working environment is more flexible, and the communication process is likely to be less complex and easier to manage. Moreover, SMEs have been found to often operate on a single site. In addition, SMEs are also likely to have an organic structure. Workers in small firms often perform a variety of tasks, implying a low degree of specialisation in the employees' jobs.

Culture in SMEs has been reported as unified, with few interest groups.

Employees have usually been characterised as having a corporate mind-set emphasising the company as a single entity. The unified culture may provide SMEs with a strong foundation for change, as employees easily understand what the company is trying to achieve. In addition, compared to large enterprises, culture in SMEs has been characterised as more organic and fluid. In the same time, as a result of the strong dominance of owner-managers in SMEs, culture is easily shaped and influenced by their personality and outlook.

The operations and processes in SMEs are usually characterised in smaller scales and less complicated than those of large enterprises.

Moreover, the processes in SMEs are also often more flexible and adaptable to changes taking place around them. Therefore, SMEs are likely to be more adaptable to implementing new initiatives, as they are less likely to be "locked-in" to their existing processes. One implication of the need to react quickly is that that most of the activities in SMEs are governed by informal rules and procedures, with a low degree of standardisation and formalisation.

3.10.4 Environmental characteristics

The market encompassed by SMEs has mostly been reported as local, having limited international range. In general, SMEs are characterised as dependent on a small customer base with frequent and close contacts with customers.

Major customers or suppliers, who are typically powerful in their supply chain, may force SMEs to adopt a system compatible with their extant solution and thus influence innovative IT system implementations in these organisations.

SMEs are typically characterised by a high level of environmental uncertainty. The uncertain and unstable environment influences any long term investments in information technologies. Uncertainty relating to the technological environment and the competition is likely to significantly affect IS implementation in SMEs.

3.10.5 Technological characteristics

In a similar vein, a recent study assessing ERP adoption in SMEs concluded that lack of IS knowledge may inhibit SMEs from adopting ERP systems (Shiau et al., 2009). The findings showed that the more IS knowledge CEOs have, the more they are inclined to

adopt ERP systems. Also the results by Chang and Hung (2010) indicated a positive influence of the CEO's IS knowledge as well as employees' IS knowledge on ERP system adoption.

SMEs are also often reported being constrained by limited internal IT/IS technical expertise. Many SMEs possess insufficient level of in-house IT/IS expertise necessary for successful IS adoption, and are thus more likely to purchase a packaged software instead of developing a system in-house.

This argument has been supported by a recent study of ERP system adoption in SMEs (Chang and Hung, 2010), which reported a lack of IT/IS professionals and a shortage of developing resources. Also, Shiau et al. (2009) indicated that SMEs do not have the technical IT expertise to evaluate information systems. On the other hand, the studies by Olsen and Saetre (2007b, 2007a) propose in-house development of ERP systems as the best alternative for SMEs, stating that nowadays SMEs may have sufficient IT competence. Similar, a study by Olson and Staley (2012) reported in-house development of an ERP system as an option considered by the case SME, as the company had experience in software engineering.

The IS function in most SMEs is typically perceived to be in its early stage of evolution. For example, a study evaluating readiness of SMEs for ERP adoption recognised that most of the studied SMEs used quite complex IS solutions (Raymond et al., 2006).

3.11 Enterprise Resource Planning (ERP) Implementation

Numerous studies addressing various topics and issues of the ERP phenomenon have been conducted over the years (Botta-Genoulaz et al., 2005; Moon, 2007; Esteves and Bohorquez, 2007; Schlichter and Kraemmergaard, 2010; Grabski et al., 2011). A recent literature review by Schlichter and Kraemmergaard (2010) distinguished between the following eight research topics covering the range of aspects published within the ERP field: implementation, optimization of ERP, management and ERP issues, the ERP tool, ERP and supply chain management, studying ERP, ERP and education, and the ERP market and industry. According to the results of their literature review, 80% of the reviewed articles fall into the first four research topics. The implementation aspect was reported as a predominant subject counting for 30% of the studies.

Naturally, ERP research builds on more general IS research. A large body of knowledge has been accumulated in the IS research field over time, and various taxonomies to

classify different types of IS research have been proposed. A classic example is the typology introduced by Orlikowski and Baroudi (1991), classifying IS research as positivist, interpretive and critical research based on ontological and epistemological assumptions. Another common perspective for classifying IS research is the distinction between variance and process theories, based on Mohr (1982). This perspective was first introduced in IS by Markus and Robey (1988) and has since then received considerable recognition. Variance theories are concerned with: "predicting levels of outcomes from levels of contemporaneous predictor variables" (Markus and Robey, 1988, p. 589), while process theories are concerned with: "explaining how outcomes develop over time" (Markus and Robey, 1988, p. 589).

A substantial part of IS research has focused on the notion of IS implementation, and numerous theories and models of IS implementation have surfaced over the years, varying in research approaches and methods of investigation applied. Due to a multitude of such contributions, IS implementation theory has been characterized as quite diverse (Marble, 2000). Also the conceptualizations of implementation itself differ in literature. My intention here is not to provide a thorough overview of the theories and conceptualizations applied, for this I rather refer to former meta-analysis studies of IT/IS implementation research (e.g., Tornatzky and Klein, 1982; Kwon and Zmud, 1987; Alavi and Joachimsthaler, 1992; Marble, 2000; Premkumar, 2003). This thesis adopts the definition of IT implementation as: "an organisational effort directed toward diffusing appropriate information technology within a user community" (Cooper and Zmud, 1990, p. 124).

A general trend has been a move towards more focus in IS implementation research (Marble, 2000), with studies focusing on individual factors significant in the implementation, special types of systems, or specific types of organisations. Due to the uniqueness of SMEs, a number of studies have focused on IS implementation in this context. A good overview of this research stream is provided by Premkumar (2003).

ERP implementation has received great attention in the research literature, and several perspectives to study this phenomenon have been developed. These are introduced in the rest of this section. In line with Robey et al. (2002), I organise the ERP implementation literature according to the two theoretical approaches introduced above: variance and process research. Each sub-section discusses a particular topic in a general way, followed by a focus on research in SMEs.

3.11.1 Contextual Influences on ERP Implementation

Studies investigating the influences of various contextual factors on ERP system implementation can be categorised in the variance research stream. This research focuses on investigating influences of various factors on the adoption of an ERP system, thus restricting the scope to a limited part of the ERP lifecycle.

Moreover, few studies have examined the influence of the unique SME characteristics. Various theoretical perspectives to investigate influences of contextual factors on ERP system implementation have been applied. One of the common approaches employed is the concept of fit, originated from contingency theory (Lawrence and Lorsch, 1967; Donaldson, 2001). The fundamental perspective of contingency theory is that organisational effectiveness is achieved by fitting organisational characteristics to contingencies, when a contingency is defined as "any variable that moderates the effect of an organisational characteristic on organisational performance" (Donaldson 2001, p.7). The contingency theory has been widely utilized in IS research (e.g., Khazanchi, 2005; Khalifa and Shen, 2008; Raymond and Bergeton, 2008), and the concept of fit has also been applied in ERP research (e.g., Hong and Kim, 2002; Morton and Hu, 2008; Ifinedo and Nahar, 2011). The concept of fit within the ERP context can be defined as "the congruence between the original artefacts of ERP and its organisational context" (Hong and Kim 2002, p.27). The contingency theory was considered as a potential theoretical lens in the beginning of this research project (Zach, 2009). However, this perspective was found to be too static and narrow in scope, ignoring the richness and complexity of ERP implementation, and was not pursued.

3.11.2 Critical Success Factors

The studies on ERP critical success factors (CSFs) represent the predominant research stream adopting a variance approach. The term CSF was coined by Rockart (1979), defined as "the limited number of areas in which results, if they are satisfactory, will ensure successful competitive performance for the organisation" (Rockart, 1979, p.85). In terms of ERP research, CSFs are factors that should be present or fulfilled in order to guarantee ERP implementation success (Robey et al., 2002; Nandhakumar, 2005).

Numerous studies have investigated CSFs of ERP system implementation (e.g. Holland and Light, 1999; Nah et al., 2001; Somers and Nelson, 2001; Akkermans and van Helden, 2002; Al-Mashari et al., 2003). The findings vary to some extent, but the commonly articulated ERP CSFs are top management support, project team

competence, project management, clear goals and vision, project champion, user involvement, use of consultant, business process reengineering, and minimal system customisation.

CSFs have also been investigated by studies in SMEs (e.g., Loh and Koh, 2004; Reuther and Chattopadhyay, 2004; Sun et al., 2005; Snider et al., 2009; Doom et al., 2010; Kale et al., 2010; Malhotraa and Temponi, 2010; Upadhyay and Dan, 2010).

The studies discovered that most of the general ERP CSFs apply to SMEs (e.g. Doom et al., 2010), while some studies also found CSFs unique for SMEs (e.g., Snider et al., 2009).

3.11.3 ERP Effects

Variance research also includes studies of ERP effects, focusing on the outcomes of ERP implementation (Robey et al., 2002). This issue has received substantial attention and the ERP literature includes numerous studies investigating ERP system outcomes.

Over the years, various approaches to ex-post evaluation of ERP system outcomes have been developed. These include studies employing ERP success assessment tools (Tan and Pan, 2002; Gable et al., 2003; Ifinedo and Nahar, 2011), ERP benefit frameworks (Shang and Seddon, 2000; Shang and Seddon, 2002; Staehr, 2007; Williams and Schubert, 2010), and ERP balanced scorecard frameworks (Chand et al., 2005; Velcu, 2007; Uwizeyemungu and Raymond, 2009).

The following model presented in “Figure 6” is an Enterprise Systems Success model which is purely a measurement tool for assessing the ERP success, and it does not propose any causality effects between the dimensions (Gable et al., 2003). The model gained considerable recognition and has been further employed in several studies (e.g., Sedera et al., 2003; Sedera and Gable, 2004; Sehgal and Stewart, 2004; Ifinedo, 2006a; Gable et al., 2008). Petter et al. (2008) in their thorough literature review found the ESS model to be the most comprehensive tool for IS success measurement. They state one of its strengths to be that it avoids overlap between the constructs and measures.

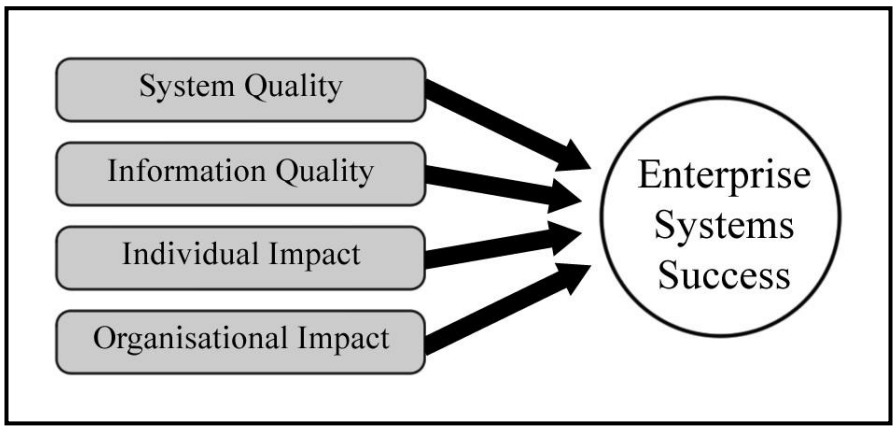

Figure 6. The ESS model (adapted from Sedera et al., 2004)

3.12 Online Technologies and Collaboration within Construction SMEs

The construction sector is a highly fragmented, data intensive, project-based industry depending on a large number of very different professions and firms, with strong data sharing and processing requirements across the lifecycle of its products (primarily buildings). The process of designing, repurposing, constructing and operating a building involves not only the traditional disciplines (Architecture, Structure, Mechanical and Electrical) but also many new professions in areas such as energy, environment and waste. All of these professions have large data sharing requirements. In this context, data management within the industry can often be fragmented with a lack of an overall data management policy. Additionally, data sets relating to a particular project can often be stored in: (i) local computers of designers/architects - often with limited network connectivity, persistence and availability; (ii) independently managed, single company-owned archives – where access is dictated by a company specific policy or by a charging model; (iii) ad-hoc document archives, or (iv) Web-based document management systems in the context of a particular building project – based on an access policy associated with the project. Sharing data and supporting coordination between people involved is therefore often difficult – relying on the use of third party tools to support such capability. We believe that Cloud Computing platforms provide a more efficient and robust mechanism for individuals within the construction industry to collaborate and share data.

3.13 Cloud Computing in Construction Industry

Our efforts in engaging with the industry have shown that Cloud Computing is still an emergent technology within the AEC sector. Technologies such as Google Drive and DropBox are often used informally and in an adhoc way between individuals - but

concerns over security and the protection of intellectual property often dissuade major companies from adopting such services.

One of the key issues within the industry is the storage of building data during design/construction and over the entire life of the building. Several companies have developed servers for the storage of building data (represented using the Building Information Model) including the Onuma system (www.onuma.com), REVIT Server (www.autodesk.com), ProjectWise and AssetWise (www.bentley.com), Graphisoft BIM Server (www.graphisoft.com) and EDMmodelServer (www.jotne.com). However, these servers often require local infrastructure and maintenance within the organisation that is using them - tending to utilise either central (accessible to all team members over the WAN) or local (accessible to team members over the LAN) connectivity.

Data processing is also an important concern for the industry. During construction, a large part of the work takes place on-site. It is of particular commercial importance that up to date plans are used and delivered. This can prove to be a major challenge when computing resources on constructions sites are limited. Allowing users to amend and update plans, using a portable device on site, that will remotely process any updates, and ensure site plans are completely updated, offers a solution to this challenge.

3.14 Summary

In this chapter, various existing construction collaboration tools and online technologies including cloud computing were reviewed and studied. Thereafter, various technological innovations were looked at and the desire of SMEs to adopt different online innovations were looked at to find out whether or not their advantages are acknowledged by different users or there would be the need to change existing mindsets.

In the next chapter, the research design, methodology and methods will be reviewed in depth and adopted interview and data collection technique for this research will be discussed.

Compared to large enterprises, SMEs represent fundamentally different environments, with a number of characteristics typifying the SME context. Because of these distinguishing differences, the findings from studies of Enterprise Resource Planning implementation in large enterprises cannot be fully applied to SMEs.

The SME characteristics are grouped into three contextual dimensions: organisational, environmental, and technological.

In terms of organisational characteristics, SMEs have been found to be constrained in terms of their financial, as well as human resources. They usually do not arrange to develop and manage their own IS and so they are likely to rely on third parties such as vendors and consultants. This may lead to limited control over the information resources thus increasing the level of risk.

In terms of Environmental characteristics, SMEs are typically characterised by a high level of environmental uncertainty. The uncertain and unstable environment influences any long term investments in information technologies. Uncertainty relating to the technological environment and the competition is likely to significantly affect IS implementation in SMEs.

In terms of technological characteristics, SMEs are also often reported as being constrained by limited internal IT/IS technical expertise. Many SMEs possess insufficient level of in-house IT/IS expertise necessary for successful IS adoption, and are thus more likely to purchase packaged software instead of developing a system in-house.

The studies on Enterprise Resources Planning critical success factors (CSFs) represent the predominant research stream adopting a variance approach. The term CSF was coined by Rockart (1979), defined as "the limited number of areas in which results, if they are satisfactory, will ensure successful competitive performance for the organisation.

The construction sector is a highly fragmented, data intensive, project based industry, involving a number of very different professions and organisations. Projects carried out within this sector involve collaboration between various people, using a variety of different systems. This, along with the industry's strong data sharing and processing requirements, means that the management of building data is complex and challenging.

The Cloud Computing based models featured in this chapter displayed a feasibility study that aimed to explore the feasibility and potential for utilizing Cloud capability to address data storage and processing needs of stakeholders within the construction industry.

4 Research Methodology and Design

The aim of this chapter is to outline the methodological process adopted to achieve the research aim and objectives. Building on preceding chapters, this chapter provides the basis for the design of the research questions used in the data collection stage. This includes the chosen research philosophy, methodology and research method. It also presents an elaboration of the techniques used to analyse the collected data, and a description of the ethical considerations and of the validation and triangulation processes to achieve the anticipated research outcome.

4.1 Theoretical Overview

Research requires a systematic approach by the researcher regardless of what is being investigated and the methods adopted (Fellows & Liu, 2003). This provides the overall direction of the research including the process by which the research is constructed (Remenyi, Williams, Money & Swartz, 2005). Various terms have been used by different authors as the umbrella under which research processes are informed (Crotty, 2003; Wainwright, 1997). Sarantakos (2013) and Creswell (2009) use the term "worldview", while Blaikie (2010) refers to "broadly conceived research methodologies." Crotty (2003) prefers "epistemologies" and "ontologies", while Guba & Lincoln (1990) and Mertens (1998) both refer to "paradigms". Saunders, Lewis & Thornhill (2012) define a paradigm as a way of examining social phenomena through which a particular understanding of a phenomenon can be gained and explanation attempted, while Guba & Lincoln (1994, p.105) define a paradigm as a basic set of beliefs (or theory). In another perspective, a research paradigm is presented as an overall conceptual framework within which research is undertaken - a theoretical framework which includes a system through which people view events (Remenyi et al., 2005; Fellows & Liu, 1003). Sarantakos (2013) presents it as a philosophical stance that informs the methodology, tuides the process of research and provides an arena in which the logic and structure of the research is embedded. Putting the above views into context, it could be inferred that research paradigms and research philosophy are an important part of the methodological process that help researchers to achieve their aim and objectives through a structured approach (Saunders et al., 2012; ;Ontenyi et al.. 2005). They guide how the researcher makes decisions and carries out the, search (Saunders et al., 2012). The methodological process put forward by Kagioglou et al, popularly known as the "nested approach" thagioglou et al., 2000), is characterised by

the paradigm of research philosophy, approaches and techniques grounded in the actor research philosophy of pre-understanding, understanding hermeneutic learning spiral. In this context, the research philosophy found in the outer ring energises and unities the research approach with the research techniques found in the middle and inner rings of the model. The research process is thus said to consist of a dominant theory generation and testing method, while the research techniques comprise the data collection tools (Kagioglou et al., 2000).

In the research paradigm put forward by Crotty (2003), epistemology is described as a process of understanding and explaining how we know what we know. This further informs the theoretical perspectives that provide the framework for the methodology adopted from a range of methodological processes and the methods used to achieve a research outcome. In Crotty's narrative, a research paradigm from ontological perspective about the assumptions of the nature of reality was not considered prominent in the structure of the research paradigm. In Crotty's view, the strategy, plan of action and design underlying the choice and the use of a particular method, as well as the interface of those methods to achieve the desired outcomes are referred to as methodology (Crotty, 2003). In this same continuum are the research methods which Crotty defines as the techniques or procedures used to gather and analyse data related to the research question or hypothesis to achieve the research outcome.

In the "research onion" methodological process put forward by Saunders et al (2012), the research philosophy was classified into four different categories namely, positivism, realism, interpretivism and pragmatism. Creswell (2009), on the other hand, classifies research philosophy from the perspective of positivism/post-positivism, interpretivism, critical inquiry, feminism, and postmodernism. These varying terms evidenced the ambiguity and inconsistency of the taxonomies used by various authors in research philosophical paradigms, as argued by Wainwright (1997).

For the purpose of this research, the term "research methodological process" will be adopted to imply the sequential, structured process that is followed to achieve the research aim and objectives. The terms "paradigm" and "methodological process" are used interchangeably in this research. It is acknowledged that a structured process in research undertaken aids the researcher to develop an understanding of the topic being researched, and of the process by which the research is constructed (Easterby-Smith, Thorpe & Jackson, 2012; Remenyi et al., 2005).

4.2 Research Philosophy

The concept of research philosophy refers to the progress of scientific practice based on people's views and assumptions regarding the nature of knowledge. According to Collis and Hussey (2009), and Neville (2005), two major drivers of the knowledge are: phenomenological paradigm and positivism paradigm.

Generally the scientific studies ground on positivistic research philosophies. Positivistic approach has a detached attitude to human behaviours like in natural sciences. The methodologies of positivistic approach try to explain the research subject statistically, from the objective perspective of the participants and in a rational manner.

Contrary to positivistic approach, approaches of phenomenology suggest that human behaviour cannot be understood as in natural sciences. It is more complex than this because humans are driven by forces that are not easily observable. Unlike positivistic approach, phenomenological ones are used to design the study from the subjective perspective of the participants (Neville, 2005).

While ontological positions are referred to as representationalism, relativism and nominalism, epistemological positions are referred to positivism, relativism and social constructionism (Easterby-Smith, et al., 2008). Although, relativism is a common position that falls into both ontology and epistemology categories, modern researchers associate relativism to realism in epistemology (Marsh and Furlong, 2002). This research is in agreement with the relativist epistemological assumptions, i.e. knowledge is only of significance if it is based on observations of the external reality (Easterby-Smith, et al., 2008).

4.3 Research Ontology

Ontology is another approach to philosophy that is concerned with the nature of reality, acknowledged always to be the starting point for most of the debate among philosophers (31aikie, 2010). Ontological perception is concerned with what constitutes the nature of reality relative to how things really are and how things work (Blaikie, 2010). From an ontological perspective on research, the researcher first establishes the perspective from which the reality of the phenomenon is being investigated by stating whether the reality is objective and external to the researcher, or socially constructed and only understood by examining the perceptions of human actors (Walter, 2013; Crossan, 2003). Ontology examines the claims and assumptions that are made about the constituents of reality,

and about what exists, what it looks like, what units make it up and how these units interact with each other (Sarantakos, 2013).

Different authors have used different terms to describe the two fundamental competing ontological schools of thoughts. Saunders et al. (2012) refers to them as objectivism, subjectivism or constructionism, while Easterby-Smith et al., (2012) use the terms realism and nominalism. The differences between these two contrasting ends of the continuum are mainly based on the epistemological and axiological assumptions about the phenomenon being investigated by the researcher, which the researcher needs to be explicit about (Sexton & Lu, 1990).

Constructionism argues that all knowledge, all meaningful reality is contingent upon human practices, being constructed in, and o of interaction between human beings and their world, and developed and transmitted thin an essentially social context (Crotty, 2003). It asserts that social phenomena are created from the perceptions and consequent actions of social actors (people, stakeholders). It stresses that social interaction between actors is a continual process, considering that social phenomena are constructed by human beings who are constantly evolving (Crotty, 2003). This assumption is based on the understanding that, as social actors engage with their world, they are interpreting and providing meaning to phenomena (Crotty, 2003). This supports the stance of Saunders et al (2012), which acknowledges that individuals have different living standards, differences in social and cultural environments and different personalities that determine the nature of the individual person. This reflects the nature of the setting or sector within which the research is conducted.

4.4 Interface of Positivism and Interpretivism

Positivist assumptions argue that the world exists externally, and its properties should be measured through objective methods (Easterby-Smith et al., 2012). The basic reasoning behind positivism is the belief that, there is an existence of an objective reality which is independent of human behaviour, and therefore not a creation of the human mind (Crossan, 2003). With the positivist school of thought, the researcher is viewed as a neutral observer and reality is not mediated by the researcher's senses, on the basis that the investigated objects have an existence independent of the knower (Saunders et al., 2012; Crotty, 2003). Consequently, the positivist approach is founded on ontological assumptions that the things we experience are things that exist. As such, its epistemology requires that 4.3.1.1. The interface of positivism and interpretivism

experience is verified through the deductive methodological reasoning of scientific methods (Wainwright, 1997).

Positivism is the application of natural sciences to the study of social reality...An objective approach that can test theories and establish scientific laws... It aims to establish causes and effects (Walliman, 2006).

While positivism assumes that reality is fixed, directly measurable and knowable with the claim that there is just one truth, one external reality, a new philosophical assumption emerges which holds the view that reality is not objective and exterior, but rather socially constructed and given meaning and interpretation by people (Easterby-Smith et al., 2012; Creswell, 2009; Guba & Lincoln, 1994). Interpretivism assumes that reality is not a rigid thing, but rather a creation of those individuals involved, as the individuals who observe reality cannot be separated from their real world (Webber, 2004). It argues that the understanding of knowledge by different people may construct meaning in different ways. Therefore, objective truth and meaning are not discovered, but constructed by social actors (people) (Saunders et al., 2012; Crotty, 2003). This stance recognises the intricate relationship between individual behaviour, attitudes, external structures and socio-cultural influencing issues. Interpretivism also claims that reality does not exist in isolation, but is subject to various significant factors such as the culture, gender and belief from which it is constructed (Weber, 2004). It follows that objective reality as proposed by the positivist school can be seen as a one-dimensional aspect of reality.

The positivist research paradigm advocates a clear quantitative approach to investigating phenomena, in contrast to the interpretivist approach which explores and describes in depth phenomena from a qualitative perspective, and in some cases through the combination of both quantitative and qualitative perspectives (Saunders et al. 2012; Easterby-Smith et al., 2012; Creswell, 2009; Crotty, 2003). These research methods are most often seen as opposing and polarised standpoints, but are often used interchangeably (Denscombe, 2010; Creswell, 2009). It is acknowledged that the distinction between these philosophical assumptions has been overstated by some authors (Weber, 2004).

The positivists also assume that reality is fixed, knowable and directly measurable, and as such that there is just one truth and one external reality. In contrast to this assumption, the interpretivist assumes that reality constantly changes and that reality

can be known indirectly through the interpretation of the actors (people). Hence, the interpretivist champions the understanding that the knowledge of reality we seek to build and understand is influenced by culture, experience, beliefs and other factors. Therefore, reality has multiple versions.

4.5 Research Aspects

Undertaking a research, in other words being part of a process with the purpose of performing an enquiry and investigation about a specific subject can be achieved through developing a new knowledge and/or benefitting from existing knowledge in an inventive way hence, generation of "new concepts", "understanding" and "methodologies" can be executed (Neville, 2005). One of the acquisitions of a research is enhanced stock of knowledge about a certain field. In this way, improved knowledge can be benefitted with the intention of creating new applications (OECD, 2002).

According to Collis and Hussey (2009), the rationale of research can be listed as follows:

- To review or synthesize already developed knowledge
- To examine existing problems or conditions
- To make solutions to existing problems available
- To investigate and analyse more general issues
- To develop or create new procedures or systems
- To explain a new phenomenon
- To produce novel knowledge
- To make a combination of any of the above

In his work on research methodology, Neville (2005) identified four different types of research; "exploratory", "descriptive", "analytical", and "predictive".

Among these research types "exploratory research" is used when the number of previous studies is not adequate. This kind of research finds hypothesis, examples that can be tested and become the building blocks of the new research. Case studies, observation and reviews of previous studies are the typical examples of exploratory

research. “Descriptive research” is undertaken with the intention of identifying and classifying the aspects or features of the subject (i.e. number of days lost because of material transportation delays). This research type frequently benefits from quantitative techniques to “collect, analyse and summarise” data. “Analytical research” broadens the descriptive research and adds questions of “why and how something is happening”. In other words, analytical research tries to find out the causes of a situation (i.e. underlying causes of material transportation delays). This research type also identifies and locates different factors (or variables) involved. As its name implies, “predictive research”, is undertaken to make predictions of a future probabilities of a situation based on close analysis of available evidence of cause and effect (Neville, 2005).

4.6 Research Approaches

Reasoning is the process of using existing knowledge to draw conclusions, make predictions, or construct explanations (Blaikie, 2010). Reasoning that informs the choice of a research approach is acknowledged to enable researchers to make better-informed decisions about the research design (Sarantakos, 2013; Saunders et al., 2012). According to Blaikie (2010), there are seven types of research reasoning approach. Saunders et al. (2012) and Blaikie (2010) both acknowledge that only three of these, namely deduction, induction, and abduction, are often considered in social science research. Each of these forms of research reasoning has a philosophical and theoretical ancestry and foundation (Blaikie, 2010; Guba & Lincoln, 1994). This is in relation to ontological perceptions about the nature of reality, and an epistemological understanding of how that reality can be known. Deductive reasoning occurs when the conclusion is derived logically from a set of premises, with the conclusion being true when all the premises are true (Saunders et al., 2012). It begins with a tentative hypothesis or set of hypotheses, that form a theory which could provide a possible answer or explanation for a particular problem, and proceeds to use observation to rigorously test the hypotheses (Blaikie, 2010). On the other hand, inductive reasoning starts with observations that are unique and limited in scope, before proceeding to a generalised conclusion (Saunders et al., 2012; Blaikie, 2010). It begins with gathering evidence, seeking patterns and forming a hypothesis or theory to explain the findings. Compared to deductive reasoning, inductive reasoning claims that reality influences the senses (Blaikie, 2010). This approach assumes that all scientific investigation starts with an observation, which provides a secure basis from which knowledge can be derived (Blaikie, 2010; Sarantakos, 2013). The conclusions of an inductive argument make

claims that exceed what is contained in the premises, with the expected outcome aimed at extending knowledge beyond a particular phenomenon that appears to support the actual experience (Sarantakos, 2013; Saunders et al., 2012; Blaikie, 2010). This school of thought further argues that the more an observation demonstrates a relationship between phenomena, the higher the credibility of the final outcome. This entails the idea that the verification of derived generalisations comes through observations of a particular phenomenon that appears to support it. The third form of reasoning is known as abduction (or abductive reasoning). Abductive reasoning is a combination of deductive and inductive reasoning. This has the flexibility to move from theory to data (as in deductive reasoning) or data to theory (as in inductive) (Saunders et al., 2012). It is a process that is used to generate social scientific accounts from social actors. (Blaikie, 2000). This process begins with the observation of a "surprising fact", and works out a plausible theory to account for how this could have occurred (Saunders et al., 2012). This surprising fact is then assumed to be the conclusion rather than the premises. Based on the conclusion, a set of possible premises is then determined that is considered sufficient or nearly sufficient to explain the conclusion (Saunders et al., 2012; Blaikie, 2010).

Neville (2005) defines research approaches as "quantitative/qualitative" and "deductive/inductive". Researchers can combine different kinds of approaches. To explain briefly quantitative research looks for statistical, mathematical data. Quantitative research designs are highly structured and the researchers who use this method judge qualitative methods as being not well structured. Qualitative research has a more subjective nature than quantitative. Unlike quantitative methods, qualitative data is harder to analyse and interpret.

In general the starting point of deductive research is a generic theory, or ideas about a situation, and evolves towards a specific position (Neville, 2005). It is a theory testing process which commences with an established theory or generalisations in addition to seeking to see if the theory applies to specific instances (Hyde, 2000). On the other hand inductive research's point of departure is a specific position and it reaches to general theories from this point (Neville, 2005). This research approach is a theory building process, starting with observations of specific instances and targets to establish generalisations about the phenomenon under investigation (Hyde, 2000).

From the reasons mentioned above, it can be concluded that the conducted study benefits from inductive approach. Also qualitative research strategy has been adopted as

the research methodology of this research. To describe the sequence of the steps of the inductive approach, Bryman and Bell (2007) suggest different steps which are displayed in “Figure 7”.

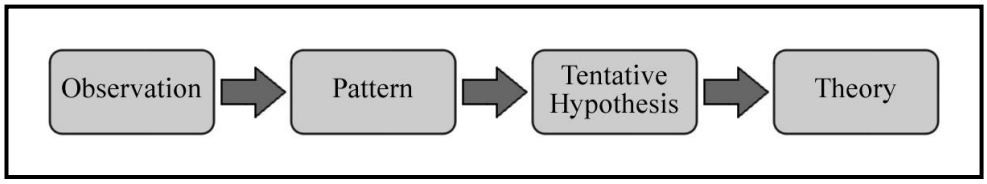

Figure 7. The Inductive Sequence (Bryman and Bell, 2007)

4.7 Document Synthesis and Review

To justify any research endeavour, it is necessary to carry out a literature review (Blaikie, 2010). Literature refers to the existing body of knowledge. A literature review is a critical evaluation of the existing body of knowledge on a topic which guides the research (Collis & Hussey, 2014). According to Jankowicz (2005), a literature review provides a description and critical analysis of the current state of knowledge in the subject area at the outset of and throughout the work, and during the systematic development of a conceptual framework.

Kumar (2011) describes a literature review as an essential preliminary task in any research undertaken. A literature review is further acknowledged to:

- Bring clarity and focus to the research problem,
- Improve the research methodology, and
- Broaden the knowledge base in the research area

This research commenced with the synthesis and review of literature pertinent to the research subject area. Knowledge is disseminated through various types of publication, which can he in hard copy or digital form, and the data can be qualitative (as in text or illustration',) or quantitative (as in tables or statistics) (Collis & Hussey, 2014). According to Mauch and Birch (1998), mixed methods research relies on a range of sources including less conventional “literature” such as letters, documents, newspaper reports and works of art to set the scene for the work.

The overall aims of the literature review, in relation to this period, were to:

- Gain an overview of the knowledge of the research subject area
- Discover whether research on the same topic had been conducted

- Identify any aspects of the research topic not considered in previous work
- Gather valuable knowledge that could serve as the foundation of the research
- Search for any information that could enable the researcher to take an appropriate philosophical stance and select a suitable methodological research framework that could guide the research process.

4.8 Research Strategies

Research strategies (Blaikie, 2010), research approaches (Creswell, 2009; Remenyi et al. , 2005) or research style (Fellows & Liu, 2003) use tools such as surveys, case studies, experiments, ethnographic investigations, action research, grounded theory, as well as mixed methods as a basis for research design (Denscombe, 2010; Creswell, 2009; Fellows & Liu, 2003). It is acknowledged that the range of strategies available to modern-day researchers has increased over the years. This is predominantly influenced by advances in computer technology which has led to faster and alternative options for analysing complex data, as well as innovations in the procedures for conducting social research. Some of the considerations in deciding on the research strategy to be adopted, as suggested by Yin (2009), include:

- The type of research question posed;
- The extent of control an investigator has over actual behavioural events;
- The degree of focus on contemporary as opposed to historical events.

Yin (2014) argues that the appropriateness of a particular research strategy interfaced with the available research methods to achieve the research aim is guided by the research questions. Thus there is no single research strategy or method that can be recommended as the best in all circumstances (Denscombe, 2010; Yin, 2014). Research strategies for social science researchers include Surveys, Case Studies, Experiments, Ethnography, Action Research, Grounded Theory, and Mixed Methods. In the following sections some of these strategies are discussed in more details.

4.9 Surveys

A survey is a research strategy aimed at describing accurately the characteristics of a population on the basis of statistical sampling to provide a quantitative or numerical description of trends, attitudes or the opinions of a population by studying a sample of

that population (Denscombe, 2010; Fellows & Liu, 2003; Polgar & Thomas, 1995). Fink (2003) describes a survey as a system for collecting information from or about people to describe, compare or explain their knowledge, attitudes, and behaviour.

Like other research strategies, a survey allows for the simultaneous measurement of multiple factors and includes the examination of possible underlying relationships to generate an answer to such questions such as 'who', 'what', ' where', 'how many' and 'how and much'? (Yin, 2014; Creswell, 2014). Polgar and Thomas (1995) note that surveys have been used to describe accurately trends and the characteristics of specific phenomena as well as for other purposes.

Survey strategies are broadly classified and grouped into two methods of collecting and interpreting data, commonly referred to as quantitative and qualitative research methods. Each of these methods has strengths and weaknesses, and as a result they are often combined in what is referred to as a 'mixed methods' approach (Creswell, 2014; Denscombe, 2010; Fellows & Liu, 2003).

4.10 Case Studies

The case study is a research strategy which allows for in-depth exploration of processes. It is an empirical inquiry that investigates a contemporary phenomenon in its real-life context, especially when the boundaries between the phenomenon and the context are not clearly evident (Saunders et al., 2012; Denscombe, 2010; Yin, 2014; Remenyi et al., 2005; Fellows & Liu, 2003). Information is gathered using a combination of data collection methods, including quantitative and qualitative methods, or a mix of both, to collect and analyse data in order to generate answers to the questions of 'why'? as well as 'what'? and 'how'? (Yin, 2014). Saunders et al. (2012) note that compared to other methods of inquiry, the case study is most often used in exploratory and explanatory research.

As well as documentary data analysis, the case study employs interviews with key stakeholders to understand the complex relationship between factors as they operate within particular social settings. In other words, case study research uses qualitative and quantitative methods or a mix (triangulation) of methods (questionnaires, document analysis, interviews and observations) to collect data (Yin, 2014). It is thus an empirical research strategy that investigates a contemporary phenomenon within its real-life context, especially when the boundaries between the phenomenon and the context are not clearly evident.

4.11 Questionnaires

A questionnaire is a document designed for the purpose of seeking specific information from respondents (Polgar & Thomas, 1995). It is a method that seeks written or verbal responses from people to a written set of questions or statements. Questionnaires are broadly classified as based on 'open' or 'closed' questions (Parahoo, 2014; Denscombe, 2010; Polgar & Thomas, 1995). Open-ended questions are those that allow respondents to decide the wording of the answer, the length of the answer and the kind of matter to be raised in the answer (Denscombe, 2010). This type of questionnaire allows the respondent to provide answer in their own words. In closed-ended questionnaires, the researcher designs questions which allow only answers that fit into categories that have been established in advance (McLeod, 2014; Denscombe, 2010).

Both open and closed-ended questionnaires have advantages and disadvantages in different circumstances. According to Denscombe (2010), the advantages and disadvantages of closed-ended questionnaire design are a mirror image of open-ended design. The author further suggests that the main advantage of a closed-ended questionnaire is the structure it imposes on the respondent's answers, which gives the researcher information of uniform length, and in a form that lends itself nicely to being quantified and compared. One of the main disadvantages of this design is the lack of an in-depth response from respondents. According to Denscombe (2010), there is less scope for respondents to supply answers which reflect the exact facts or their true feelings.

A further advantage of open-ended questionnaire design is that the information gathered in the responses is more likely to reflect the full richness and complexity of the view held by the respondents (Denscombe, 2010). Open-ended questionnaires elicit more detailed responses. Questions in this type of questionnaire tend to be short, and the answers tend to be as long as the space given to respondents to express themselves in their own words. Yet one of the disadvantages of this type of questionnaire design is the time it takes the researcher to analyse the data, as the ‘researcher have to read the answers and try to put them into categories by coding which is often subjective and difficult’ (McLeod, 2014; Denscombe, 2010).

4.12 Interviews

As part of the qualitative data collection techniques employed for this research to achieve the research aim and objectives, interviews were conducted among construction

SMEs in England. Parahoo (2014) describes 'qualitative interview' as a broad term used to denote a family of interviews with the common purpose of studying phenomena from the perspective of the respondent. Research interviews are one example of qualitative research methods. Others include questionnaire, document review, and observation (Hannabuss, 1996). An interview is a purposeful conversation between two or more people that requires the interviewer to ask concise and unambiguous questions, and carefully listen to the answers in order to be able to further explore the phenomenon under investigation (Saunders et al., 2012). An interview provides a means of finding out from people what they do, and their thoughts on the phenomenon under investigation.

Interviews can be conducted with individuals or groups of individuals face-to-face, or by telephone or video-conferencing methods. According to Britten (1995), an interview is a flexible and powerful tool often used in the health sector for investigating research questions of immediate relevance to everyday work which would otherwise be difficult to investigate. It is a widely used tool to access people's experiences and their intuitive perceptions, attitudes and feelings of reality (Zhang & Wildemuth, 2006). Compared to other qualitative data collection techniques; interviews are concerned with exploring 'data' about understandings, opinions, what people remember doing, attitudes, feelings and the like that people have in common (Arksey & Knight, 1999).

A number of terms have been used to described qualitative interviews, including 'unstructured', 'depth', 'informal', 'non-directive', 'focused', and 'open' (Parahoo, 2014). Based on the degree of structure and flexibility, interviews can be divided into structured, unstructured and semi-structured (Walliman, 2006; Zhang & Wildemuth, 2006).

4.12.1 Structured Interviews

A structured interview is an interview that has a set of predefined and standardised questions (Walliman, 2006; Zhang & Wildemuth, 2006). Using this technique, the researcher asks pre-determined questions from a written list in a person-to-person interaction which may be face-to-face or by telephone or electronic social media. The researcher often uses closed-ended questions in a structured interview (Collis & Hussey, 2014). Compared to other forms of interview, structured interviews are easy to construct and require fewer interviewing skills. They provide consistent information which ensures the comparability of data (Kumar, 2011). According to Fellows & Liu, (2003),

structured interviews give little scope for the researcher to probe responses by asking supplementary questions to obtain more details or to pursue new and exciting aspects.

4.12.2 Unstructured Interviews

Compared to structured interviews, unstructured interviews are more flexible. Depending on the responses received, the questions can be changed and adapted as the interview progresses. In this method of data collection, none of the questions are prepared in advance but evolve during the course of the interview (Collis & Hussey, 2014). These authors further note that in unstructured interviews the researcher uses open-ended questions which cannot be answered with a simple 'yes' or 'no' or a short factual answer. Unstructured interviews generate qualitative data through the use of open-ended questions which require longer, more developed answers (Collis & Hussey, 2014; McLeod, 2014).

4.12.3 Semi-Structured Interviews

Semi-structured interview questions are acknowledged to get a more considered response than closed questions, and therefore provide better access to the interviewee's views, interpretation of events, understandings, experience and opinions (Silverman, 2011). This form of interview occupies the middle part of the spectrum between structured and unstructured interviews, and contains both closed and open-ended questions (Collis & Hussey, 2014; Arksey & Knight, 1999). Semi-structure interviews also give interviewers the opportunity to add questions based on the participant's responses. Denscombe (2010) argues that semi-structured and unstructured interviews are a continuum and, in practice, they move back and forth along the scale. He further argues that what separates them from structured interviews is the fact that they allow interviewees to use their own words and develop their thoughts. McLeod (2014) supports this view, pointing out that semi-structured interviews allow respondents to talk in some depth and choose their own words, which help the researcher to develop a real sense of the respondent's understanding of a situation. Both techniques have as their aim ‘discovery’ rather than ‘checking’ (Denscombe, 2010).

4.13 Adopted Interview Technique

The above synthesis and review of the literature on pertinent to interviews and the sequence of interviews highlights the usefulness and prominence of interviews in qualitative research. Within the healthcare sector, interviews are acknowledged to offer a powerful means of uncovering the complex experience of patients, carers and

clinicians during treatment and decision-making processes. They allow the subjective analysis of complex human experience, making them a powerful tool for increasing our knowledge of important processes (Broom, 2005; Riesman, 2001).

Because this research was conducted on the basis of the explanatory sequential mixed methods model, the semi-structured face-to-face interview technique was considered the most appropriate within the time available to complete the research. Furthermore, it gives the targeted participants the opportunity to express their opinions based on their experiences.

The researcher chose a face-to-face technique rather telephone or web-based (Skype or video conferencing) interviews because this method is more personal and makes it easier to explore participants' experiences face-to-face. Furthermore, it gives the researcher the opportunity to ask complex and sensitive questions in order to collect comprehensive data (Collis & Hussey, 2014; Rebar et al., 2010). This rationale is also supported by Easterby-Smith et al., (2011), who claim that semi-structured interviews give the researcher an opportunity to probe deeply, uncover new clues, open up new dimensions of a problem and secure vivid, accurate, inclusive accounts that are based on personal experience.

4.14 Research Design

Any method that is adopted by the researcher during the course of study to find a solution for the identified problem can be named as “research methods”. During this process, from the researcher’s point of view, collected data and unknown aspect of the problem have to be relevant to each other in a way so that the possible solution can be identified. In line with this, research methods can be put into three major categories which are as follows (Armstrong, 2012):

- Data Collection: Methods which are used to collect relevant data
- Data Analysis: Methods which are used to create relationships between the collected data and unknowns
- Data Evaluation: Methods that researcher benefits in order to evaluate the accuracy of the obtained results

In circumstances where already available data to solve the predefined problem is not sufficient, the researcher must collect data relevant to the research problem so that

collected data can assist the researcher to identify a solution. It is necessary to highlight at this point that there are two types of data gathering; “primary data” and “secondary data”(Crowther ve Lancaster, 2012). Primary data does not actually exist until and unless it is generated through the research process by the researcher as a part of finding an answer for predefined problem. On the other hand, secondary data is the information that already exists in some form but which was not primarily collected.

It is acknowledged that there is no single research process or strategy that can be recommended as the “best” in all circumstances (Easterby-Smith et al., 2012), and so the choice of research process depends on identifying the one that works best for the particular research undertaking. It is also noted that the choice of a particular research methodological process is influenced by its suitability and feasibility, and by ethical considerations relative to the research question, problem, cost and time, as well as the skills of the researcher (Easterby-Smith et al, 2012; Denscombe, 2010; Remenyi et al 2005).

Methodology occupies a central position in any research process (Sarantakos, 2013). It is the strategy, plan of action, the process or design that underlies the choice and use of a particular method or technique to discover reality. It is a process that translates ontological, epistemological and axiological principles into guidelines that show how research is to be conducted (Sarantakos, 2013; Easterby-Smith et al., 2012; Creswell, 2009).

This research uses interviews to collect primary qualitative data. The questions are set prior to interviews taking place (available in appendix 1). Some of the questions asked from the participants would include their attitude towards the existing communications methods within their SME and how using a web based collaboration model could improve their activities and increase the level of efficiency and effectiveness of their products and services. SME workers’ motivations are influenced by a range of personal and organisational factors as well as relationships with others, and many features of the construction industry within SMEs are influenced by the motivation of their workers. It is important to study those scenarios and see how different cultures could adjust to adaptation of such technology and whether or not, it would have a long term positive result within the SMEs.

In this research initially an in depth literature review was conducted in order to have solid understanding of Online Technologies, Construction Industry and collaboration

within Small and Medium sized enterprises within that sector, hence refining the research aim and objectives. In this stage the author has identified the knowledge gap considering the previous researches undertaken by others. It was found that the construction industry lacks innovativeness in regards to adopting new technologies for collaboration. To help and understand better what influences the new adoptions within companies, the TOE framework was reviewed to give a clear understanding of factors affecting the adoption of new innovative IT solutions within organisations. This was followed by collecting qualitative data by interviewing 17 individuals working in construction SMEs. After conducting the interviews, the recorded version was transcribed and analysed to create the framework. This was used to produce the first version of the framework. Then it was presented to 3 experts for validation to produce the final version of the framework and the corresponding flowchart.

4.15 Qualitative Data Collection and Sample

For qualitative interviews, purposive sampling is a non-probability sampling method where cases are selected based on researchers' judgements according to certain criteria of the participants (Cooper and Schindler, 2001). In addition, the influence of purposive sampling is about selecting data rich cases that demonstrate the phenomena of interest strongly towards facilitating more insight into the theoretical construct underlined in the proposed study (Patton, 1990).

As this research looks at the importance of how taking advantage of an innovative, user friendly and cost effective Cloud Computing related framework, effective collaboration and efficient understanding within construction SMEs, enables and improves the process of gaining experience, skill, awareness, confidence, belief and becoming competitive in the industry. Resulting in high quality, cost effective and in-time delivery of projects, micro, small and medium sized enterprises were considered as major criteria of selecting samples to facilitate comparability. Therefore, two important criteria for selecting the purposive samples were: a) construction enterprises considered as micro, small and medium sized as far as the number of employees are concerned and b) Firms that specialise in either Construction Design and Architectural activities or are contractors and sub-contractors (see Table 3).

Size of Firm	Type of Firm	Position of Respondents
Micro (MI)	Advisor (A)	Manager (M)
Small (S)	Contractor (C)	Technologist (T)
Medium (ME)		Designer (D)

Table 3. Types of Respondents, Their Code Number and Characteristics

In order to ensure the richness of qualitative data, the tables above report the firms' sizes and job position of major participants. For clarity of classification, cases are categorised according to their category classification code (see Table 4).

Reference	Size of Firm	Type of Firm	Position of Respondent
INT#1	ME	A	M
INT#2	S	C	M
INT#3	S	C	M
INT#4	MI	A	M
INT#5	MI	A	T
INT#6	MI	A	T
INT#7	MI	A	D
INT#8	MI	A	T
INT#9	ME	A	M
INT#10	ME	A	D
INT#11	ME	C	T
INT#12	ME	A	M
INT#13	S	A	D
INT#14	MI	A	T
INT#15	ME	C	T
INT#16	MI	A	M
INT#17	S	A	D

Table 4. Interviewee Comparison

4.16 Model for Qualitative Interview

There are many qualitative data collection techniques such as interviews, oral history, focus group interviews, Delphi group interviews, observation approaches (Luna-Reyes and Andersen, 2003). Among these, in particular, this study used in-depth interviews and followed set research models. These models were utilised as a guideline to obtain rich data from the relevant sources (Carter, 1999) where questions related to the issue of research led to a series of follow-up questions. The model included carrying out and recording interviews for seventeen individuals that was revised for better flow based on feedback, ideas and recommendations.

4.17 Qualitative Data Analyses

As it was argued, the grounding of theory in data is a significant factor towards achieving the more general aim of supporting claims with credible evidence. This also represents a particular link between data and theoretical statements. As such, this study has strived to use this paradigm where qualitative data were collected to test theoretical

arguments/links and analyses which follow the constant comparative method (Glaser and Strauss, 1999). Although each interviewed person was termed as a unit of respondent or a single case, cross-case analysis allowed for comparison and contrast between cases (Patton, 1990).

As highlighted earlier, there is no single standard approach for analysing qualitative information; however, this study used cross case analysis. For ease of analysing field data via cross-case analysis (Patton, 1990), data was coded into categories to facilitate comparison among/between cases towards exploring properties of each category (Douglas, 2003). The coded transcript and its side margin were used to write/note major themes of interview. The integration of categories and their properties with respect to different constructs were grouped together enabling comparison, discussion and interpretation of the phenomena (Patton, 1990; Seale, 1999). The six major categories/positions of respondents were coded based on the size and types of firms and the code numbers are used in the description and interpretation of the qualitative data analysis section. For case identification in the analysis process, interviews are coded as INT#1 to INT#17. The profile of the interviewees and their categories are discussed in the following section.

4.18 Qualitative In-Depth Interview Profile

Based on the criteria of selecting knowledgeable key informants for in-depth interview, rigorous attempts were made to select respondents in each category. As a result, seventeen individual respondents were identified from Advisory and Contractor based SMEs. All seventeen interviews were recorded. Each of the in-depth interviews took around forty five minutes. Using the Australian Bureau of Statistics (e.g., Office of Small Business, 1999) business classification code, the interviewed firms were classified as seven micro, four small, and six medium sized firms.

4.19 Summary

In this chapter, initially the philosophy of research was described (see section 4.1, 4.2, 4.3 and 4.4). This was followed by explaining different aspects and approaches for research (see section 4.5 and 4.6). The chapter was continued by reviewing some of the major research strategies, in particular “Interviews” which was adopted as the technique for this research (see section 4.8, 4.9, 4.10, 4.11, 4.12 and 4.13). Thereafter, the design for this research was outlined (see section 4.14) and data analyses models and procedure was described (see section 4.15, 4.16, 4.17 and 4.18).

In the next chapter, analyses of the collected data have been carried out and further discussions have taken place. Various collaboration options including internal and external collaborations for construction SMEs have been explained thoroughly and pre-validated framework as well as finalised framework after three separate validations were carried out, have been included.

5 Data Analyses and Discussion

This research aims to propose a collaboration framework for construction SMEs based on online technologies. To achieve this aim, primary qualitative data was collected and analysed. In this chapter, the investigated sample will be described and the results of data analyses will be presented.

5.1 Analysing Collaboration Dimensions

Analysing the interviews highlighted different dimensions for collaboration in construction SMEs. For example, while collaboration amongst the employees within each SME can be important for the firms, there are other forms of collaboration which can specifically benefit SMEs. These include collaboration between SMEs and also between them and other stakeholders. In the following sections, each of these dimensions is discussed and analysed based on collected data and the reviewed literature.

5.1.1 External Collaboration

One of the main differences between SMEs and larger enterprises is available resource. Larger enterprises, especially in the construction industry, benefit from a range of resources from legal representation to heavy machinery that facilitate in obtaining large projects. Conversely, SMEs do not have the same levels of resource and prove to be no competition to the large companies However, if construction SMEs can work together and share their resources, they would be able to compete with larger companies, and by doing so, will not necessarily need to compete with each other. For example, INT#4 suggests “If rival companies in our working environment were using particular technologies, that would have an impact on the business, we have to be competitive”. However, if rivalry can be replaced by collaboration, a new technology for another firm can increase the chances of collaborating with them on bigger projects. INT#12 suggests competitive edge as a factor for adaptation of any system. He explains “The system should give us an edge over our competitors in order for the sponsors in our company to look at it”. On the other hand, one may argue that sharing resources with other firms can bring the opportunity of competing in markets which could not be reached without collaboration.

INT#10 supports the extended market as a result of collaboration among SMEs. He suggests “A successful collaboration could mean that we offer one service and one of

our partners offers another. So it's being able to offer all the services, but not just through one company, through the collaboration". INT#13 confirms this by arguing "For design and architectural companies, trying to bid for larger work, and wanting to work together, firstly the mind-set needs to change, because obviously we're competing against each other. But I am sure there will be an inclination for many small companies to get more work if they can do that together".

The collaboration can also exist in financial matters. INT#17 takes Crowd Funding as an example and explains "There is a term called Crowd Funding. Someone wants to set up an enterprise, they don't have enough money, they go on FACEBOOK and ask for an investment, and they get investments which far outstrip anything they could ever imagine, to get the idea to float. A kind of a similar approach to this really. You're stretching out to SMEs that wouldn't have the opportunity to deal with big projects, but they can invest into that".

One of the practical examples in construction industry is insurance. Currently, each firm needs to look for an insurance deal which suits them. However, this too can be done collaboratively. INT#1 explains "The client will want single point risk responsibility. If the SMEs together can get an insurance policy, then your client would be happy working with them".

One of the benefits of external collaboration is the possibility to share resources. These resources can range from human resources to technology and knowledge transfer. For example, if one firm requires ten building workers at short notice, and another firm is experiencing delay from their supplier and their labourers have nothing to do, there may be an opportunity which could benefit both companies. This can also be applied to sharing hardware and technology. INT#1 explains "Why do firms do jobs together, it is technology transfer. That is why joint ventures work because one firm is taking the skill set from one and one is taking from the other".

Every organisation needs to work within a framework of assured environmental factors and there is a permanent communication between the organisation and its environment. The influence of environment on organisation is varied. The communication implies a relationship between the two. The environmental factors may have an effect on various parts of the organisation in multiple ways, because different parts communicate with their relevant external environment. For example, the operations environment may influence the firm's finance department. Moreover, these factors of the environment

may have immediate effect on some parts but not on others. For instance, any change in the financial strategy of government may influence the finance department immediately but it may only concern operations and human resources departments indirectly because their plans may be revised as a result of new circumstances, although not inevitably. INT#2 explains that "There are environmental factors impacting the adoption of Cloud Computing because you want to be ahead of any competitors".

Though there are some types of collaboration systems already in place within most of these SMEs, most of them include limitations. They would love to be able to interact with different departments internally as well as external working with their partners for specific projects but they have not got the required system in place for their needs and wants. INT#2 explains that "Our current collaboration system includes limitations. We want to link it to our accounting system, also link sub-contractors onto specific project locations".

When companies work with other contractors or sub-contractors, there would be a need for constant collaborations in order to exchange the necessary files based on each individual job. The other company would expect to receive the files associated with each job, and if they do not get the latest versions of those documents at certain dates and times, there would be a negative impact on the project. INT#3 states that "Sub-contractors rely on us emailing them a drawing and some people may say they haven't seen the drawing. I can access it and say they have looked at it at a certain time and date".

Companies want to be competitive in the market and this is an important aspect of making the decision, as to whether or not a new innovative collaboration system would be useful to the company. INT#3 explains that "Another Element that has been a barrier to acceptance of the system is the culture. People do want to use it but are apprehensive about using it because it's different. I like to use anything that makes my job better, but some people may find it harder to adapt to it".

Organisations constantly strive to maintain a competitive position in the market. With regard to the overall quality of their projects, they would never want to fall behind their prospective rivals. If their rivals have adopted a new innovative system that potentially helps them to attract more clients, they would also want to be able to adopt the same system, or something very similar to it, in order to keep pace with with their rival companies and maintain their own competitiveness within the market. INT#8 explains

that “We keep an eye on what other local practices are doing, particularly in their presentations, drawings, things like that; it’s hard to know what they are doing in terms of their client computing. I suppose it could make a difference if a perspective new client might decide to engage with another architect; because they can make more IS computing services available to that client”.

Many organisations either already collaborate with external companies, or they are completely open to develop a partnership and collaboration with other external firms. However, they would need reassurance that levels of security would be maximised in order to ensure that only relevant individuals from each organisation are allowed to access and edit files. INT#10 explains that “In terms of collaboration, I think the issue is security. Although we are doing collaboration with other organisations, I don’t think there is any IT measures in place at present”.

For the organisations to be motivated to collaborate with other external firms, they need to be provided with benefits and advantages that they would achieve. They may have certain limited resources but at the same time no access to other desired resources. When they realise they can have a joint partnership with another external company in order to allow them to take on a project that they would otherwise be unable to accept, that would give them motivation for such collaboration activities. INT#10 explains that “A successful collaboration could mean that we offer one service and one of our partners offers another. So it’s being able to offer all the services, but not just through one company, through the collaboration”.

The system must allow the companies and their external partners to view exactly what files have been shared, the time at which it was originally shared and when any changes were made to the initial file. If all the necessary information associated with shared files does not get recorded, one of the two parties could claim they were not sent the correct file version or they did not receive it at the correct time. INT#11 explains that “We had an issue with one of our subcontractors saying that we didn’t issue the correct drawings, and when we had an issue on one of the jobs, the sub-contractor said it was because we didn’t send them the right drawings, but we couldn’t prove that we had sent them the correct drawings at that point in time”.

Companies would always want to be one step ahead of their rivals and if certain competitors start using systems in order to attract more clients, they would at least be interested to know what advantages that system offers and learn whether to adopt the

same system or a different system which ensures even more benefits in order to remain competitive in the market. INT#12 explains that "The system should give us an edge over our competitors in order for the sponsors in our company to look at it".

Many companies acknowledge the fact that there are advantages in working alongside other organisations. However, considering the fact that they are also competitors with each other, they should be convinced that the rivalry will not affect the joint project work in a negative way, but instead they can share resources that they would otherwise lack, and hence securing big projects that they would otherwise have to pass on. INT#13 explains that "For design and architectural companies, trying to bid for larger work, and wanting to work together, firstly the mind-set needs to change, because we're competing against each other obviously. But I am sure there will be an inclination for many small companies to get more work if they can do that together".

Many companies have to go through the process of employing people on a temporary contract basis because they need certain expertise for specific projects within a particular timeline. They have to interview the individuals and then develop a mutual trust and then agree on employment terms and many other aspects. All of these would account for intense responsibilities for a limited period of time. Collaboration with external companies that could provide the same level of expertise would save them a lot of time and hassle. INT#13 explains that "Our work is project based so we're talking about one particular project that we're trying to win, again if the company doesn't have the expertise necessary, then what might happen is that you should employ somebody short term, as a contract member of staff, to fulfil that gap. If that process could be more efficient and easier to organise, that would be a great help. It would be amazing to be able to save time with regards to finding the right committed individual".

Having to approach individuals for temporary work positions would provide no guarantees for organisations to find the right person for the job who would be available at a short notice. INT#13 continues by stating that "So the issue then would be, we apply for a project and win it tomorrow, and we need somebody to start tomorrow, they might be working on another project. It's guaranteeing that they have the time to meet our project. That would be a primary concern. For us, architecture is our main process, but we also have interior designers within the company, and they might not necessarily be fully employed all the time, so with specialities, we have landscape architects as well, we have master planners and often we keep the separate elements fully employed all the time. So if there was a process of being able to have these available when

necessary rather than as full time employees, then that would be of interest to medium sized companies".

Some companies would like to be able to have a joint partnership to be able to take on a project with other experts and pay them based on that certain project as opposed to drawing a long term contract with them. INT#13 explains that "If we can have the option of pay per project with committed individuals that would be very beneficial". INT#13 continues by stating that "The big issue is having the right number of people who are efficient enough in using the different systems for what you need to do. If you could avoid that and everybody was able to produce sufficient work at a correct level of quality without having extensive knowledge that would be a great help. I think it's the problem of mind-set in design companies and getting people to be more open to wider collaboration. I think this sort of system would be part of it, if there is a way of doing it easily, I think that will encourage people to at least try and have a go".

5.1.2 Internal Collaboration

Construction SMEs can have up to 250 employees. In many cases these employees work in different locations, different working hours, and sometimes even different time zones. However, to deliver a successful project, these resources need to work together efficiently. There are currently some online services which can be used to provide remote access to documents. For example, INT#3 describes "We have a folder for each job and it is on our server which I can't get accessed to remotely, so we use Dropbox". Using such online services can bring additional benefits. The fact that any access to documents is usually logged in such systems can be used as a monitoring capability. INT#3 explains "Sub-contractors rely on us emailing them a drawing and some people may say they haven't seen the drawing. I can access it and say they have looked at it at a certain time and date".

While existing online systems can be used for online collaboration, the fact that these are not specifically designed for construction SMEs can add to the complexity. INT#7 highlights one possible scenario which is usually associated with limited space available through the existing services. He explains "Currently, let's say a client deletes the downloaded file and they refer to that email, we may have cleared that file from our Cloud based system, so that when they click that link, they can't download it anymore. It's expired so we would have to do it again". There are other issues with existing systems. INT#16 describes internet connection and upload time as some of the

challenges. He explains “Occasionally the files don’t appear straight away, and that’s because of me, I turn my computer off too quickly, it’s on the local drive of that computer, but not uploaded to the Cloud drive. Actually there is a limitation, if the internet goes down, you can work with local files, but you can’t do any collaboration with people elsewhere”. INT#13 also emphasises this point by saying “We go out on site a lot, or meetings with other consultants. So anything that would help that process of being able to access that information from being wherever one is, would be a distinct advantage”. He adds “A big part of how we need to run the business is considering the fact that we have people working away from the office more, they need to be able to work at giving access to information on a wider basis, and still keeping it secure and well managed”.

Internal communication is one the main uses of online technologies. For example INT#14 explains “Work goes to the boss who then checks it all, I don’t just issue drawings without him seeing them, for proofreading, mistakes etc. He just opens it up on his system and reads it. He has the same software as me. So that’s the sort of collaboration we do is check each other’s work”. However, online collaboration is more than just a new tool for communication. Instead it can be a platform to improve teamwork in workplace.

Internal collaboration within an SME can include all of their stakeholders. INT#17 explains “The thing that excites me is the commercial side and this is where all the programme stakeholders could get a cut out of it and everybody could win out of it, because it’s controlled and connected properly”.

INT#9 explains that limited resources means SMEs sometimes have to rely on their employees working from home. He describes “SMEs can have limited resources, limited time, and so what systems should they use, to support their SME. Often people still want to access data from home and it still takes a long time”. While office places can reduce the distance between employees, it does not necessarily guarantee an efficient collaboration.

A major issue within organisations is to manage to convince every member within the team that adaptation of the system would be in their best long term interest. A lot of people particularly the elderly employees prefer to continue their routine without having to commit to any type of changes. INT#2 explains that “there is a lack of confidence and fear of new technologies”.

There is a significant requirement for the organisation workers to be able to access various files that are placed on the company's server from different locations. Based on the level of allocated authorisations, people should be able to edit and update the files too. Failure to provide such facilities would affect the overall speed and quality of the project process. INT#3 explains that "We have a folder for each job and it is on our server which I can't get accessed to remotely".

Many organisations acknowledge the importance of using innovative systems and technologies in order to enhance the level of collaboration and communications amongst the workers. The main problem is that they only tend to take advantage of some of the most basic options on the market in order to save money and that would result in numerous limitations. As a result of using some of the most basic services, people may not be able to rely on being able to transfer any file sizes and they may not receive confirmation messages and notifications when files are edited and updated by their colleagues. INT#3 states that "The company has the potential to explore any new IS innovations. Though it is basic we do use Dropbox it works fine but it is basic. I don't know when people have put documents in Dropbox or if there has been any editing, whereas with some systems I may get email notification that something has been put in or edited". He continues by explaining that "At the moment, I don't know if any new drawings have gone out to people, or they are just on Dropbox for me to look at, I only see the folder that is there. It's only our company that uses Dropbox, not other contractors".

The size of organisations and total number of their employees would have a direct effect on training because there will not be enough employees to cover for the ones who need to take time out in order to be trained. INT#3 explains that "The firm size would have an impact because of training costs. Let's say my colleague and I are doing a job and he needs to be trained. He can't do his job whilst he is being trained, so that is the impact the training would have, according to the number of employees whilst the training is being done."

When completing tasks, staff members within organisations may have no choice but to create larger file sizes. When necessary, file sharing between colleagues should be a straightforward process, without any concerns that the maximum size allowance for transferring files is being exceeded. It maybe that not all those involved in a task where file sharing is necessary, have the knowledge or the techniques of how to reduce file size.. INT#5 explains that "They also only allow a maximum file transfer the size of

five megabytes. If you send a file of over five Megabytes and there are a total of four hundred people working there and they are all receiving five Megabytes files, their servers would crash so they have a maximum file size that they will allow to come in and out at any one time". INT#8 also states that "There were restrictions to the size of the files that couldn't be sent via email".

A lot of SMEs believe that if they simply use the most basic collaboration facilities, this will save money and the facility will still be able to meet their requirements. Unfortunately a lot of basic and free services contain major limitations that may cause problems and inconvenience to employees when they are in the middle of doing projects whilst they have to share files, or other limitations that are applied when using free collaboration services. INT#8 explains that "We use email for everyday use, but we tend to find the problem with email is because of the incoming and outgoing limits on file size. With quite a lot of our work the files we need to send can be 30, 40, 50, 60 MBs".

Sometimes organisations adopt a new collaborative system without doing enough research to learn how feasible it actually is. The system may not be so simple, or user friendly, and if users have not been provided with adequate and necessary training, that will allow them the vision to appreciate the advantages of the system, inevitably there is a lack of interest in using it. INT#9 explains that "Often you can have a collaboration system and not many people use it. So you implement a collaborative platform without the strong training, without the leadership, without the communication, vision, without those things, it doesn't work".

In many cases, organisations only use email facilities to share their files. The problem is that there are many instances when someone has created or updated certain files but they have not emailed them to their colleagues. If that person is ill or out of office for any reason, nobody will be able to access those files and when an entire project is put on hold, based on the fact that there is no accessibility to a certain file, that would cause a lot of inconvenience to everyone else who is working on that project. INT#11 explains that "If there is a file that is really important but it's sat on someone's desktop and nobody can access it, because that person is on holiday or off sick, someone else may need that information and no one can access it".

Many company workers have to face restrictions on the certain file sizes that they are allowed to receive, as well as having a limitation in total file sizes they are allowed to

transfer. The file sizes that are not allowed to be received by them may include zipped and executable files that might contain viruses. INT#14 explains that "The maximum file that I can download is 5Megabytes and I can't have zipped files to receive bigger files. If any attachments have any visualisations and they have executables to allow the video to run, I don't get those either. So I am quite tied down to what I physically can use".

5.1.3 Stakeholder Collaboration

There are usually many stakeholders that are involved in each construction project. The major stakeholders are clients and suppliers. However, there are usually other stakeholders that need to be taken into consideration. For example, neighbours, councils, and other local authorities, can all have a stake in a specific project.

5.1.3.1 Client Collaboration

Another dimension which can be assumed for collaboration within construction SMEs is the one between them and their client. Such collaborations can differ from one project to another, yet it can improve the traditional seller-buyer communication. However, there is currently an array of different platforms and technologies which are used by SMEs. INT#16 says "With my main clients who account for 60% of my work, I use their server and all collaboration is done off a server in the corner of the office. When I work with another client we use Dropbox and then when I work with another client and for myself as well, I use Skydrive because it's free".

Organisations are concerned that their employees and clients constantly receive requests to change firewall settings which give them real concern regarding possible security breaches. INT#5 states that "One of the issues affecting the adoption of cloud computing in our firm is clients' concern about getting through their firewalls and for them to keep managing and checking their security".

Many firms would like their clients to be able to collaborate and communicate with their employees by being able to share files in a simple and straightforward way to speed up the delivery process of individual tasks as well as enhancing the quality and minimising any future dissatisfaction. INT#6 explains that "One of the characteristics the company considered to be influential for the implementation of the collaboration system would be the needs of the clients for file sharing at the time. This is important based on the fact that the end results must meet the requirements".

5.1.3.2 Supplier Collaboration

Contractors need to be able to communicate directly with the sub-contractors and architects that have been assigned to a certain job. In many cases the original quotation given to the customer cannot be met, based on the fact that due to additional requirements, the overall profit level may go down though the job has already been agreed and a contract drawn. Direct collaboration gives contractors the ability of ensuring they can have precise and thorough estimates from the sub-contractors and architects whenever any parts of the requirements have been changed. This would ensure that the figures originally quoted on the contract could still be met. INT#13 explains that "The contractor will have provided a cost to the client, for how they're going to deliver the building; the builder provides a cost for the design. When the building starts, the contractor basically makes money from being able to cut corners or find more efficient ways of doing things, so the architects seem to be in constant confrontation with the contractors. They will increase their profits by being able to change the project if possible, by using a cheaper door frame or window manufacturer. We on other hand are trying to maintain our design".

5.1.3.3 Other Stakeholders Collaboration

In previous sections (see section 5.1.3.1 and 5.1.3.2), the collaboration between SMEs and their suppliers and clients was discussed. However, there are other parties which can be involved in each construction project. These can vary from one project to other. Hence, in this research they all categorised as "Other Stakeholders". This can include local authorities, insurance companies, consultants, and even the neighbours. They all can have a stake in the project, and consequently the projects can benefit from collaborating with them. INT#1 explains "If I have a project and I am a client, I put it out to tender. People bid and groups of organisations can bid in order to get that work. But there will be a lead consultant, who is taking the primary responsibility and the insurance will be with that lead consultant". He further explains the associated credibility by stating "Companies want to get on council approved lists, because it shows their insurance rating. That is why people work for councils. Not because they make a lot of money at it, but it shows that they have the credibility".

It should be noted that there is already some form of collaboration between SMEs and local authorities. INT#1 explains that "Central Data Environment is what the UK government is pushing for as part of the BIM mandate, that you have central data environments and that everybody uploads to a single place". Furthermore, INT#1

suggests that “If the SMEs together can get an insurance policy, then your client would be happy working with them”.

In some more sensitive projects, there could be more involvement from government and local authorities. For example, INT#4 states that “If we were going to go into other markets, as in, say hospitals, then you would be more involved with the Government. Some bodies are subsidised by the Government. Then essentially you would need the latest technology and information, so we would have to be more competitive and get on board with the CLOUD systems and more technology and information”. Such involvements can be extended in the future. For instance, INT#11 states that “It is a government initiative that all contractors are going to have to be at a certain BIM level by 2017”. Finally, INT#13 explains that “Nowadays design tends to involve three dimensional programmes, and sometimes this requires different consultants to work on the same model”.

5.2 Collaboration Dimensions for Construction SMEs

Based on reviewed literature and collected qualitative data, three main dimensions were identified for collaboration in construction SMEs. These are “External Collaboration”, “Internal Collaboration”, and “Stakeholders Collaboration”.

5.2.1 External Collaboration

External Collaboration is defined in this study as any potential collaboration which can be assumed between SMEs. As explained earlier (see section 2.3), construction SMEs usually do not have sufficient resources to compete with large enterprises. However, if these small companies can work collaboratively and share their resources, they would have a better chance of attracting more clients.

5.2.2 Internal Collaboration

As explained earlier (see section 2.3), construction SMEs usually have less than 10 employees. However, these can work in different locations, times, or even time zones. In this research study, internal Collaboration is defined as any type of collaboration which can take place between the employees of each SME. Such internal collaboration can improve productivity and creativity, and consequently it could be advantageous to construction SMEs.

5.2.3 Stakeholders Collaboration

In any construction project, there are usually numerous stakeholders. From suppliers and clients to neighbours and local authorities, there can be a level of collaboration which can be perceived. Such collaboration can improve communication and enhance quality of delivery, as well as saving time and money for SMEs. This collaboration dimension is defined in this research as Stakeholders Collaboration (see Figure 8).

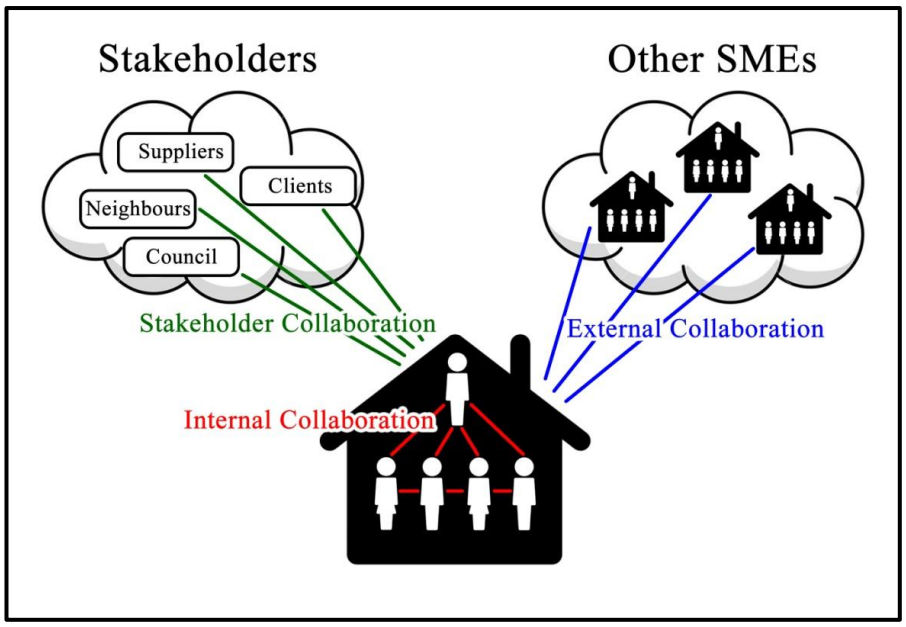

Figure 8. Collaboration Dimensions for Construction SMEs (See section 5.2)

5.3 Analysing Collaboration Optimisation

Following a rigorous investigation and discourse analyses of the collected data, different aspects were found to be highlighted by many interviewees as deficiencies in current systems and practices. These have been categorised and discussed in the following sections. Later in this chapter (see section 5.4), these aspects are further discussed and used to build a framework for online collaboration in construction SMEs.

5.3.1 Collaboration Dimension Combination

In previous sections (see section 5.1, 5.2) different dimensions were highlighted for collaboration in construction SMEs. While the data highlights the existence and importance of such collaborations for the firms, these dimensions are usually approached from separate angles and using different platforms. For example, many of the interviewees suggested that according to the preference of the other parties and the existence of available platforms they choose separate techniques for online collaboration. In many cases, the internal collaboration is carried out by using less secure and informal channels, such as telephone conferences or third party applications

such as Dropbox or Google Docs. For external collaboration, a more formal approach such as email, fax or even written correspondence is used. For other stakeholders' such as local authorities, usually the firms are obligated to use the provided platform (e.g. companies' house or the council).

One of the issues which can be observed by analysing the data is the separation of the channels for different parties and different dimensions. This can bring lack of synchronisation, duplication or out of date documents. Hence, one can argue an ideal solution should combine all of these channels for all parties and every dimension of collaboration. Fortunately, online technologies have made such a unique channel publically available.

5.3.2 Platform Independency

There are a range of roles in each construction SME, and ideally any tool which is used to improve collaboration amongst employees needs to be accessible to all of them. From CEO and engineers, to building workers and cleaners, all employees need to be connected to the same collaboration tools.

One of the main benefits of online systems is that in many cases these do not require installation and as long as there is browser and internet connectivity, these systems can work. This can have a great impact on the required hardware and implementation costs. This is currently not the case as INT#15 explains "A lot of our systems are like that, we pay for the software, then the installation and the yearly licence price, or, a support charge after the installation. That's how the majority of our software works. If you didn't have to pay anything, that's a massive advantage".

If one system can replace multiple existing systems, this can have many advantages for the firms. Although this can be seen as an opportunity to save money, furthermore it can reduce the need for training. INT#13 suggests "Another massive advantage would include not needing to use different applications". INT#13 also explains that having employees with sufficient knowledge for multiple applications can be challenging. He states "The big issue is having the right number of people who are efficient enough in using different systems for what you need to do. If you could avoid that and everybody was able to produce sufficient work at a correct level of quality without having extensive knowledge that would be a great help".

Many architectural SME workers need to work on several visualisation files on multiple machines. Considering the fact that some of these files require individual executable files in order to be installed and run properly, and keeping in mind that each different device may or may not be compatible with the required executable files, the members of staff will face the challenge of having to get everything to work properly on various machines which may run different operating systems. INT#14 explains "If any attachments have any visualisations and they have executables to allow the video to run, I won't be able to get those. So I am quite tied down to what I can physically use". INT#14 continues by saying that "For anybody to access that system and use it, they must also have this software to enable them to download it, then you've got to think about whether that software will read their software so if someone is downloading AUTOCAD, your models have to accept AUTOCAD files, work them out, know what they are, correct them, then the engineer has to do the same with his, because he uses different sorts of software." Furthermore, INT#14 mentions that any potential system must be able to recognise different file formats or icons, otherwise it may not work. He states that "For your system to work successfully, it has to be able to recognise the different files because if you're saying you can alter your software so it runs my way, I used to do customisation of AUTOCAD so I know how complex it is to run. It's all icon based now, it's whether your icons will recognise AUTOCAD files and AUTOCAD programming, otherwise it won't customise it."

In many cases, organisations are given projects that would be ongoing for a number of years. During this period, they would not want to face any difficulties with regards to incompatibilities between older and more recent files. This would cause a lot of problems and result in an unnecessary waste of time and prevent the smooth process of the project. INT#5 explains that "You have also got the legacy systems you already have and how compatible they are with the new software whatever you're running. Quite often you find that they are not compatible, so then you have the problem that you've got a job, let's say some projects last five years you've got to run two systems, the old and the new side by side. So you need operators that can do both and it all adds to the cost and makes it a lot more cumbersome".

Many architectural companies would be interested in minimising the number of various applications that they need to purchase, install and upgrade if they could still be provided with the same facilities, but all within one independent platform. Such a service would save the company a lot of time and money and would avoid any

confusion that may be caused due to having to use a different number of applications that are in place. INT#13 states that "A massive advantage would include not needing to use different applications".

Many architectural organisations face the challenge of having to share files by physically taking the documents from one machine to another in order to allow multiple people to view the files and make further changes. Because a lot of drawing files are very large, there are restrictions on email and many other basic file sharing services with regards to the total file size that can be transferred. Having to keep transferring the work between multiple machines is very time consuming and inconvenient. The other problem is that someone might have the necessary program for opening certain file types on their machine at work, but if they want to continue working on the file from a different machine outside their office, that does not have the necessary program installed, there would be major issues as they will not be able to continue working on the file in such case scenario. INT#14 explains that "Work goes to the boss who then checks it all, I don't just issue drawings without him seeing them, for proofreading, mistakes etc he just opens it up on his system and reads it, he has the same software as me. So that's the sort of collaboration we do is check each other's work".

5.3.3 Centralised Management

Currently many SMEs store some of their documents locally and some on online servers, which can have some disadvantages. For example INT#17 explains "The downside of REVIT is its reliance on internal and external networks. We have local copies and we store the main model on our server and we synchronise with that and it's pretty slow". In addition to document management, a centralised system can be linked to other applications. For example INT#2 suggests "Our current collaboration system includes limitations. We want to link it to our accounting system, also link sub-contractors onto specific project locations".

It is usually too expensive for smaller companies to setup a local server. INT#15 explains "Micro companies that we work with now don't want to pay the money to have to look after the servers in house". Consequently, a centralised and fully managed online system can be very beneficial for them, and they would be able to access it from anywhere they wish without technical or maintenance concerns.

Another benefit for using a centralised system instead of a local system is its extendibility. INT#15 says "If we suddenly did a job that needed a huge amount of

people to collaborate on it, I know that our internet system wouldn't be able to cope with hundreds of people, we only have 10 Megabytes of download limit at the moment". However, in centralised systems there is usually extra space and functionalities which can be used if required.

It is extremely important to ensure that there is a standard procedure for storing files, according to any special significance that would apply to any ongoing projects. They should be categorised efficiently, otherwise the provided space on the server could fill up very quickly with many files that it is particularly necessary to keep. This will lead to serious problems trying to manage the storage space and locate correct files quickly whenever it is necessary. INT#2 explains that "We don't want to use storage systems as dumping grounds, we want to store in the right file structure which is difficult to do".

Based on the fact that many organisations choose to use the basic collaborative systems in place, employees may face a lot of inconvenience when attempting to access, share and edit files that are placed on the main server from different locations outside the office. It could slow progress as the documents may not load properly to allow people to have a complete control, and be able to edit the documents. INT#9 explains that "Often people still want to access data from home and it still takes a long time".

When organisations use manual backups, the major risk is that at some point, someone will overlook this duty, as well as unforeseen accidents such as building fires, that would mean all or most up-to-date copies may no longer be avaialable. Apart from the considerable cost, there are other aspects of these scenarios that cannot be reimbursed, such as loss of manpower time and expertise. In a simple and straightforward manner. INT#10 explains that "One inconvenience is that we have a system whereby we have to change a backup tape every day to capture the information in case anything happens with the server. And if one person isn't here, or it doesn't get done, then there is a chance that data could be lost".

When organisations use only one server or have limited storage space, without the option of increasing the overall storage space, they face the challenge of having to store only certain files and are required to constantly remove older files. This causes a lot of inconvenience as the older files that have been removed may at some point be needed again. They need a dedicated storage facility which does not limit them to a certain space capacity of storing files and documents. INT#11 explains that "Our main challenge at the moment is probably storage space. It's always the increasing amount of

data that we have and it's a massive task for us to keep on top of that. Our biggest use of data is always photographs because we need proof of things we've done in our construction, so our progress photographs take up large amounts of space. There are other things that take up big amounts of space like drawings".

Companies would like to ensure that their staff can collaborate with each other in real time particularly in the case of architectural companies, when different colleagues need to work on the same file simultaneously, even when they are at different locations. If they cannot access or edit the files at the same time, there would be issues because one employee cannot deliver his/her point to another employee without having to wait for the other person to stop editing the file, and transfer access to them which would inconvenience all members of the team. INT#11 explains that "Regarding our existing system, if we were to have some external licences and to buy the collaboration part, you can draw on drawings and people can make notes on drawings and that would be the collaboration part so it might be that our Design Manager might ask the Architect to email that out and put a big circle round it and when the Architects logs on he'd see that as well but we don't pay for that. I don't think that's real time either, only one person could do it at a time, so if our Design Manager was looking at it the Architect couldn't look at it and log in and do it real time".

Traditionally, many companies only use email facilities to share documents between people who are part of the project. The issue is that it is time consuming and inconvenient, when there are so many different people involved in a project who need to be able to see the final edited versions of the documents, as well as being able to edit and update files to provide others with their latest updates. INT#11 explains that "Communication from site, back to head office, and then maybe back to the client as well, or perhaps other sub-contractors that we are using. Traditionally with email and things like that, it takes time for all that to happen, whereas if he had a device that would do all that for him, there and then, as long as he's got a signal; that would be great".

The issue regarding not having a centralised management system, is that users may have some files on their system but if others have made any changes and emailed it to them, they may not be checking their email and may continue working on the old version of the file. Also if they make changes to the documents and forget to email it to the other team members, or they do not email it in time, others would have no way of knowing about the latest file version. INT#11 explains that "Users are used to using the

traditional file system, they will have files sat there in a folder and they will use those, and if a new version comes through, they won't be necessarily looking at the right one. By files, I mean drawings. Sometimes you can get numerous revisions on the same drawing. It will be the same drawing reference number, but the reference number would have a revision number on it, even if they are only minor revisions. That's why it's important to be using and accessing the system".

Many companies are provided with limited storage space and that causes a lot of inconvenience for them when they have to deal with multiple jobs at the same time and keep updating different tasks within each project, whilst having to ensure that they do not run out of storage space, and as soon as the space capacity is close to being full, they have to resolve the issue by eliminating the older files that relate to the finished jobs. The problem is that any of those eliminated files may be required again at some point. INT#14 explains that "I know the size of my files and the job files come out probably about 10 or 12 Megabytes, plus engineers' reports, you're talking about maximum of 100 to 150 Megabytes per job. Once the job has finished, I have to have it all in place and kept, after that I can ask the client if they want the job file. If not, I can get rid of it. I'd have to work out how many jobs, I would have to think that at any one time, we could have ten jobs live of that sort of size and we'd have storage for that. Once the jobs are finished and have elapsed, I can archive them off, I've still got them on the hard drive, but they're not physically on the server, so we need storage for that, for them to run we need these programmes, which take up storage space".

When a company has any issues of space capacity, or download size limitations by exceeding the allocated limits this would affect the entire project work. It may result in the system crashing. This means losing a significant amount of work time trying to put everything back on track, and the time it would take to ensure there is no re-occurrence of this issue. A lot of people may be working on the project simultaneously whilst being in different locations. It would be hard to manage the collaboration, whilst also having to control the overall space capacity for file sizes. INT#15 explains that "The other thing is putting the server in here in our own business, or any other company' own business. You are reliant on the connection speed that you have in your building. I know our connection speed isn't that fast, but if we suddenly did a job that we needed a huge amount of people to collaborate on it, I know that our internet system wouldn't be able to cope with hundreds of people, we only have 10 Megabytes of download limit at the moment".

Many organisations acknowledge the fact that it is inconvenient to have to store a specific file on multiple different locations. You may not remember which file is the most updated, and which file needs to be replaced with the one containing the latest updates. Also many files are very large in size therefore email services and basic file sharing facilities will not allow users to transfer files that exceed a certain size. These aspects all contribute to problems that must be prevented when the main responsibility of workers is to focus on the main project. INT#16 explains that "At the time I worked from home and I worked from an office. I wanted a centralised user space so you haven't got one file in different locations. I often do a file size that may be 50 Megabytes, so you can't email them". INT#16 continues the discussion by stating that "The influential characteristics would include being able to get the information on my phone, on my computer at home, being able to get it on my computer at work, so basically different points of access".

It is significant to ensure that all files are stored on a centralised storage facility that will also allow the files to be opened on the facility. On many occasions architects have to deal with drawing files that are extremely large, and if users have to open them on different machines, instead of being able to open these files within the online storage system, they may take more time to open, and different machines may not even have sufficient memory that is necessary for downloading larger files prior to opening them. Also internal networks within different companies have various limitations with regards to bandwidth capacities and maximum file sizes that are allowed to be transferred. INT#17 explains that "What we've found is, there are significant bandwidth issues using BIM, because if you were to have that stored in a CLOUD and you were to open it on your machine, it would take ages to open because it will be a very large file. The average file size for a medium sized project could be 100 to 180 Megabytes. It doesn't sound like much, but when you open in a 3D environment, it does and at the moment, our internal networks are limited to a hundred Megabytes".

5.3.4 Cost Efficiency and Licence Management

Construction SMEs usually have a limited budget; therefore financial benefits can be a motive for adopting a new system.

Cost efficiency can be one of the main justifications to roll out a new application. INT#2 suggests "Top Management would support using cloud; it would save us a lot of money in the way that we transfer documents to sub-contractors". He continues by

suggesting such financial benefits as one the factors for using the existing technologies; “IT could help us save money. Dropbox is a good example as it saves us about £1000 a year in printing costs”. Furthermore, INT#10 suggests “An upside in adoption of new “IS” innovations would be the affordability aspect. It will be a major advantage, as they would have to invest less money”.

On the other hand, INT#3 highlights financial restrictions as a barrier for adopting new technologies; “We could be far better in exploiting new innovation and we will pursue it, but there are financial restrictions at the moment”. INT#5 also supports this assumption by saying “The main barrier to acceptance has been the cost. It is a critical element that needs to be considered in developing alternative collaboration approaches”. Furthermore, online systems usually need periodic updates and sometimes new trainings. This too can be jeopardised as a result of financial limitations. INT#6 explains “We haven’t upgraded for a few years since 2009, if not before, because of the financial constraints. Whereas we used to have a cycle of upgrading a machine every two years, that stopped in 2009”.

INT#7 suggests that the effect of financial reasons on business decisions has increased in recent years. He states that “The biggest challenge since 2008 has been the recession. We have to balance the investment whilst not jeopardising the quality of the work and maximising potential, but keeping the investment as low as possible, which is what we’ve had to do since 2008, whereas before we were able to invest quite heavily in anything that we thought we needed”. INT#8 also highlights finance as the main challenge by stating “The obvious challenge that we would be confronted with in adoption of new IS innovations would be finance, depending on what the system is”. Similarly, INT#11 says “Because of the recession, we’ve not been able to spend as much money as I would like anyway, on either workspace or training for workspace or generally IT as a whole”.

While budget can be limited, in many cases companies are happy to pay extra for higher quality product. For example INT#12 explains “We are based within the UK as a company, so the cost of change and impact of IT can be quite expensive. But also, the last thing you want is to buy a product that’s a bit cheaper and it’s always for example crashing on you, and gives you problems”.

Usually, construction SMEs buy multiple licences for multiple applications. INT#17 complains “We have got loads of licences coming out of everywhere”. An online

centralised system can replace this with a pay per use licensing. In this case, companies only pay for what they are using at any given moment. For example, if in a particular time period there is not that much work available and the number of employees is reduced, they should be able to save some money by paying less for their licences.

If firms are ensured that using specific new systems would allow them to save a lot of money, they would be more than happy to consider it. SMEs have limited funds and any possibility of making some savings in the long term would be welcomed by them. INT#2 states that "Top Management would support using cloud; it would save us a lot of money in the way that we transfer documents to sub-contractors".

Companies are concerned that utilising a new innovative system may result in further cost imposed on them in order to have to upgrade their existing software and hardware systems. INT#4 explains that "At the moment we are assessing whether or not to adopt a cloud based system. Obviously with the downturn in the economy money is tight and we're looking at taking on board BIM. The problem is that to do so, we would have to upgrade all our hardware which is cost prohibitive". These companies acknowledge the significance of using innovate systems but are concerned about the overall cost that they may eventually pay whilst they need to cut back on additional expenses to continue running their business smoothly. INT#4 continues by stating that "We could be far better in exploiting new innovation and we will pursue it, but there are financial restrictions at the moment. We have looked at web based storage facilities in the past but we aren't in that position financially".

One of the major reasons that resulted in organisations facing financial problems was the global recession that occurred a few years ago which also heavily affected the UK economy. Although many organisations had a reasonable budget to invest in innovative new systems, the credit crunch influenced their policies and they had to cut back on a lot of additional costs in order to be able to continue with their business. INT#6 explains that "We haven't upgraded for a few years since 2009, if not before, because of the financial constraints. Whereas we used to have a cycle of upgrading a machine every two years, that stopped in 2009".

Many organisations that have been using the same systems for many years acknowledge the fact that their hardware and software facilities are outdated and decrease the production and project quality levels but they maintain a concern about the costs and whether or not they must invest in new facilities. Some of them believe that they should

stay away from any additional cost while others realise that cost is in their favour with regards to enhancing and improving the overall projects qualities but still prefer to stay away from any type of new investments. INT#9 explains that "One of our challenges might be that the system is quite old; the server may have been there for ten years and it's had some upgrades. We use tape to do backups so it is quite antiquated really. So I guess there are challenges around maintenance, there is concern that it's old, and that it will fail. Where our applications fail is perhaps in an environment where we're putting together large documents, we do a lot of bid work producing major documents for bidding and I guess we do a lot of graphics and so on. Talking about an SME that has been around a long time, there is a cost to do research, understand what is out there and a cost to make that investment".

Production data is what the companies need on a daily basis and they have to repeatedly update it to make sure they have the most accurate data at all times. When the company has a limited storage space, they have to use lots of resources to ensure that only the most necessary production data gets stored and older data is removed. Another issue with this, is that by eliminating the older data, if it is needed at a future date, this could cause problems INT#11 explains that "We move data around from production storage which is obviously more expensive than archive storage which is that cheap storage".

With regards to SMEs, since they have limited budgets, there is always a challenge for them to acquire their necessary tools to enhance the level of quality that their clients expect, without having to invest heavily. A new system could take a lot of pressure off the individual members of staff that have to be in charge of collaborative activities and allow the employees to take advantage of a system that has the potential to boost their overall productivity. INT#11 states that "Cost wise the fact that we're a smaller company makes a difference. For the past two or three years, the resources for the IT Department, was only myself. I acquired a new member of staff this year but if you can imagine, we didn't have the IT resources as a department for me to do everything that I needed to do, so resources in an SME aren't always there. For us, it's been to do with the recession; we're working on very tight margins so the money hasn't been there for more staff and hence the resources are overstretched".

A lot of companies want to save money whenever possible and an advantage to them would be using a server that is not kept in house as they do not wish to take on the responsibilities associated with keeping the server at their premises, as they do not wish to dedicate any additional time and money for it. INT#14 explains that "Micro

companies that we work with now don't want to pay the money to have to look after the servers in house. We don't have a security expert here, I do it, I get advice off people, it is a very important thing to us, but I'm not sure if the small companies realise how important it is. A lot of the smaller companies don't have that expertise in house".

Keeping servers in house may result in additional cost with regards to support and having to replace the server when it becomes faulty, whereas external server providers would not charge any more money if they have to replace certain servers within their premises and lots of them provide unlimited support as part of their basic services. INT#15 explains that "If the server that's its running on doesn't operate, we'd have to replace the server. Whereas, if we're paying an ongoing cost for somebody else to do that not in here, they will do all of that for us. If we did have a project that ran for say six months, I know that my lease line connection. I'm tied into that for three years, so if I upgraded my internet connection to cope with that traffic but the project was only six months long, I would then be in a contract for three years".

Architectural enterprises may need to use lots of different programs for every task within each of their ongoing projects. This creates a lot of confusion for them and at the same time they are faced with the challenge of what programs to purchase for certain machines. Purchasing individual program licences in order for them to be installed on every single machine would literally cost a significant amount of money and many SMEs will not be able to afford such heavy investments. So in many cases they only purchase some of the necessary programs for some machines and other required programs for other machines. INT#17 explains that "In order to edit a file, REVIT itself will open it, what we do have to use, are lots of other programmes which are affiliated to that. For instance, rendering package, which is like a bolt-on but not every machine has it, because we can't afford to have it. But if you want to get a good rendered output from something, you would have to have access to it. Our company and other architectural companies would really appreciate achieving a solution for opening anything and everything all in one space".

5.3.5 Security and Trust

Trust is one of the important factors in any industry, and construction is no exception. So, any collaboration framework needs to address this matter. While collaboration amongst different SMEs can bring their resources together, it can also reveal some industry secrets. For instance, INT#1 explains "The reality is a lot of firms will never

tell you who they work with, because as soon as the other organisations understand those connections they will take them off you. So the problem with setting up collaborative environments is that other people that you may want to get may become aware of clients that you may have and will potentially compete with you for those clients". Hence, any collaborative tool needs to have the required confidentiality procedures, and the collaborators should be able to choose what is shared with whom. INT#1 continues by stating that "Ultimately, if you want to work with other people, what is the critical thing? It's trust."

In many cases organisations are concerned that allowing any outside sources to access their servers and add new files or make changes to existing files may result in security issues and possibilities of getting viruses through their systems. INT#5 explains that "We run Autocad, our office landlord provides all the networking facilities within our office. If we were to link to an outside source, they would become concerned about getting viruses through that system".

Organisations are concerned that their employees and clients constantly receive requests to change their firewall settings, which gives them real concern regarding possible security breaches. INT#5 states that "One of the issues affecting the adoption of cloud computing in our firm is clients' concern about getting through their firewalls and for them to keep managing and checking their security"..

Many organisations are also cautious about taking measures to prevent hacking. There systems hold confidential information for many different clients, if this information was compromised by someone accessing this confidential information, without authorisation, this would have serious consequences for the organisation. INT#5 states that "Another concern is the security for stopping viruses, and people hacking in. Because they do a lot of accounts and it's all on one system, so they have to be careful about who can and can't access their system".

A vital aspect is that many companies are concerned about keeping their files secure and they acknowledge that if they do not have external file backup, in the case of any accidents, they may lose all their work. This is a serious security matter and may prove to be extremely costly for organisations who have worked on projects for a long time and loss of the files would be disastrous for them. INT#7 explains that "It would be beneficial to have a cloud backup. Let's say the backup I have on the external hard

drive. If I could back that up to the cloud as well, it would mean if there was a fire or burglary I would lose nothing".

Many organisations have to reassure their clients that their data is safe and secure and only certain individuals have the authorisation to access edit or update the information. In many cases the clients need to see solid proof and evidence provided by the companies in order to gain enough trust to develop a partnership with them and allow their confidential and sensitive documents to be accessed and viewed by them. INT#9 explains that "Our clients would request that we provide evidence of how that information is stored, and who has got access to sensitive data and what the risks are".

Organisations must be reassured that any incoming and outgoing data gets handled in the most secure way possible to avoid any viruses affecting their systems, as well as preventing anyone without authorisation to access the files. INT#10 explains that "Another main influence is to ensure that the information that you're getting out of it will be secure enough".

Companies need reassurances that there are different levels of accessibility depending on who is authorised to do certain tasks within a project. INT#11 explains that "The security is important for off-site, but also a collaboration system doesn't mean that all documents are accessible by everyone".

Many organisations are particularly concerned about file types that are sent to their server and they prohibit sharing certain file types, such as executable files because they would like to minimise any possibility of viruses getting through to their systems. INT#14 explains that "All our IT is handled by our landlord and he is very strict at how he locks down all the machines. He's worried about viruses getting down to these servers. Any zip files or executable files, anything like those are instantly shutdown".

5.3.6 Standards and Legislations

Many aspects of the construction industry are associated with government legislations. Additionally, in many cases conflicts can happen between the involved parties, that can lead to legal issues.

One of the challenges which were highlighted during interviews was standards and particularly ISO. INT#2 explains "We want to be ISO compliant, for example 90001 (Quality Management System), 140001 (Environmental Management System), 180001 (Health and Safety Management System)". INT#5 suggests "We are very poor in

exploiting new “IS” innovations and our current method is the old fashion way; Print it out, red mark it and then we alter it, the old QA way ISO 90001”. Compliancy with standards and legislations can have a great impact on whether or not the firms win work. INT#9 states “There are some British ISO standards that clearly define the standards that you need to comply with to work with a particular client. The issue is that if you don’t meet those standards, you won’t win work”.

Governmental legislations are important factors within the construction industry. INT#14 explains “By law you’ve got to keep your information for five years. With the data protection acts that are coming out, they have this BIM and it’s all to do with model and how you would run your system”.

It is significant to ensure that prior to accepting and taking on new projects, by using the collaboration system, an approved legal team are engaged to ensure the contracts are drawn-up and finalised correctly by taking compulsory, necessary and standard pieces of legislation into consideration in order to prevent any future disagreements between the involved parties. With regards to the innovative collaboration system, INT#17 explains that “There is potential provided that the right contracts can be drawn up and signed off”.

5.3.7 Usability and Ease of Use

Currently some applications such as Dropbox enable construction companies to experience some sort of online collaboration. However, the fact that these applications are not specifically designed for construction SMEs can force the companies to use more than one. Also, these applications are not necessarily compatible with each other, hence technical issues can become a challenge for users. Usually change brings some sort of resistance. INT#12 explains “If there is going to be a change in IT systems, a natural reaction people have, is that they don’t like any disruption to their current ways of working”. INT#4 suggests the resistance could be more in older generations. He states “The organisational elements that have an impact on the implementation of Cloud Computing include cultural factors. The older partners are not particularly good with computing technology”.

There are so many occasions whereby the system is absolutely necessary within the enterprise and everyone realises that there is a need to have the necessary facilities in place. The problem is that in most cases, a lot of people find it hard to come to terms with having to change their style of thinking and working, even though it is in their best

interest and will have considerable advantages that will enhance the standard of their work. INT#2 continues by stating that "Organisational factors impacting the adoption of Cloud Computing in our firm include people, culture and confidence in how to use it".

INT#15 suggests software confusion is somewhat more severe in the construction industry in comparison to other industries. He says "Training wise, a lot of people, especially if they've been in construction a long time, find software confusing or hard to use, so the simpler it is to use, the simpler the training, and therefore simpler to understand. If something is really complicated and they don't understand it, they will use it less. Or it would take a long time for it to be used to its full potential". This also suggests ease of use can have an impact on adaptation success rate.

If using an application requires an extensive or expensive training, it can reduce its chances of adaptation by SMEs. INT#6 describes "With regards to "IS" innovations, we were actually one of the original firms to get REVIT software. At the time we were training two members of staff, one of them left and the support wasn't in place. We were training people and when one of them left there wasn't really the support so we decided that we weren't going to invest anymore time and effort into it, so we dropped it". INT#2 argues the existing applications are too complex to be used for sharing information. He explains "We want to simplify BIM applications to help us share files with our architects and project team".

It should be emphasised that even after adoption of an application, training is an ongoing process. INT#2 explains "User training includes, new members of staff having an induction session. Also there is an internal system user guide". INT#6 suggests "A newly implemented collaboration system must be user friendly for those who aren't very IT literate". The inability to train staff has been suggested by INT#8 as a major obstacle. He explains "If it was a system that required intense training courses, or to go elsewhere for training, there aren't enough people to cover those who are off learning what they need to learn. There is a time factor in learning about a new system. In small companies this is an issue. In a large enterprise, they can spread that one person's work around a few different people, we can't here".

It should be noted that simplicity can be one of the factors which can persuade SMEs to replace their existing systems with a new one. INT#13 explains "The REVIT system has taken over the world basically and everyone needs to be able to use it properly, it's very complex, it's very clever, but it takes time to get the go. If there is anything that

could improve making that easier and quicker to use it would help massively. All people involved in construction are going to have to know how to use it. It's a global system basically".

Although the usage of technologies in developing new innovative systems may help the team members to achieve their goals in a much more effective and efficient way, the reality is that people need to genuinely feel the positive impact made by the system in order to agree to learn and use the service. The training must be made simple and users must find the system to be easy and straightforward to learn. INT#2 explains that "The critical elements that need to be considered in developing alternative collaboration approaches include getting people to agree on the process of your system, how it works and ensuring to make it simple to use".

People will resist any new facilities because they do not wish to change their existing routines. It is important to explain to them in detail that adaptation to certain technological systems may help them to do their job more effectively and efficiently and provide better results. INT#3 explains that "Another Element that has been a barrier to acceptance of the system is the culture. People do want to use it but are apprehensive about using it because it's different. I like to use anything that makes my job better, but some people may find it harder to adapt to it."

The reality is that the main concern about needing to adapt to new technological facilities is between elderly members of staff. The fact that they are older means they lack confidence in taking on new innovative systems or having to change their routine in any way, form or shapes. INT#4 explains that "The organisational elements that have an impact on the implementation of cloud computing include cultural factors. The older partners are not particularly good with computing technology".

One of the most important aspects to enhance the potential decisions of organisations to adopt a new innovative system is how simple and user friendly the system is. If the system is not easy to use then employees may hesitate about using it. INT#4 states that "Another expectation from the collaboration system would include being user friendly".

One of the major problems for SMEs is the fact that they can only afford to have a small number of employees and when they invest in training them, and unexpectedly even only one of the employees leaves the firm, this can have an unfortunate impact on the firm. INT#6 explains that "With regards to "IS" innovations, we were actually one of the original firms to get REVIT software. At the time we were training two members of

staff, one of them left and the support wasn't in place. We were training people and when one of them left there wasn't really the support so we decided that we weren't going to invest anymore time and effort into it, so we dropped it".

A lot of SMEs are concerned about adopting new systems because they believe that they would have to provide long hours of training with continued support. Providing this level of support may not be possible taking into account their limited resources.. INT#7 explains that "The other thing to consider, especially from my point of view, is the current workload and having an experienced workforce means that introducing a new system would mean huge amounts of training with continued support by me and also technical support so to speak".

If there was a solution for the fact that SMEs do not have enough employees to cover the ones who need to be retrained, SMEs would be more motivated to adopt the new systems and make arrangements for their employees to receive training. INT#8 states that "Another challenge would be training of staff. If it was a system that required intense training courses, or to go elsewhere for training, there aren't enough people to cover those who are off learning what they need to learn. In a large enterprise, they can spread that one person's work around a few different people, we can't here".

People will always try to avoid any possible changes to their routine. The solution is to train them in a professional and skilful way, that will enhance the realisation that new innovation schemes will make their job easier, and even help them to achieve their personal goals in the most effective and efficient way.INT#10 explains that "The main challenge is going to be people's resistance to change. It is going to be difficult because people have to input information into a new system, so there is going to be a lot of upheaval. Another aspect to a certain extent would be changing people's approach and the trust issue about whether the IT is always going to be there, is it going to work? It's the faith in the system that is the real challenge and the trust that the system is going to work. The culture is going to be a challenge. Getting people to change their mind set and go towards a new approach".

Many employees try their best to resist any change but the reality is that many changes are to make their job easier to handle and it is in their best interest to adapt to new innovative systems to be able to enhance the quality of their delivered tasks. They need to be trained and taught precisely how the system would be beneficial to them and would also save them a lot of time during their activities. INT#11 explains that

"Regarding a web based front end, people aren't used to looking for files in that way, they are used to looking for files or documents in shared folders on the server, so they aren't used to working like that. And because there are a couple more steps to get the document into the system, or out of it to edit, people don't like that change". INT#11 continues by stating that "you change the way people work, they just don't like change, unless you can prove to them that it's going to make their life easier and it's a better system for them, and it's not too much change and effort for them. For collaboration I think the users might have trouble using it, because it's a big change for them, they're not used to working on things together. I've seen the features of all the new tools and I think some of them are brilliant, but for some of the guys, who've been working here for thirty odd years, gradually working their way up from a building site to now management they don't necessarily see the advantages. That's the challenge to get the users to change their cultural thinking, and for them to realise that they might have to change their way of working, they might think it's more work to start off with, but just like anything else, they will learn it and get used to it, but the advantages that you get out of it at the end are much better, especially with collaboration".

When people who have been trained and adapted to the new innovative systems leave the company and are replaced by new employees, this is an inconvenience to the company. Management have already invested in training for the previous employees and convinced them to revise their existing culture and now everything has to start again with the new emlpoyees. This may be difficult but not if the system is simple enough to use, very user friendly and the right training is provided. INT#11 states that "We've had a lot of changes in management over the past few years which haven't helped. If people leave they knew what was going on, and then when new people arrive, they don't necessarily understand and if they've not had experience of this before, they are going to have to learn, and it may not be necessarily quick enough to then push that out to their departments, to make them understand why it's a useful tool. That has happened here and some of the new managers aren't up to speed with the historical processes that we've gone through. So for internal factors, it's basically user take up and resistance to change, getting the users on-side. Getting people away from a traditional way of working with files on desktops and straight onto collaboration is a massive leap, unless the system is really easy to use. Ease of use is the key. Training is always the key. Changing the way users think, and maybe the way they work. Once users get used to doing something, it becomes second nature to them. The barrier is the change for the users and how it will make their jobs easier, maybe the access to

information is better than what they're used to. We need to push the advantages of the system out and explain to them why they may need to do this extra step for the benefit they get out of it at the end. When people have realised how it works and what they can do with it, they will probably see the advantages of it being able to be accessed by someone externally".

There are always individuals who will resist any potential changes to the existing facilities and do not have any level of interest to adapt to the new innovative facilities, the reason is they may instantly assume that any change will result in potential difficulties within their jobs. They need to be trained properly and reassured that the upgrade is only going to help them, and add positive aspects to their existing working routines. INT#12 explains that "Internally you are going to get individuals who don't want change. They don't like new systems; they are used to the old ones, so that's always a challenge. If you want to bring in something new, there's an influencing factor on individuals when it comes to change. I've not had much training for the software I use to be honest with you, I haven't had that much positive training within the company. If there is going to be a change in IT systems, a natural reaction people have, is that they don't like any disruption to their current ways of working. If you want me to be interested in a new IT system, you want to know how it will affect me personally. Is it going to make my life difficult or is it going to make my life easy? What advantages are there in the implementation?".

A significant aspect to motivate company workers to adapt to new innovative software systems is to ensure simplicity of the system and training sessions. INT#15 explains that "Training wise, a lot of people, especially if they've been in construction a long time, find software confusing or hard to use, so the simpler it is to use, the simpler the training, and therefore simpler to understand. If something is really complicated and they don't understand it, they will use it less. Or it would take a long time for it to be used to its full potential".

It is very important to make sure that the culture within the company can be changed to appreciate technology in the right way but without trying to impose it on employees too quickly because this will have a negative impact. There are a lot of people in the construction industry who are not confident of using computer systems and it is very important to train them efficiently and effectively and explain to them the positive aspects that using a new innovative system will provide to them. INT#16 explains that "There are a lot of very intelligent people on site, in the industry who have never gone

on a computer so even they should be able to take advantage of the system. The culture aspect is the issue. If from the top, from all directors down and all the office juniors up, they all have to understand collaboration".

The older employees of enterprises are those who will resist change involving new technologies, more than younger staff members. It is very important to be able to train the older employers accurately and with patience to ensure that they are given the right vision to bring acceptance to new technologies and realise these technologies could help them carry out their jobs more conveniently with less stress . INT#17 explains that "I think what's happening is people as such, the next generation on from me, are more connected and used to being connected. Connectivity as a person my age, your project framework, is in advance of the industry at the moment. From my perspective; I don't have the same level of connectivity that somebody slightly younger in the practice has and that is expanding all the time".

5.3.8 Accessibility

Information management or in other words document accessibility is one of the challenges for many construction SMEs. INT#11 highlights a very practical example by stating "If there is a file that is really important but it's sat on someone's desktop and nobody can access it, because that person is on holiday or off sick, someone else may need that information and no one can access it". Also, by having a document management system, the firm will be able to decide what level of access each user should have. For instances, while an engineer can have the ability to edit an existing design, the customer should only be able to view it. INT#14 explains "If I do a design, I have to make sure that if it goes somewhere else, they cannot change it because as soon as they start changing it, I can't check the designs and make it right. I will send them the drawing in CAD for them to work on, but they don't alter that drawing. If they've got an issue they will ring me up and say they have an issue with this work, and I will either meet them or we'll talk it through". INT#14 suggests "The only way it would work for me, is that my drawing files would become fully locked, they will then go on, and then the engineer can download them and work on top of them but can't alter them, so it's just in image form".

Many companies work with clients who wish to allow protected access to only the main individuals in charge of the project and they would need to have a reassurance that their requests will be fully complied with. INT#13 explains that "We get clients that will

want additional requirements in terms of who will have access to their product because they are security sensitive, so we might have to include additional safeguards which limits who has access".

Based on the fact that many employees work from home and still need to access the files that are placed on the company's server, the accessibility levels have to be very secure to prevent anyone from accessing the information without having a full authorisation for doing so. INT#13 continues by saying that "A big part of how we need to run the business is considering the fact that we have people working away from the office more, they need to be able to work at giving access to information on a wider basis, and still keeping it secure and well managed".

It is significant for the organisation to be reassured that accessibility is completely controlled and nobody without permission would be able to access protected files. At the same time, all the people who are allowed to access and edit the safeguarded documents must be able to proceed without any inconveniences caused to them. INT#14 explains that "Somebody could, not maliciously, or even maliciously, but somebody could by not knowing what they were doing, alter something which then doesn't get picked up in any checks. It might be to just move a column a foot one way and it's not picked up because on the drawings you don't see it. This is why the way I work, it's very rigid but I will do the designs, I will go to the engineer, and work out a structure if you wish, I then do the structural grid, I lock it.". INT#14 continues the discussion by adding that "If we had the collaboration system you're describing, you can do with what you call overlays. The only way it would work for me, is that my drawing files would become fully locked, they will then go on, and then the engineer can download them and work on top of them but can't alter them, so it's just in image form".

Simple and straightforward file access is amongst the most significant requirements of most employees within enterprises. They all would like to be able to access the necessary project files anywhere, any time without any kind of inconveniences. INT#16 states that "I would say that the most useful thing at this moment in time until things change, I would say is easy file access".

5.3.9 Time Efficiency

It's significant for organisations to develop effective tactics for managing their time in order to balance the conflicting demands of time for various tasks within each individual project. Time management expertise is priceless in the entire project from the

start until the project delivery time. INT#2 explains that "Our reasons for implementation of a collaboration system include cutting down on paperwork and speeding up the process". INT#3 also confirms that "Time is a challenge confronted with in adoption of new "IS" innovations".

Many organisations choose to use the most basic facilities in order to provide some level of collaboration within their firm. The problem is that as a result of various limitations within certain basic services, the project could be delayed and not completed on time. INT#3 explains that "One issue with Dropbox is when documents are put on the "P Drive" which is our server. Documents don't necessarily go in there unless somebody puts it in. So somebody needs to be checking "P Drive" to move things to Dropbox. So at the moment I may be a week behind because information hasn't been put into Dropbox yet".

A major problem faced by SMEs is the fact that by providing training courses for their employees, they will not have enough backups to cover the shifts of those who are being trained. They cannot afford to employ additional people because the costs are unaffordable and they do not have a sufficient number of employees to take over the duties of those who are being trained. As a result, the training may prove to cost the SME a lot of production and management time. INT#5 explains that "It's actually getting to grips with the software and the time to learn it and sending people on courses. That takes you out of the office, so you're non-productive and for a small company, if one person goes on a training course it doesn't work, to send everyone that also means you're losing production time. Then one person may have to train others, so that takes more people out of the office while that's being done".

As a result of having to use a server with limited capacity, many organisations may remove project files from their server as soon as the associated client or supplier has been sent them. The problem is that if the correspondents wish to access the file again and have not previously saved it on their own system, or if they have not managed to check the file in a long time, or accidentally deleted it, they may need to be able to access the file again via the platform that they were originally sent the file on. In this case, the predicament is that if the company has already deleted the file, presuming that there has been no further requirement for keeping it on their server, and it is not backed it up elsewhere, time would be lost recreating the file from scratch. INT#7 explains that "Currently, let's say a client deletes the downloaded file and they refer to that email, we

may have cleared that file from our CLOUD based system, so that when they click that link, they can't download it anymore. It's expired so we would have to do it again".

A lot of times, organisations attempt to save some money by avoiding the implementation of new innovative systems that have been proven to be successful and would help to boost their business. Instead, they utilise some of the most basic systems in the hope that they will still be able to do the exact same jobs without having to spend any extra resource. Unfortunately, using systems that are very basic comes with consequences. There are always a number of limitations and one of the main disadvantages is having to work with a very slow speed throughout the entire project, and with this the significant time loss that could have been avoided by simply using a more innovative system. INT#9 explains that "We're actually sharing data and word documents haven't been that successful. The reason seems to be the speed of access to the information, it seems to have been quite slow, and so in some ways we seem to have gone backwards".

The other thing to be considered is that on many occasions, employees need to access the files outside the office and they may be affected by the low speed of accessing and loading the files via the main server. INT#9 explains that "Often people still want to access data from home and it still takes a long time".

Organisations who take responsibility of running their own server may not be able to enhance the speed level when many people use the system simultaneously. INT#11 explains that "Another challenge that we have is the speed of our systems on site. Everything is a bit slow. It's a bit slow for the staff out on site".

Many companies only use email services to share their documents. The issue is that there may be lots of occasions when somebody has produced or updated specific documents but they have not emailed them to other employees. If that person goes on holiday or has to be out of the office for any other purposes, nobody will be able to access those documents and when the whole progress of the project has to be delayed because there is no accessibility to a specific file, that would cause a significant amount of lost time and as a result, the project delivery deadline date may not be met. INT#11 explains that "If there is a file that is really important but it's sat on someone's desktop and nobody can access it, because that person is on holiday or off sick, someone else may need that information and no one can access it".

Since a lot of organisations only choose to use email facilities for sharing their files, there may be situations whereby the speed of accessing different emails are slow and since multiple emails must be transferred between team members, the slow speed will lengthen the overall duration of individual tasks and may also lead to some updated information being omitted as a result of the delayed correspondent email containing the latest updates. INT#12 explains that "Speed of access is the main thing for me, obviously if you're working in the office the speed is a lot quicker. Today I am working from home remotely so the time it takes to upload the documents, sending emails can be a bit slow".

Many companies face the challenge of having to spend a long time on company training sessions. When employees leave and new members of staff are employed, the whole process needs to start again. Companies will look for training options that can save them a lot of time, be simple and very user friendly. INT#13 explains that "It's the whole process of taking several months to be able to use it, so anything that is going to reduce that will be a big advantage. People leave the company, new people have to be retrained, and it's a constant battle to keep people up to date".

Companies that have to manage their own servers face the difficulty of having to constantly increase its capacity. This is a very time consuming process and very inconvenient to have to dedicate a lot of time to resolving the capacity issue whilst trying to concentrate on an actual project. INT#13 explains that "We have an individual server within the office, which has to be managed and we're constantly having to increase the capacity of it".

Speed of the internet ultimately affects the speed of project progress and individual activities from people on various tasks. People are reluctant to be provided with low speed systems or low speed internet speed because that will have a direct effect on the speed of their project deliveries. INT#15 explains that "If everything's in house then connection is going to be the key to how well your software framework works, because if it's slow, no one wants to use it". INT#17 states that "Also there is connection speed limitation. We have local copies and we store the main model on our server and we synchronise with that and it's pretty slow".

5.4 Developing the Framework

After analysing the interviews, three different dimensions were assumed for collaboration in construction SMEs (see section 5.1 and 5.2), and different techniques

were outlined to optimise this collaboration (see section 5.3). This was the basis for developing the original framework which was later presented to experts for validation. Based on reviewed literature (see chapter 3), and analysing primary qualitative data, several aspects are identified and recommended by this study (see section 5.3). These aspects are illustrated in "Figure 9".

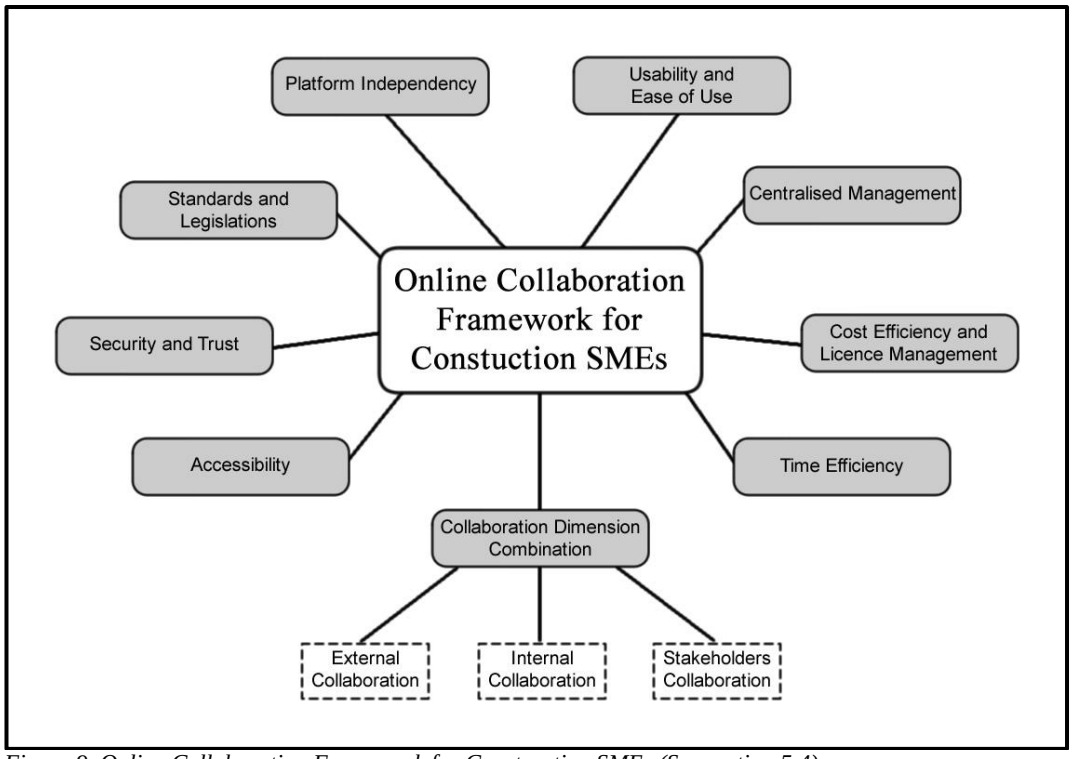

Figure 9. Online Collaboration Framework for Construction SMEs (See section 5.4)

In the following sections each of the suggested aspects for the proposed collaboration framework are discussed.

5.4.1 Collaboration Dimension Combination

As explained previously (see sections 5.1 and 5.2), three different dimensions have been assumed in this research for collaboration in construction SMEs. These are "External Collaboration", "Internal Collaboration", and finally "Stakeholder Collaboration". External collaboration includes any collaboration which can take place amongst different SMEs. It was explained that by sharing resources and information, SMEs would be able to compete with larger enterprises to increase their market share. The second dimension is internal collaboration which represents the collaboration within each SME. Ideally, individual employees within a company should work together and collaborate towards achieving the companies' business goals. Finally, stakeholder collaboration is introduced in this research to represent any possible collaboration between SMEs and their stakeholders (e.g. clients, suppliers and local authorities).

The initial aspect which is highlighted by this research is “Collaboration Dimension Combination”, in other words, an online solution that is able to combine the three dimensions of collaboration within the same platform, enabling users to collaborate on different levels, and in doing so, connects everyone who is associated with a specific project, from the suppliers, the work force and the clients, assisting in communication and online collaboration. Consequently, if there are changes that will affect the project plan, for example whether or not the delivery is delayed, the supplier can update the schedule, and this information will be disseminated to those involved in the project. In many cases one change in a plan can have a knock on effect, therefore by combining all dimensions of collaboration, the communication gap between suppliers, employees and clients can be reduced.

Currently there are many different platforms which are used by SMEs. In many cases the platform which is used internally is different to the one which is used externally for supplier or client collaboration. Hence, there will be duplication of information, and delays in updating different platforms. On this basis, combining collaboration dimensions is one of the main aspects of the framework which is proposed by this study.

5.4.2 Platform Independency

Different employees within each construction SME use various devices in and out of the office in order to work on projects. They may use their office computer at certain times during the day, but may also have to be on site, using their mobile or tablet device to access project files. One of the challenges would be that they are unable to view necessary files on the server, as they are using devices that are not compatible with the stored data, as well as the fact there may be desktop users who have incompatible operating systems. Although most people happen to use Windows operating systems, there are a high percentage of people who use Apple Macintosh, Linux or other operating systems that are not compatible with many windows based configurations and file types. So in reality, there will be people who use desktop devices, whilst others use mobiles, tablets or other equipment, and the compatibility is different within each of these platforms, whilst users who use the same platform may still use different operating systems. For instance, whilst two people may both use mobile devices, one may use Apple iOS whilst the other may be using Android operating systems that are both completely different in many aspects and configurations. Furthermore, people may

use the same devices and the same operating systems, but at the same time, the versions of their operating systems, may not be the same.

Other significant issues include the fact that there are many different file types and extensions, and whilst many files types are compatible with Windows operating systems, they may not be compatible with Linux or other operating systems. When employees are trying to focus on delivering project tasks they do not have either the time or expertise to resolve such difficulties relating to compatibility issues.

Another major factor that could cause difficulties is the fact that different file types are created and used within companies. Many of them are not compatible with certain devices or operating systems, which forces the employees to use only certain machines or operating systems. This is especially inconvenient if an employee is at a location where access to certain devices and operating systems is limited.

With the widespread usage of mobile devices, platform independency is one of the main elements that must be considered when designing collaborative tools. Enhancing the usability and user-experience of collaborative tools may motivate SME workers to take advantage of these tools to actively collaborate and communicate amongst themselves.

Web-based technologies offer influential accessibility solutions that have changed the way content can be accessed. However, the majority of these tools remain complex, restricted in accessibility, and at times challenging to use from various devices or browsers (Rosato et al, 2007). The progression in web-based technologies proposes new opportunities for improving user experience, content-accessibility, and usability of collaborative tools, via applications which are platform independent, quick, and s

This study proposes a framework which allows people to access different file types using numerous devices and various operating systems, without having to deal with any compatibility issues with regards to accessing the files or using the functionalities. This is a significant aspect of the study, because it gives employees the opportunity to work from any location, at any time, using any machines, irrespective of their operating systems. Regardless of an individual's internet connection speed, everyone will be able to quickly and easily access files with no limitations, and based on the individual's user rights, make any necessary changes. This is particularly helpful to those users who are not experienced with IT and have no knowledge of how to resolve compatibility issues, especially if they are working at a time or location where assistance from more knowledge colleagues is not an option.

5.4.3 Centralised Management

When a group of employees work on projects as a team, there will be many files generated by each individual. If they retain their own files on specific devices, it will be a significant issue to retrieve the files that have had the latest updates as the individual may have used multiple files and overlooked the necessity to merge the files together based on any updates to the files, therefore colleagues may not receive the latest versions that are needed for them to continue with their own tasks. In many cases some employees may be on sick leave or holidays which would mean their files would remain on their own device, with no one else having the possibility of accessing the files.

Many companies use in-house servers to allow all employees to store their work in one place, and allow other team members to access the work. There is an issue with this service, in that companies do not know whether the utilised server storage space will be sufficient or not for the overall number of documents that need to be stored, and could be costing the company more money than they need to spend. In many cases, companies may realise that they are running out of storage space whilst working on other projects which is significantly inconvenient. A considerable amount of time would have to be spent eliminating older documents from the server, in order to free up more space to store the new documents, and there could be substantial issues with the failure to keep any copies of older files, if for some reason, an associated older document may be needed for reference in any future project work.

Additionally, keeping the servers in-house means that companies must provide maintenance and any necessary support which would add to their existing costs. Keeping the data on a centralised server will in many cases include ongoing support as part of the package offered by the service provider. This means the overall costs will be a lot less without concerns about when immediate and urgent support is required.

By allowing each individual to access the files on their personal machines, editing them and sending them to others, there are possibilities that viruses will spread through different devices. If one user happens to have had their machine infected by viruses or spywares, the company's files might also get infected and as a result, all other machines that would access the files in the future will risk their systems being infected by malicious viruses and spywares. In the case of decentralised management systems, there are sometimes no immediate backup files and any unexpected incidents caused

naturally, such as a fire incident, will destroy the individual machines resulting in files being totally eliminated.

With centralisation, information systems will need to be consolidated, and thus data will become visible and more accessible for a range of functions (Ross & Vitale, 2000), opposed to being localised in a few functions across various sites. Data such as material inventory levels, supplier delivery reliability and exact cost contributions, will be visible and accessible and can thus be incorporated into day-to-day decision making. If data is centralised, the actual reliability of the data will become known, as you become less reliant on external parties' feedback. Centralised decision making is an advantage discussed both by the stakeholders and literature (Munson, 2007). Centralised decision making has the ability to optimise over the entire system leading to a higher efficiency than when decisions are locally optimised for the different subsystems.

Having a centralised server ensures that the overall maintenance costs are much lower. The centralised server providers may include continuous support as part of the service, whereas having multiple servers that are kept in-house require technical expertise to provide continuous support that results in additional cost. Also the centralised server providers mainly take advantage of the best security solutions on their systems to avoid virus and spyware infections as well as ensuring maximum security to defend against any possible hackers. This level of expertise is gained through vast amounts of experience. Trying to achieve all these facilities and services in-house would be much more difficult, costly and time consuming and the final result may not be efficient and effective as a centralised server.

Centralised server providers will back up the system continuously and at numerous times during the day, in case of unforeseen incidents such as fire. Therefore, files are kept safe at all times and data will not be lost. Having such facilities in-house would increase costs as well as being time consuming, and there is also the risk that individuals will forget to back up the latest versions of their work as a result of files being stored on various machines.

This study proposes a framework which will ensure the files will be stored, accessed, edited and saved on a centralised management system which will be automatically backed up at numerous times during the day in order to make sure that any sudden incidents to the original server system, will not affect the backed up files as they will still be safe and secured. Also, the centralised management systems has the advantage

of powerful anti-virus and anti-spyware facilities installed to keep the online environment safe and secure at all times. This will discount the need for numerous individual machines to be scanned constantly to avoid the spread of any virus and spyware infections. Additionally, a centralised management system promotes collaboration and communication between employees holding different positions in the company, as they share and access only one file, rather than having various files stored on various machines, which can cause confusion and increases the possibility of latest updates not being shared amongst the entire members of a team.

5.4.4 Cost Efficiency and Licence Management

Most architectural enterprises have to use several different software packages in order to carry out different phases of designing their construction project models. Based on the interviews that were carried out, some employees stated that considering the fact that each one of these individual software systems are quite expensive and they have no alternative other than purchasing and installing all of them on their various machines within their company, as well as on devices that are located outside of the office, there is always a consequential financial pressure that may create tension with investors, directors and employees.

Software traders, as investigated by Flexera & IDC (2013), are continuing their insistent practices of inspecting their clients for software license compliance with 63% of companies been audited in the last 18-24 months. This is not an isolated incident as 37% of the companies claim to have been audited two or more times over the last 18-24 months, with a focus on large companies (i.e., one third being audited three times or more). Besides the significant effort that these audits represent to the companies (16% took more than 6 months to complete), according to Express Metrix (2013), they also represent significant non-planned costs for the companies (with 10% of the companies claiming to have paid approximately £500.000 for each contract year).

Furthermore, considering that software costs are increasing every year and represent nearly 25% of the IT budget of companies (Forrester, 2013) and that compliance with legal and contract requirements are mandatory for each organisation it is clear that this should become a top level management.

During development of new software that is to be sold on service basis, the need for a framework for handling licenses, user authorisations and software configurations emerges. The framework should be usable for both existing and future developed

software applications and modules. The software vendor wants to sell licenses, both for software as a service (SaaS) and other types of applications. Where possible, the customers want to get a ready to use, pre-packaged solution, and for this they are willing to pay license fees. This approach is appealing in contrast to the conventional way of working closely with the vendor to create custom software solutions, or to customize existing software, where the front-up costs are sizeable.

The framework solution has to be very generic, so that it can be used for any new software being developed as well as existing software systems. Sample applications would include software components, mobile device software (both for smart phones and more specialised devices) and hosted applications. Licenses could be invoiced by the time the license or application has been active, by usage count or by other rules where necessary. Hence, there would multiple options to allow cost reduction by allowing companies to pay; based on the length of time they have used a certain application, as opposed to being invoiced for a one-off sum of money, regardless of how often the application would be used in the future. In many cases the applications may hardly ever be used on certain machines whilst a heavy sum of money has been paid for obtaining life time licenses for them on each individual device.

For applications caching or storing sensitive data, like confidential customer information, sales figures, manufacturing details etc., the stored data should be unusable for anyone after the license expires because the individuals who have full authorisation to access and modify that data may no longer be interested in obtaining it until their clients request them to do so. If they do wish to access and obtain the stored information in the future, they must pay for license activation for the duration of time that they need to use the system and go through the data. This way, they simply pay for the license activation when it is necessary for them to access the application and use it, rather than a one-off payment whilst the application may hardly ever be used on certain devices. However, another vital point is that people with maximum authorisation levels to access the confidential data, must be aware of the fact that license expiry would prevent anyone else from accessing the sensitive and confidential data and this would ensure that nobody else who may obtain access to the application will have the ability to view the data, until the person who has been assigned with the original license, would decide to renew their license again.

This study proposes a framework whereby each machine will only ever be eligible for a license based on the total number of times that each software application has been used

on each machine. In many cases, there might be several software systems installed on a specific device, but some of them may never ever be used, whilst other systems may only be taken advantage of as little as once or twice a year. The companies will only pay a small fee for each individual usage that would save a considerable sum of money they would have otherwise paid; regardless of how often they used each software application. It does not matter whether they have installed various software systems on various desktop and mobile devices, they will only ever be charged based for each time that they actually use an individual software system on each device.

5.4.5 Security and Trust

Many small businesses believe that due to their size, their information is of no interest to cybercriminals, however this could not be further from the truth. Combating cyber-risk in business is no longer the exclusive concern of large businesses. It has fast become a regular consideration for small businesses wishing to maintain trust, protect their reputation and, most importantly, keep their business afloat. A recent UK Government survey (2014 Information Security Breaches Survey – Department for Business Innovation & Skills) revealed that 74pc of small businesses had reported suffering a security breach in 2015. Many SMEs continue to trail behind on information security, with many failing to give it the priority they should. Targeting SMEs can give hackers access to larger companies, which means it is vital that SMEs are prepared. The three main causes of a data breach are malicious or criminal attack, a system glitch, and human error (HM Government 2015 Information Security Breaches Survey). The cost of a data breach can vary according to the cause and the safeguards in place at the time of the incident, but a recent UK Government survey showed that the average cost of a data breach has more than doubled between 2014 and 2015. In addition to the expense of responding to cyber attacks, companies find they must spend heavily to regain their brand image and acquire new customers. Additionally, senior management is acutely aware of the impact that a tarnished reputation and associated loss of customer loyalty can have to the bottom line.

SMEs could save a lot of cost and time by investing in an online collaboration technology with existing facilities to maximise the security levels of the online server by utilising the best anti-viruses and anti-spywares that have been tested thoroughly by experts as well as having experienced experts and specialists in the field of IT security who support the online servers continuously to identify and be defensively prepared in

case of any possible cyber-attacks which could put any data, particularly the confidential one, in danger of being accessed by unauthorised people.

Also, companies need to be able to trust online server providers by knowing that their data is being protected using some of the most efficient and effective anti-virus and anti-spyware facilities, as well as having a team of experts and specialists in the field of IT security who will be prepared to defend well against any possible cyber-attacks. Company directors and managers need to gain the ultimate level of trust to realise that keeping the data server in-house will be more costly to them as they need to further invest in a maintenance aspect such as employing experts to oversee the server as well as costly investment in high quality anti-virus and anti-spyware facilities. This can be achieved in a much more economical way, by gaining trust towards the online server providers, who have major experience in providing ultimate security for their servers.

The importance of IT security and social media to businesses cannot be understated. The majority of attacks which have occurred through Social Media seem to be unidentified by SMEs, leading to attacks not being often reported. Interestingly, there has been a significant increase in the number of employees who use Social Media as companies continue to leverage on the popularity of Facebook and Twitter for marketing purposes, which in turn has resulted in businesses becoming prone to attacks (Gonsalves, 2013). Consequently, there has been a steady increase in crimes against SMEs, over 15,000 small businesses admitted to have fallen victims of various cyber-crimes (Business Matters, 2011). Viruses, Malwares and other types of cyber threats do not discriminate on the size of the business; rather for Cybercriminals, what matters most is exploiting loopholes and disrupting business, which results in economic loss. SMEs are failing to invest in information security and security awareness due to so many reasons, which include a limited budget, fewer compliance drivers etc. (Goucher ,2012) . Criminals may attack SMEs as a result of lapses on their security platforms which may not be as effective as that of larger enterprises (Westin and Hoffman, 2006).

According to Parmar and Hedges (2012), social media sites are dependent on the internet and at a time when about 24% of UK SMEs currently conduct all, or most of their day to day business on the internet, it is disturbing to note that SMEs still do not consider investing so much on Information Security as a top priority. Information security is down the “pecking order” when it comes to investment priorities of SMEs

(Goucher, 2012). Findings of a survey report by, Parmar and Hedges (2012) indicated that, Cyber-attacks and Data leakage are the biggest threat to over 60% of SMEs due to a rapid surge in cases involving Identity theft. As a result of the sophistication cyber thieves adopt in carrying out their attack, 68% of businesses have problems identifying fraudulent attacks and security breaches on the corporate network (Ayrapetov, 2013). Most SMEs are not aware of compliance issues. Others are of the belief that they are compliant and have put the right security checks and balances in place. Sadly, close to a million small businesses in the US have fallen victim of information security fraud (TrendsLab Primer, 2011). SMEs need to have an awareness of the fact that on Social Networks, there are no inspections or assessments to enforce compliance, nor any rules guiding the way customers and attackers alike use the platform (Shullich, 2011).

SMEs and businesses in general, keep adopting new technologies without considering the security implications (Kaspersky, 2012). Only a few SMEs are prepared for the security challenges ahead which acts as an incentive for the ever deceitful and sophisticated cyber criminals to keep exploiting and developing malwares, spywares and other harmful applications disrupting businesses. Anti-Viruses, anti-malware etc. are no longer as effective in dealing with the diversity and volume of threats businesses tends to face (Kaspersky, 2012). What may initially seem like business benefits can suddenly develop into IT security challenges such as loss of data, corporate identity theft, and unauthorised access to systems or data, breach of data protection, laws or regulations, and fraud, if the integration of social media and business is not properly managed. Interestingly, some of the most pressing issues in the field of cyber-crime and security as it relates to SMEs is to do with failings in people, processes and technology (PWC, 2012). One of the major reasons why businesses and SMEs have suddenly become targets of attackers is because there are inadequate security measures and practices in place.

It has become imperative for SMEs to develop a strategy that can be used to identify and detect these types of threats. To effectively reduce security risks, SMEs ought to make employees aware of the prospect of becoming a potential target by way of social media (Gonsalves, 2013). They also need to educate employees and customers alike on the implication of negligence, especially as it concerns information dissemination whilst using social media as a marketing tool. Consequently, security awareness training should be a primary concern of all SMEs in tackling the issue of cyber-crimes on the Social Media platform.

Security is defined as “the safety of a state or organisation” (Hawker and Waite, 2009). However, information security refers to the protection of information assets (Upfold, 2005). These two statements conclude that in order for organisations to maintain security over their information assets, they must follow key security principles. With 76% of small organisations becoming victims of security breaches in 2011, statistics show there are concerns especially for SMEs (Potter and Waterfall, 2012). Various organisations have become victims as a result of failing to govern their organisations according to the principles of appropriate security frameworks such as ISO 27001 and 27002. Studies prove this as 75% of SMEs have poor understanding of security policies. In addition, 58% of small enterprises are failing to carry out adequate risk assessment (Potter and Waterfall, 2012; Upfold, 2005). As part of overcoming arising concerns, SMEs need to consider security risks and breaches, which often occur as a result of cyber-attacks and mishandled information (Whitman and Mattord 2011; Upfold, 2005). With 20% of SMEs breaching data protection act (DPA) laws by failing to protect information, security breaches are costing between £15k-30k (Potter and Waterfall, 2012). This makes evident that a solution is imperative (Potter and Waterfall, 2012; The Standish Group, 2004; Upfold, 2005).

With risks concerning viruses rising from 20% to 73%, e-mail intrusion has risen from 2% to 29% and theft of hardware rising from 23% to 46%, information security failures are a concern for SMEs (Calder and Watkins, 2008; The Standish Group, 2004). Although Baldin (2010) claims organisations are imposing strict policies, this is a controversial statement. Policies and procedures are important aspects of security, but they are only a part of effective principles in terms of protecting information (Upfold, 2005). Also, SMEs need to be aware that in imposing policies and procedures that are too severe and can restrict employees from operating effectively. Instead, organisations’ needs to consider security measures that are relevant and flexible to maintain security on a corporate level (Schneier, 2003; Upfold, 2005). According to Potter and Waterfall (2012), it is imperative that SMEs engage in information security processes as well as adequately understand and appreciate the purpose of addressing security threats as part of maintaining effective risk management. However, a failure of many SMEs is that they are choosing to forget, ignore and act promptly on security failures. Instead, they should take into consideration the risks and threats that have occurred in order to develop future solutions for information protection. The reason for this is because the issue may possibly be the same, but the solution is different (Ashford, 2012). SMEs are also known for relying purely on luck rather than appropriate security measures which

suggests that they are playing a game of trial and error as part of preventing threats (Calder and Watkins, 2008; Mardjono, 2005).

A critical key factor that affects SMEs in maintaining good security is the war they face against banks (Duan et al 2009). Many SMEs are suffering financially which is symptomatic of banks refusing to lend money to organisations' as they believe it involves a high risk of unpaid repayments. This in turn affects SMEs in terms of staff capacity alongside in-house training opportunities, especially as 54% of organisations are lacking programmes that educate staff about security risks (Deschoolmeester et al 2008; Upfold, 2005; Potter and Waterfall, 2012). With SMEs lacking funds to employ in-house IT staff, they are forced to outsource information security services to external organisations. Although outsourcing can be cost effective in managing information security, there are tendencies that outsourcing pose risks (National Computing Centre, 2005). Outsourcing vital information and security measures to external organisations can have detrimental consequences as confidential information can be lost or even incriminated (Calder and Watkins, 2008; Deschoolmeester et al 2008; Whitman and Mattord, 2011). To add to this, financial difficulties also affect SMEs as they are unable to implement effective and modern hardware and software. In many cases, the installation costs are too much causing SMEs to settle for less (Upfold, 2005). Also with the IT industry rapidly developing, organisations are unable to keep up with the modern changes (Hilty, 2008; Pattinson, 2011).

With modern changes allowing many employees to bring personal mobile devices to a working environment, organisations internal networks are becoming vulnerable. A recent study proved that 60% of employees were accessing internal networks using personal mobile devices. 17% of these employees had previously accessed the internal network without detection. This is a concern as it shows that organisations are not considering policies that protect them from external intrusion (Ashford, 2012; Scott, 2012). Despite this, further analysis produced more damaging evidence, with 89% of organisations concerned about viruses intruding their internal networks, whilst 91% believed their information is vulnerable to external attacks, SMEs are suffering, especially from the lack of in-house IT departments (Deschoolmeester et al 2012; Scott, 2012).

With SMEs lacking in-house IT expertise, there are complications in maintaining software updates and patches. This then causes weaknesses in the system providing hackers with vulnerable areas to gain access (Upfold, 2005; Whitman and Mattord

2011). Despite the strength of an organisations internal system, once a weakness has been identified, attackers will exploit various means in order to gain entry (Schneier, 2003). Schneier (2003) refers to this as the weakest link in a chain. Many SMEs are failing to acknowledge the importance of identifying their weaknesses, rather than focusing on various methods of protection. Regardless of the security measures imposed, SMEs will be unable to successfully protect themselves from external intrusion until they eliminate the open door attackers that are walking through (Schneier, 2003). This draws awareness that security is not about numerous countermeasures, but rather countermeasures that are able to function independently and in series as well as the present various hurdles that slow and stop attack (Schneier, 2003). Furthermore, internal threats such as fires, floods and other natural disasters are also an issue (Calder and Watkins, 2008, Deschoolmeester et al 2008; Whitman and Mattord 2011). An incident involving BT where a fire destroyed underground cables affected various organisations in North West Manchester (BBC, 2004). Organisations were affected as they were unable to gain access to their networks because of this disaster (BBC, 2004; Goodwin, 2004). In addition, failures to impose and comply with effective business continuity plans caused many organisations to lose their information. From earthquakes to other natural disasters, organisations have been forced to learn the hard way. The 9/11 caused various organisations to suffer financially which in many cases led to bankruptcy. Organisations from data centres, universities and IT firms lost credential information due to failures in producing consistent back-ups, damaged network infrastructures and even the positioning of their data centres (Cullen, 2011; Monaco, 2001; Savage, 2004). In such incidents, statistics show that an estimated 70% of SMEs fail to continue in business, or close within 3 years of a major disaster (Anon, 2009; Gosling, 2008). This concludes that protecting the value of information is crucial, especially as it is part of the key driving force within an organisation (Cole, 2012; Oppenheim et al 2001; Calder and Watkins, 2008).

Security and reliability issues also significantly inhibit ICT adoption and range, from the fear of computer viruses to the theft of money during electronic transactions and data theft (Arendt, 2008; Scupola, 2009). The majority of people do not believe that their information is safe online. For this reason, individuals and SMEs might be reluctant to perform transactions online that require the exchange of personal information (Olusegun et al., 2006; Faloye, 2014). The lack of trust in supply chains can be argued not to be the fault of the organisation, since customers might not be interested in using the ICT solutions offered by a firm. This can be for reasons that include the

potential for data or money theft (Olusegun et al., 2006). Such developments may also require a restructuring of the entire logistics and supply chain system to more effectively serve and retain customers (Arendt, 2008), and this may be the reason for a firm to shun the idea of implementing ICT solutions.

Considering the significance of security and trust for construction SMEs, the proposed framework for this research suggests any solution which is provided needs to take into consideration the possible vulnerabilities which exist in the virtual world, and assure the SMEs that they can trust the system with their sensitive information.

5.4.6 Standards and Legislations

Online services fundamentally change the way ICT resources are delivered and consumed. Customers should assess which online services are compatible with applicable legislation. Depending on the setting, a range of laws could apply which include legislation on the protection of personal data, legislation on sector-specific data like financial data, legislation for critical information systems, such as energy or transport, and legislation on the handling of state classified data, criminal law, administrative law etc.

Depending on the setting, there may be different requirements which could have important impacts on the way online services can be used by SMEs; the clients must also assign security measures.

Many Data Protection Authorities across the EU have developed excellent information, in local languages, about compliance to the applicable personal data protection legislation in their country. For instance, UK data protection authority, ICO, issued guidance on cloud computing which can be found at:

http://ico.org.uk/for_organisations/data_protection/topic_guides/online/cloud_computing

The Article 29 Working party, a forum of national DPAs across the EU, has issued several opinions about cloud computing and on the concept of processors and controllers. The EU Cloud Strategy recognizes that personal data protection legislation across the EU is currently a barrier to the adoption of cloud computing. Under the cloud strategy the EC has worked jointly with industry on a code of conduct on personal data protection for cloud computing providers, to be submitted for approval by the Article 29 Working party. The code of conduct aims to make it easier for customers to be

compliant with data protection legislation while using cloud computing. The progress of that work can be found at:

https://ec.europa.eu/digital-agenda/en/cloud-select-industrygroup-code-conduct

Identifying, assessing, treating and managing information security risks are key procedures that need to be done if organisations intend to protect their information assets (National Computing Centre, 2005; Lomas, 2010). Since protecting information assets is vital, it is important SMEs comply with effective security principles from ISO 27001 and 27002 practices. ISO is a well-known framework that defines what should be done within an organisation to sustain information security (Calder and Watkins, 2008). ISO will ensure products and services are reliable, safe, and of high quality (Calder and Watkins, 2008). Furthermore, ISO 27002 will implement adequate procedures for managing and training employees, as part of allowing staff to receive appropriate updates on relevant policies and procedures in relation to security (Calder and Watkins, 2008; Gehrmann, 2012). This will ensure SMEs are able to diligently adapt to modern changes being made within the IT industry. It will also ensure employees gain relevant technological experience and knowledge, broadening their understanding of possible security risks, especially as skills and knowledge are vital in terms of protecting information (Paul, 2013). In combining practices from ISO 27001:2005 with ISO 27002:2005 security techniques as part of managing security is imperative, because of the mass of data, as well as the risks of security breaches including cyber-attacks, malicious code and other incidents like sabotage fires and floods that can affect software and hardware within SMEs (ISACA, 2009). By imposing and complying with control orders, such as key security principles that relate to good governance, will maintain confidentiality, integrity and accessibility with concern to information assets. This will help assess and prevent misuse of information by internal and external threats. It will also succeed in managing other possible risk that has the potential to pose threats towards the state of information's security (Calder and Watkins, 2008; Hardy, C and Thomas, R, 2014).

It is known that potentially, in the event of disasters, SMEs face detrimental consequences that may cause information assets to be jeopardized. It is crucial that appropriate business continuity plans are imposed (Anon, 2002; Monaco, 2001; Savage, 2004). Business continuity plans are designed to articulate the nature of internal and external risks and what can be done as part of preventing their effects. In having effective business continuity plans imposed, SMEs will reduce risks posed towards their

information assets and technology (Herrick, 2011; Savage, 2004). Also, SMEs will be able to recover effectively whilst maintaining integrity of their systems. In addition, risk management must be incorporated into business continuity plans in order for it to be effective. This will be done by integrating a combination of practices from both ISO 27001 and 27002, which will provide a sustainable structure in managing developments, maintenance as well as analysing risk to reduce security threats (Calder and Watkins, 2008; Savage 2004).

As well as imposing and complying with information security frameworks, as part of improving security, organisations need to consider important security skills. Maintaining good communication throughout an organisation, and with outside contractors is extremely important. This will strengthen security within SMEs as there will be a clear understanding of possible risks and threats, allowing issues to be resolved much more effectively (Paul, 2013; Stackpole, 2012).

Security is becoming an issue for SMEs, especially as cyber criminals are concentrating their attacks on small firms. Despite this, there are numerous information security principles available for SMEs to adopt to protect their business.. However, the main concern is that organisations' need to comply with security principles in order for these principles to be effective. Employees need to sufficiently understand the importance and process of security policies and procedures, as well as risk management. This will cultivate an attitude within organisations to minimise the issues they are facing in terms of internal and external security threats. Implementing effective principle from ISO 27001 and 27002 will help resolve further issues that confront organisations, such as business continuity plans and in-house IT expertise and will provide a strong framework for SMEs to maintain good governance as part of sustaining security within their organisation. In a broader perspective, ISO principles will assist in reducing security risks, improving service delivery and ensuring compliance (Calder and Watkins, 2005).

The main focus of a risk assessment is to prioritise which information assets need immediate attention and protection, as well as analysing whether these “safe-guards” will be cost effective for the enterprise (Mitnick & Simon, 2011, pp-260-262). The application of the ISO 27000 standards will guarantee the probability of risks is reduced or removed completely through the agreement of a security framework which will be applied companywide (Digital Curation Centre, 2009). Another benefit to using the standard is that it also offers appropriate actions for the administration of digital and physical data, maintaining its integrity, accessibility and confidentiality.

In construction SMEs, the projects need to follow a specific set of standards and legislations. The proposed framework for this research takes into consideration SMEs' dependency on such standards, and also the fact that these standards and legislations can be modified or amended in the future. Hence, any solution needs to be up-to-date with the latest rules such as privacy policies as well as architectural and contractual legislations.

5.4.7 Usability and Ease of Use

Many people within SMEs feel intimidated by adapting to new technologies because they are concerned about how difficult it may be to use the new facilities and whether or not it would make their routine duties more complicated. It is important to be able to reassure people that any new technology based systems integrated at their workplace will be user friendly and simple to use and the most effective and efficient training session will be carried out to make sure that they will learn everything in a certain period of time.

The barriers that inhibit the utilisation and adoption of ICT in SMEs can be broadly classified as internal and external (Jones et al., 2003; Kapurubandara and Lawson, 2006; Apulu et al., 2011; Awa et al., 2011). Internal barriers are those that exist within an organisation and can also be resolved within the organisation. They typically include organisational culture, lack of resources, owner/managers' attitude' toward ICT, and the level of training of employees.

The external barriers are those that lie outside the immediate control of the organisation. These include a lack of infrastructural facilities and limited funds from banks and other governmental bodies. It has been suggested that in order to overcome these barriers, SMEs need to work collaboratively (Kapurubandara and Lawson, 2006).

Perhaps one of the most surprising barriers to ICT adoption is the lack of knowledge of ICT solutions, how they work, their implementation and perceived benefit to the SME sector (Adenikinju, 2005; Arendt, 2008; Asharfi and Murtaza, 2008). Prior studies have demonstrated that most owner/managers of these firms, and some of the employees, could not select an ICT solution that would be appropriate for a given type of organisational problem (Apulu and Latham, 2009; Abor and Quartey, 2010). Hence, there is a need for both the owner/managers and the employees to undergo appropriate training in order to be aware of the evolving nature of ICT and identify the optimum solution for their firm (Paul et al., 2008).

However, many owner/managers fear that they will lose their employees to other firms after investing in training (Arendt, 2008; Jones et al., 2013). The number of ICT graduates has fallen sharply, despite a general increase in the requirement for skilled recruits. Businesses have also criticised universities for not adequately preparing ICT graduates for the workplace, commenting that they are lacking in relevant experience, general business knowledge, and interpersonal skills (Doucek and Novotny, 2007; Koppi et al., 2008; Miliszewska, 2008; Oxford Economics, 2009; Llorens et al., 2013). If this trend continues, then one could expect ICT skills in SMEs and even larger companies to become severely depleted and ICT adoption to become even more challenging.

The adoption of ICT in SMEs may also require considerable effort from its users, who need to learn how to use the system and optimize its functionality to deliver greater value (Korpelainen and Kira, 2010). Furthermore, highly experienced employees of a firm might become entrenched with a particular software or system and then find it difficult to adopt new technology (Paul et al., 2008). However, a rapid rate of adoption can be seen when an organisation identifies that an innovation or new technology is meeting the needs of the customer (Alam et al., 2007).

Nguyen (2008) argues that there are three main reasons for the slow rate of adoption and unsuccessful implementation of ICT in SMEs. Firstly, the management of the firms is not transparent about how and why their firms should adopt ICT initially (Chibelushi and Costello, 2009; Modimogale and Kroeze, 2011). Directors and Managers of SMEs do not understand the relationship between ICT and the firm: for example, younger managers tend to be fascinated by unique and fresh initiatives and are more willing to take risks than older owner/ managers. An older owner/manager may therefore be reluctant to take risks to try out a new technology (Chuang et al., 2009). Finally, the ever- changing ICT environment requires regular updates and training to remain abreast of developments and opportunities (MacGregor and Vrazalic, 2006; Modimogale and Kroeze, 2011).

The attitude of management in an organisation plays a crucial role in the adoption of ICT as in most cases in SMEs the managers are also the owners (Apulu and Latham, 2009). Support from the management of an organisation, most especially top management, is essential for successful ICT implementation and adoption for SMEs (Matlay and Addis, 2003). If the management is not disposed to its adoption and utilization, then SMEs will not be able to use ICT (Akpan-Obong, 2007; Agboh, 2015).

The owner/manager's weakness therefore becomes a limitation of the business as well (Modimogale and Kroeze, 2011; Faloye, 2014).

This research proposes a framework in which usability and ease of use are considered. Any unnecessary complexity needs to be redundant to provide an "easy to use" and "easy to train" application which can be used by people even without extensive IT knowledge and experience.

5.4.8 Accessibility

Access control, as the name suggests is a security measure that regulates access to resources and confidential data by verification of access rights of users. Depending on the type of the project and the sensitivity of the information, not everybody should have access rights to the entire project data and hence, access control measures must come into play. Access right management should work on both individual user and group level. Certain users must be issued the access rights based on what parts of the data they must be authorised to view and whether or not, they may also be authorised to edit and modify the associated data files. Numerous individuals, who work on a certain project, must allow the system to grant or deny them the access rights to different sets of files on the server, according to the policy set by the administrator who has full rights to every single file within the associated project.

When having various project files stored on a server, it is significant to keep track of the 'change log' which is essentially a log or record of all important modifications taken place on associated project files. This file may be referred to whenever there is a need to check what updates have taken place within the project documents as well as observing the potential reports of any recent bug fixes and new features in accordance to the files.

With regards to accessibility, there are different scenarios in which, people need to access different files based on the project they are working on. When a group of individuals work as a team, each person may be working on a certain task, which must then be passed on to other team members upon completion (NOT necessarily the case when working collaboratively). The other team members may then make further changes to the same file which is passed between the other relevant project parties. Problems can arise if someone who is a significant figure within the project and has been working on a certain file, is not available for some reason such as annual leave, and has omitted to give the other team members access to the file that is on this person's personal machine. This would result in time wastage for all those working on the

project, and no-one else is able to progress the work because the file is not accessible to them.

This study proposes a framework to allow people to store any file types on the server, whilst different levels of authorisations are allocated to each user, dependant on their level of involvement in the project. Some people may have no access rights to the files whatsoever, whilst others will only be authorised to view the files, and some people will also have file editing permissions. The important factor is that with regards to individual files within the project, everyone will be looking at the only one same file, stored in one location, as opposed to multiple files stored in multiple locations that have to be updated separately and shared amongst others. The fact that there is only the one file, that can be accessed at any time and from anywhere, whilst allowing people with a high level of authorisation to edit them, reduces the risk of overriding files by mistake, or forgetting to share the latest updates amongst every member of the group. Also in case of any unforeseen and unexpected incidents, there will be one backup of the latest version of the file that everyone has been working, saving considerable time if this were not the case.

5.4.9 Time Efficiency

Time efficiency is by far one of the most important aspects of any project; any task or activity that may save time, increases the likelihood of project completion within the deadline, additional time spent, may result in failure to deliver projects before the final deadline date. When SME employees work as part of a project team, files are stored on multiple machines. When files are updated by an individual on their own machine, they are transferred between the team members. This takes a considerable amount of time due to how often this happens throughout the project. It can also happen that individuals may not distinguish between multiple files, replacing recently updated files with older versions. If there is no backup of the most recent file, it would be lost, and the entire changes would have to be repeated adding more time to the overall length of the project. Using a single file on a centralised server provides a greater level of time efficiency. It allows everyone to work on a single file, rather than various files that need to be continually updated and exchanged between the team members. This removes the possibility of overriding files or documents. Also, because there are no files stored on individual machines, if other team members are unable to access an individual's machine, they are not restricted from being able to work on that file, albeit levels of access rights would differ based on allocation authorisations for each individual user. In

construction, cost, time and efficiency are often quoted as overriding priorities (Loosemore and Holliday, 2012). Three factors are necessary to achieve innovation: motivation, time and money. Those participating in the process must be motivated and have sufficient time and money to carry out the task. All three factors are necessary to some extent. No matter how motivated, nobody can achieve anything without time and money. Similarly, an infinite amount of time and money will achieve nothing if there is no motivation (Wide'n, 2002). With respect to Eaton et al. (2006), the benefits of innovation in construction included the improvement of working conditions, lower construction costs, quicker construction times and better value for clients. Innovation can also result in increased organisational commitment and higher organisational motivation (Dulaimi et al., 2002).

The proposed framework for this research takes into consideration the importance of time for construction SMEs. Hence, time efficiency needs to be considered for adopting the new technologies. In other words, the time which is spent for introduction and training must be regained by using the system.

5.5 Pre-Validated Framework

After reviewing the literature and analysing the collected data, the pre-validated framework (see Figure 10) was developed to be presented to experts for validation.

5.6 Validation and Final Framework

After preparing the first version of the framework, it was presented to three different experts (one of the transcripts is presented in Appendix 2 as an example) from construction SMEs in different sizes (Micro, Small and Medium). The experts explained their feedback with regards to the proposed framework, and their feedback was used to improve the framework and present the final version (see Figure 11).

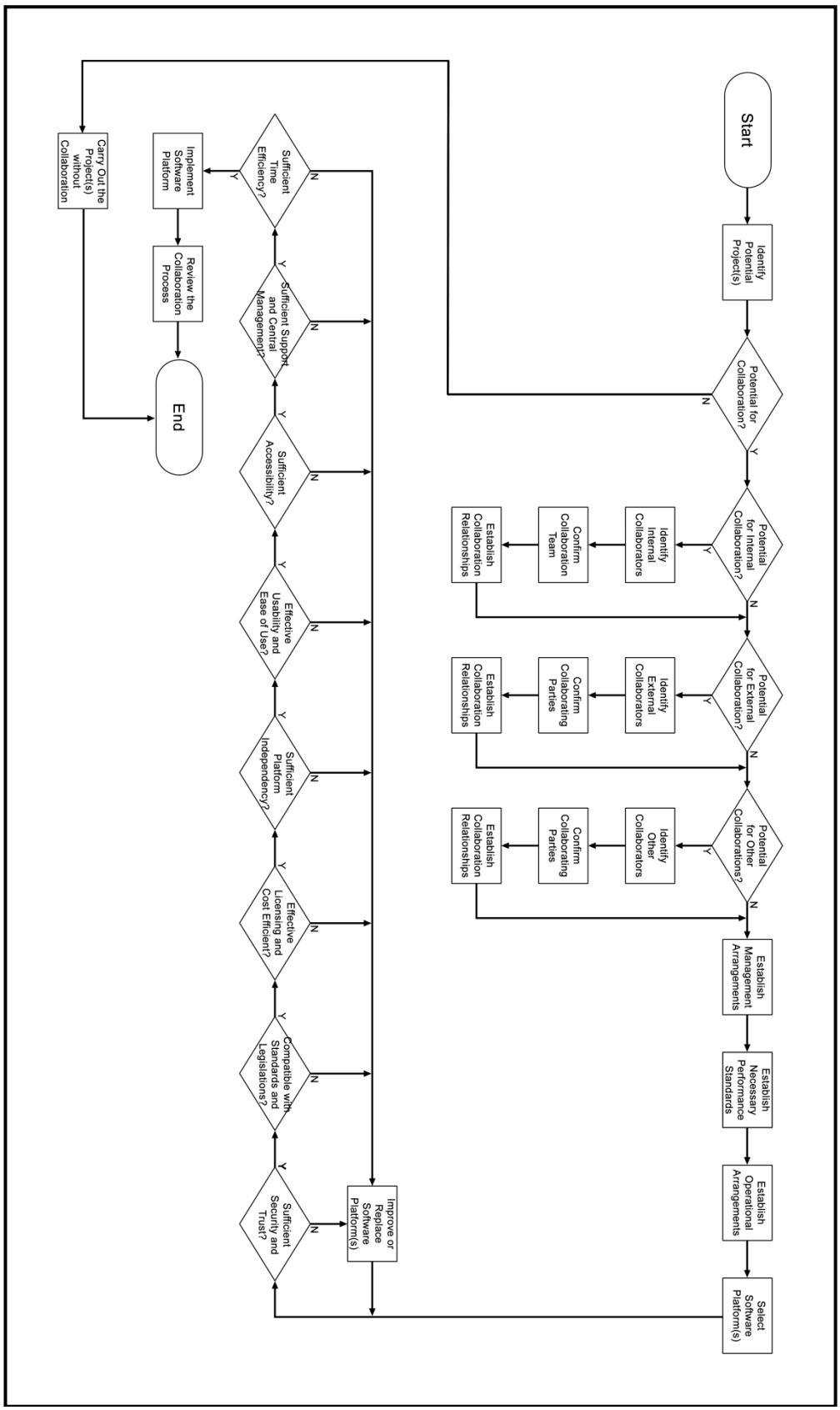

Figure 10. Pre-Validated Framework for Collaboration in Construction SMEs (See section 5.5)

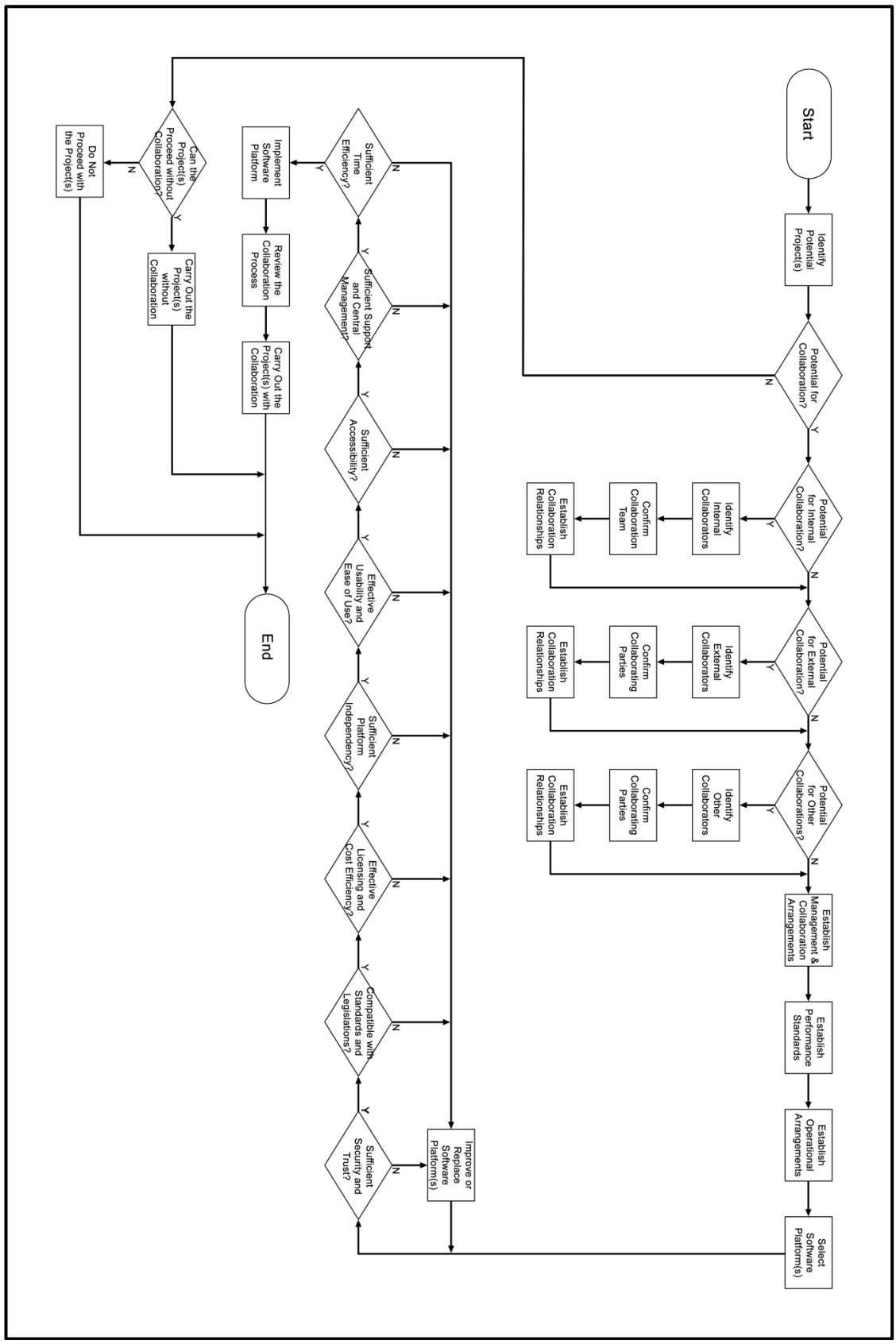

Figure 11. Online Collaboration Framework for Construction SMEs (See section 5.6)

5.7 Summary

In this chapter, analyses of the collected data have taken place and additional discussions have been carried out. A number of different collaboration options including internal and external collaborations for construction SMEs have been stated in details and pre-validated framework as well as finalised framework after three separate validations took place, have been integrated into the research.

This chapter describes the three proposed dimensions for collaboration in construction SMEs, and a framework for using online technologies to improve collaboration in each and every dimension.

The three dimensions are “External Collaboration”, “Internal Collaboration”, and “Stakeholders Collaboration”. External collaboration is defined in this study as any potential collaboration which can be assumed between SMEs. Therefore, when there are multiple SMEs working on one construction project, their associated staff must be able to communicate and collaborate with the staff in the other firms in order to enhance and improve the final quality of the delivered tasks. Internal collaboration is defined in this research as any type of collaboration which can take place between the employees of each SME. This will allow members of staff to share information with their colleagues and subsequently save a lot of time by transferring their useful knowledge to others and ensure a higher and more advanced result for the individuals and group tasks. In any construction projects, there are usually various stakeholders including suppliers, clients, neighbours and local authorities. Allowing effective and efficient means for them to collaborate and communicate with the SME workers would make a positive impact on the overall quality of the.

Based on reviewed literature (see chapter 3), and analysing primary qualitative data, several aspects are identified and recommended by this study. Collaboration Dimension Combination is the first aspect introduced within this thesis that will bring “External Collaborations”, “Internal Collaborations” and “Stakeholders Collaborations” all together in order to allow every individual who is associated with a certain project to collaborate with one another. Platform independency is another aspect within the framework which would allow people to collaborate with one another and access different file types regardless of what operating system or devices they use. Centralised management is an aspect within the framework which would allow everyone involved within a project to work on a single file stored on a certain server to prevent any issues

that may waste time or distract the collaboration or project progress. Having a centralised management system means there is only a single file for everyone to work on and the backup would also need to be carried out for a single file as opposed to multiple individual files stored on various machines and devices. Cost efficiency and license management is another aspect within the framework which would save money for SMEs by allowing them to pay for application licenses only based on each individual usage. Therefore, a significant one-off license fee would not be imposed on every single license whilst many machines and devices that have had the associated application installed on them, may hardly ever be used by SME workers. Security and Trust is an aspect within the framework which focuses on the fact that SMEs may save a lot of time and money by investing on an online collaboration framework which already has some of the most efficient and effective anti-virus and anti-spyware systems installed on them and supported by expert IT security specialists, rather than having to do a separate research on what security steps to take if they choose not to adopt an innovative collaboration solution. Standards and Legislations define the next aspect within the framework. Identifying, assessing, treating and managing information security risks are key procedures that need to be done if Construction SMEs plan to protect their information assets and since protecting information assets is vital, it is important that SMEs comply with effective security principles from ISO 27001 and 27002 practices. Usability and Ease of use is yet another key aspect within the framework to ensure the individuals who take advantage of the system would find it simple to use and the necessary training would be provided in the shortest and most convenient manner for them. A significant number of users, particularly those who are older may find adapting to any new technologies or systems unattractive. The framework must be simple and easy to use and users need to be proven that using this service will make their job easier and allow them to deliver their responsibilities in an easier and more straightforward way. Accessibility is another aspect within the framework which is a security measure that regulates access to resources and confidential data by verification of access rights of users. Depending on the type of the project and the sensitivity of the information, not everybody should have access rights to the entire project data and hence, access control measures must come into play. Time efficiency is one of the most important aspects of any project; any task or activity that may save time, increases the likelihood of project completion within the deadline, additional time spent, may result in failure to deliver projects before the final deadline date. This framework saves a lot of time with regards to numerous factors such as

allowing everyone to work on the same file regardless of their location as well as reducing the possibilities of mistaken file overriding.

Next chapter is the research conclusion and includes reviewing aim, objectives and various contributions to knowledge as well as detailed discussions of advantages provided to construction SME workers, clients, suppliers and stakeholders. Also, existing limitations within the current research and final achievements have been explained.

6 Conclusion

During the previous chapters of this thesis, the research aim and objectives were set and described, the appropriate research method was chosen, data collection process was explained, and data was analysed, and findings were presented as a Collaboration Framework for Construction SMEs. In this chapter, initially aim and objectives are reviewed and the achievement of each is described. This will be followed by practical recommendations for construction SMEs, and suggestions for future researchers.

6.1 Reviewing Aim and Objectives

The aim of this research (see section 1.2) was to develop a validated collaboration framework specifically for construction SMEs based on the utilisation of online technologies. The following objectives were identified to achieve this aim:

- To critically review the associated literature with regards to differences between SMEs and larger enterprises in the United Kingdom construction industry;
- To critically review the associated literature with regards to performance factors in the construction industry;
- To examine the features of exiting online technologies and their potential benefits to collaboration working;
- To identify and assess the current collaboration arrangements which occur within the construction industry;
- To examine the key requirements pertaining to effective collaboration within construction SMEs;
- To seek to develop and validate a collaboration framework for construction SMEs based on online technologies.

The first objective was achieved by reviewing the literature with regards to the construction industry (see section 2.1), and SMEs (see section 2.3). The second objective was achieved by reviewing the relevant literature (see section 2.2). Similarly, the third objective was achieved and the findings were stated in section 2.4 and 2.7. This was further investigated and more specific reviewed and presented in chapter 3. To achieve the fourth objective, initially the literature was reviewed (see section 2.5 and 2.6). This was further investigated by collecting and analysing primary qualitative data

(see chapter 4). To achieve the fifth objective, and as part of data analyses the requirements for effective collaboration were listed and described (see sections 5.1 and 5.2). Final objective was achieved by describing collaboration dimensions in construction SMEs (see sections 5.1 and 5.2) and presenting the framework (see section 5.6).

6.2 Contributions

This research contributes to knowledge by in-depth review of existing literature in the field of construction, SMEs in general, innovative online technologies and collaboration working. Although construction sector is classified by many as one of the most significant fields in industry that has major impact on national economy, it was proven through the literature review that associated firms are known to be traditionalist and conservative with regards to adopting new innovative facilities. Although multiple initiatives with demonstrated significant values to the enterprises have been launched to improve the performance and image of the construction industry, there has been no major focus on addressing the fundamental problem of creating a more systematised approach to continuous activities of innovative collaboration in the industry (see section 2.1). SMEs form the most significant and dominating part of all businesses in the UK. According to Department for Business, Innovation & Skills, Business Population Estimates for UK and the Regions, at the beginning of 2015, there were 5.4 million businesses in the UK. More than 99% of these were SMEs (see section 2.3). ICT can influence firm productivity and as a result there are a large number of published studies which have considered the adoption and diffusion of ICT-based innovations. Several theoretical and empirical studies have examined ICT innovation adoption, and many theories have been tested (see section 2.7.1). Collaborative technologies, described as, a mixture of technologies that together produce a single shared boundary between two or more interested people, can have great capability to promote the necessary collaborative working in the construction field. This allows them to take part in an innovative process in which they share their collective knowledge, skills and understanding, in an environment of trust, directness, sincerity, mutual admiration and respect, which together deliver the best results, to their general goal (see section 2.2.3)

This research contributes to knowledge by bringing together previous researches and presenting a specific collaboration framework based on online technologies and services. The reality is that construction sector shows less interest towards new innovative systems compared to many other industrial fields and with regards to the

SMEs in construction sector, there are further issues involved including the fact that they have limited budgets compared to large enterprises, and they are cautious with regards to any sort of extra expenditures. Since the global recession, many of the SMEs have become even more wary of staying away from anything that may add to their costs.

What this research has proposed is taking advantage of some of the most advanced online technologies and services to develop a unique collaboration framework specifically for construction SMEs and the framework offers them benefits that ensures enhancements and improvements in multiple aspects of their project works. The unique facilities include bringing all SME workers together and allowing internal and external collaboration amongst them based on whether projects are done only by one construction SME or multiple ones. The proposed framework ensures that construction SME workers who do not have considerable IT knowledge or the ones who follow a routine culture of resistance to change, would be convinced that a new level of innovative collaboration can be achieved. This would be user friendly and using the necessary training sessions, their every day responsibilities would be made much more straightforward, efficient and effective. Additionally, they would face less confusing or unclear situations since they may collaborate with their colleagues at any time and location using any operating system and device as long as they have an internet connection. Using such system would increase the speed of their project deliveries as well as enhancing the quality, whilst their SME could save substantial sums of money that they may have spent for adopting other systems. They also would not have to worry about losing any files stored on their machines and devices for which they would be personally responsible for.

The proposed framework introduces a new approach to collaboration for the UK construction SMEs, their workers, clients, suppliers and project stakeholders. They may all take advantage of using advanced and innovative online technologies to have direct collaborations with other associated bodies for each particular project and the proposed framework suggests improvements in major aspects including the overall quality of deliverable tasks and final project, saving time, costs and maintaining competitiveness in the marketplace.

The knowledge contribution which is established by this research study includes a new factual and proven collaboration framework which has added new information and data to the existing knowledge by extending the scope of technology-based and innovative

services adopted by construction SMEs. Professional individuals were selected from various SMEs, ensuring that the sizes of their enterprises ranged from micro to small and ultimately medium. The fact that different SME sizes were taken into consideration upon selecting the interviewees, guaranteed that the final framework would be much more accurate, efficient and effective. The questions involved asking the interviewees about the existing digital collaboration services adopted by their enterprises and the numerous limitations and issues associated with those facilities as well as investigating certain functionalities and requirements that were not available in their existing systems. The generated data was then joint by relevant literature reviews and resulted in developing a collaboration framework for construction SMEs using online services to ensure a more efficient and effective facility compared to the limited existing options that were adopted by their companies.

This research contributes to practice by proposing an improved collaboration method which can affect the firms in various forms which are described in the following sections.

6.2.1 Construction SME workers

Internal collaboration: To allow SME workers of particular construction SMEs to collaborate amongst them in order to enhance their project progress and delivery in the most efficient and effective way as well as saving overall time and costs.

External collaboration: To allow SME workers of construction SMEs to collaborate with SME workers of other construction SMEs when they all work on the same projects and need to take advantage of continuous knowledge, resource and file sharing as well as exchanging guidance and advices to ensure the best results for the finalised project as well as saving overall time and costs.

6.2.2 Construction SME Clients

To allow clients to be able to view the progress of their projects as well as providing direct collaboration between SME workers and them to ensure that the projects can be delivered according to the expectations and with the highest possible quality. If clients wish to pass on any feedback or comments regarding their projects, they may do so via direct collaboration with associated members of the construction SME in charge of their project. This would help to speed of the overall project progress as well as enhancing the quality of delivered project.

6.2.3 Construction SME Suppliers

If suppliers and SME workers wish to pass on any feedback or comments to one another regarding their orders, contract or any other project related matters, they may do so via direct collaboration with associated and relevant individuals. This would help to speed up the overall project progress as well as enhancing the quality of delivered project.

6.2.4 Construction Project Stakeholders

Every construction project includes a number of individuals and organisations who would be classified as stakeholders of that specific project. Some examples of these includes nearby neighbours and local authorities such as government and local council. Using this framework would allow the project stakeholders to keep a close observation on the progress of the project and provide them with the opportunity of being able to have a direct collaboration with associated SME workers in charge of the project to allow a fast delivery of any potential feedback, comments or updates to the relevant bodies in order to avoid any future issues being arisen when it is too late and the project is already completed and delivered.

6.3 Limitations

Although this research was carefully carried out, certain limitations and shortcomings are acknowledged in this section. First of all, the research was focused on theoretical side of the framework whilst the programming and development was beyond the scope of this research.

Secondly, it could be more effective and efficient to take advantage of interviewing more SME workers. However, after experiencing various failed attempts it was decided to finalise the framework using data generated from interviewing fewer participants. During the data collection process, many enterprises did not even respond to requests and showed no interest regarding participation in a non-profit PhD thesis. Also, the allocated time to complete this phase could not be prolonged to accommodate further attempts to obtain more participants.

Finally, the individuals who took part in the interviews were all employed by UK based construction SMEs and the workers were all residing in the UK at the time of their participation in this research. Therefore, it is unclear whether or not the same research results could be applied within construction SMEs in other countries. Hence, the results are based on data collected only from UK based SMEs.

6.4 Recommendations for Future Research

The research carried out in this thesis appears to have brought up more questions than it has answered. There is certain research aspects emerged from this work which could be followed and any future work may contain new proposals and deeper analyses of specific methods.

This thesis has been specifically focused on the development of an online collaboration framework for construction SMEs in order for them to enhance the level of projects that they work on. The framework allows taking place of external collaboration as well as the internal one and the results were obtained from related literature reviews as well as conducted interviews with a number of staff within various SMEs. This has left the study of clients' perceptions and perspectives regarding the adaptation of an online collaboration framework with SME workers, outside the scope of the thesis.

One of the potential future research studies could involve investigating the possibility of collaboration amongst SME clients and suppliers. For instance, they may collaboratively procure new ideas and innovations to consider using in the SME environment. This could enrich the collaboration aspect, and improve the planning phase of the construction projects.

Another prospective research that could be explored in the future would be to allow the existing customers and new customers to collaborate with one another. For example, the ones who have already experienced designing their own property using the collaboration framework will offer their guidance and experience to the new customers whilst advising them on any queries they may have.

Although this particular collaboration framework has been designed for constructions SMEs, there is no reason why anyone would not be able to conduct a related type of research to develop a collaboration framework for members of SMEs in sectors other than construction. The concept may work in many other fields and the fact that there are other sectors that are more dedicated to the usage of technology compared to the construction field, could be a particularly positive point as far as the researcher is concerned.

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Appendix 1. Interview Questions

Interviews Guidelines

This interview is aimed at identifying and gaining an understanding of the key issues in current collaboration methods within Construction SMEs. The findings will direct the development of the requirements and conceptual solutions to enhance the collaboration methods within the Construction SMEs. Please feel free to state any important points as you think is appropriate without limiting the questions stated here. Thank you for your participation in this research study.

Section A: General Characteristic Information

- Interview Number:
- Interviewee's General Information:
- Job Description:
- Department:
- Years of Employment/Appointment:
- Highest Qualification / Background:
- Date of the interview:
- Contact Details:

Section B: Interview

(Phase 1) – General Information on the interviewee's professional experience

- Please describe your professional experience within your construction SME.

(Phase 2) – Status of current collaboration system within construction SMEs and the need for future improvements

- What are the main challenges/benefits of running your IT operations on-premises?

- What are the current IS applications used within your firm for internal and external Collaboration? (i.e. Email application, CRM, Data Storage, CPU Usage, etc.)? How effective are they in terms of their contribution of services?
- To what extent do you feel your firm is aware of Cloud Computing and advantages of using this technology?
- What IS innovations does your business need and how successful do you think it would be in exploiting them?
- What challenges do you think SMEs are confronted with in the adoption of new IS innovations? Why?
- What organisational and environmental factors do you think may impact the adoption of Cloud Computing in your firm? Why? (Pros & Cons)
- Internal matters that would make an impact include: "firm size", "top management support", "innovativeness", and "prior IT experience".
- External matters that would make an impact include: "competitive pressure", "industry", "market scope", "Supplier efforts" and "external computing support".
- How do you use the current IS related collaboration system in your organisation?
- What characteristics/features of the company would you consider influential for the implementation of a Collaboration system?
- Do you think the fact that the enterprise is an SME affects the implementation?
- How would you define the success of a Collaboration system implementation?
- What are the outcomes of your Collaboration system and to what extent has the system been accepted by the users so far? What have been the barriers to acceptance? (If any)
- How extensive and effective is IS training at your firm?
- What factors would you consider the most important for the success of a collaboration system implementation?

- What limitations, problems or complications do you face regarding your existing Collaboration system and what could be done to overcome these issues?
- What are the critical elements that need to be considered in developing alternative collaboration approaches /improvements to the existing collaboration methods within construction SMEs? Was the implementation project according to plan?
- Would you like to make any other comments?

Appendix 2. Sample Transcript

Hi there, how are you?

I am good

I am here with Mr [...]. Your information is going to be completely anonymous. May I ask on record, may I record our conversation please?

Yes you can

Thank you so much for this. We are starting validation of the flow chart of my PhD thesis which is to develop a Collaboration Framework for Construction SMEs using Online Technologies. We are taking a look at this and I would like to see the views of the interviewee about this. I have come up with considering collaboration as the first step. Decision to collaborate is followed by the identification of the collaborators. So we choose how to divide the collaborators. So those are the processes. Now I come up with the two decisions of having Internal Collaboration as well as External Collaboration. They are both then broken down into Confirm Collaboration Team.

Would that be the mixture of the two?

Yes. Not mixing them together but you basically have your own internal team but also an external team which means all the internal and external employees of SMEs collaborating, however, internally you have your own employees who collaborate together. However, as the process continues, we add other stakeholders' interests as well. Because other stakeholders such as the Council and the Neighbours want to have their say as well, so it would be good to offer them the platform to them as well to collaborate and have their say on the matters. Then, you just establish collaboration relationships as the next process. The process continues onto Confirm Security and Trust Arrangements. So, obviously the system has to be very secure but also people who use it need to acknowledge the security of the system and they also need to be able to trust it and know that it works. They need to know that it is a very reliable system that won't let them down and it is very easy to adapt.

And that it is very secure as well because if they don't trust it to be secure; then they won't put information on unless they know it is very secure.

Absolutely. So it has to be very secure as well. And then continuing on, it has to establish Management Arrangements, so obviously it has to be managed correctly as well and setup the rights for everyone. So who has the right to edit and who has the right to only read. And the managerial sections have to be separated like that. And then to identify project opportunities, so using the collaboration, you can obviously identify other project opportunities. For example, a project that only be given to a large enterprise, using the right level of external collaboration, can be given to a set of small and medium sized enterprises that will take on the project and collaborate remotely in order to deliver the end result. So that's the next process. Now, the next decision that gets made on the way, is Select the Software Instruments. So basically, another thing about the architectural companies is that they use a lot of software systems, they have plenty of them. They have to pay for every copy that they install on each machine; they have to pay for the licence. So there has to be a system in place so they will not have to

pay as much or they pay only when they use something rather than paying for things that they may not even use. So that will save them a lot of money and hassle on the way. So, then we continue onto Confirm Licence Arrangements which as I just mentioned now, depends on each copy of the software. So they pay for what they use. But also, there are some rules and regulations in the next part that they also need to study well, such as ISO regulations that also need to be taken into the consideration. Next is the Performance Standards to be achieved, for example ISO standards are the example of what has to be achieved by studying before. Then, Implement Operational Arrangements. You have to have certain arrangements to allow different workers to collaborate depending on their duties that an operational project needs. For example, you have Contractors' work, you have different people, sub-contractors, Architectural designers, architects, etc. So, various individuals with different duties will be working on the project. And then we conclude the Collaborative Frameworks.

Based on studying these and what we went through, I would like you to give me your ideas about how this works and what levels of improvements could be adjusted into it.

OK. So if thinking of different structures in construction, I will draw them in the back of one of these sheets for you. So up here, is the client, the actual person who wants the project and then below, we have different routes into getting the project constructed and they are called procurement routes. The most common ones in the UK construction are the Traditional Form of Procurements and then there is the Design and Build Form of Procurement. Your Software will fit on different stages depending on Client's requirements. I will split them down the middle, if you want to get an understanding of this; there is a book, Masterman on the Procurements. On the traditional form of procurement, what happens is, client, (let's say for students' accommodation) they say we want to build some student accommodation for the university of Salford. We want it to have high standards and high specification quality set of accommodations. So if the clients are well established, they may have an in-house consultant team to advise what route to take. If they were to choose the traditional form of procurement, what that means is that the client would then engage most likely with the architect. Traditionally, the architect is the Lead on the project from the design prospective. So the architect will collaborate with the quantity surveyor who deals with the cost and cash and so on, there would be civil engineers who would look at the underground, car parks, access, road, etc... There would be building services for plumping, mechanical and electrical. Structural would be concerning the actual frame of the building. They may also be a planning officer. Now what would happen is that all these people would collaborate together with the purpose of getting the design that contractors could look at the specifications and know exactly what the clients wants and then can offer a pricing to the client. It then comes down to the next stage, so this would be Traditional. So you'd have Design, and then it comes to Construct. Now, this stage here is the Design stage.

The quotation is a part of the design or part of the construction?

It's a crossover. It is where we go from when the design is pretty much done, so we need to get a price so we can get them recommended. So we go to construct phase. In the Construct phase, the way that it generally works is that the Client is at the top of the tree, then you will have the main Contractor, and then there will be someone who will represent the client like the client's representatives or their agent. They will be in an advisory role for the client but they are not in a contract with the contractor. The main contractor is employed directly by the client and then the main contractor

employs sub-contractors. The purpose of selecting the sub-contractors is to deliver the design that was introduced before. We then come to completion stage, and that is after the construction has been completed. Listening to what you explained about this Framework, I see the possibility of a traditional form for it to be a two stage approach. There is a definite collaboration between the client's design team. From experience, this is often a disjointed issue and one of the benefits of design and build over traditional procurement is that it can be a shorter time to get the design done, because the person who is constructing it, is also designing it, whereas in traditional method, the design is done before construction. So these companies, the engineers, architects and quantity surveyors, they could often be working on different projects at different times, which means the process of the flow of the information is slow, it takes time to get things approved and there is often a breakdown in collaboration.I think something there would allow the designs to be undertaken and would allow the information to be fed into the quantity surveyors so they can work out the price and they can then advise on materials which have been selected and may be too expensive. All of what you are saying is linking really well with that stage.

With the design part, yeah?

Definitely, yeah. Now the client may at this time have appointed an agent or they may have someone in-house. The agent could be an SME. It depends on how you define an SME. You mentioned before about architect practices and how they have different ways of working. To help with this process that goes on with construction project commencements. You mentioned before about companies having the ability to compete with larger entities because they all collaborate whereas the big companies can already do this. So some companies have all of those in one entity, so they are able to do this in-house because they have all the resources. Atkins is one of them and we as the smaller companies cannot compete with them because we do not have those facilities in-house. What you are suggesting is a way for small and mediums sized enterprises like mine, being able to collaborate with building services, engineers, structural engineers, planning officers and the architect, in order to offer that. So that is where the collaboration would come in there. Ultimately, the client normally goes to the architect and the architect is the one who will say, yes we will use this framework. If the architect decides to use the framework and the potential collaborators are already on the framework, they can choose who to work with in order to compete for projects with large enterprises. We can also offer the same level of skills and compatibility as large enterprises. If you come down to the construction section, what would happen is that the way in which contractors normally use sub-contractors can be a little different but it does still work. So the main contractor receives what is known as the tender document and they will assess them. Then, they will send it to the sub-contractors and they will then workout the cost of the work. The main sub-contractor then sends it back to the client. Many main contractors have already established a pool of preferred sub-contractors that they work with all the time. The bad thing about that is that those selected sub-contractors may not be as good as some others, but the good thing about it is the fact that there is trust there and you know you will get what you need. However, if you have a framework where sub-contractors such as joinery, brick-layers, electricians, plumbers, plasterers and painters are all part of the framework, the main contractor would not need to go to the sub-contractors. He can just collaborate with the workers who are already on the framework. However, this still needs to be a relationship somewhere of how they are going to collaborate, what's going to be the contractual arrangements. Is it going to be a price and references to say that we are going to do that? That can still happen,

but it may be that the process of finding a project and then finding the right collaborators still needs to somewhere be factored in.

So the additions that we put in are finding the project and finding the contractors.

Yes, so step 1 is project identified, so there will be many SMEs who would want to collaborate on this framework because they want to be part of bigger projects, the person who receives the project opportunity is normally the architect. They are going to say, are we going to collaborate on this?

So there could be a couple of other steps before this in the process.

Yes, so they start with identifying the Projects and identifying the Collaborators which could include certain skills. For example, do we need a quantity surveyor, do we need structural engineer, and do we need building services engineer? So we identify what services are needed, and then the Internal and External Collaboration Team. Although the client is in collaboration with all the necessary workers, there is a possibility that the client will only appoint the architect and then the architect will choose the others. However, the client may also go to each worker individually. The external collaboration is where everyone teams up to achieve the objective of designing the project. The collaboration team could be a point of contact in each of those organisations. And then the Stakeholders can feed into the cycle. It is all about that shared responsibility. Not only the collaborators can be the architects of the SMEs, they could also be the clients because the client will then see different collaborators and view their progress.

Clients and Suppliers are parts of the Stakeholders.

You will need to think about it in the procurement of construction. If it is design and build, it will be a period where the client and the client's agent will identify and call it the employer's requirements. That then goes out to up to 5 main contractors who are aware that it is a design and build project. So the client is will say, this is what I want, give me the best design and then get on with it. When that happens, there is a main contractor now appointed, the main contractor can break this down into starting with limited design completed. So it will be a quicker process to get onsite. In this point here, we would have the main contractor in the middle and then we will have all the sub-contractors and they are all working together with the purpose of getting the design done for the project. It normally costs the client more money, because they are getting the project started before identifying what they actually want, but they can start the project sooner and that might be beneficial to them. When using the collaboration tool, it does not necessarily always have to be for the architects and the professional design team, because it could also be for builders and also for their sub-contractors who can possibly use it for their design processes and all of that process would be fed back to the main contractor during their work together. The traditional procurement is still more popular because clients want more certainty on overall costs and designs. We will have Detailed Design and then price per item, because we know how many doors are needs, how many lights there are. So this method would represent more detailed information. So if the client wants to start sooner but they also want relative aspects of the process, they will be able to choose the Design and Build form of procurement. In this form, although they won't get the detailed design stage, they will get to a stage before that which will say Developed Design, they get prices back and they are reasonably accurate but not the perfect accuracy. You could

identify the project followed by identification of the procurement route, and then consider collaboration. Then make the decision regarding the collaborators. The collaboration will take place but the choice would be between whether it will be between the design team for the client or between the design team for the contractor and sub-contractors. So you go:
Start > Identify Project > Procurement route chosen > Consider Collaboration
If the chosen option is the Traditional Procurement, then the architect will consider and decide on the Collaboration. However, if the selected option is the Design and Build procurement, then the main contractor who will consider on decide on the collaboration.
The procurement roots are classified as processes because most of the time they have already been chosen beforehand.

If this platform is pitched at the right level of company with the benefits set out to them clearly and its functions all work, I think it would be a great platform to use.