THE USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY IN THE CONSTRUCTION SECTOR IN GAUTENG: A CASE STUDY OF KHUTHAZA AFFILIATED CONTRACTORS.

Progress Hlahla

A research report submitted to the Faculty of Engineering and the Built Environment, University of the Witwatersrand, Johannesburg, in partial fulfilment of the requirements for the degree of Master of Science in Engineering.

Johannesburg, 2013

DECLARATION

I, Progress Hlahla, declare that this research report is my own unaided work. It is being submitted to the Degree of Master of Science in Engineering to the University of the Witwatersrand, Johannesburg. It has not been submitted before for any degree or examination to any other University.

…… ……

Signed Date

ABSTRACT

Information and Communications Technology (ICT) has gained increased use in the construction industry in recent years. ICT brings many benefits to an organisation including improving the way information is sourced, manipulated and utilised to increase the efficiency of business processes and improve a company's productivity. This research demonstrates that while ICT has a role to play in the construction industry, its exploitation by SMEs in South Africa still needs development as they focus on simpler forms of ICT such as mobile phones and landlines, but not advanced solutions such as Enterprise Resource Planning systems and CAD. Furthermore, one of the major challenges identified in this research is the issue of poor ICT skills and the lack of information on available ICT solutions. The government and the private sector have a role to play in ensuring that requisite ICT skills are developed and improved in the sector.

Keywords: Information Communications Technology; Skills; Small and Medium Construction Enterprises

This report is dedicated to my loving wife, Deliwe Thabede Hlahla,

I love you.

ACKNOWLEDGEMENTS

I wish to express my appreciation to the following, without whose assistance this report would not have been possible:

- To God for granting me this opportunity to carry out this research;
- To my supervisor, Dr Anne Fitchett, for her unwavering support and guidance in the preparation of this report;
- To Ms Elizabeth O'Neal and Ms Cindy from Khuthaza for their support;
- To participants from Khuthaza for participating in this research;
- To the Wits library staff for their assistance.

Contents

LIST OF FIGURES

LIST OF TABLES

ACRONYMS AND ABBREVIATIONS

ADSL	Asymmetric Digital Subscriber Line
BBBEE	Broad Based Black Economic Empowerment
BEE	Black Economic Empowerment
BIM	Building Information Modelling
CAD	Computer Aided Design
CIDB	Construction Industry Development Board
CIPC	Companies and Intellectual Property Commission
DTI	Department of Trade and Industry
ERPS	Enterprise Resource Planning Systems
ICT	Information and Communications Technology
ITU	International Telecommunications Union
NDP	National Development Plan
NGO	Non-Governmental Organisation
NGP	New Growth Path
NPO	Non-Profit Organisation
NRF	National Research Foundation
PDA	Personal Digital Assistant
R&D	Research and Development
SCM	Supply Chain Management
SEDA	Small Enterprise Development Agency
SET	Science, Engineering and Technology
SETI	Science, Engineering and Technology Institutions

SME	Small and Medium Enterprises
SMME	Survivalist, Micro, Medium and Small Enterprises
THRIP	Technology and Human Resources Programme
TIPTOP	Technology Innovation Promotion through the Transfer of People
TWIB	Technology for Women in Business
VoIP	Voice over Internet Protocol
VR	Virtual Reality

1. Introduction

1.0. Introduction

Small and Medium Enterprises (SMEs) in the construction sector are faced with various challenges in their endeavour to remain profitable and sustainable in the execution of their projects. These challenges include increased competition for new work, shortage of skills and lack of access to finance (ILO, 2001; Thwala and Phaladi, 2009). Furthermore, the lack of technical, contractual, financial and managerial skills impacts negatively on their profitability and sustainability (Thwala and Phaladi, 2009). This has generally led to the high failure rate of SMEs as discussed in section 1.1below. One area that presents a potential for improved productivity and competitiveness in infrastructure provision is Information and Communications Technology (ICT). ICT has been demonstrated by various researchers to be beneficial to SMEs especially in improving their competitiveness as discussed below. It is therefore the aim of this research to understand the level of ICT penetration in the construction industry in Gauteng. Such an understanding will help to evaluate whether ICT is being exploited fully for the benefit of the construction sector.

The link between ICT use and improved productivity of companies and SMEs in particular has been explored by a variety of authors (Anumba et al, 2006; Ballan and El-Diraby, 2011; Underwood and Khosrowshahi, 2012). Researchers in this field generally agree that the exploitation of ICT is beneficial to a business especially when it is integrated into business processes and aligned to the industry's value chain (OECD, 2004).The benefits of ICT include improved productivity which stems from better communication; better record keeping; access to new sales opportunities and improved customer relations, among other benefits (OECD, 2004; Anumba et al, 2006; Ballan and El-Diraby, 2011; Underwood and Khosrowshahi, 2012).

While some researchers have argued that construction companies do not experience the benefits associated with ICT potential (Tan, 1996; Rivard, 2000; Martin, 2003 and Yang, 2007), overall ICT has been demonstrated to be of value to an organisation, especially in the role it plays in the sourcing, processing and utilisation

of information in the construction sector. This role results in improved productivity and is important for SME survival especially given the high failure rate of SMEs both globally and in South Africa as discussed in section 1.1 below.

Background information on the challenges faced by construction companies is provided below to justify the need for improved competitiveness by construction companies and to identify the role ICT can potentially play in the sector. The role of ICT in the construction sector is further explored in the literature review section. Ultimately, this research will seek to establish the level of ICT use in the construction industry in Gauteng focussing on Khuthaza affiliated contractors. The focus on Khuthaza is in line with government's commitment to redress past inequalities and to enhance the penetration of women into previously male dominated industries as outlined in section 1.3 below.

1.1. The state of the South African Construction Sector

In order to explore the potential role of ICT in the South African construction industry, it is essential to understand the current challenges experienced in this particular sector in terms of concerns such as the high failure rate of new SMEs and to contrast this with experiences across other countries.

According to the ILO (2001), globally, the construction industry has many challenges, among them: the poor skills of the labour force; uncertainty of future work supply and the dispersed location of project sites. Furthermore, the industry faces the challenge of the high rate of enterprise failures (CIDB, 2011). The ILO (2001) adds that the industry also attracts unskilled labour and consequently fails to invest in its labourers' training resulting in reduced productivity and quality. The construction industry also employs a large proportion of its labour through subcontractors, resulting in most of the construction jobs being temporary (ILO, 2001). The large proportion of migrant workers makes the provision of training difficult resulting in a shortage of skills in the industry; consequently resulting in reduced competitiveness for the firms involved (ILO, 2001). The observations above are also true for the South African environment (Department of Public Works, 1999; cited in ILO, 2001). The challenges highlighted above need to be explored in greater depth, therefore the issue of insolvency is explored in more detail below while shortage of skills is discussed in chapter 2.

Globally, the percentage of insolvencies attributed to the construction sector varies significantly, ranging from around 6% to averages above 25%, depending on the country being explored. In 2010, the United States, Britain, Spain, Australia and Japan averaged around 14.5%, 5.6%, 31.5%, 8.2% and 26.3% respectively of the entire insolvencies of all business sectors combined (D and B Special Report, 2011).

Locally, statistics indicate that there were 532 liquidations of construction companies in 2007, 554 in 2008, 371 in 2009 and 236 in 2010 (CIDB, 2011). According to Statistics South Africa (2011), during the same period there were a total of 3 151, 3 300, 4 133 and 3 992, liquidations across all sectors respectively. Generally the construction industry averaged around 5% of liquidations with the majority of liquidations being in the financial and retail industries (more than 70% on average). These statistics seem to indicate that the construction industry is performing better than other sectors. However, the Department of Trade and Industry (2011:42) notes that 78% of the 2.6 million Small and Medium Enterprises (SMEs) in South Africa are informal. Therefore, since the Statistics South Africa report focussed on registered enterprises, it failed to capture the dynamics affecting the majority of the SMEs which are not formal.

Furthermore, in terms of registered companies, the South African economic landscape seems to be less harsh to construction companies compared to other countries as discussed above. However, if informal SMEs are accounted for, these percentages will change in line with the observation by Bruwer (2010:1) that 70% to 80% of new SMEs fail within the first 5 years.

Given the above rate of failure of new SMEs, it is necessary to explore the reasons for this high rate of failure and to provide a brief background on SMEs and the challenges they face in the execution of projects in the construction sector. This is dealt with in the sections below.

1.2. The importance of Small, Micro and Medium Enterprises (SMMEs) and the challenges they face

SMMEs face a variety of challenges in the execution of projects which need to be explored in greater depth, to allow for holistic approach in defining ICT’s potential

role in the construction sector. This requires a brief look at government policy on SMMEs and the role of organisations such as the CIDB in the construction sector.

Kandie et al (2009) argue that the construction industry and especially small contractors play a significant socio-economic role in developing countries. They also stress that South Africa's economic growth is reliant on increased investment on infrastructure, delivered by the construction industry. In his 2012 budget speech, the Minister of Finance indicated that the Medium Term Expenditure Framework (years 2012 to 2015) has earmarked R 845 Billion for infrastructure development. This funding must be capitalised upon through the provision of infrastructure to obtain value for money and it also creates an opportunity that SMEs can exploit to their advantage provided they can execute the projects successfully and profitably.

The need to assist SMEs in being more productive is directly linked to the South African government's plan to create 5 million jobs through the New Growth Path initiative and the Broad Based Black Economic Empowerment (BBBEE) initiative to transform ownership in various sectors of the economy as SMEs have been identified as a vehicle through which these initiatives can be realised (SEDA, 2009 and Department of Trade and Industry, 2011).This research can potentially impact on these initiatives by providing information on the experience of SMEs regarding the use of ICT in their sectors and identifying the role that SMEs feel ICT should play in enhancing their productivity

The White Paper on National Strategy for the Development and Promotion of Small Business in South Africa, Notice 213 of 1995, identifies four categories of SMMEs in South Africa as Survivalist Enterprises, Micro Enterprises, Small Enterprises and Medium Enterprises. Generally SMMEs can be viewed as owner-managed or controlled businesses that employ up to 200 workers (SEDA, 2010). This research focuses on Small and Medium Enterprises (SMEs).

While the CIDB grading[1] does not seem to link directly with the definition of SMEs as defined above, the general approach adopted by researchers in the field of ICT

[1] The CIDB grading lists contractors in terms of their ability to perform construction projects. This ability is determined by evaluating their highest annual turnover in the last 2 years and determining the largest contract performed by the contractor in the last 5 years. This is then linked to the largest capital that the contractor can secure for the execution of construction works. The number of qualified

use in construction is to limit SMEs to contractors up to level 4 on the CIDB register (those capable of tendering to contracts up to R4 million). These contractors will be the focus of this study. This limitation is line with the approach by Thwala and Phaladi (2009) and Martin and Root (2009), who carried out similar research.

The CIDB third quarter survey for 2011 notes that overall, the number of registrations in Grades 2 to 4 account for around 60 to 70% of the total registrations in Grades 2 to 9, whereas the number of registrations in Grades 7 to 9 account for around 8% of the total number of registrations. If Grade 1 contractors are included, then Grades 1 to 4 will account for 88% of all registrations. The number of SMEs in all sectors significantly outweighs large companies, however, they only contribute 27 to 34% to the national GDP while large enterprises contribute 40 to 50%. Informal enterprises account for 21 to 24% of the GDP (SEDA, 2006; cited in Department of Trade and Industry, 2011).

Surveys carried out by the CIDB in the last quarter of 2011 regarding the performance of SMEs in the General Building and Civil Engineering categories indicate that one of the major challenges they faced was regarding competition in tendering, which meant that businesses were experiencing difficulties in obtaining new work. Consequently, profit margins remained under pressure during the survey period. The other challenge reported by respondents was in relation to the poor supply of building materials and skilled labour shortages. They also reported that insufficient demand for building work was constraining their business operations (CIDB, 2011b). This seems to suggest that SMEs would benefit from programmes and technology that can give them an advantage in tendering and in providing timely information on construction materials availability and prices, a role that ICT can play.

1.3. The focus on women in construction - Khuthaza

While there has been a clear focus on SMEs through government policy as discussed in section 1.2 above, government policy has also moved to improve gender balance in the construction industry as discussed below. This approach has required that the competitiveness of women led SMMES receives particular focus

professionals employed by the contractor also has a bearing on the grade of the contractor. This grading is divided into 9 levels, with level 1 being the lowest and level 9 being the highest. These levels stipulate the largest amount of a tender that a contractor is allowed to execute.

with the aim of improving their sustainability. This is an area in which ICT has a role to play, especially in improving project management in the provision of infrastructure as discussed in the literature review.

Government policy on gender equality is directed by the Bill of Rights of the South African Constitution (1996). Gender equity has also found expression in the South Africa's National Policy Framework for Women's Empowerment and Gender Equality (2000), also referred to as the Gender Policy Framework. According to the Gender Policy Framework (2000), women held a disadvantaged position in the South African society before 1994 and the policy seeks to set out a strategy of redressing this historical imbalance. The policy lists poverty, location of women in rural areas, HIV/AIDS, poor access to basic resources, poor access to employment opportunities, poor access to land, poor access to science and technology and limited access to political power as factors affecting women.

According to the Department of Trade and Industry (2011:22), SMEs play a central role in the empowerment of women. This is coupled with the fact that there were an estimated 2.6 million SMEs in 2006 in South Africa, and the number was growing at an average of 5.4% per annum. Of the 2.6 million SMEs, approximately 22% were formal and women own 40 to 47% of the formal SMEs. However, statistics indicate that 80% of women owned SMEs are informal (Department of Trade and Industry, 2011:42). In order to assist these SMEs in becoming formal and being more competitive, programmes and strategies that improve their competitiveness will be important to ensure their sustainability as they enter the formal economy. Technology can play many roles including assisting in the way SMEs source and utilise information to enhance their productivity.

Furthermore, in response to challenges faced by women in general, the South African government has moved to empower women through policy frameworks being implemented by departments such as the Department of Trade and Industry (DTI).The DTI is promoting gender equality through programmes such as the Broad Based Black Economic Empowerment (BBBEE) and through focused research programmes aimed at better understanding industry trends and identifying interventions that can positively impact on women owned businesses. This research

builds on this thrust and aims to contribute to government initiatives to empower women through making women owned business more productive through access to technology that can enrich their internal business processes.

One of the organisations actively pursuing government policy in improving women's representation in the construction industry is Khuthaza. This is a non-profit organisation established in 1995 which focuses on supporting women in the housing and construction sectors. It offers training programmes that are aimed at helping women gain entry and remain competitive in these sectors. While Khuthaza focuses mainly on women, it also provides training for men who lead construction companies. Khuthaza has several sponsors including government, financing institutions and educational institutions. Joining this organisation is voluntary, and as a result it tends to attract proactive members who already operate a construction business. This aspect of Khuthaza is particularly relevant to this study as it helps ensure that the targeted members are knowledgeable in matters that influence the construction industry. Khuthaza is further explored below.

1.4. Khuthaza

Having explored government initiatives aimed at establishing skills transfer in the construction industry, it is also necessary to focus on Khuthaza, whose members were participants in this study. The information below has been obtained from the Khuthaza website (www.khuthaza.org.za).

Khuthaza was founded in 1995 as Women in Housing and is registered as a non-profit organization. The name Khuthaza was adopted by the organisation in 2009, in line with the organisation's increased involvement in the entire built environment as opposed to just the housing sector. Khuthaza implements programmes that are aimed at contractor development, talent development and networking. It mainly focuses on supporting the development of women in the built environment. Though its main focus is on women, Khuthaza does not exclusively carter for women needs but also encourages participation by male members of the construction industry in its programmes.

However, Khuthaza's main thrust is to empower women and thus develop equal opportunities for women in the built environment. As such it subscribes to various

government initiatives as discussed in section 1.3 which include the Broad Based Black Economic Empowerment. It aims to transform the built environment from being male dominated to an environment which has equal representation of men and women and its programmes are designed with this in mind.

Khuthaza attracts participants from the entire construction industry, especially those in companies in grades one and two on the CIDB grading scale. Participation in its programmes is entirely voluntary. Thus, through its composition, the organisation inherently allows contractors participating in the programme to achieve a degree of representativeness within the construction industry. However, this representation is skewed in favour of women participants. The bias in representativeness is particularly important to this research since focussing on an organisation such as Khuthaza, whose main members are women, is informed by empirical findings on skills transfer programmes in the built environment. Research in this field has shown that in general women perform better in training for employment through programmes such as the EPWP (Betcherman et al, 2004; cited in Meth, 2011). Focusing on Khuthaza increases the likelihood of obtaining research participants who are better informed on issues common to the built environment, ICT being one such area.

Furthermore Khuthaza is located in Johannesburg and targeting contractors located in Johannesburg also provides a stronger likelihood that a greater number of respondents would be utilising advanced forms of ICT than in less sophisticated parts of the country. The other relevant aspects of Khuthaza that strengthens its choice as a target organisation for this research are discussed in the methodology section.

1.5. Problem statement

Construction companies that fail to embrace the various new forms of technology that are available might find themselves being less competitive in an increasingly competitive world. Given the recent global recession, the competition for new work has become very intense, requiring that contractors improve on their quality while lowering their construction costs (Underwood and Khosrowshahi, 2012). It is

therefore important for contractors not to miss this opportunity presented by new technologies in information and communication in general (Chien et al, 2010).

In terms of the 2007 global ICT rankings by the International Telecommunications Union (ITU) South Africa is ranked 3rd among 41 African countries and 92nd in the world among 159 countries in terms of ICT usage (International Telecommunications Union, 2011). This ranking indicates that compared to other countries in Africa, South Africa's level of ICT use is quite high. However, the rankings are based on household ICT use and this may differ from the experience of enterprises. Therefore, it is necessary to research the level of ICT use in the construction sector and to evaluate whether it is significantly high and comparable to the ITU ICT usage rankings. Knowing the penetration level of ICT use might assist in the formulation of properly researched strategies to assist SMEs in acquiring and utilising new technology. While this research will not attempt to formulate such strategies, its results may be used for such a purpose.

Furthermore, while the role of ICT in the construction sector has been demonstrated by a number of authors in various regions of the world, research in this field has largely focussed on enterprises in industrialised nations. This has led to a gap in research on its applicability in SMEs located in developing nations, especially in South Africa where the role of ICT in the construction sector remains under-researched. It is therefore necessary to establish whether the findings of researchers in industrialised countries are equally applicable to the South African context in terms of the level of ICT penetration in the construction industry.

1.6. Research question:

What is the level of ICT penetration in the construction industry in Gauteng?

1.7. Research objectives

The objectives of the study are to:

- Identify the forms of ICT available for use by contractors;
- Establish the extent to which the sector is exploiting the available forms of ICT;

- Determine the experience of contractors regarding the use of ICT;
- Determine how ICT has enriched their internal processes;
- Identify the ICT technologies that contractors would like to acquire.

1.8. Importance of study

This study provides insight into the level of ICT penetration in the SME segment of the construction sector in Gauteng. The research details the type and level of usage of ICT tools in the sector and the experience of SMEs in the exploitation of ICT. Furthermore, this research distinguishes between simple and sophisticated ICT tools that are available to the SMEs. Overall, this research explores trends associated with ICT use in the SME segment of construction sector in Gauteng.

By understanding these trends, this research allows conclusions to be drawn on the adequacy of ICT investment by the targeted companies. It also contrasts the South African context with that of industrialised nations, identifying similar and dissimilar trends in terms of ICT usage in construction. The research also critiques interventions by government aimed at improving the ICT skills of SMEs and demonstrates their inadequacy in achieving their intended objectives. Finally, the research draws conclusions on the level of ICT penetration and provides recommendations that are aimed at improving ICT exploitation in the sector.

The findings of this research will allow other researchers in this field to develop tailor-made interventions that can be implemented for the benefit of SMEs in general. These interventions may include further training of SMEs on available ICT tools that would benefit them by improving their competitiveness. The findings of this research will also assist relevant government departments, private companies, academics and other interested stakeholders in identifying the gaps that need to be addressed to ensure that ICT is exploited fully by the industry to ensure maximum productivity.

1.9. Research scope limitations

This research is limited to Khuthaza affiliated contractors, the majority of which are companies run or owned by women. The research will not seek to develop new

policies or strategies, but rather focuses on analysing the level of ICT use by the targeted companies.

While project management is an important field in construction, its domain is complex, with many aspects including various concepts, techniques and technologies that affect SMEs in construction. This research approaches ICT use from the broader business sustainability perspective. It focuses on ICT and its effects on business processes. Project management techniques and technologies are not covered here but are recommended to be addressed by a separate detailed study that would analyse the practises currently employed by SMEs in the South African construction sector.

1.10. Structure of the research report

This report is divided into seven chapters:

Chapter 1 is the introduction and it states the objectives for the report. It also explains the focus on Khuthaza and the challenges that SMEs face in the construction sector;

Chapter 2 is the literature review and it discusses the various forms of ICT available in the construction industry and also provides information on how they have been used to improve productivity in other countries. It also discusses the various ICT related government initiatives that are aimed at bringing technology to SMEs;

Chapter 3 is the research methodology and it describes the approach taken for the study together with the procedures, methods and tools used for the study;

Chapter 4 contains the results obtained for the study and these are presented in tables, figures and charts;

Chapter 5 is the data analysis and it discusses the results obtained in the study. The chapter also analyses the trends and compares them to results obtained in other regions of the world;

Chapter 6 is the conclusion and recommendations to provide some guidance on the appropriate forms of ICT for the construction sector and improvements that can be made by stakeholders in the industry in terms of ICT exploitation.

Thereafter references and appendices with the questionnaire used for the study will follow.

2. Literature review

2.0. Introduction

This literature view opens by discussing the various challenges SMEs experience in the construction sector both locally and internationally with a particular focus on the skills problem. It then identifies government initiatives that are technology related which aim to address the skills gap in the construction sector. The literature review then focuses on Khuthaza as an organisation involved in the construction sector, and will explore its composition, aims and relevance to this study.

Finally the literature review explores the role that has been identified for ICT in the construction sector building on arguments presented in the introduction. It will focus on the available forms of ICT, their classification and the experience of the construction industry in other countries in their exploitation. The literature review also discusses the benefits associated with ICT exploitation in the construction industry and its contribution to a company's bottom line. As part of the discussion, the literature review refers to results obtained in Australia, South Africa, Taiwan, Turkey and the United Kingdom by other researchers.

2.1. Subcontracting and the skills problem

The challenge of skills in the construction sector stems from a variety of reasons and these are explored in the section below. These challenges are not unique to the South African business environment, but are common throughout the world in both developed and developing countries alike. The challenges explored below are not only experienced by SMEs, but all companies in construction regardless of size. This section also explores the issue of skills transfer with a particular focus on available technology training initiatives that are government led. These are analysed on their suitability to impart ICT skills to the construction sector.

The ILO (2001) notes that subcontracting is gaining popularity due to the flexibility it offers construction companies in the recruitment of labour. The proponents for subcontracting argue that since tendering and the acquisition of new contracts is not guaranteed, keeping a large labour force which may lie idle in times of scarce work is not desirable and hence the need to subcontract the provision of labour to smaller

companies. Furthermore, the labour skills a contractor requires will vary depending on the projects that the company is awarded, and hence the need for a flexible pool of labour where the contractor can access the required skills (ILO, 2001).

Contractors often find that the outsourcing of labour helps to cut costs associated with labour and welfare legislation. Given the challenges discussed in section 1.1, competitiveness is a major issue for contractors and hence the need to limit costs. Furthermore, subcontracting allows for the delegation of supervision responsibilities, a factor which is particularly advantageous to contractors especially given the potentially dispersed location of sites (ILO, 2001).

The challenge then becomes the issue of training. While the construction industry faces the challenge of poor skills, there is still unwillingness by contractors to invest in training of their labourers (ILO, 2001). This trend can be explained by the inherent fear that training labourers may not be beneficial to a company as the trained workers will be lost to other contractors in the labour market. Furthermore, the need to train workers is offset by subcontracting, since the main contractor does not necessarily need to have a large skilled labour force as he/she can rely on the subcontractor. Also, since the labour force tends to be highly mobile, there are challenges in planning and implementing training initiatives. Contractors also view time spend on training as lost productivity and hence the reluctance to train labourers (ILO, 2001).

The ILO further argues that in most developing countries most of the skills in the construction industry are acquired through informal apprenticeships. The challenge associated with informal skills transfer is that often only a narrow skills range is transferred and skills tend to be kept within a particular family, clan or tribe. Furthermore, informal skills transfer proves inadequate when there is a sudden large demand for skills such as in times of economic prosperity (ILO, 2001).

The South African government has also noted these trends and agrees that labour subcontracting is a major issue in the local construction industry (Department of Public Works, 1999; cited in ILO, 2001). It then follows that the challenges reported above are also experienced locally.

While the ILO generalises the skills problem to cover technical, contractual, financial and managerial skills, this research focuses on ICT related skills. The OECD (2004:5) notes that “lack of ICT skills and business skills are widespread impediments to effective uptake once adoption decisions are made. Governments have major roles in providing basic ICT skills in compulsory schooling, and an important role in conjunction with education institutions, business, and individuals in providing the framework to encourage ICT skill formation at higher levels, in vocational training and in on-going lifelong learning.”

To address the challenge of poor skills of the labour force, various training initiatives have been established throughout the country. These initiatives are aimed at assisting SMEs and large contractors to bridge the skills gap. The discussion on training shall however, be limited to training initiatives associated with ICT.

2.2. Addressing the skills gap: Government led ICT training programmes for SMEs

Government has moved to play its role in closing the skills gap as identified above. To this end, the government, through the Department of Trade and Industry (DTI) and the Small Enterprise Development Agency (SEDA) has developed the technology programmes identified below. These programmes are included here to demonstrate that the role of technology in the construction sector is receiving attention from the government, financing institutions and training organisations. This inclusion is intended to strengthen the argument for interventions to ensure that benefits associated with ICT are fully exploited by SMEs. The information below has been obtained from SEDA (2009), SEDA (2011) and the concerned organisations’ website.

2.2.1. Technology for Women in Business (TWIB)

The Technology for Women in Business (TWIB) programme is a government led initiative that aims to assist women entrepreneurs to apply science and technology based business solutions to grow their businesses. The DTI introduced the initiative in 1998, and targeted women led businesses of all sizes. TWIB aims to improve a business’ competitiveness and foster growth through mentoring and training.

This programme also assists women in taking up science and mathematics in schools through career guidance initiatives that provide information on career opportunities and learning programmes.

The programme also hosts annual awards for women exploiting technology to enhance their business processes and to improve productivity and quality of their products and services. These awards are not sector specific.

Objectives

The objectives of this programme are to:

- Facilitate focused action by female entrepreneurs at all levels;
- Create successful role models;
- Unlock solutions to progressive approaches to doing business in a global economy;
- Exploit partnerships with government, corporate entities and woman focused organisations;
- Facilitate focused action by women entrepreneurs at all levels.

Activities

The activities of TWIB include the following:

- Identification of technological needs of women in business in the following market sectors:
    - Information and Communications Technology;
    - Construction and Infrastructure;
    - Textile, Clothing and Crafts;
    - Agriculture, Food and Agro-Processing;
    - Tourism;
    - Mining and energy.
- Addressing the identified needs through technological interventions in a project specific way;

- Facilitation of linkages between women in business and technology service providers;
- Identification and creation of market and business opportunities for the beneficiaries of the TWIB programme;
- Recognition and celebration of the success of women in the various business sectors;
- Identification and provision of support to learners in the science and technology field;
- Establishment and maintenance of a database which contains relevant information on TWIB activities;
- Establishment and maintenance of a TWIB website;
- Exposing south African women to international trends in science and technology;
- Demonstration and diffusion of technology; and
- Incubation of start-up businesses.

Participation in TWIB

This programme focuses on providing access to women led businesses and as such the participants are women. Prospective participants can gain access to training initiatives hosted under this initiative through a variety of ways:

- The initiatives are advertised online on the DTI website;
- Information is also advertised in newspapers especially free government gazettes that are available at local government offices;
- Prospective participants can also contact SEDA directly to obtain information on application into the programme. SEDA has branches in all district municipalities.

Methods of conveying information

The programme utilises a variety of methods for conveying information, including formal courses, workshops and lectures. TWIB also pairs start-up firms with mentors who are professionals in the sector to allow women led businesses to be assisted during the first few years of their establishment.

TWIB recognises women entrepreneurs who have successfully exploited appropriate technologies to improve the performance of their businesses. This is done through the hosting of annual awards for its members.

Suitability of TWIB to training SMEs in construction

This programme is applicable to this research especially given its focus on women entrepreneurs. It is a useful platform from which SMEs can be targeted to help them exploit ICT solutions applicable to their businesses. Furthermore, mentorship works well in helping start-up businesses benefit from the experience of experts and to avoid common pitfalls.

However, the programme is not well marketed, as demonstrated by the difficulty in finding information for this programme during this research. The programme also does not have a dedicated website, making it difficult to find information about it online. The poor online visibility is ironic given that the programme aims to improve access to technology by women and yet it does not have a dedicated website.

2.2.2. South African Women Entrepreneurs' Network (SAWEN)

SAWEN is a networking platform established by the DTI and is registered as a Non-Profit Organisation (NPO). It provides a platform for women to network and share ideas that benefit their organisations. It mainly targets women who own SMEs, both formal and informal; with the understanding that the informal businesses will gradually be formalized as they grow. It assists women with setting up a business and on running an SME successfully.

Objectives

The objectives of this programme are:

- To provide a national vehicle that brings women and women’s groups together to address their challenges;
- To lobby government, public and private institutions on issues such as policy, legislation and/or proposed legislation affecting either directly or indirectly the trade and commerce activities of women entrepreneurs;

- To align SAWEN with other bodies or organisations with similar business interests at both national and international level, and to leverage the relationships arising out of these alignments for the benefit of its members;
- To facilitate access to business resources, information and opportunities for South African women entrepreneurs in a way that promotes their effective participation in the global economy; and
- To profile and affirm women in business leadership positions in both public and private sectors.

Participation in SAWEN

The majority of participants are women. However, up to 20% of participants can be men. The reason is that while the main focus is on getting women into the programme, the programme does not discriminate against male participants. However, the programme, on average, has more women than men.

Access to training initiatives under this programme is through a variety of ways. The initiatives are advertised online on the SAWEN website and also on the DTI website. Prospective participants can contact SEDA to obtain information on the application process. SEDA has branches in all district municipalities to assist with information dissipation. Information is also advertised in newspapers especially free government gazettes that are available at both local and provincial government offices.

Methods of conveying information

This programme is a networking platform which allows women to share their knowledge on how to operate a successful business. To achieve this, the organisation hosts conferences, breakfasts, lunch and dinners for its members. SAWEN also carries out capacity building & training for its members through workshops and seminars. It also hosts special courses and other special programmes to meet its members' demands.

Suitability of SAWEN to training SMEs in construction

As a networking platform, the programme is useful for providing information to SMEs on developments which impact them in their sectors. This allows SMEs to position their companies to exploit opportunities created by dynamics in their sector.

Networking also facilitates the development of professional contacts and referrals which are important when tendering for new work.

A networking platform also offers potential for greater private sector involvement, through facilitating the sharing of ideas between service providers, training organisations and SMEs for mutual benefit.

2.2.3. Technology and Human Resources Programme (THRIP)

The Technology and Human Resources Programme (THRIP) is a research and development programme funded by the Department of Trade and Industry (DTI) and administered by the National Research Foundation (NRF). This initiative aims to foster technological advancement in the country through the development of technological skills for the industry and support for research into new types of technologies that may benefit businesses in South Africa. To achieve this, THRIP works in close partnerships with institutions of higher learning to foster research in technological innovations. THRIP was launched in 1991 and supports an average of 235 projects a year.

However, the challenge with this programme is the advanced level of research it is associated with. This makes it difficult for new entrants to the industry to form part of the programme i.e. this programme is relevant especially when skills needed are at a degree level or higher. Since the objective of training identified in this research is to impart basic ICT skills to a largely mobile workforce, this programme may not be suitable for this task. Furthermore, it's also unlikely that SMEs would be carrying out advanced forms of research as required by this programme.

2.3. Analysis of the training initiatives

While summarised information on the training initiatives outlined above is relatively easy to find, detailed information on the training programmes in terms of the material being covered and the level of sophistication of the SMEs involved is difficult to establish. It is therefore difficult to establish how the government views the level of ICT penetration for an SME involved in these initiatives. It is also not clear how the training programmes are linked to individual growth of the SMEs, and whether or not they result in formal accreditation for the participants.

As discussed earlier, ICT adoption must be linked to other business processes for its benefits to be realised. The technology programmes above do not show evidence of this link. This weakness will result in the full potential of ICT not being realised as participants may lack the other equally important skills required to run a business. Furthermore, visibility of these programmes is poor as indicated earlier.

Analysis of the available information on TWIB and SAWEN suggests a less structured approach to information dissemination. While these programmes enrich the participants' knowledge, they do not seem to be structured in a clearly progressive way in which participants add on to the knowledge they obtain from each workshop or seminar. Without a clear programme of the courses offered and material to be covered, it becomes difficult for SMEs to plan their attendance of future courses, and this in turn might lead to low attendance of these programmes.

Furthermore there is no evidence of post training assistance or monitoring of the participants to ensure that they are utilising the skills learnt. This follow up would allow for feedback on the appropriateness of the training and could be useful for tweaking the programmes to better meet SMEs expectations.

In this respect, a separate study on these initiatives, their suitability for the industry and their success stories is recommended.

Having discussed the various government technology programmes, it is necessary to explore ICT in greater detail. The sections below build on arguments presented in the introduction with the aim of identifying the role ICT plays/should play in the construction sector.

2.4. ICT and businesses

While many authors have written on the role of ICT in improving a business' competitive advantage (Anumba et al, 2006; Ballan and El-Diraby, 2011; Underwood and Khosrowshahi, 2012), some authors believe that the benefits of ICT are not as substantial as companies believe (Carr, 2003).This has led to the debate on whether ICT should be viewed as a beneficial resource to a business or as an added cost that all companies must bear as part of the 'cost of doing business'.

Carr (2003) contends that while businesses have invested significant amounts of their annual budgets into IT, they have done so under the mistaken assumption that IT is a strategic resource for a business. He argues that for a resource to be strategic and to provide a sustained competitive advantage, the resource must be scarce. The basis of this argument being that: “you only gain an edge over rivals by having or doing something that they can’t have or do” (Carr, 2003:4). He contends that since functions of IT such as data storage, data processing, and data transport are available to all, this advantage is lost. Hence, IT has just become a cost of doing business that all companies must meet but which offers distinction to none.

Furthermore, Carr argues that software packages have increasingly become standardized, with companies such as IBM and Microsoft positioning themselves as software utilities, leading to homogenisation of IT capabilities as more companies replace customised applications with generic ones. Carr further contends that since business processes are increasingly intertwined with software, they have become replicable. This implies that when a company purchases software, it also effectively purchases business processes (albeit generic ones) resulting in any distinctiveness (to the company) being lost (Carr, 2003).

Carr also claims that businesses spend too much on IT solutions yet empirical research has shown that companies with the largest IT investments rarely post the best financial results. He further claims that it has become very hard for companies to achieve a competitive advantage through investment in IT. Carr concludes by advising companies to “spend less”, since there is a high chance of wasteful expenditure associated with IT; “follow, don’t lead”, since waiting will decrease the chances of buying technologically flawed IT solutions and to “focus on vulnerabilities and not opportunities” since it is unlikely that IT will provide any competitive advantage to a company (Carr, 2003:9).

The OECD (2004) has also weighed in on this debate, adding that for an investment in ICT to be beneficial to an organisation, it must be accompanied by investments in skills, organisational change and innovation. These complimentary investments invariably increase the cost of ICT adoption which companies may not be prepared

to meet. The OECD further notes that difficulties associated with ICT implementation may arise from the suitability of the ICT solutions to the company's business processes and influence from the supply chain. The OECD contends that there are instances where businesses have been reluctant to implement ICT especially e-commerce as they feel it is not relevant in their line of work. It concludes by noting that "SMEs may have more difficulties, compared to larger firms, in finding an e-business case applicable to them because of the lack of the time, information and knowledge" (OECD, 2004:20).

While Carr's argument may be relevant, the key issue here is on the amount spent. Over-expenditure on any resource, be it IT or otherwise, is generally not good for an organisation as it implies increased costs that should have been avoided. Furthermore, while Carr's claim that companies who do well spend less on IT might be true (based on the researched companies in the study he cites); it does not suggest that businesses who have not invested in IT have done well. On the contrary, empirical research has proven otherwise (OECD, 2004:9). In conclusion, companies should be wary of over-investing in ICT (as discussed in section 2.8.1), but they should not dismiss ICT's role and potential benefits as discussed below.

2.5. The role of ICT in the construction industry

According to Rust et al (1994), Science, Engineering and Technology (SET) impact broadly on society, stimulate economic growth and can potentially positively affect the environment. They further claim that Research and Development (R&D) has a significant impact on both economic development and social development. Furthermore, they identify R&D and SET as having a wide impact in the construction sector through, among other things, the enabling role that ICT plays to improve the competitiveness of businesses in that sector. This may imply that ICT, when fully and correctly exploited, can enhance processes in SMEs resulting in their being more competitive in their sectors, and might help to reduce the high rate of enterprise failure in the construction industry as discussed in section 1.1.

Information and Communication Technologies (ICT) can lead to benefits such as time savings through improved coordination as ICT can provide faster access to important information, better information storage, tracking and security, and

improved customer relations through improved communication with clients and the setting up of feedback structures (Ballan and El-Diraby, 2011:758). ICT also potentially provides a means of facilitating the delivery of training and support, especially to newly established contractors. Thus the role that ICT can play in the construction sector appears to be broad and it can potentially improve the competitiveness of small enterprises in the sector. Further benefits of ICT use are discussed under section 2.7.

However, Manseau and Seadon (2001) claim that “despite its potential contribution, technological development in the construction industry has fallen behind many other industries, with the consequent use of ageing technologies.” While this observation is quite old, its validity is not readily disputed in current literature. One of the challenges that makes it hard to dispute the above claim is that the role of ICT in the South African construction sector remains under researched, despite the general realisation of its potential impact on the industry as demonstrated in other countries, especially first world economies such as Australia, the United Kingdom and Turkey.

Other authors such as Whiting & Janasz (2004) concur with the view that ICT penetration in the construction sector is quite low and contend that while technology transfer is present in the construction industry, it appears to occur at a slower pace than in other industries such as business and commerce. This state of affairs is clearly in contrast with the inherent characteristics of the industry such as a highly mobile workforce who would benefit from improved on and offsite communication (May et al, 2005). Adriaanse & Voordijk (2005) agree with this observation and add that although the construction industry is information intensive, it still fails to use available ICT systems effectively resulting in avoidable communication difficulties. This requires further scrutiny, as there is a need to understand this anomaly i.e. the low level adoption of ICT by an industry which could potentially benefit from its increased use.

Further analysis has provided a potential explanation for this trend. This can be explained by the fact that, generally, construction companies believe that an investment in ICT often fails to deliver the expected benefits (Tan, 1996; Rivard, 2000; Martin, 2003; Yang, 2007). Ballan and El-Diraby (2011) add that the level of

familiarity with available tools, reluctance to invest time and money into ICT systems and general poor leadership are to blame for its slow adoption in the construction industry. Consequently then, the failure to distinguish between tools and information needs, poor adoption and consequently the poor results associated with ICT are not as a result of problems or challenges with the hardware or software but rather of poor leadership.

However, maybe the broader questions that one should be asking are not whether or not ICT should be adopted for use in construction, but rather what role it must play and at what level this role must be. Some authors have even gone further to broaden discourse on ICT adoption. Irtishad and Maung (2008) present an alternative argument on ICT use in construction. They claim that “ICT is used by and large as mere enhancement tools, not as agents that can transform and thus revolutionize the process of construction. A new approach based on the technology management principles will enable researchers to formulate new strategic directions,” (Irtishad and Maung, 2008:900). This suggests that the approach to ICT adoption and use must be revised from where ICT is viewed as a tool or process, to viewing its potential role for transforming or revolutionising the process or the organisation. This approach however, is clearly more difficult to interpret and implement than simply viewing ICT as a means to an end, namely: improved productivity. Re-engineering the business environment and ‘revolutionising’ it would probably require deeper understanding of inherent business processes and strategy, a state which is not always readily associated with SMEs. As a result, this falls out of the scope of this study.

2.6. Barriers to adoption of ICT

Having discussed the planned infrastructure investment and appreciating that ICT has a role to play in improving productivity in the construction sector, there is need for further discourse on why its adoption has been slow in this particular industry.

Change in organisations is often resisted for a variety of reasons. The adoption of new technology generally represents some form of change in areas such as business processes and the skills required to implement such a change. Thus change is not always readily accepted by employees who often act as implementing agents for the required change. According to Ballan and El-Diraby (2011) the

following barriers often work against the migration to new technology in organisations:

- Difficult in convincing workers to change to a new and often unfamiliar technology;
- High costs associated with the training of staff to utilise the technology;
- Poor integration of technology across different trades involved in the implementation of the project;
- Challenges in convincing role players in the construction industry to migrate from a culture of oral communication to methods and forms that allow for significant use of ICT;
- Loss of time due to oversupply of information resulting from poor filtering of important and non-important information;
- Difficult in establishing the track record of the technology in terms of its reliability and durability;
- Problems with the new technology such as limited connectivity in rural areas.

Michaloski and Costa (2010:370) add that: “In addition, deficiencies in information and the lack of integration among the actors involved in the construction process contribute to information systems being regarded as falling short of expectations. This is what has been reported in the literature as being some of the difficulties these companies face.” This lack of integration exacerbates the negative view on ICT adoption and works as a barrier to change in the industry.

The challenges identified above suggest that the people involved in the implementation of new technology in organisations play an important role in ensuring that ICT achieves the intended objectives. This view is supported by Anumba et al (2006) who indicate that the way in which ICT is implemented and its suitability to the tasks at hand has a large influence on whether or not the adoption of ICT succeeds in the target organisation. They demonstrate that if the implementation process is not responsive enough to the changing environment in the organisation, then the process will fail. They also show that the implementation of ICT must be accompanied by a clear vision and purpose for the ICT tool which takes due cognisance of the needs of end users and other stakeholders. They conclude that

there is always a need to communicate the changes to end users to ensure that their concerns are effectively addressed.

Thus the issues that may work against the adoption of a new technology, if correctly managed, can help to ensure that the required technology is adopted by the target organisation. The benefits of adopting ICT are discussed briefly below.

2.7. Benefits of ICT

Underwood and Khosrowshahi (2012) argue that ICT adds value and efficiency to business processes and this aspect has been recognised by senior managers in business. They further claim that this has resulted in increased investment in ICT by businesses in the United Kingdom. The authors also indicate that since the construction industry is “knowledge based and information intensive”, ICT has been demonstrated to improve a business’ competitiveness by enriching the information available for decision making in the respective industry. The same views are also supported by Ballan and El-Diraby (2011) who add that these benefits can be experienced regardless of the size of the organisation, as long as the underlying technology is understood and utilised correctly.

Locally, authors such as Arif and Karam (2005) also support these views as they note that the use of IT in the construction sector can potentially have a positive impact on the productivity of local businesses on the domestic and international markets.

Furthermore, ICT has been demonstrated to have many benefits to an organisation, some short term and others long term. The flexibility of ICT allows it to be applied to virtually any business. However, for the purposes of this research, the benefits discussed below shall be limited to those directly linked to the construction sector.

Many authors (Anumba et al 2006; Ballan and El-Diraby 2011; Underwood and Khosrowshahi 2012) have identified the benefits of ICT, which include the following:

- Faster and improved information exchange which leads to time savings as important information is quickly made available when required. This may also lead to improved productivity;

- Better real time communication through the use of devices such as Personal Digital Assistance (PDA) which can assist in improved handling of ad hoc onsite problems;
- Improved information tracking and better security through the use of encrypted communication channels between participants in the conversation;
- Customer relations may also be improved through better information exchange between stakeholders as important information is made available timeously.

However, for these benefits to be realised, proper planning and implementation needs to follow as discussed in section 2.6, as a wholesale adoption and implementation of an ICT policy without fully understanding the underlying business processes and the workforce is bound to fail. This pitfall will most likely affect SMEs, since some of them will be start-up businesses, who may be trying new procedures and work processes. They may fail to appreciate these underlying principles and may rush to adopt systems that they believe will work in the businesses simply because they have worked elsewhere, albeit under potentially different business environments.

2.8. Types and classification of ICT

For purposes of this research the classification of ICT is approached from a perspective of making the analysis and interpretation of the data collected for this research easier. The approach laid out below is intended to ensure that all relevant areas around ICT use in construction are covered. Thus there will be an attempt to cover all thematic areas as discussed in the body of this research.

There are a variety of ways in which researchers in ICT use in construction have classified their results. Arif and Karam (2005) use three classes i.e. General IT usage, Use of Computer-Aided-Design (CAD) and Use of Networks. It should be noted that since Arif and Karam focussed on architects, a profession associated with construction, their selection of classes is not expected to be the same as the one for contractors. However, their classes are used here for comparison, to add insight into ways in which ICT use can be classified.

Mutesi and Kyakula (2009), in their study of ICT use in the Ugandan construction industry, classify their findings into: computers and communication systems, benefits and impacts of ICT and constraints to the use of ICT. Michaloski and Costa (2010) use five classes i.e.: Structure of IT; Resources; Perception; IT problems; and Administrative management and technology. Chien and Barthorpe (2010) classify their findings into seven categories i.e.:

- The appropriate level of ICT investment;
- ICT applications;
- Current use of CAD software;
- Virtual Reality;
- Communication systems and procedures;
- Tendering online;
- Knowledge management.

In analysing the classifications of ICT research above, there seems to be a clear progression, from a very simple classification by Arif and Karam (2005) and Mutesi and Kyakula (2009) to a more comprehensive classification by Chien and Barthorpe (2010).The challenge of oversimplifying ICT classification, as done by Mutesi and Kyakula (2009) is that some aspects that may need to be given specific focus are overlooked in the generalised summary of the results.

However, it must be noted that while the classes used by the researchers above differ considerably, they have common themes that are being discussed. These include ICT applications, benefits of ICT, challenges in utilising ICT, and the level of ICT investment. Therefore, even though the classes emphasize the groupings that are of particular interest to the author; the content follows the general themes identified above.

This research adopts a classification that addresses the economic, technical and knowledge management processes that occur in an organisation. The rationale for this is that ICT does not exist in isolation in the organisation, but is incorporated into other businesses processes. This classification is guided by the underlying themes identified above. To elaborate further on the approach adopted for this research, the classifications above need to be explored in more detail.

The classification by Mutesi and Kyakula (2009) of computers and communication systems, benefits and impacts of ICT and constraints to the use of ICT, can be viewed as encompassing all of the classes proposed by Chien and Barthorpe (2010). This further emphasises the linkages between the classes. However, their classification does not address the issue of how ICT decisions are made and the factors that influence the level of investment in ICT.

Again, the approach by Michaloski and Costa (2010) focuses more on knowledge management in an organisation and does not emphasize other areas such as the acceptable level of ICT investment. The bias towards one particular area of interest weakens its focus on other equally important aspects surrounding ICT use in construction. However, aspects of their classification are still important to this research hence the adoption of areas such as IT problems and the perception of ICT. These areas work to balance the research.

The classification by Chien and Barthorpe (2010) is biased towards ICT applications and does not emphasise other equally important areas as highlighted in the body of this research. To achieve balance, the classes highlighted above need to be integrated. This will ensure that this research covers all areas that are relevant to the exploitation of ICT in the construction industry.

In conclusion, the classes relevant to this study are an integration of all classes presented above. They can be summarised as:

- Communication systems and procedures
- ICT hardware
- ICT applications
- E-commerce
- Benefits of ICT
- Challenges in using ICT
- ICT skills and ICT training
- The appropriate level of ICT investment
- Barriers to investment in ICT
- Factors that influence ICT decisions

Some of the classes above have already been discussed earlier in the literature review. As such, the focus will be on discussing the remaining classes by Chien and Barthorpe (2010) especially on areas that have not been discussed fully such as the appropriate level of ICT investment; ICT applications; current use of CAD software; Virtual Reality; Communication systems and procedures; e-commerce and Knowledge management. The section of e-tendering has been replaced with e-commerce in general, as e-tendering is a form of e-commerce. Each section will be discussed briefly below.

2.8.1. The Appropriate Level of ICT Investment

Some researchers argue that, generally, construction companies believe that an investment in ICT often fails to deliver the expected benefits (Tan, 1996; Rivard, 2000; Martin, 2003; Yang, 2007). While it is difficult to establish the exact reason for this, several explanations have been offered including that the low return on investments might be caused by the failure of the companies to understand the relationships between an organisation's choice of technology as related to its business and the type of organisational structure that it employs (OECD, 2004). Furthermore, another possible reason might be too much focus on short term goals including short term cost reduction without taking proper cognisance of the long term (Chien and Barthorpe, 2010). It follows then that the level of ICT investment must be just right, too little and the objectives may not be realised, and too much might result in increased costs without the expected increase in profitability.

Underwood and Khosrowshahi (2012) show that, amongst the UK companies they investigated, the investment in ICT was 0.74 to 0.76% of their annual turnover. Chien and Barthorpe (2010) discovered that the majority of Taiwanese construction companies invested 0.1% of their annual turnover. Generally, these companies invested less than 1% of their annual turnover on ICT. However, given the differing levels of ICT investment found in empirical research, it would be useful to discuss the concept of an acceptable level of ICT investment as outlined below.

Woksepp and Olofsson (2008) propose a comprehensive approach to evaluating the acceptable level of ICT investment. The rationale behind this approach is that since it is quite difficult to measure the exact effects associated with an investment in ICT,

and since decision makers in ICT investment do not fully understand the dynamics surrounding the business and the rapidly changing ICT environment, there is need to develop a generic tool that businesses can apply (Woksepp and Olofsson, 2008). The tool proposed by the authors is useful to businesses that fully understand their environment, and have access to experts that can fully advise them. This is not always true for SMEs. Furthermore, since it also relies on the underlying assumption that all benefits (tangible and intangible) can be quantified in monetary terms, it exposes itself to challenge as intangible benefits such as user satisfaction may be difficult to measure in such monetary terms.

There is a general rule that Ramesys (2001; cited in Chien and Barthorpe, 2010) applies which indicates that 2.5 to 3% of an SMEs' annual turnover will be an adequate level of ICT investment. This indicates a significantly higher level of investment than that found in empirical research, and therefore it can be construed that this level might be more of an upper limit, above which the benefits may not really justify the increased expenditure. However, while this rule might be a pointer to an adequate level of ICT investment, background information on how it was determined is not readily available. As a result, in the absence of further information on Ramesys' figure, this research will utilise the empirical findings of the researchers outlined above. It might be the case that similar levels reported in empirical research are present in South Africa or that the industry is capable of utilising lower investment proportions while still achieving its desired level of productivity.

According to Ballan and El-Diraby (2011) organisations should exercise reasonable care in deciding whether or not the investment should be on software as opposed to hardware. The authors note that in the construction sector, the hardware is mostly of adequate standards but the problem lies rather with the software that is used. They further contend that the low return on investment associated with ICT is linked directly to the limited capabilities of software systems that companies employ. This observation may help to explain why some organisations have not realised marked improvements in their productivity even though they have acquired advanced forms of ICT hardware.

2.8.2. ICT Applications

Many applications have been developed for use in the construction industry and these include Accounting, Financial Management, Electronic Document Management, Estimating, Project Management and Human Resource Management. These applications can help to improve the effectiveness of construction management (Chien and Barthorpe, 2010).

The ability of a company to own and utilise these applications is related to the level of ICT investment, as the ability to purchase the 'right' software is influenced by the available budget for such a purchase. Having the correct software application and the skills to fully utilise the software might help to reduce the time needed for decision making through making the right information available at the right time. A brief overview of the software categories is given below.

Accounting and Financial Management

In the course of executing a project, project managers need to have proper procedures for project control and record keeping, ensuring that important information is not lost or provided too late, to the detriment of the project. Accounting and financial management software packages help to ensure that all financial transactions are properly recorded and progress and challenges faced are properly accounted for (Hendrickson and Au, 2008).

While there are many applications available, choosing the right software can work as an important tool to better manage processes associated with construction. However, these packages require some level of expertise and hence automation of accounting processes does not necessarily automatically imply the correctness and accuracy of the information supplied. Neither does it imply improved efficiency as it is possible to automate inaccurate processes which might require revisions leading to time wastage (Hendrickson and Au, 2008). SMEs will still need to practice 'due diligence' in order to ensure that their financial management processes are aligned to the relevant legislation and reporting standards.

Estimating

Companies who tender for construction projects need to be capable of giving correct estimates to their tendering value. This important function allows an enterprise to

establish a baseline against which the project cost at the various construction stages can be measured. Arriving at a reasonably accurate cost estimate is a subject of engineering judgement and experience in the application of the appropriate scientific tools designed for that purpose (Hendrickson and Au, 2008). Cost estimation is directly linked to profitability and an error in this stage might have negative implications in all other stages of construction (Hendrickson and Au, 2008).

While there cannot be a substitute for experience and good engineering judgement, software applications are available to enhance this important step in project management, and when correctly used, can improve an enterprise's ability to arrive at a reasonably accurate estimate.

Electronic Document Management applications

Electronic document management systems are designed to allow enterprises and project teams to keep track of both hard and soft copies of documents. These systems are able to track the different versions of a document as it moves between various users in a computer network (Björk, 2002). Björk notes that a mixture of different generation methods for managing documents is utilised in the construction industry, including traditional methods where documents are printed and sent out using couriers to more advanced methods where documents are produced and transmitted electronically to the target group e.g. through the use of e-mail attachments. The use of e-mails may appear faster but it has the disadvantage that retrieving the original document may be difficult and often requires accessing the author's personal computer, which may be a challenge where the author is no longer available (Björk, 2002). However, this challenge can be easily overcome through the use of shared drives where many users have access to the document that is created, hosted and accessed on the shared drive.

Electronic document management systems are referred to using various names including Project Extranet, Project Web, Project Bank, Project Specific Website, Document Pool, Project Information Management System, and Virtual Project. The meanings attached to these systems might be slightly different since some systems enrich the documentation they track by providing further information about the

project. However, broadly, these systems serve the same purpose of tracking and managing documents electronically (Björk, 2002).

Proper document management is important and links to the above sections where any documents, e.g. project estimates, must be properly filed, and any changes made must be properly tracked to ensure that all team members work from the current document. Electronic document management systems can also be linked to a company's communication systems and procedures as discussed under section 2.8.5.

Enterprise Resource Planning (ERP) systems

According to Ahmed et al (2002), Enterprise Resource Planning (ERP) systems are important for the integration of company wide information systems. ERP systems are used in construction to link together and improve information flow to customers; "strengthen supply chain partnerships, enhance organisational flexibility, improve decision making capabilities and reduce project completion time and lower costs" (Ahmed et al, 2002:1). Thus ERP systems integrate and automate a company's business processes. It must be noted that ERP systems are not only for large companies but are applicable to SMEs as well.

Cork (2010) adds that ERP systems improve efficiencies in the construction sector by ensuring timely cost-value reconciliation, for example where site based valuations are directly linked to applications for payment, thereby reducing the time needed for cost control processes which traditionally were carried out by the accounts department resulting in time delays. By ensuring information flow on finances, the contractor is able to make adjustments quickly through the implementation of the project thereby reducing the risk of discovering losses when it may be too late (Cork, 2010).

ERP systems can also be extended to link construction with asset management. This adds benefit to the building owners as every element of their building is linked to a preplanned maintenance schedule (Cork, 2010). While ERP systems may differ, examples include software such as Pastel Evolution and Microsoft Dynamics which also integrates project management. Thus the functionality of software such as Microsoft Project can also be integrated into an ERP system.

2.8.3. Current use of CAD Software

Tse and Wong (2004) note that Computer-Aided Design (CAD) has become quite important for the production of drawings in the construction industry since its introduction over two decades ago. Based on their study carried out in Hong Kong, the authors contend that these applications have not been widely adopted. This scenario might be true for that particular region of the world but not necessarily so for South Africa. However, this must be viewed from the perspective that in terms of the 2010 ICT development index[2], China is ranked 6th while South Africa is ranked 97th, meaning that, in general, China is more advanced in terms of ICT use than South Africa (Measuring the information society, 2011:27). In contrast, a study carried out in the use of CAD in the professional services sector within the construction industry in South Africa concluded that CAD use was common throughout the sector (Arif and Karam, 2005). The reason for the differing observation might be that CAD use is widespread in the professional services but might not have permeated into the construction side as much. Further research in this field may help establish the status of CAD use in the construction industry in South African context.

Computer aided design (CAD) is linked to Building Information Modelling (BIM), which allows different applications to be linked in the execution of a single project. BIM is also sometimes referred to Virtual Building, Parametric Modelling and Model-Based Design (Davies et al, 2000). The issue of Virtual Reality is treated separately in section 2.8.4.

BIM has been developed further to link with 4D modelling, which comprises a 3D model linked to the 4th dimension of time, which follows the construction programme (Davies et al, 2000). This concept is quite flexible and can be extended to cover all other functions in the whole lifecycle of the project. There has been research done

[2] The ICT development index is a measure of the developments in ICT in 154 countries in the world. It is managed by the International Telecommunication Union which is a specialised agency of the United Nations. The index combines 11 indicators that relate to ICT access including the use of fixed and mobile telephony, fixed and mobile internet access, internet bandwidth, the number of households with computers and Internet access and the accompanying broadband technologies associated with internet access and the literacy levels of the users. The tool is used as a single measure that benchmarks ICT use on a global level, region level and country level. But, it should be remembered that this tool is oriented to domestic and not business use, although one may argue that for SMEs, there is a possibility that those with home internet access will also have work internet access.

by some universities into these models, with the University of Salford having carried out a pilot study which integrates “time, cost, buildability, accessibility, sustainability, maintainability, acoustics, lighting and thermal requirements” while utilising applications such as Autodesk Architecture Desktop or ArchiCAD (Davies et al, 2000). Understandably, this field is quite sophisticated and requires specialised skills to manage. However, it still presents an opportunity that can be explored to aid construction firms, especially by well established SMEs who might need to enhance their construction management processes through acquiring specialised software and techniques as they develop into larger firms.

The research surrounding the use of this technology seems to be largely focussed on specialised companies in the developed nations and literature on its applicability in developing nations is difficult to establish. Though this technology might prove useful in the long term, the resources required to educate and train SMEs on its use might work as a barrier to its adoption. However, this research seeks to establish whether the target group is familiar with this technology and whether they are utilising it. This status quo assessment will allow the level of use to be established and might be used as a starting point for its adoption if it is not currently being used in the construction sector.

2.8.4. Virtual Reality

According to Bouchlaghem et al, (1996), Virtual Reality (VR) is an emerging technology that enables interactive real-time viewing of three-dimensional data and as such it is also a state-of-the-art communication tool. The authors further note that VR can also be viewed as a merge of older technologies that encompass computer graphics/displays, human computer interfaces and simulation. Virtual Reality is also referred to as Virtual Environments and it consists of a three-dimensional, interactive, computer-generated environment which is normally either a model of the real or imaginary worlds (Bouchlaghem et al, 1996).

Virtual Reality systems can be divided into two main categories: Desktop Virtual Reality and Immersive Virtual Reality. The main difference between the two is that in Desktop Virtual Reality, the user views and interacts with the computer represented image on a traditional computer graphic screen while in Immersive Virtual Reality

systems, the computer screen is replaced with a head mounted display unit (Bouchlaghem et al, 1996). It must also be noted that the hardware and software for Immersive Virtual Reality systems are more expensive and more sophisticated than in Desktop Virtual Reality. In the construction industry, the use of VR has concentrated on design and construction, and has been piloted in the development of walkthrough systems (Bouchlaghem et al, 1996). Other possible applications identified are:

- Site layout and planning;
- Planning and monitoring of construction processes;
- Evaluation of construction scenarios (Bouchlaghem et al, 1996).

Virtual Reality also has benefits in architectural design, training, sales and marketing tools (Whyte and Bouchlaghem, 2001). However, there is a lack of literature and research in Virtual Reality use in the construction industry in South Africa and more can be done to explore the potential benefits that this technology might offer. Furthermore, Virtual Reality, like Building Information Modelling, represents quite a sophisticated technology and its application in SMEs in the developing world has not been demonstrated. This might result in its slow adoption as setting aside budgets for this technology may not be viewed as a priority by SMEs.

2.8.5. Communication systems and procedures

Timely and accurate information is important in the construction industry as it forms the basis upon which decisions are made. Information needs in construction vary according to the nature, scope and stakeholders involved in the project. Communication in construction can be seen to occur between contractors, developers, sub-contractors, project managers, owner/client and labour. The information requirements of the stakeholders above are different, depending on the intended use of the information required (Rivard, 2000; Arif and Karam, 2005; Chien et al, 2010; Ballan and El-Diraby, 2011).

The various information categories on a construction project will include: requests for information; materials management; equipment management; cost management; site, schedule and construction information; quality assurance; and safety.

Organisations use a variety of communication media including e-mails transmitted through intranets and extranets to ensure that project participants remain informed on the developments in a particular project. Tools and technologies for communication will differ from one organisation to another. Technologies such as video conferencing are also sometimes used for communication by organisations. Researchers in the use of ICT in the construction industry generally agree that the use of e-mail and access to the internet is quite widespread within the sector (Rivard, 2000; Arif and Karam, 2005; Chien et al, 2010; Ballan and El-Diraby, 2011).

Ballan and El-Diraby (2011) identify the five forms of communication normally utilised in construction as face to face, phone (land line or mobile), fax machine, hard copy (courier/delivery/pick-up) and e-mail. They further contend that while information needs are not affected by location of the works, modes and methods of communication are, i.e. urban or rural areas, in terms of available tools for communications. A good example here is the limited mobile phone coverage in rural areas. This observation is true in sectors other than construction.

ICT offers distinct advantages in providing a record, ensuring timeous availability of important information and assisting in the visualisation of construction progress through drawings, details, sketches and pictures (Ballan and El-Diraby, 2011). Therefore, in general, ICT, when appropriately utilised, enhances communication procedures in the affected organisation.

2.8.6. E-commerce

ICT has the ability to increase the speed and reliability of transactions and it forms an important component of e-commerce. E-commerce can be said to encompass Electronic Document Interchange (EDI) and internet transactions (OECD, 2004). The OECD further notes that e-commerce provides many benefits to an organisation including facilitating intra- and inter-firm transactions and assisting firms in reaching new customers across different regions. When a company operates a website, it will improve its online visibility and can improve customer feedback through mechanisms hosted on the website. Also, websites allow SMEs to operate an online business. An important aspect of e-commerce is e-tendering and this is discussed below.

Chien and Barthorpe (2010) claim that tendering online (e-tendering) will gain wider use as contractors become familiar with the potential it offers. E-tendering provides potential benefits to construction companies and to SMEs in particular. Some of the benefits identified include reduced need to travel to obtain and submit tenders manually and wider reach through accessing a greater market online (Chien and Barthorpe, 2010). When pre-qualification of tenderers is carried out, it then becomes possible to define suppliers more accurately and to match the requirements of consumers better. Also e-tendering can bring suppliers and consumers closer together, which might help SMEs to obtain referrals (The benefits of e-tendering, n.d.).

However, in considering e-tendering, the following observation by Young (2002:2) must be borne in mind. He notes that, "although the internet provides an alternative medium for companies to communicate with their supply chain and to purchase contracts for goods and services, simply migrating existing purchasing processes online does not provide additional value to the purchasing process: it is the way that the medium is used that provides benefit." Young further argues that by focussing extensively on the benefits of e-tendering especially on reverse auctions[3] where buyers can make savings, the fact that the purchaser must retain control over the specification of the goods and services is often overlooked. Furthermore, not all goods and services can be procured through reverse auctions, and this may be particularly so in the construction industry (Young, 2002). Reverse auctions might be useful in the procurement of material for construction purposes, although stringent specification criteria might need to be employed to ensure that the quality of the material will meet the specified standards.

Young (2002) concludes that online tender management systems can deliver the expected benefits where the user exercises diligence in their use. This conclusion is true for the application of ICT in general as discussed in earlier sections, as there is need to match the requisite technology to broader business strategy for the company.

[3] According to investopedia, reverse auctions are a type of auction where sellers bid at prices which they are willing to sell their goods and services. These auctions have gained popularity with the introduction of internet based online auction tools and allow buyers to make savings on their purchase price as sellers compete, with the lowest price being the winning bid.

However, e-commerce and e-tendering in particular have yet to be widely adopted in sectors such as construction. One of the many challenges cited is its suitability to the sector as the general perception is that it will not bring large benefits to SMEs. Other barriers include challenges in linking e-commerce to the construction value chain, inadequate network infrastructure and the challenge of skills (OECD, 2004). Furthermore running an online business has cost implications for an SME.

The government has a role to play in developing policies that foster the adoption of e-commerce in all sectors including construction. These policy decisions will include improving network infrastructure and fostering a conducive legal and regulatory environment (OECD, 2004). In South Africa, the government encourages e-commerce and e-tendering through policies such as those proposed in the 2000 green paper for e-commerce in South Africa.

2.8.7. Knowledge Management

The issue of Knowledge Management (KM) is receiving attention by ICT researchers, with some authors claiming that KM must be integrated into the organisational structure for it to have an impact and that employees who utilise these systems must be convinced of the need for KM, for them to accept it (Hamilton, 2002 and McCrea, 2003a; cited in Chien and Barthorpe, 2010).

Understandably, given the different organisational structures employed by various enterprises, no single approach to KM can suit every organisation and, therefore, systems and company structures may need to be modified to allow KM to become part of the organisational culture. To allow KM to be effective, companies need to properly investigate available technologies that will allow them to adopt Knowledge Management (McCrea, 2003a; cited in Chien and Barthorpe, 2010).

Knowledge Management is linked to organisational learning which allows enterprises to access information from past experiences. Generally, construction companies value business knowledge and they work to capture and exploit this knowledge in order to reap some financial benefit associated with it (McCrea, 2003b; cited in Chien and Barthorpe, 2010). It can be construed from this observation that the exploitation of KM can allow companies to better learn from past experiences with a view of improving their productivity and competitiveness.

Since KM fundamentally relies on the existence and management of information, it can be directly linked to ICT. As discussed under section 2.8.5, ICT is useful for the easy storage and retrieval of information. ICT can also act as a platform for the processing of information, evaluation of trends and the forecasting and modelling of possible future scenarios that a company may be able to exploit.

2.9. Conclusion

In conclusion, it can be noted that the literature review has assessed the skills challenge in the construction sector, and has analysed the various government initiatives available to close this gap from a technological perspective. It has also looked at the various forms of ICT and their role in the construction sector. Below, is a summary of this discussion.

While the programmes outlined in the sections above strive to assist SMEs in a variety of ways, the most suited to assist with the issue of training is the TWIB project as it is directly linked to technological advancement of small businesses. However, for established SMEs, the THRIP project is potentially useful since it offers advanced research and also pays part of the salary of the trainee, reducing the burden of cost on the employer. SAWEN offers the advantage of networking, and can work as a useful tool for disseminating ICT related information. It might be the fact that an SME can start with SAWEN, then TWIB and finally end up in THRIP as the level of sophistication increases in terms of ICT use.

However, the main challenge with these programmes is the issue of access. While effort is made to advertise these programmes through SEDA branches, access is still a challenge as indicated by SEDA (2011) that participation of women in its technology programmes is still low. Furthermore, while the DTI is the custodian of the projects, there is no evidence of their integration i.e. for example THRIP annual reports do not show evidence of collaboration with the other programmes. This indicates a lost opportunity that, if exploited, can further the aims of these programmes.

The discussion on ICT in the sections above also indicates that while there are many applications of ICT, the construction sector is generally characterised by the low adoption of ICT compared to other sectors such as business and commerce.

Furthermore, advanced ICT tools have not yet made considerable headway in their adoption in the industry with technologies such as Virtual Reality and Building Information Modelling being still in their infancy. These technologies could potentially aid the industry if more funding for their research and development is made available.

Furthermore, the South African construction industry faces many challenges in its endeavour to provide infrastructure while achieving optimum levels of productivity. ICT has a potential role to play, especially in the sourcing, processing and exploitation of information to improve the efficiency of business processes. However, the penetration of ICT in the construction sector in South Africa is still poorly researched. This research is aimed at enriching the body of knowledge available in terms of the level of ICT penetration in the South African construction environment.

In addition, it can be noted that there are a variety of potential ICT usages in construction, all with varying degrees of complexity. Their adoption and successful exploitation in the construction sector will be influenced by, among other things, the organisational needs and the investment (in terms of time, money and labour) that is placed into them. Furthermore, various organisations will require different solutions and there cannot be a blanket approach to ICT adoption. However, when properly exploited, ICT will have a positive impact on productivity of the organisation concerned, and as such, companies need to ensure that they correctly exploit the available forms of ICT.

Finally, the obtaining of comparable results is important for this research, and influences the methodology adopted as discussed in chapter 3. The main thrust is to adopt an approach widely accepted in this field of study to ensure that the results obtained would be easily comparable, since this study serves as a pilot study, due to inadequate research in this area in South Africa as discussed earlier. The methodology should also take cognisance of the fact that ICT penetration in the sector is unlikely to be high (as indicated above) and thus it would be necessary to target members who are likely to be using it more than the rest i.e. technologically advanced firms. This again reinforces why Khuthaza was targeted for this particular research, as its members are likely to be technologically aware, as discussed in

section1.4. Ultimately, in addition to eliciting information on the level of ICT penetration in the SME segment of the construction sector, this research will also seek to establish whether Khuthaza members are familiar with government initiatives that are aimed at imparting ICT skills to the construction sector. This will help to establish whether the programmes above are achieving their intended purpose and will allow the researcher to make necessary recommendations in this respect.

3. Methodology

3.0. Introduction

Having discussed empirical findings by other researchers in this field it is now necessary to link this to the methodology adopted for this research. This research serves as a pilot study in the use of ICT in the construction sector. The methodology will explore the theoretical basis of this approach and demonstrate that the approach adopted for this research is not peculiar to this particular study but has been employed by other researchers in the field of ICT.

The overall objective of this study is to understand trends regarding the exploitation of ICT in the construction industry, and it aims to do that as efficiently as possible, targeting individuals who are more likely to provide rich data in this respect. This aspect has been discussed in section1.4 and will be explored again in this chapter.

3.1. Research approach

According to Trochim (2006), there are two main research philosophies for acquiring knowledge namely: positivism and post-positivism. Positivism aims to describe observed phenomena in a scientific and objective way, thus assuming that all observations can be explained through scientific means. The post-positivist approach on the other hand argues that qualitative research is more valuable than quantitative research and that scientific deduction and 'common sense' reasoning do not differ significantly. This approach holds that problem solving in everyday life does not differ significantly from the way scientists think and work, with the only difference being in the degree. Furthermore the post-positivist approach contends that all observations and measurements contain inherent errors, and therefore there is need for multiple observations to allow for triangulation to get results closer to reality. These errors may arise from the instruments being used, the underlying theory or the individual bias of the person taking the measurements (Trochim, 2006).

Jackson (2010:101) adds that when researchers employ qualitative methods in their studies, their focus will be on interpreting and explaining what they observe as opposed to simplifying, objectifying or quantifying the observations. While researchers who prefer quantitative methods refer to the tendency towards flexibility

(having less structure and control than quantitative methods) as a threat to reliability and validity of a study, its proponents regard the same characteristics as strengths of qualitative research. The main reason given for this difference is that “they (qualitative researchers) believe that the participants eventually adjust to the researcher’s presence (thus reducing reactivity) and that once they do, the researcher is able to acquire perceptions from different points of view.” (Jackson, 2010:101).

This research adopts a post-positivist approach, as the aim is to explore ICT use in the construction industry through a qualitative approach by eliciting information from a small number of subjects about their utilisation of ICT in their construction processes. This approach ensures that, in addition to quantitative data being recorded, the views and expectations of the users are also captured and evaluated as part of the project. This is achieved through the use of open ended questions and follow up telephone interviews for some of the participants where further explanation of responses is required.

3.2. Research design

Jackson (2010) identifies three types of research methods: descriptive; predictive (relational); and explanatory. Of particular interest to this research is the descriptive method and this is explored in more detail below.

There are three types of descriptive methods namely: observational, case study and survey methods. These methods allow for the researcher to match the project objectives to the approach taken for the research to optimise the research process. This research utilises the survey method, as the aim is to obtain information on ICT penetration in the construction sector in Gauteng. The survey method allows individuals to be questioned and their responses recorded, analysed and explained. While surveys can be administered through various forms including mail, over the phone, on the internet or in an interview (Jackson, 2010:25), for this research, questionnaires were handed to respondents and their responses recorded as outlined below.

For this research, a questionnaire survey method was adopted .The questionnaires were distributed during training sessions for the Khuthaza organisation which are

held at their Johannesburg offices. The researcher explained the process and welcomed questions from the participants before distributing the questionnaires. Participants were then allowed as much time as they required to respond to the questionnaires. Some participants opted to take the questionnaires back to their organisations and were then requested to return them within a period of three weeks. Allowing participants to take back questionnaires helped to improve the quality of responses obtained as they had more time to enquire and consult with their IT personnel before providing their final response.

The use of questionnaires to obtain information is in line with the approach employed by other researchers who investigated ICT use in construction (Arif and Karam, 2005; Chien and Barthorpe, 2010; Michaloski and Costa, 2010). This allows comparison of the results with key sources from the literature discussed in Chapter 2.

3.3. Sampling and sampling techniques

The Oxford English Dictionary (2010) describes a sample as a “portion drawn from a population, the study of which is intended to lead to statistical estimates of the attributes of the whole population”: it further describes a population as a “finite or infinite collection of items under consideration.” Trochim (2006) identifies two types of sampling, namely probability and non-probability methods. This research utilises non-probability methods in general and purposive sampling in particular. The rationale for this decision and the aspects of purposive sampling are discussed in more detail in the sections below.

Purposive sampling is a technique in which the researcher selects a sample that will best achieve the research objectives. By targeting a predefined group for the purposes of the study, the researcher is able to sample quickly and is also able to improve the response rate to the research. Some researchers argue that “the inherent bias of the method contributes to its efficiency, and the method stays robust even when tested against random probability sampling,” (Tongco, 2007). This view by Tongco is derived from empirical research which has demonstrated that in some instances, results obtained from purposive sampling perform better at approximating population parameters than those from random sampling. Researchers such as

Karmel and Jain (1987; cited in Tongco, 2007) and Topp et al. (2004; cited in Tongco, 2007) have also demonstrated this position.

While the strength of random sampling lies in its ability to extend results to the entire population, challenges such as missing data often “render random sampling invalid for traditional probabilistic statistical inference” (Godambe, 1982; cited in Tongco, 2007). Furthermore, random sampling is not always efficient or feasible under some circumstances: for example a high dispersion of samples may result in higher research costs for a researcher (Alexiades, 1996, Bernard, 2002, Snedecor, 1939: cited in Tongco, 2007).

Purposive and convenience sampling was used for this research; purposive in that the researcher targeted Khuthaza affiliated contractors and convenient in terms of geographical location to lower study costs. It also increases the likelihood of obtaining participants who are likely to be using advanced forms of ICT as discussed under section 1.4. This is so since Johannesburg based contractors are likely to be using advanced forms of ICT compared to contractors in less economically advanced parts of the country. Furthermore, research has shown that women do better in skills training in projects such as EPWP, and as such this increases the likelihood that Khuthaza members might be exploiting advanced forms of ICT (Betcherman et al, 2004; cited in Meth, 2011).

As discussed earlier in the introduction, members of Khuthaza are drawn from across the entire built environment, especially companies in grades one and two on the CIDB grading scale. Association with and participation in Khuthaza’s programmes is entirely voluntary. This helps Khuthaza to achieve a degree of representativeness of the construction industry. This is achieved through the entry process into Khuthaza training programmes which is open and voluntary. There is no definite pattern to entry and as such it can be described as random, with the only limit being that participants must be oriented to the construction industry. When viewed in this light, the entry into Khuthaza training programme acts as the first stage of selection of participants. The second and final stage is when the interviewer invites participants to take part in the research. This aspect is explored further under section 3.4 below.

It also ought to be noted that purposive sampling is a technique that other researchers in the same field have employed and as such is not peculiar to this particular investigation. In their study on ICT use in the Brazilian construction industry, Michaloski and Costa (2010:378) also utilised a non-probabilistic purposive sample for convenience. The rationale for this is as discussed above.

3.4. Sample size and Data collection

Chien and Barthorpe (2010) note that it is difficult to obtain a sample truly representative of the whole construction industry, and this challenge is compounded by the low response rate of postal questionnaires. A way to overcome the challenge of low response rates is to use purposive sampling; however, this affects the degree of generalisation that the results can achieve. One has to find a trade-off between the two to achieve some form of balance.

In selecting the methodology for data collection for the project, careful thought was given for the need for representativeness. The logical deduction followed was that since the majority of informal SMEs are owned by women (80%), women own almost half of the formal SMEs (up to 47%), and given the government's initiatives to uplift women in society as discussed in earlier sections, it is valuable to target an organisation that provides access to women led companies.

After attending several training sessions with Khuthaza, the researcher observed that up to 67% of participants were women. This percentage is between the 47% (formal women led SMEs) and 80% (informal women led SMEs), which is in line with observed industry statistics. This helped to build representativeness internally into the study.

The number of respondents to research in ICT use in construction varies from 22 to 120. Sarshar and Isikdag (2004) targeted 22 companies through semi-structured interviews for their investigation of ICT use in the Turkish construction industry. Arif and Karam (2005:157), targeted 300 firms through postal questionnaires and obtained a 40% response rate, Chien and Barthorpe (2010:77) targeted 100 companies through postal questionnaires and obtained a response rate of 51%, Michaloski and Costa (2010:378) targeted 51 companies through structured interviews and obtained a 100% response rate, and Underwood and Khosrowshahi

(2012) targeted 200 companies through questionnaires and obtained a 20% response rate.

Khuthaza has a total of 60 participants enrolled for the 2012 training year. The researcher made a decision to target the entire population. However, some of the participants in the programme did not manage to complete and return the questionnaires. Of the 60 participants, a total of 30 questionnaires were obtained. This represents a response rate of 50% and is within the range of response rates given above.

The questionnaire was designed to elicit the necessary information to meet the research objectives. It contains both open ended and closed questions. Closed questions were included to ensure consistency in responses and open ended questions allow the researcher to obtain more information which may not be obtainable using closed questions. This approach was utilised by Michaloski and Costa for the reasons given above (2010:378).

3.5. Results and analysis

Results obtained during the research are aggregated, summarised and detailed in Chapter 4. A comparative analysis of the results was done (Chapter 5) against the findings of other researchers in other regions of the country and the world. The data was mainly analysed using Microsoft excel through associations and frequency counts. As part of the data mining process, cross tabulation of data was carried out to map trends in individual responses of the participants. Patterns emerging from the data were also analysed using the colour coded cluster method. These methods are explored below. There was also an attempt to explain discrepancies where they occurred. The analysis allowed for robust conclusions to be drawn on the trends in the sector, and enabled the researcher to offer recommendations on addressing undesirable trends where they occurred.

The Journal of Information Technology in Construction (ITcon) which is a peer-reviewed scholarly journal on the use of IT in architecture, civil engineering and facility management was identified as a source of material that was used for this comparative analysis. Analysis is discussed separately in Chapter 5. However, the

methodology for cross tabulation and colour coded cluster analysis employed in this study is discussed below.

3.5.1. Cross tabulation

Cross tabulation, which is also referred to as contingency table analysis can be defined as a comparative analysis tool where data is analysed and displayed in a two or more dimensional table. The cells representing the intersections of rows and columns will then contain comparative data. In this way cross tabulation provides better understanding of how variables in a data set are related and is useful for identifying patterns (Cross tabulation analysis, n.d.).

3.5.2. Colour coded cluster method

Colour coding of interview responses is designed to make the interpretation of results easier by allowing visual patterns to be picked up easily by the reader. (Gorden, 1992) Colour coding follows two basic logical characteristics i.e. it is all-inclusive and mutually exclusive. It is all inclusive in that the set used must include the entire range of relevant responses in a particular category being tested. It is mutually exclusive in that the response being given to a particular question must logically fall only into one category.

Once the questions to be colour coded are selected, colours are then chosen and assigned to each category. While there is no basic rule to this, the normal approach is to choose colours that show some form of progression in line with the responses. An example here might be choosing the sequence of rainbow colours to represent a particular set of responses e.g. red, orange, yellow, green and blue to represent strongly disagree, disagree, neutral, agree and strongly agree respectively. The assignment of the specific colours to a certain category allows for the summarising, condensing, and storing of data with visual depictions that are easy to follow. This allows patterns to be easily identifiable to the reader at a glance.

The data can then be processed further by, for example, grouping individuals with similar responses as shown in chapter 5. This allows the reader easily to follow the summary of the results obtained for this study. In-depth information on this approach can be obtained from Gorden (1992).

3.6. Conclusion

The approach taken for this research is based on purposive sampling for convenience, an approach that other researchers in this field have also employed. Generalisation of the results into the population, however, may not truly reflect the trends as the sample was not a random one. However, the purpose of this study is not necessarily to generalise the results but rather to obtain an in-depth understanding of the ICT utilisation trends in the construction industry. There is not one study that can fully explain these trends, but through collaboration with other researchers, the picture and trends for the South African context can begin to be fully understood.

4. Results

4.0. Introduction

The need for technological development of SMEs has been identified by various role players in the South African construction industry as demonstrated by different programmes being implemented to aid Research and Development (R&D) in the sector and to enhance the use of ICT by SMEs in general. This thrust is in line with the general observation that ICT has many benefits to businesses including its role in improving communication among businesses and consequently improving business processes. These programmes are offered by organisations which include the Department of Trade and Industry (DTI) and the Small Enterprise Development Agency (SEDA) as discussed in chapter 2.

This research builds on these initiatives and explores the way ICT is viewed and utilised by SMEs in the construction sector in Gauteng. By understanding the dynamics around ICT in the construction sector, organisations such as SEDA and the DTI mentioned above can better target SMEs for inclusion in their programmes. Furthermore, well researched interventions can be developed and implemented to cover any gaps that may be identified.

The investigation on the use of ICT in the construction sector in Gauteng was carried out from October to December 2012 and it targeted organisations affiliated with the Khuthaza training programme. As discussed in earlier sections, this organisation is responsible for training both men and women in construction, with a larger percentage of participants being women. The results obtained are summarised in the sections below.

4.1. Profile of the participants

A total of 60 questionnaires were distributed for the study and 30 responses were obtained. This represents a 50% response rate for the study. The following graphs indicate the breakdown of the respondents in terms of age, gender and company size.

4.1.1. Age and Gender

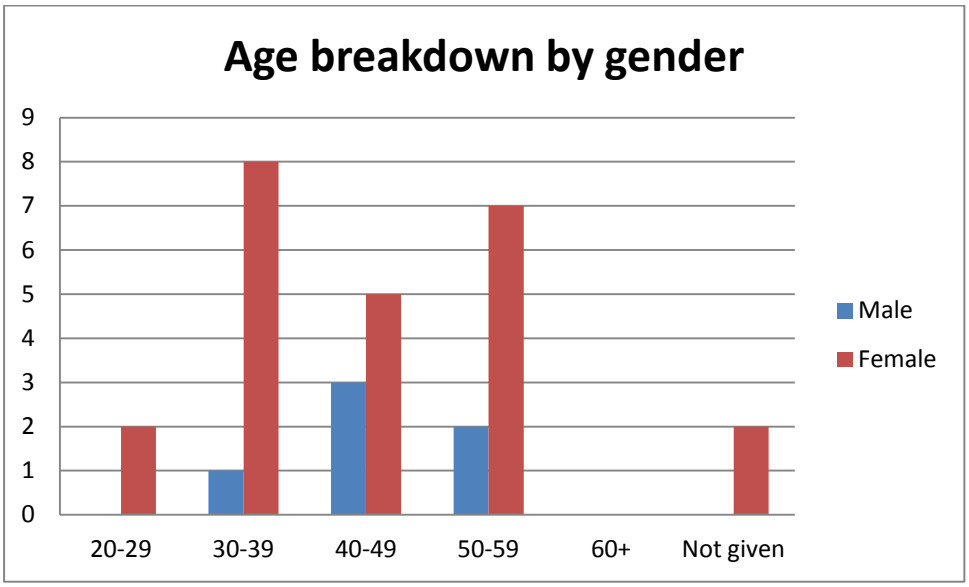


Figure 4-1: Shows the breakdown of company size by gender of owner

As expected, the results show a bias towards women respondents. 80% of the respondents are women and this is consistent with the perception that Khuthaza mainly targets women led construction companies. Men represent the minority of 20%. The presence of men is as a result of the Khuthaza open door policy i.e. while they target women in construction, they do not discriminate against men who want to join their programmes. Furthermore, Khuthaza also utilises word of mouth to target participants, and this further encourages the broad spectrum of participants that end up in training. In training sessions that the researcher attended, some participants attributed their joining Khuthaza as being as a result of conversations they had at social gatherings. As a result men tend to learn about Khuthaza at these social gatherings as well. Their responses are included here to give a broader spectrum of Khuthaza participants.

Figure 4-1 indicates that the majority of the respondents are between the ages of 30 and 60 (87%). Generally though, there is a spread from those over 20 years to just under 60 years of age. The column chart also shows that the majority (57%) of the respondents are 40 years or older which might indicate a delay in starting entrepreneurial activities in this industry.

4.1.2. Company size

Figure 4-2 shows the distribution of the respondents in terms of company size. Of those who responded, the average company size consists of less than 10 individuals, which translates directly to the definition of SMEs as given in earlier sections. There are a few organisations with more than 40 employees and these represent just a small fraction of the population surveyed; only adding up to 10% of the respondents who provided their company size information. Some respondents were not comfortable with divulging their company size as well as their age. As a result 11 (37%) respondents declined to provide information on the sizes of their companies. There was a general feeling by some respondents that alerting other participants to their company size might be used as a measure as to how well their organisations were doing. This might then lead to further scrutiny with other SMEs potentially targeting their source of lucrative tenders. This issue was evident in the tendering class that the researcher attended.

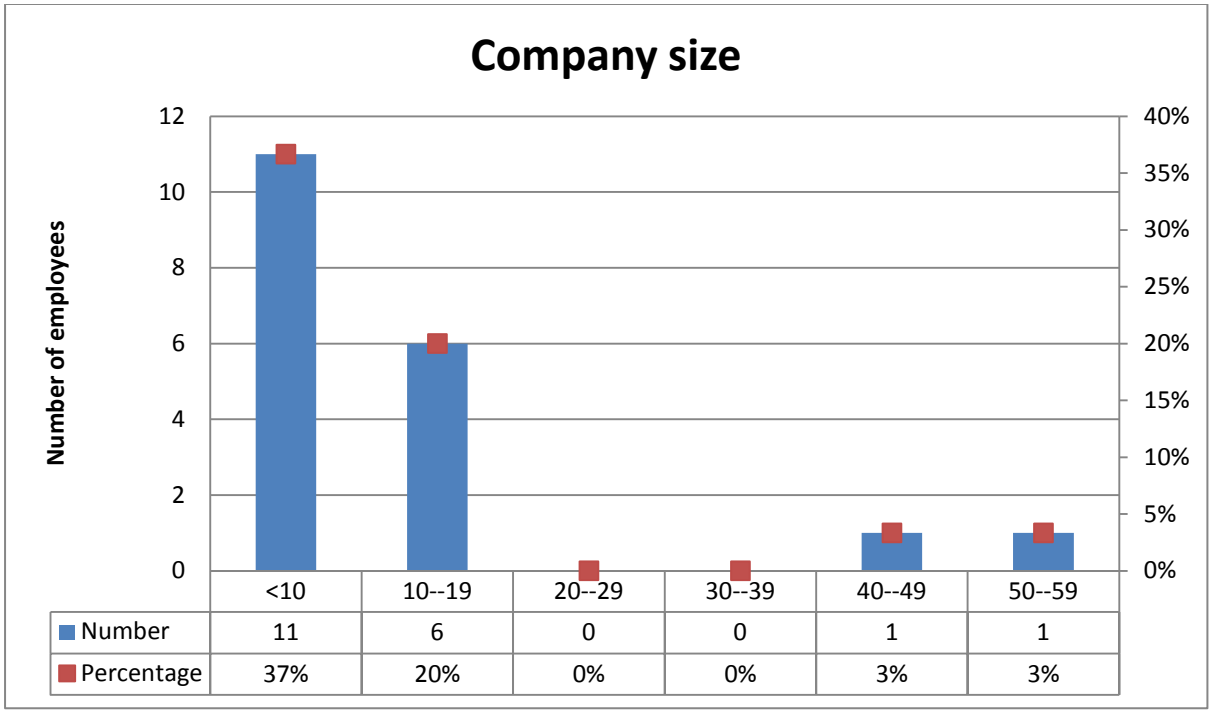


Figure 4-2: Breakdown of respondents by company size

Table 4-1: Shows the breakdown of company size by gender.

			Company size				Total
			<10	10-19	40-49	50-59	
Gender	Male	Count	4	0	0	0	4
		% of Total	21.1 %	0.0%	0.0%	0.0%	21.1 %
	Female	Count	7	6	1	1	15
		% of Total	36.8 %	31.6 %	5.3%	5.3%	78.9 %
Total		Count	11	6	1	1	19
		% of Total	57.9 %	31.6 %	5.3%	5.3%	100.0 %

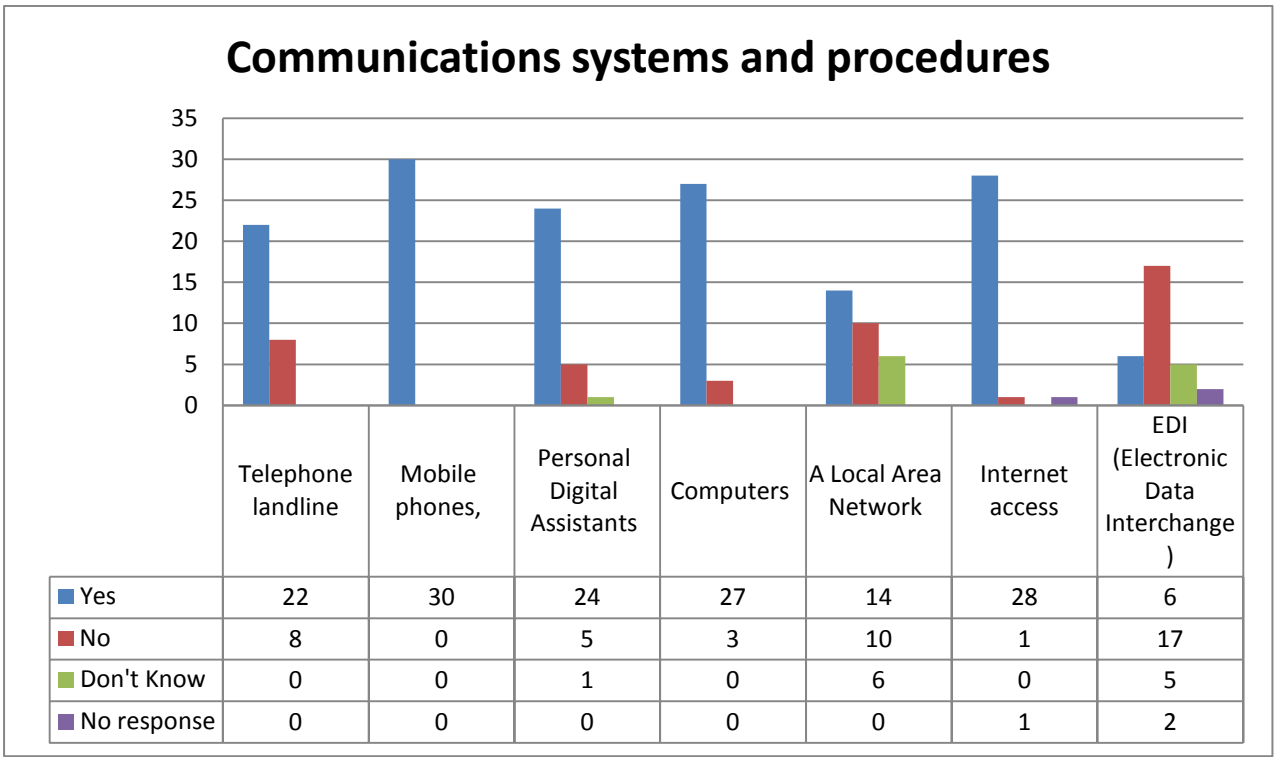
Table 4-1 shows that all male led companies had less than 10 employees. The presence women led companies with more than 10 employees is encouraging as it indicates that women led businesses appear to be more competitive than their counterparts in the survey. This table also shows that the majority of respondents to this question were women, which is in line with the objectives of this research which focus on targeting women led SMEs. Furthermore, the majority of the company sizes reported are consistent with those expected for CIDB grades 1 and 2, which directly links to the aim of targeting SMEs in construction. The table also shows that male-run companies engage with female oriented organisations as part of their start-up strategy, but rapidly move on as evidenced by the absence of male-run companies with more than 10 employees.

4.2. Communication systems and procedures

As discussed in the literature review, the construction industry is one of the most information intensive industries, relying on both timely and accurate information for decision making. The results from Figure 4-3 indicate that the respondents are familiar with most communication tools with all of them utilising one form of ICT communication tool or another. Mobile phones prove to be the most popular communication device, with 100% of the respondents indicating that they utilise them in day to day communication. The use of landlines is lower, with 73% of the respondents reporting its use. Almost all (93%) of the respondents have internet

access. This might be due to the fact that most mobile smart phones in South Africa are able to browse the web.

Computers also proved to be in wide use with 90% of the respondents reporting their use in their business activities. However, Local Area Networks and Electronic Data Interchange were not very popular with just 47% and 20% of participants respectively reporting their use. This might imply the lack of integration of software applications in the majority of businesses surveyed.



	Telephone landline	Mobile phones,	Personal Digital Assistants	Computers	A Local Area Network	Internet access	EDI (Electronic Data Interchange)
Yes	22	30	24	27	14	28	6
No	8	0	5	3	10	1	17
Don't Know	0	0	1	0	6	0	5
No response	0	0	0	0	0	1	2

Figure 4-3: Communication systems and procedures

Table 4-2: Company size against Computers Cross tabulation

			Computers		Total
			Yes	No	
Company size	<10	Count	9	2	11
		% of Total	47.4 %	10.5 %	57.9%
	10-19	Count	6	0	6
		% of Total	31.6 %	0.0%	31.6%
	40-49	Count	1	0	1
		% of Total	5.3%	0.0%	5.3%
	50-59	Count	1	0	1
		% of Total	5.3%	0.0%	5.3%
Total		Count	17	2	19
		% of Total	89.5 %	10.5 %	100.0%

Table 4-3: Company size against LAN Cross tabulation

			LAN			Total
			Yes	No	Don't know	
Company size	<10	Count	6	4	1	11
		% of Total	40.0 %	26.7 %	6.7%	73.3%
	10-19	Count	1	1	1	3
		% of Total	6.7%	6.7%	6.7%	20.0%
	40-49	Count	1	0	0	1
		% of Total	6.7%	0.0%	0.0%	6.7%
Total		Count	8	5	2	15
		% of Total	53.3 %	33.3 %	13.3%	100.0%

Table 4-4: Company size against EDI Cross tabulation

			EDI			Total
			Yes	No	Don't know	
Company size	<10	Count	2	8	1	11
		% of Total	11.8 %	47.1 %	5.9%	64.7%
	10-19	Count	1	2	1	4
		% of Total	5.9%	11.8 %	5.9%	23.5%
	40-49	Count	0	1	0	1
		% of Total	0.0%	5.9%	0.0%	5.9%
	50-59	Count	0	1	0	1
		% of Total	0.0%	5.9%	0.0%	5.9%
Total		Count	3	12	2	17
		% of Total	17.6 %	70.6 %	11.8%	100.0%

Table 4-2 to Table 4-4 provide a breakdown of the communications systems and procedures by company size. They show that the presence of computers is spread throughout all company sizes. Furthermore, EDI systems prove to be unpopular, with only a small percentage of companies with 20 or less employees utilising them.

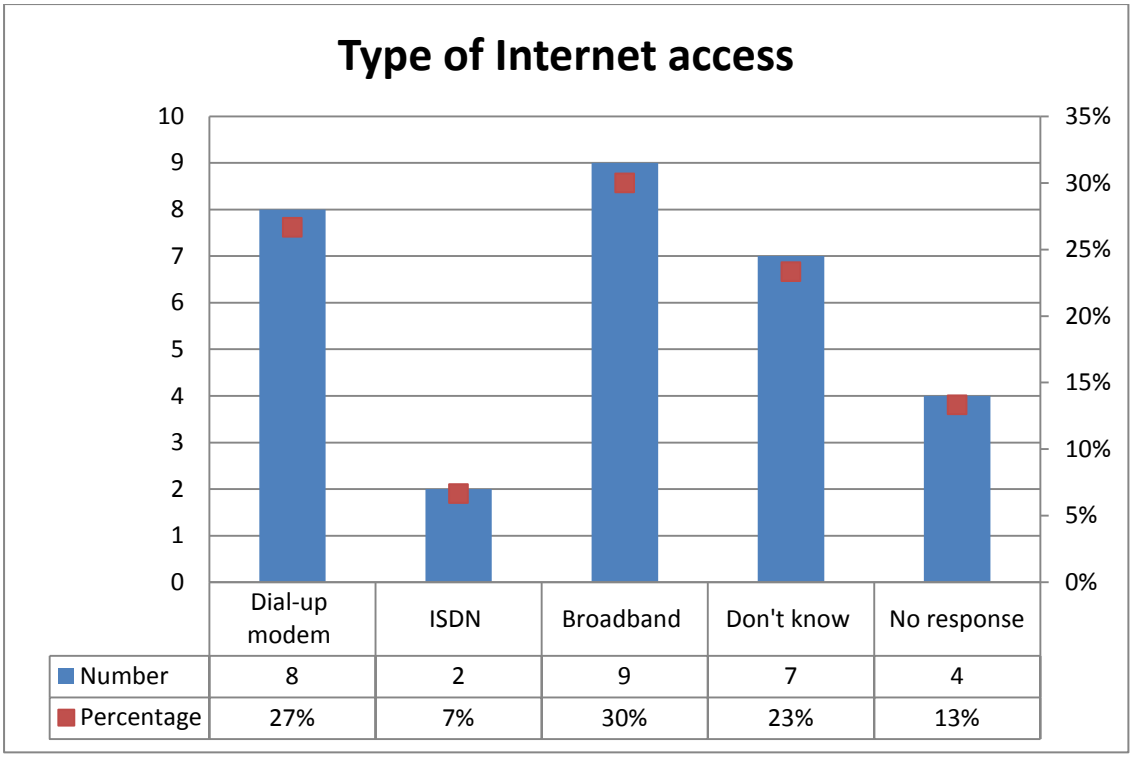


Figure 4-4: Method of accessing the internet

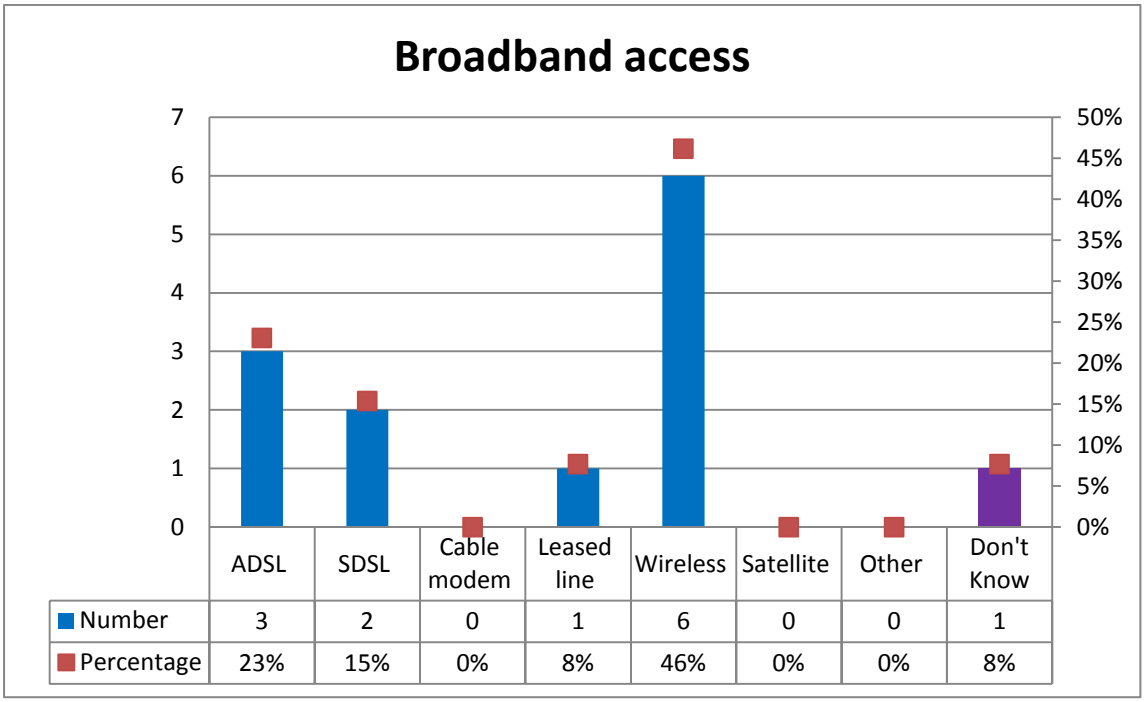


Figure 4-5: Method of accessing broadband

A closer scrutiny of the type of internet access, as summarised in Figure 4-4 shows that the use of broadband services to access the internet was recorded at 30% of

respondents and this was followed by dial up modems at 27%. The type of broadband access is recorded in Figure 4-5 . Respondents were allowed to select more than one option. 13 responses were obtained and the percentages in the graph are calculated based on these responses. Figure 4-5 demonstrates that there is a significant use of wireless connections by the respondents (46%). The use of Asymmetric Digital Subscriber Line (ADSL) and leased lines both followed at 23% and 8% respectively.

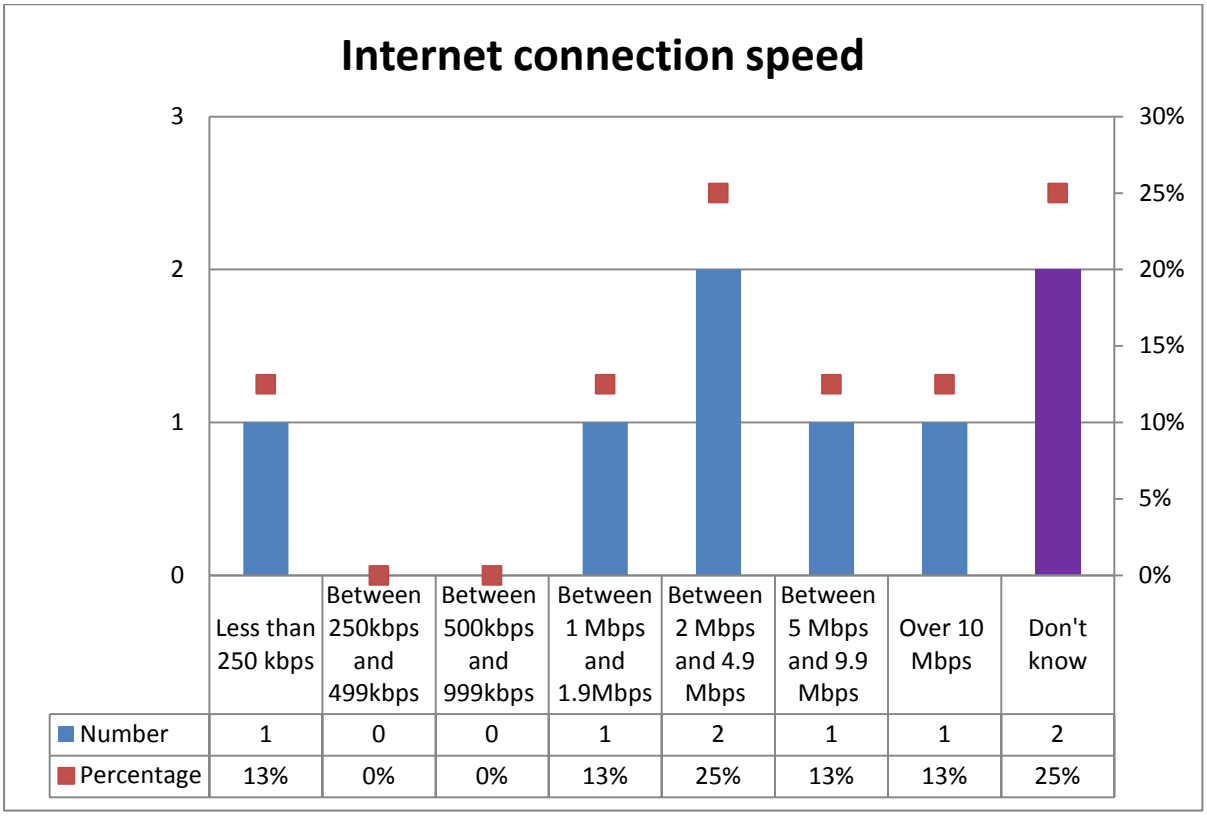


Figure 4-6: Speed of internet connection

Connection speeds (Figure 4-6) recorded for access to the internet are spread from those less than 250kbps to quite fast speeds of over 2Mbps. The percentages are calculated based on the number of responses obtained for the question. Generally, most respondents reported speeds of more than 1Mbps, with a quarter of respondents not being sure of the speed of their internet connectivity.

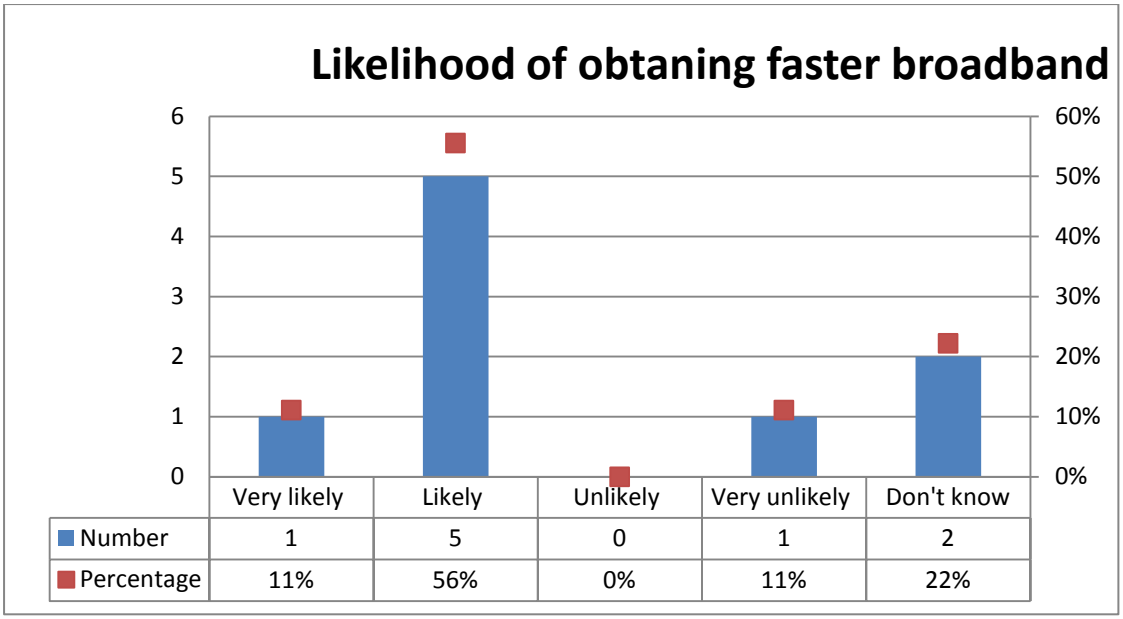


Figure 4-7: Likelihood of obtaining faster broadband in the next 18 months

Figure 4-7 indicates the desire by most respondents (67%) who have access to broadband to obtain a faster broadband connection within the next 18 months. This percentage is calculated based on the 9 respondents who indicated that they have broadband access.

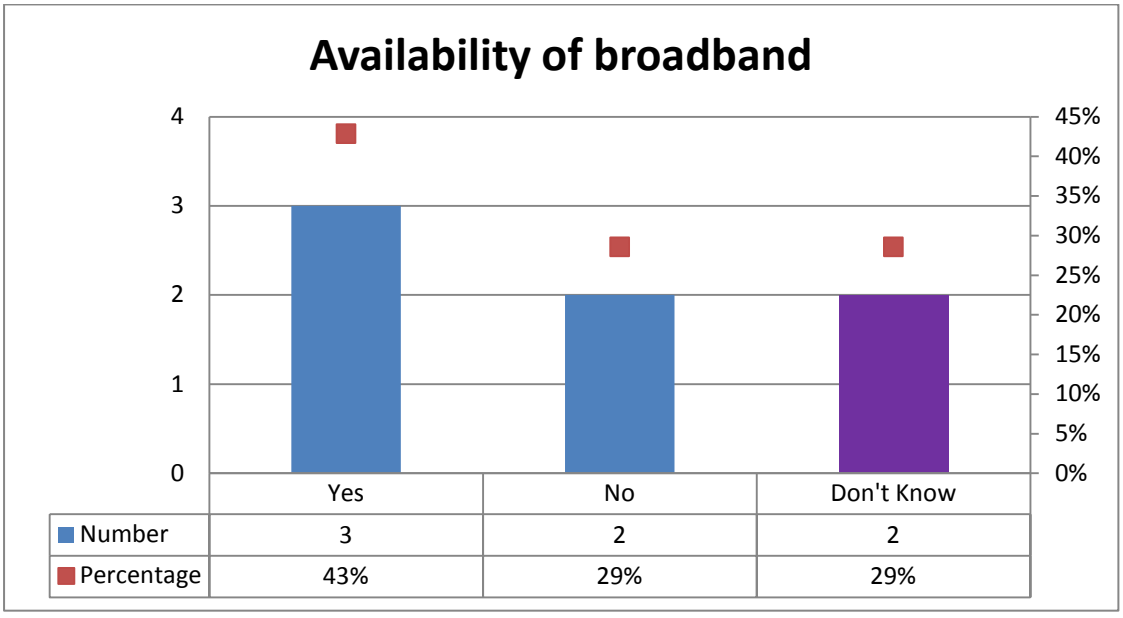


Figure 4-8: Availability of broadband

Figure 4-8 demonstrates that 43% of respondents who were not sure of the type of internet access that their organisations were utilising reported that broadband was available in most of the areas where their businesses were located.

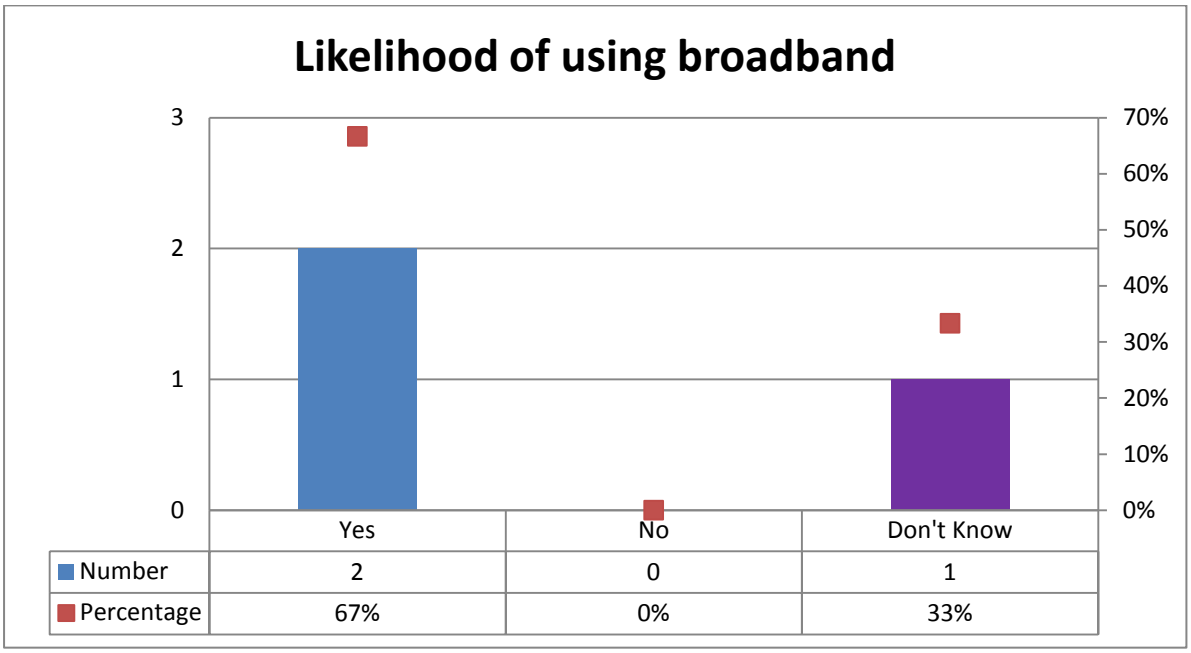


Figure 4-9: Likelihood of using broadband if it were available

67% of those without broadband, but are located in areas where broadband is available, reported that they would like to acquire broadband for their organisations as demonstrated in Figure 4-9.

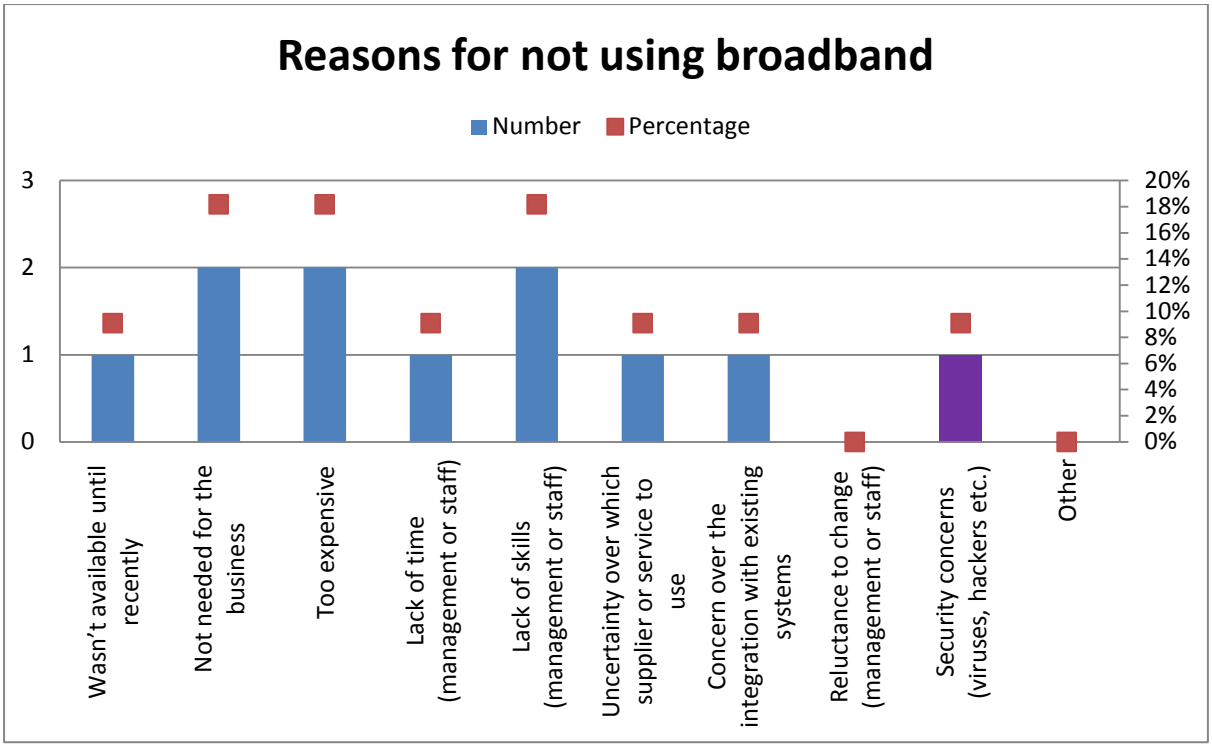


Figure 4-10: Reasons for not using broadband

Figure 4-10 provides the various reasons for not utilising broadband, with some of the main reasons provided being that it was not needed for the business(18%); it was too expensive(18%) or that there was a general lack of skills by management of staff (18%) to acquire, install and capitalise on the broadband use. The percentages are calculated based on the total number of responses obtained for the question.

Table 4-5: Company size against Type of internet connection Cross tabulation

			Type of internet connection				Total
			Dial-up modem	ISDN	Broadband	Don't know	
Company size	<10	Count	3	1	4	1	9
		% within Company size	33.3%	11.1%	44.4%	11.1%	100.0%
	10-19	Count	0	0	1	3	4
		% within Company size	.0%	.0%	25.0%	75.0%	100.0%
	40-49	Count	1	0	0	0	1
		% within Company size	100.0%	.0%	.0%	.0%	100.0%
	50-59	Count	0	0	1	0	1
		% within Company size	.0%	.0%	100.0%	.0%	100.0%
Total		Count	4	1	6	4	15
		% within Company size	26.7%	6.7%	40.0%	26.7%	100.0%

Table 4-5 shows the relationship between company size and the type of internet access. The table indicates that the majority of companies who utilise broadband have less than 10 employees.

4.3. ICT applications

There are many ICT applications as discussed earlier under the literature review. These applications are aimed at streamlining business processes and making repetitive processes easier to manage. They also can assist an organisation with keeping accurate and timely records on issues like purchases.

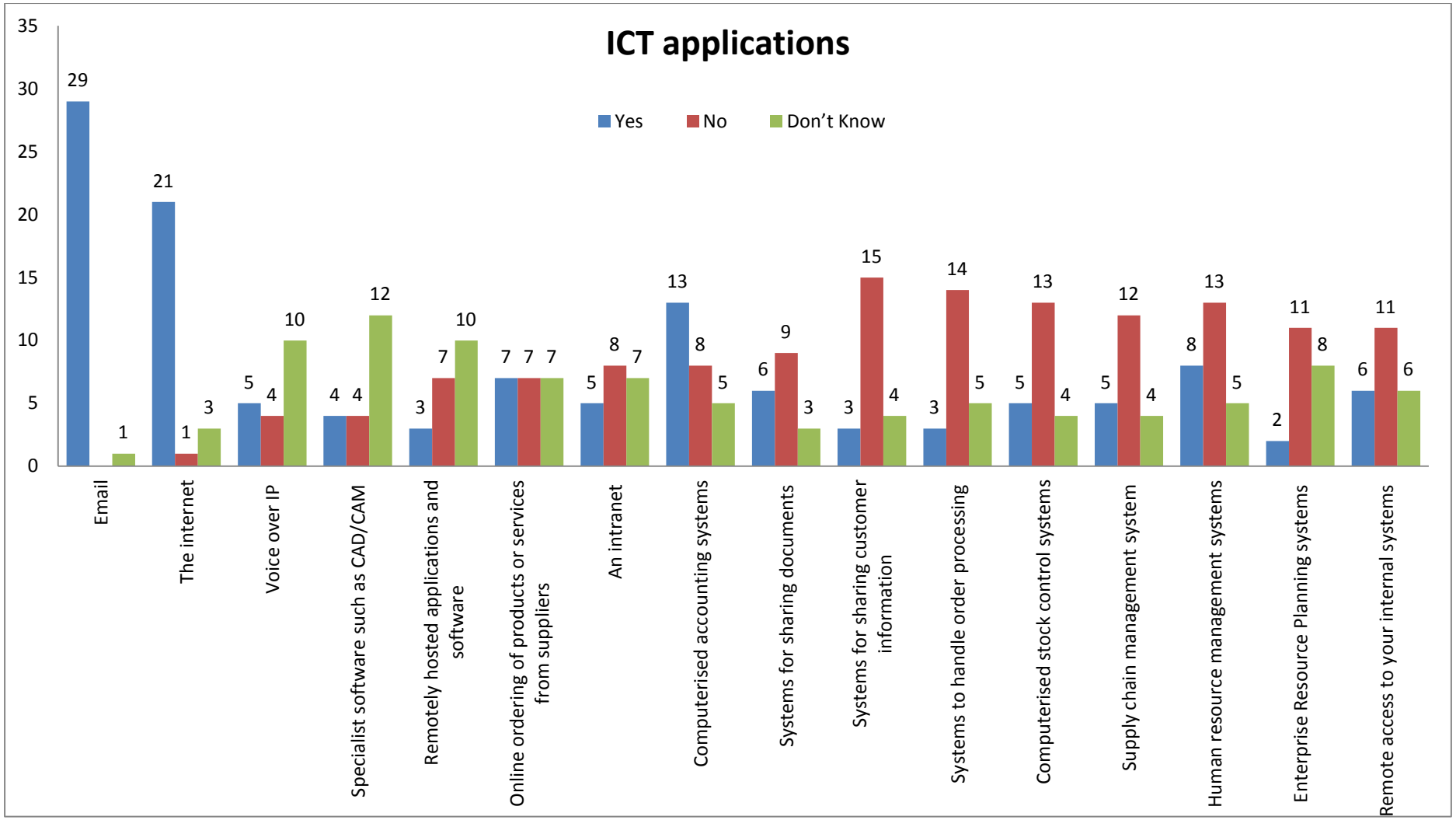


Figure 4-11: ICT applications

The results indicate that e-mail use and internet access are quite widespread as indicated by Figure 4-11. However, technologies such as VoIP, intranets, remote access and Supply Chain Management (SCM) systems prove to be quite unpopular in the construction industry among the surveyed companies.

Table 4-6: Company size against computerised accounting systems cross tabulation

			Computerised accounting systems			Total
			Yes	No	Don't know	
Company size	<10	Count	7	1	3	11
		% within Company size	63.6%	9.1%	27.3%	100.0 %
	10-19	Count	0	4	0	4
		% within Company size	.0%	100.0 %	.0%	100.0 %
	40-49	Count	1	0	0	1
		% within Company size	100.0 %	.0%	.0%	100.0 %
Total		Count	8	5	3	16
		% within Company size	50.0%	31.3%	18.8%	100.0 %

Table 4-7: Company size against Supply Chain Management systems cross tabulation

			Supply Chain Management system			Total
			Yes	No	Don't know	
Company size	<10	Count	2	7	1	10
		% within Company size	20.0%	70.0%	10.0%	100.0 %
	10-19	Count	0	4	0	4
		% within Company size	.0%	100.0 %	.0%	100.0 %
	40-49	Count	0	1	0	1
		% within Company size	.0%	100.0 %	.0%	100.0 %
Total		Count	2	12	1	15
		% within Company size	13.3%	80.0%	6.7%	100.0 %

Table 4-8: Company size against Human Resource Management systems cross tabulation

			Human Resource Management systems			Total
			Yes	No	Don't know	
Company size	<10	Count	4	5	1	10
		% within Company size	40.0%	50.0%	10.0%	100.0 %
	10-19	Count	0	3	1	4
		% within Company size	.0%	75.0%	25.0%	100.0 %
	40-49	Count	0	1	0	1
		% within Company size	.0%	100.0%	.0%	100.0 %
Total		Count	4	9	2	15
		% within Company size	26.7%	60.0%	13.3%	100.0 %

Table 4-9: Company size against Enterprise Resource Planning tools cross tabulation

			Enterprise Resource Planning tools			Total
			Yes	No	Don't know	
Company size	<10	Count	1	6	2	9
		% within Company size	11.1%	66.7%	22.2%	100.0 %
	10-19	Count	0	2	2	4
		% within Company size	.0%	50.0%	50.0%	100.0 %
	40-49	Count	0	1	0	1
		% within Company size	.0%	100.0 %	.0%	100.0 %
Total		Count	1	9	4	14
		% within Company size	7.1%	64.3%	28.6%	100.0 %

Table 4-6 to Table 4-9 above provide a breakdown of company size against ICT applications. Table 4-6 shows that computerised accounting systems are popular in companies with less than 10 employees. This is in contrast to expectations as larger companies are expected to use these systems as they would benefit more from the automation provided by these systems. Totals in these tables will differ from those in Figure 4-11 because failure by a respondent to answer both questions used in the cross tabulation results in missing data.

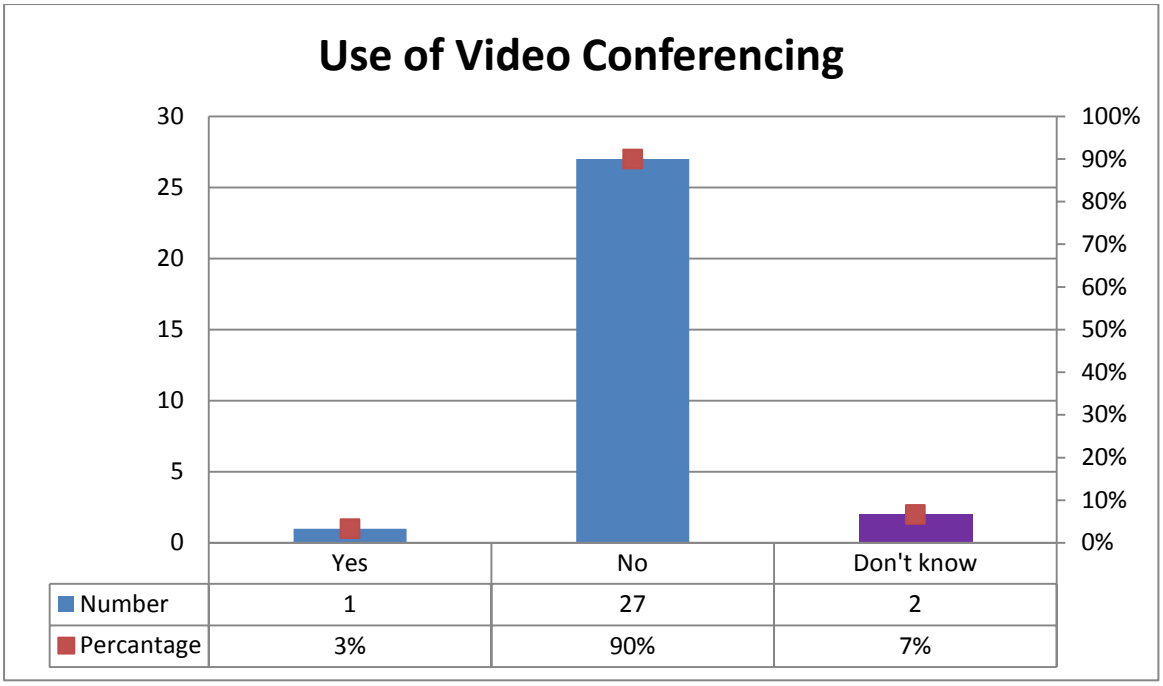


Figure 4-12: Use of Video Conferencing

Table 4-10: Company size against video conferencing cross tabulation

			Video conferencing			Total
			Yes	No	Don't know	
Company size	<10	Count	1	9	1	11
		% within Company size	9.1%	81.8 %	9.1%	100.0 %
	10-19	Count	0	6	0	6
		% within Company size	.0%	100.0 %	.0%	100.0 %
	40-49	Count	0	1	0	1
		% within Company size	.0%	100.0 %	.0%	100.0 %
	50-59	Count	0	1	0	1
		% within Company size	.0%	100.0 %	.0%	100.0 %
Total		Count	1	17	1	19
		% within Company size	5.3%	89.5 %	5.3%	100.0 %

The company above that utilises video conferencing also utilises computerised accounting systems, HRM systems and online ordering of goods.

Video conferencing is not a popular technology within the SMEs surveyed for the research as indicated by the high number of respondents who do not utilise it. This might be because start-up businesses prefer face to face meetings and the use of telephones (mobile and landline) as opposed to video conferencing.

4.4. Current use of CAD software

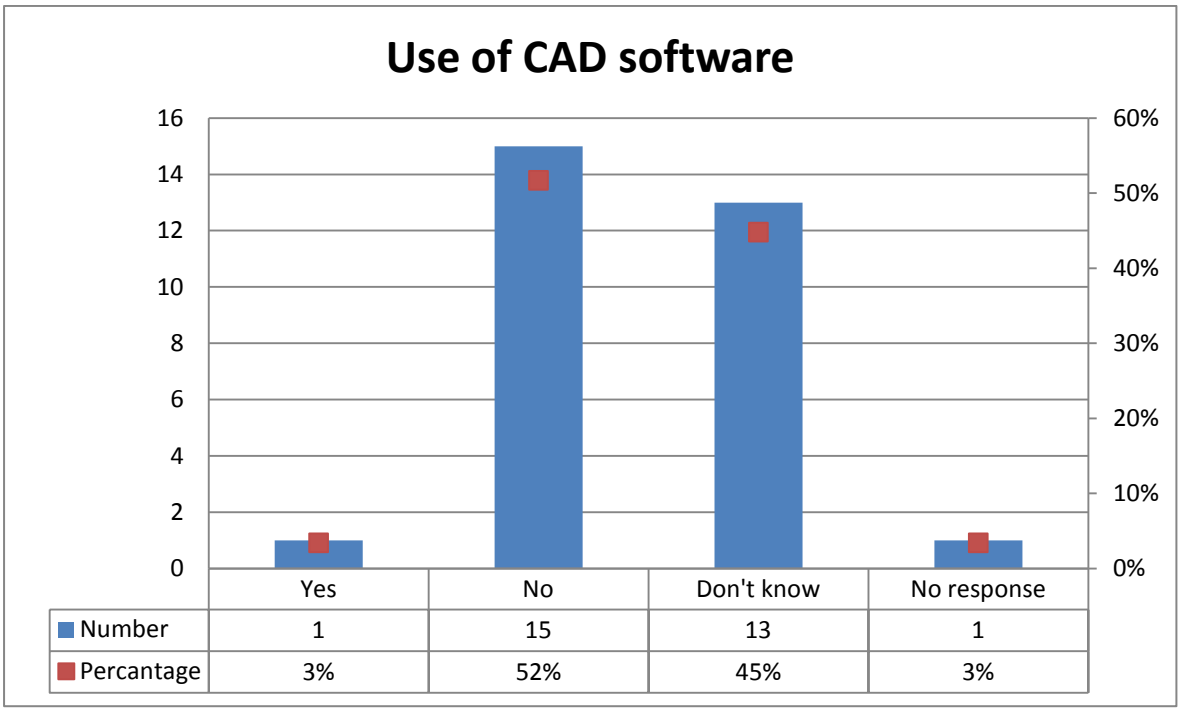


Figure 4-13: Current use of CAD software

The use of Computer Aided Design (CAD) in the construction sector proved to be quite low. Only 3% of the respondents utilised CAD in their operations with the rest either being unfamiliar with the technology or simply not utilising it at all. Figure 4-14 below shows that the majority of the respondents who answered this question were not sure as to when they might actually acquire the technology. This company's ICT profile is summarised in Table 4-11 below.

Table 4-11: Cross tabulation of CAD use against ICT applications

ICT application	Response
Specialist software	Don't know
Remote software	No response
Online ordering	Yes
Computerised accounting systems	Don't know
Supply chain management system	No
Human resource management systems	No
Enterprise resource planning tools	Don't know
Email	Yes
Internet	No response
VoIP	No response
Intranet	Yes
Systems to handle order processing	Yes
Systems for sharing documents	Yes
Type of internet connection	No response
Systems for sharing customer information	Yes

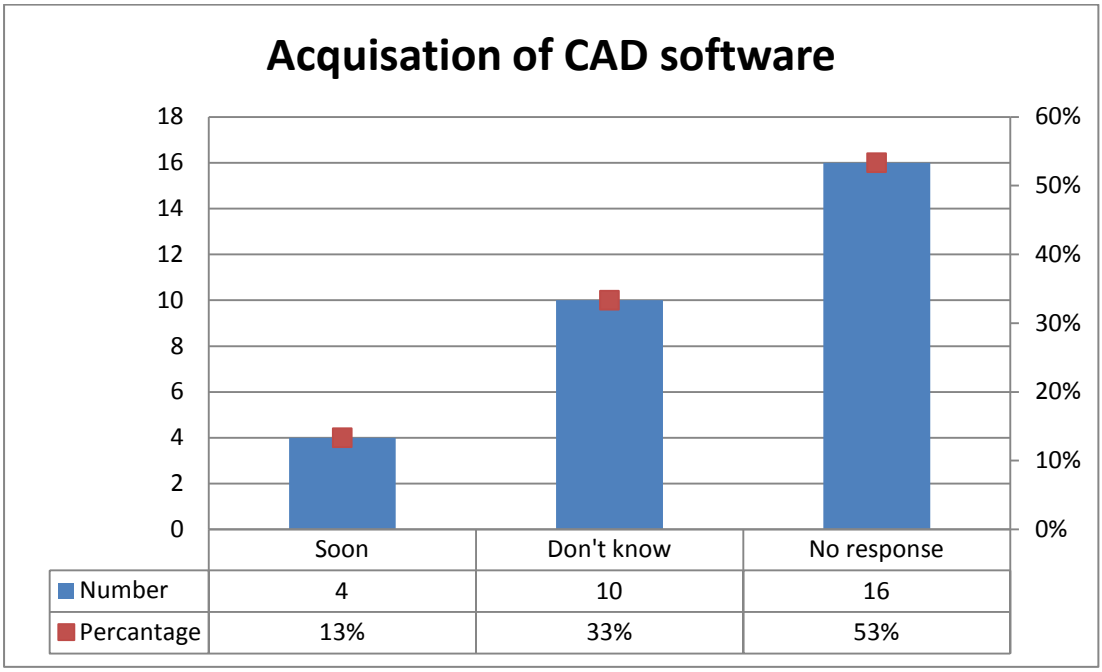


Figure 4-14: Likelihood of acquiring CAD software

4.5. Virtual Reality

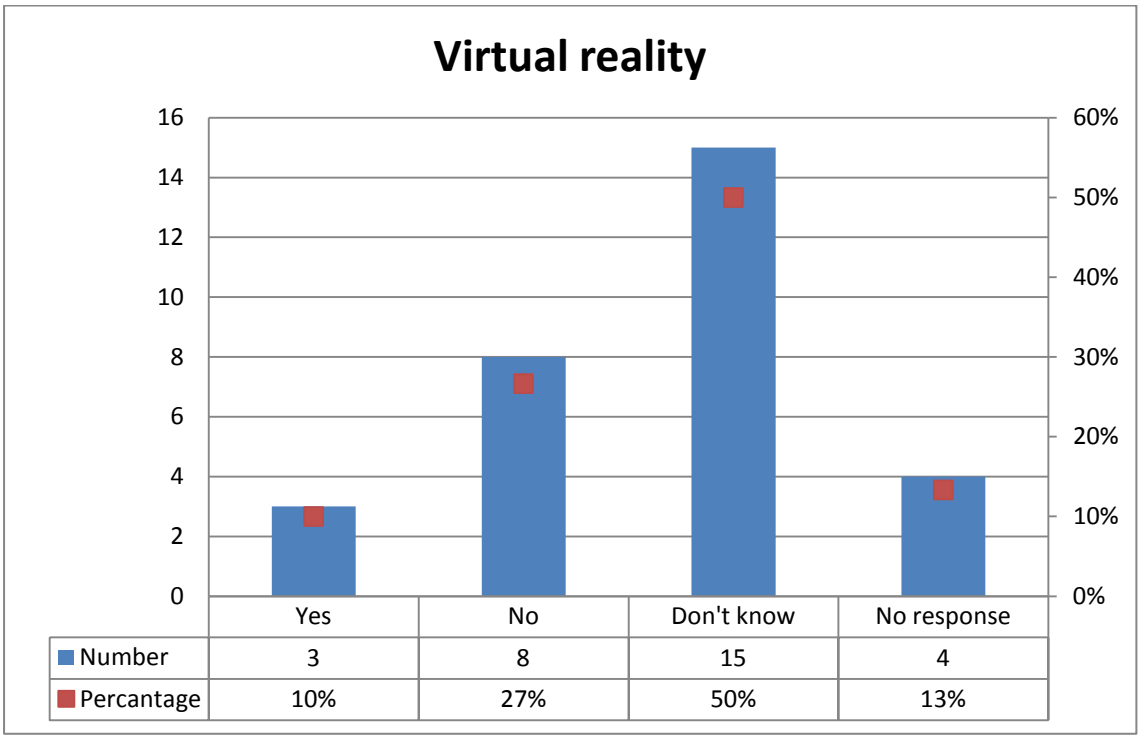


Figure 4-15: Use of Virtual Reality

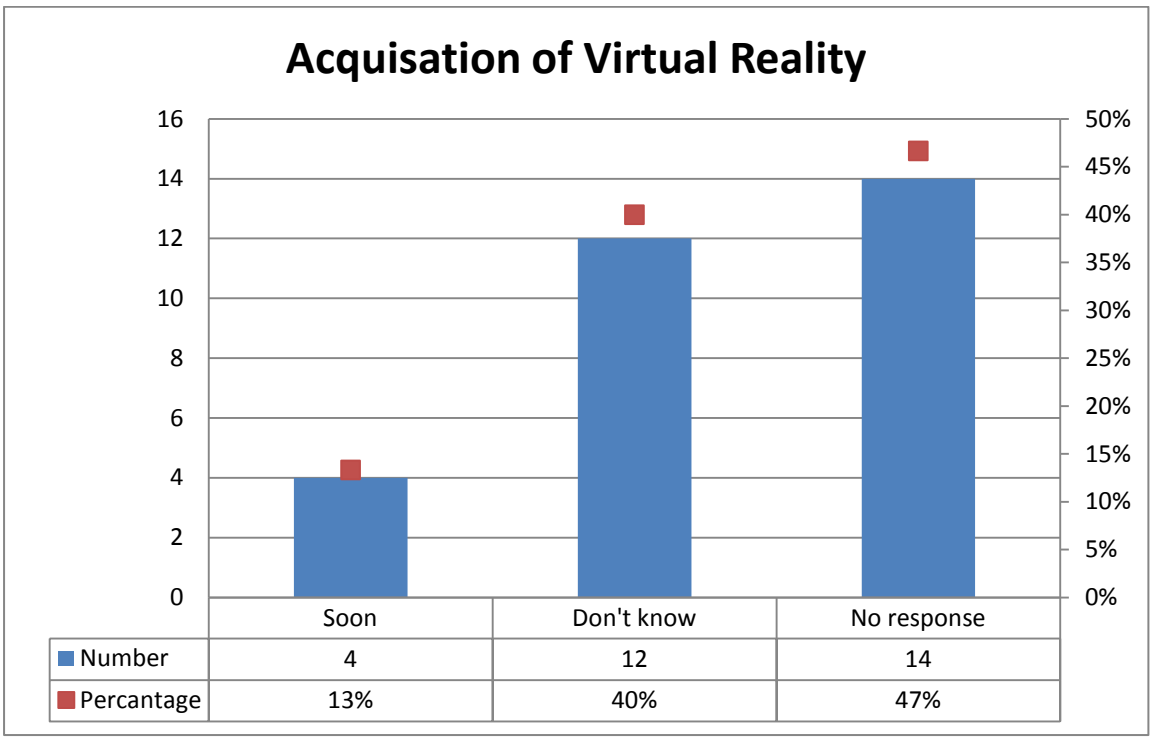


Figure 4-16: Acquisition of VR

The results obtained for Virtual Reality (VR) as indicated in Figure 4-15 were quite surprising. It was not expected that the SMEs surveyed would be familiar with this technology as it is quite advanced. However, closer scrutiny indicated that some respondents, who are familiar with technologies such as Google earth, mistakenly reported its use under this section. The reason for this is that since Google earth allows a virtual tour of particular locations, the respondents believed it to part of VR. However, its use differs from that discussed for VR under the literature review. 40% of the respondents indicated that they were uncertain as to whether they would like to acquire the technology (Figure 4-16). This is to be expected as VR technology is still in its infancy and its use in developing countries has not yet been demonstrated.

4.6. E-commerce

E-commerce provides many benefits to organisations including the reduced demand for travel and greater market access as discussed under the literature review (Chien and Barthorpe, 2010).

Figure 4-17 shows that 33% of respondents indicated that their companies owned a website, with the majority (57%) not owning one. A small percentage of the respondents were not sure. Of those who owned a website, the majority do not allow any orders to be placed online and they also do not place their orders online.

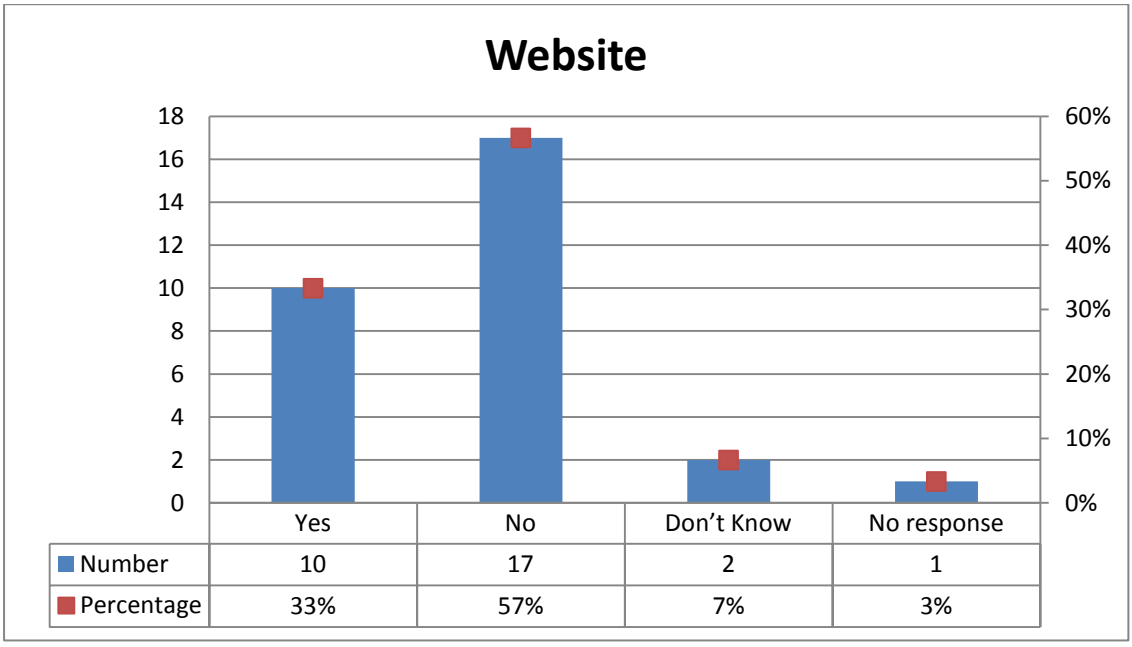


Figure 4-17: Existence of a company website

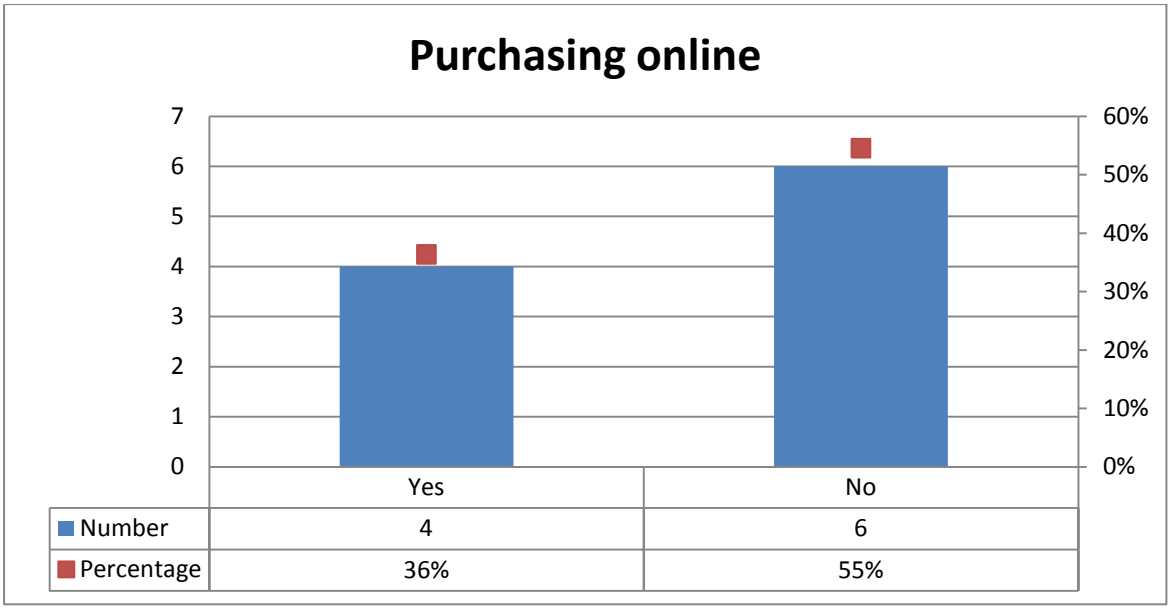


Figure 4-18: Ability of company's website to allow ecommerce

Figure 4-18 shows that websites are generally not regularly updated with the majority of respondents (90%) who own one, indicating that they update their website less than once a year. 80% of those who own websites (Figure 4-20) do not monitor traffic to their websites, which might mean that they do not measure its effectiveness as a way of advertising the services they offer.

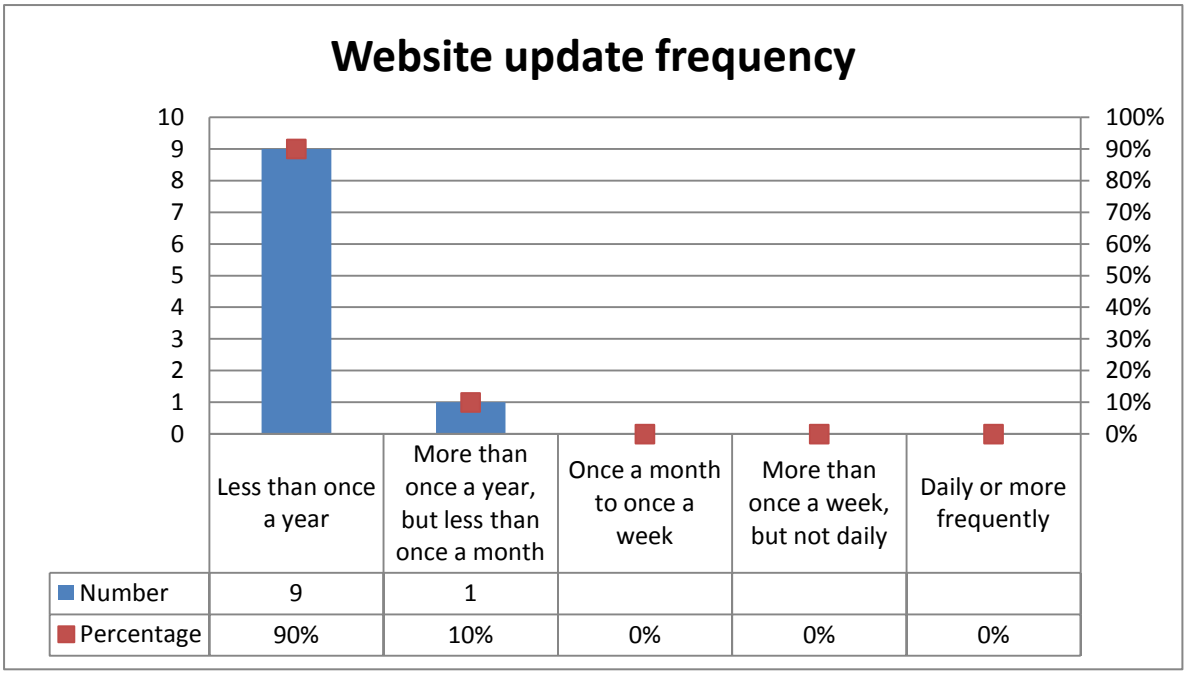


Figure 4-19: Frequency of updating the company's website

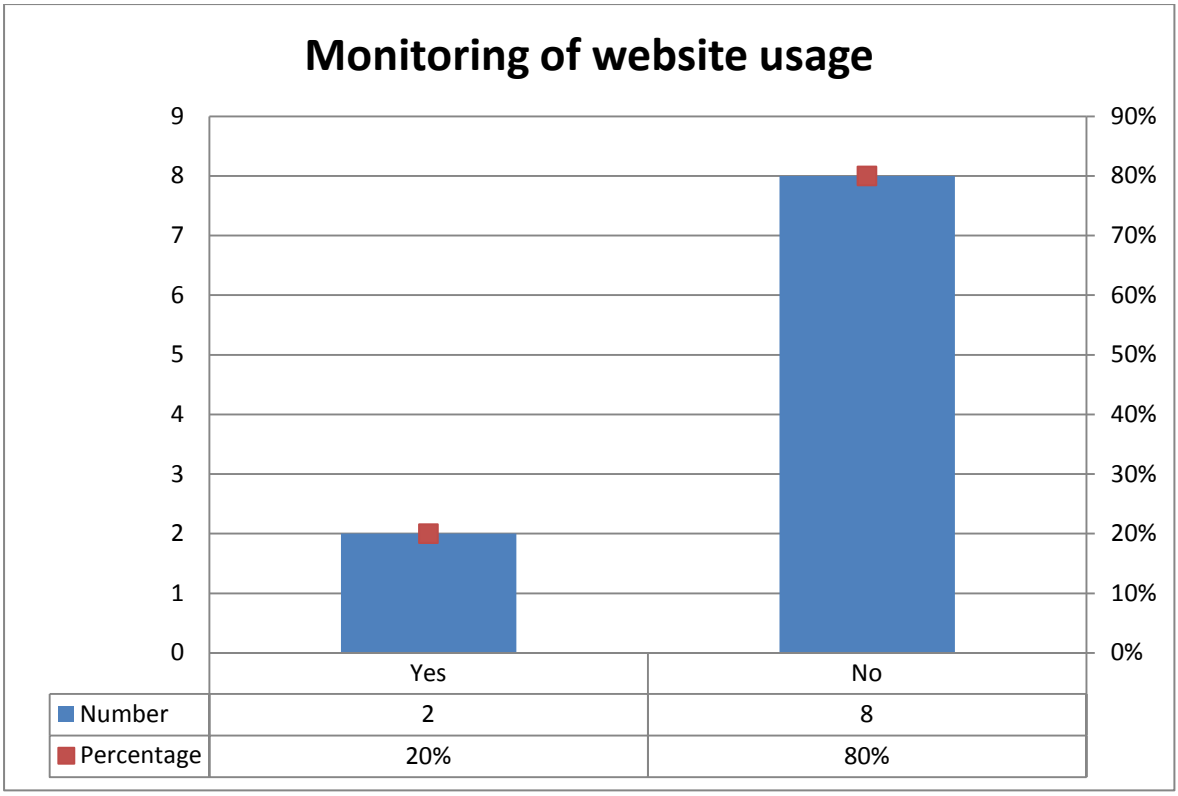


Figure 4-20: Ability of company to monitor website traffic

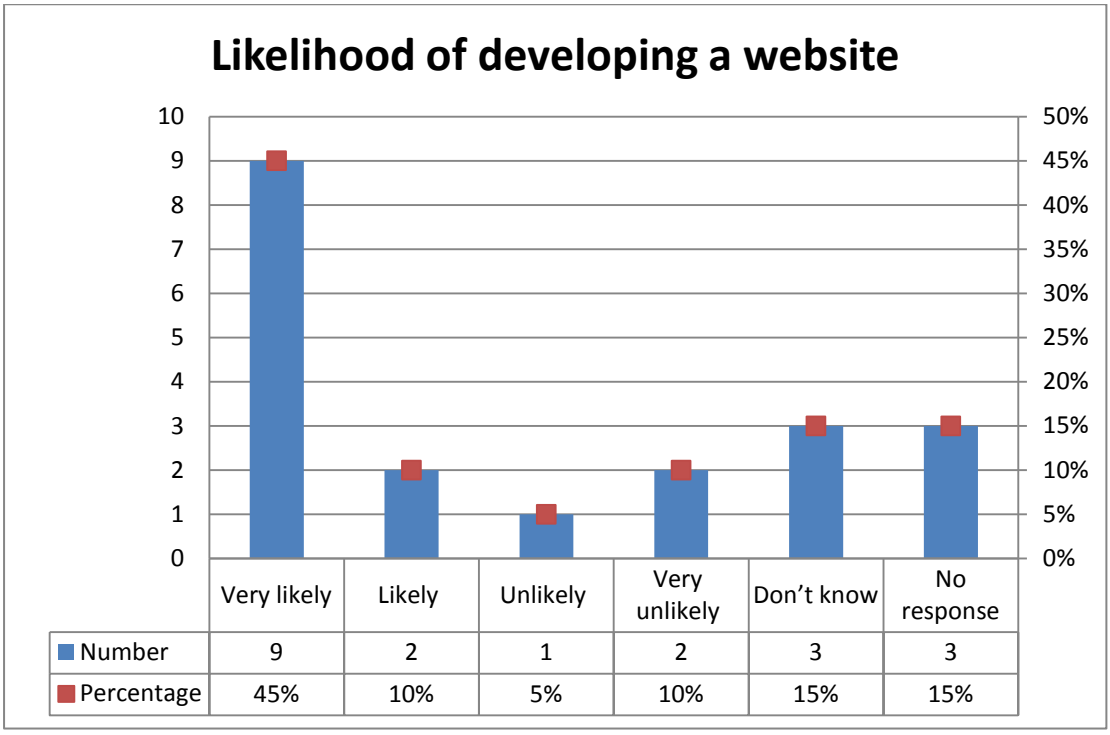


Figure 4-21: Likelihood of the company developing a website

45% of respondents whose organisations do not own a website indicated that they were likely to develop a website in the near future as shown in Figure 4-21. The percentage is calculated based on the 20 companies who do not own a website.

Figure 4-22 shows that lack of skills (10%) and security concerns regarding viruses, hackers etc (10%) were the main reasons as to why organisations without websites had not developed a website. The cost of developing and maintaining the website was not cited as a factor as to why these organisations might not develop a website.

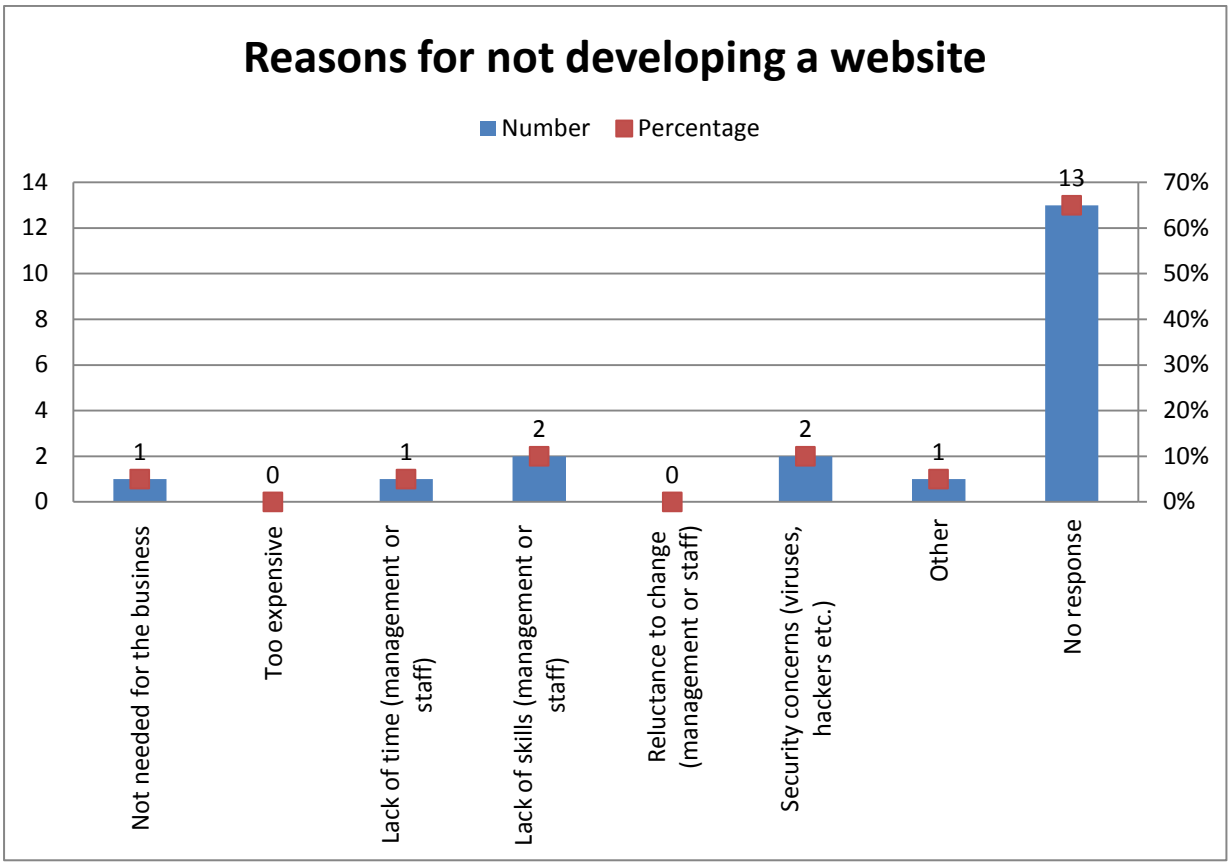


Figure 4-22: Reasons for not developing a website

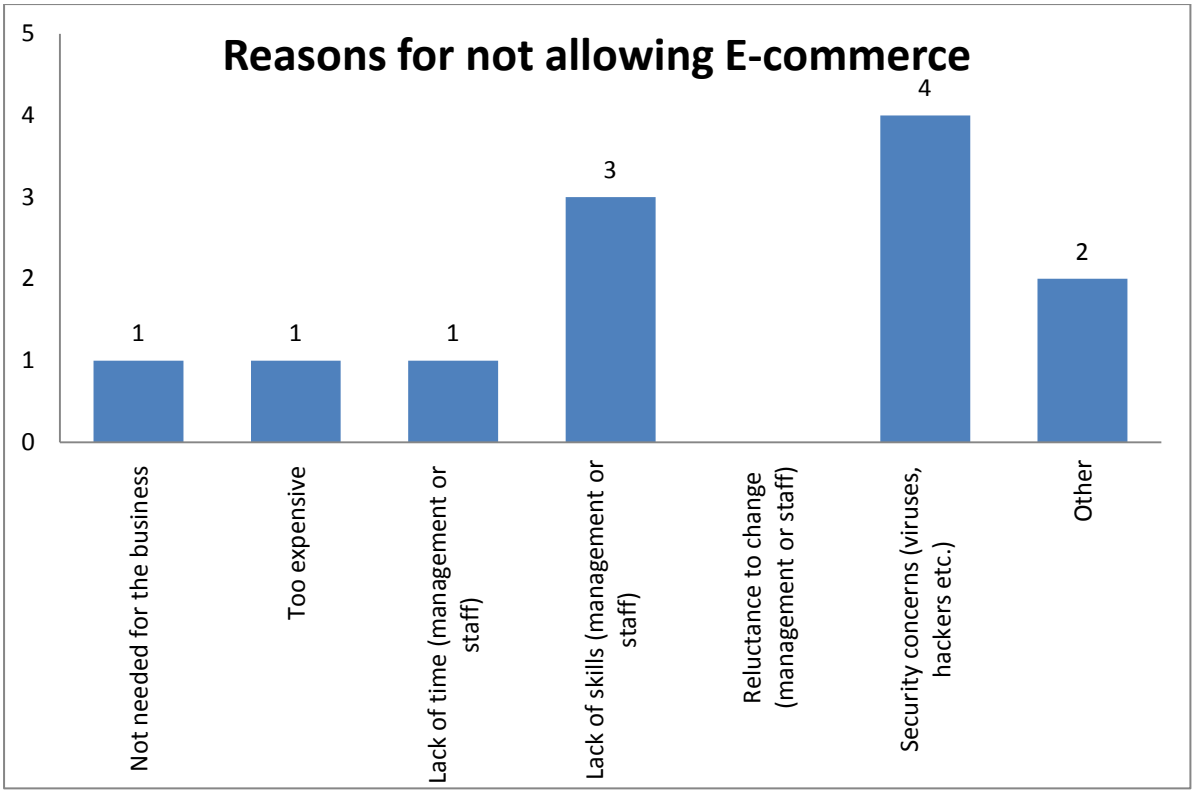


Figure 4-23: Reasons for not allowing orders of purchases on the website

Security concerns and the lack of skills proved to be inhibiting factors to the use of websites for E-commerce. Respondents cited these two factors as the main reasons for them not allowing electronic transactions on their websites. Factors such as the expense of running the website, the lack of time and the website not being needed for business were also highlighted in the research.

4.7. The appropriate level of ICT investment

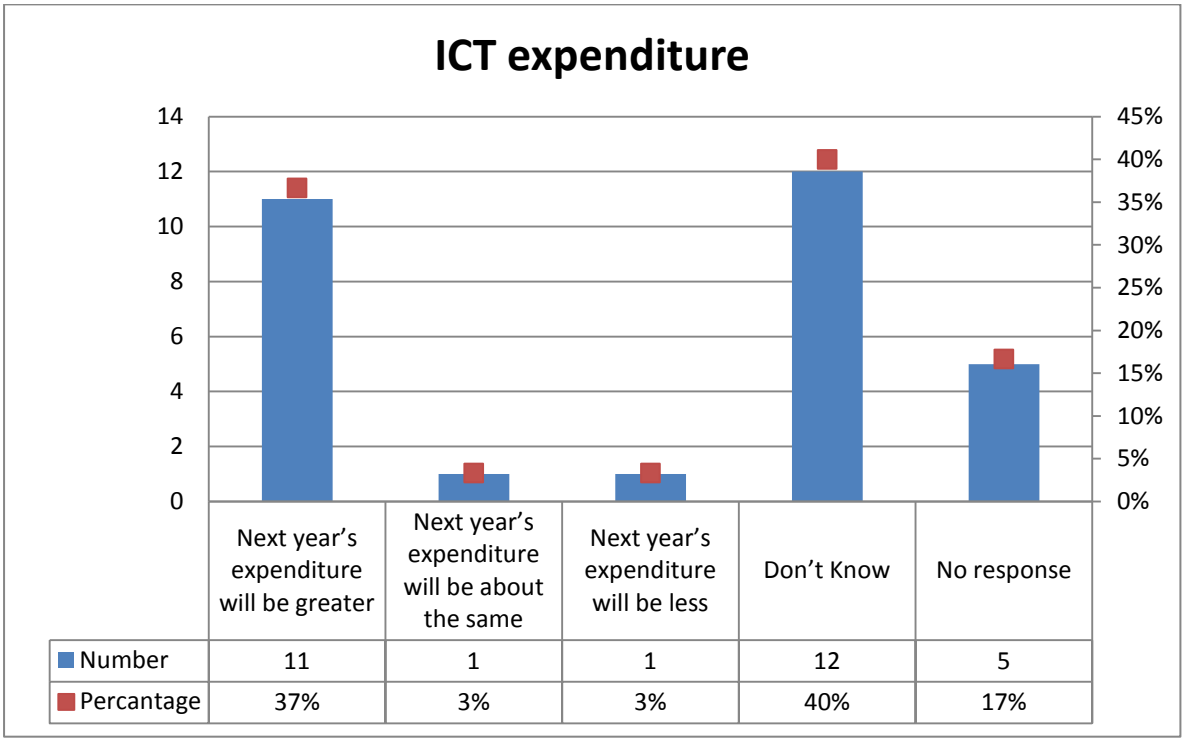


Figure 4-24: Next year's expenditure on ICT

Figure 4-24 above indicates the respondents' expectations in terms of 2013 expenditure on ICT. 37% of the respondents indicated that next year's expenditure will be greater while 40% of the respondents were not sure. There is an even split between those who think it will be the same and those who suppose that it will be less.

On average, the respondents' investment in ICT averaged around 3.27% of the organisation's annual turnover. This value is much higher than that reported in empirical research. Underwood and Khosrowshahi (2012) reported a level of 0.74-0.76% amongst the UK companies they investigated, and Chien and Barthorpe (2010) reported a level of 0.1% amongst the Taiwanese construction companies they investigated. The level of ICT investment is further discussed in Chapter 5.

4.8. Barriers to investment in ICT

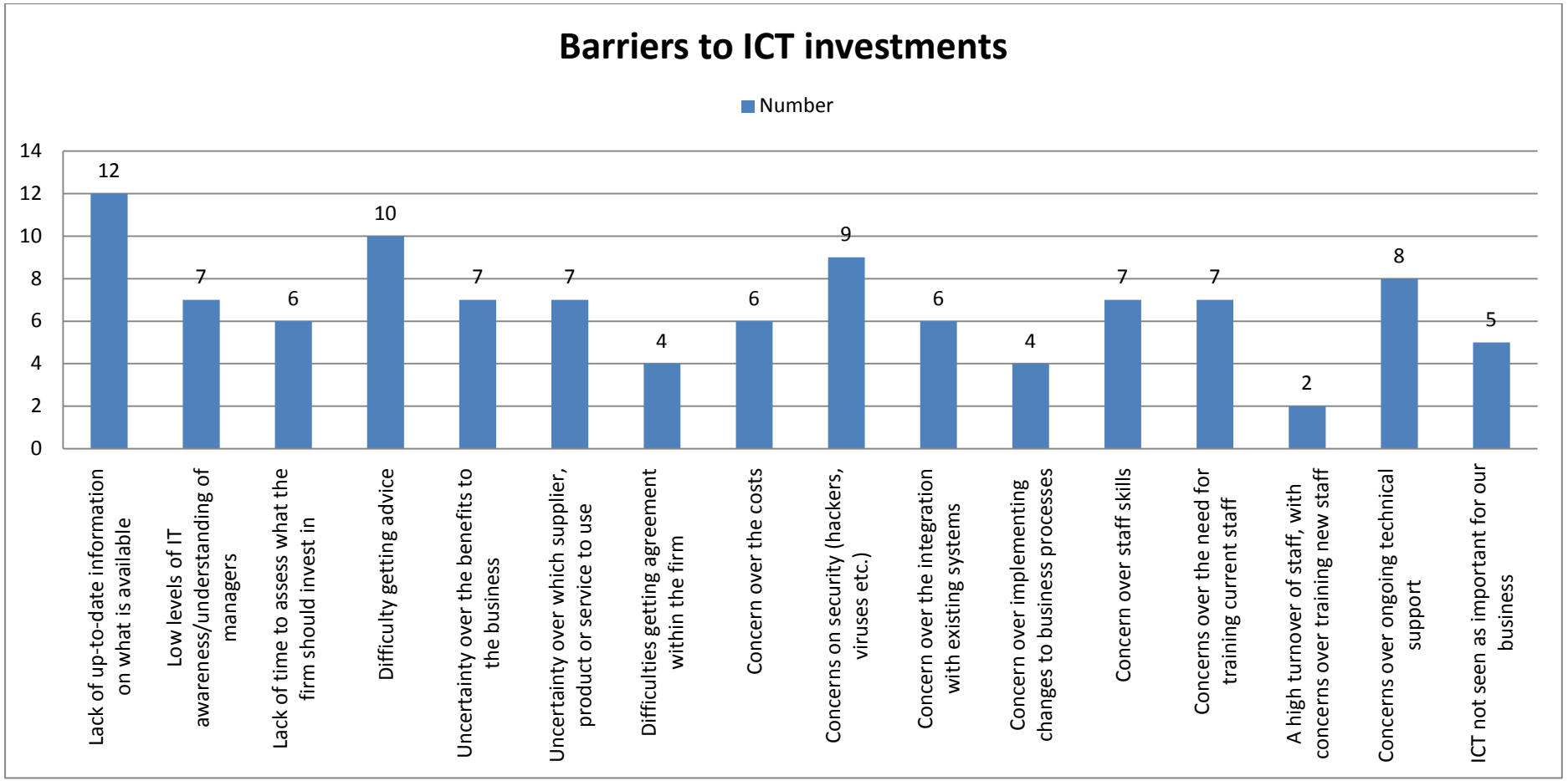


Figure 4-25: Factors that deter investments in ICT

The clustered column chart above shows an almost balanced distribution of the factors that deter surveyed organisations from investing in ICT. The two most prominent reasons given were the lack of up-to-date information on available ICT solutions and difficulty in getting advice. Further patterns in the data are explored in Chapter 5.

4.9. Benefits of ICT

Generally, on average, respondents had a positive view of the contribution of ICT to their respective business processes. Figure 4-26 generally indicates that individual companies view ICT as being beneficial to their business. Most respondents felt that ICT was helping them access new sales opportunities helping them improve interactions with customers/partners and it was helping them keep better track of their finances

It is interesting to note that overall, ICT importance was rated from 5 upwards (Figure 4-26) which shows appreciation for its contribution to individual organisations.

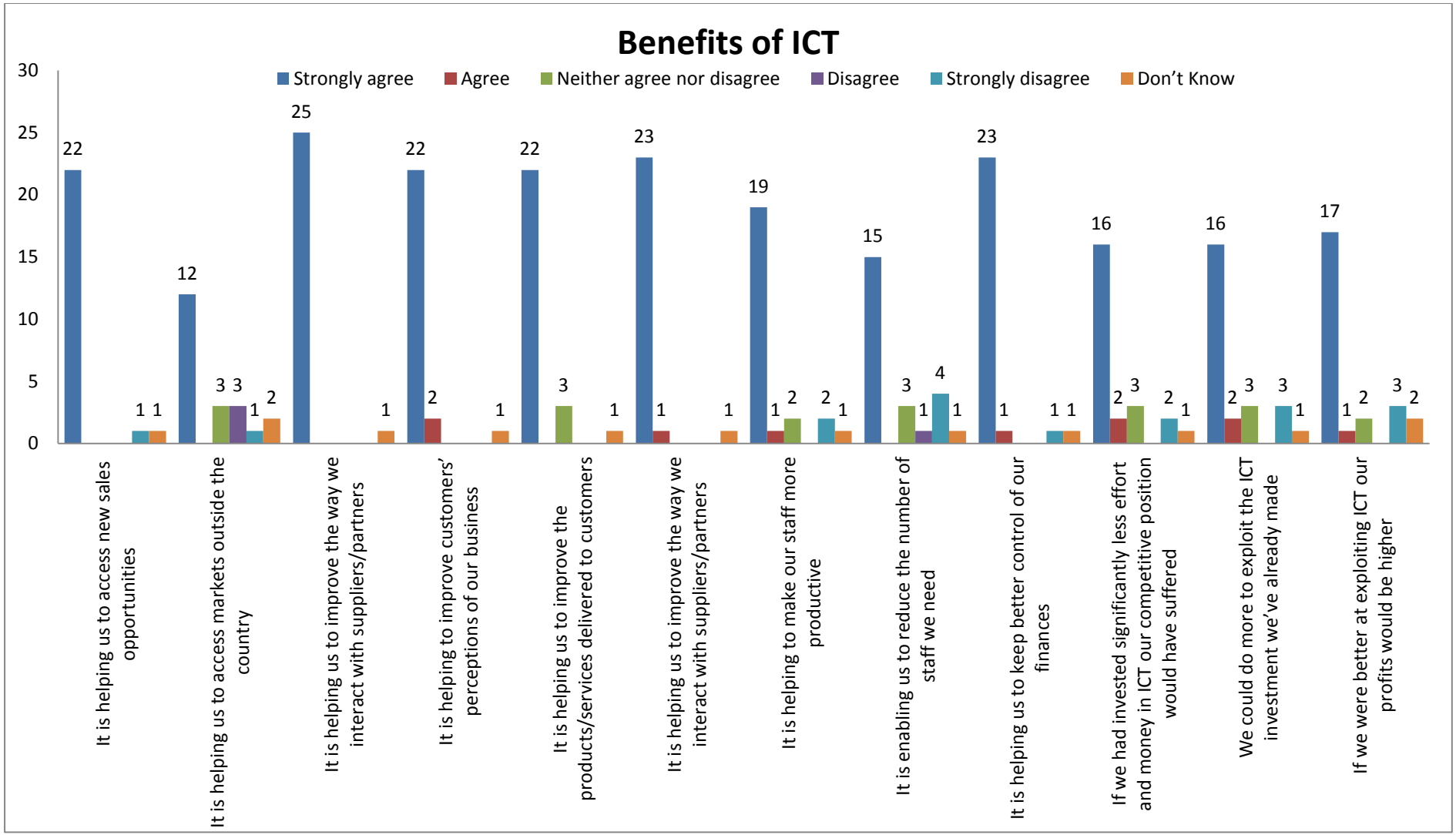


Figure 4-26: ICT benefits to the company

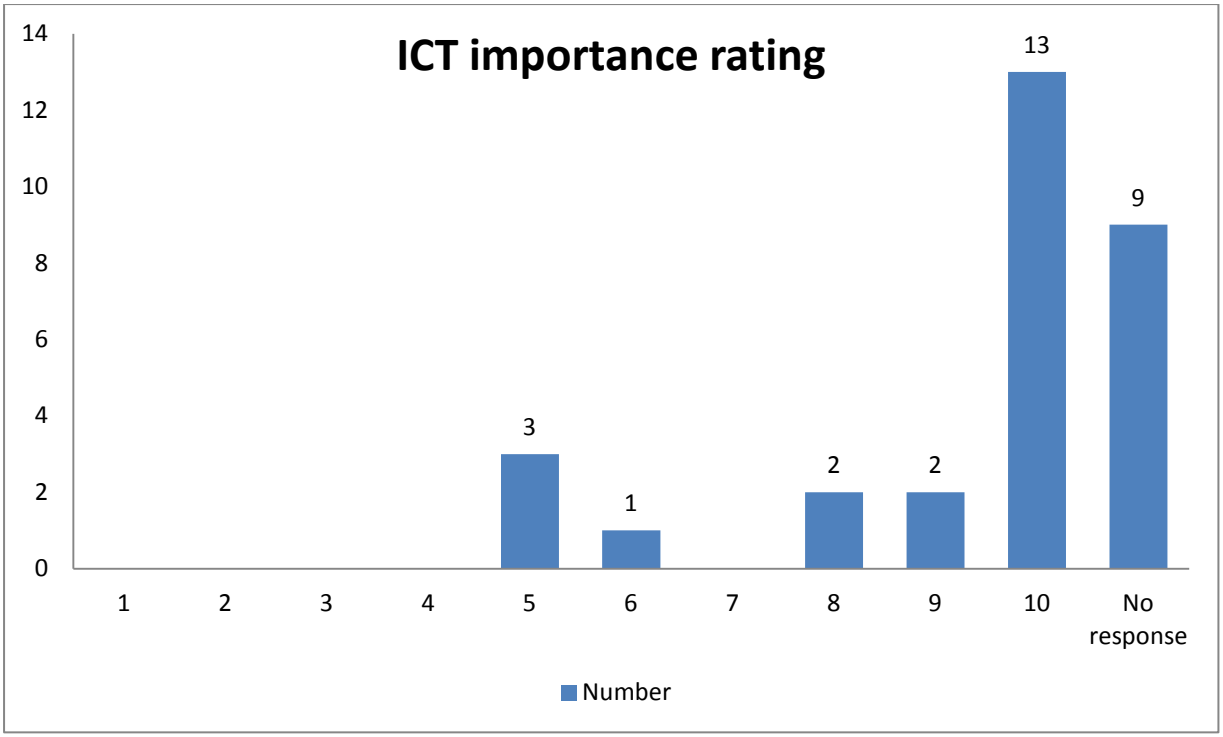


Figure 4-27: Overall rating of ICT's importance to the company's business

4.10. Factors that influence ICT decisions

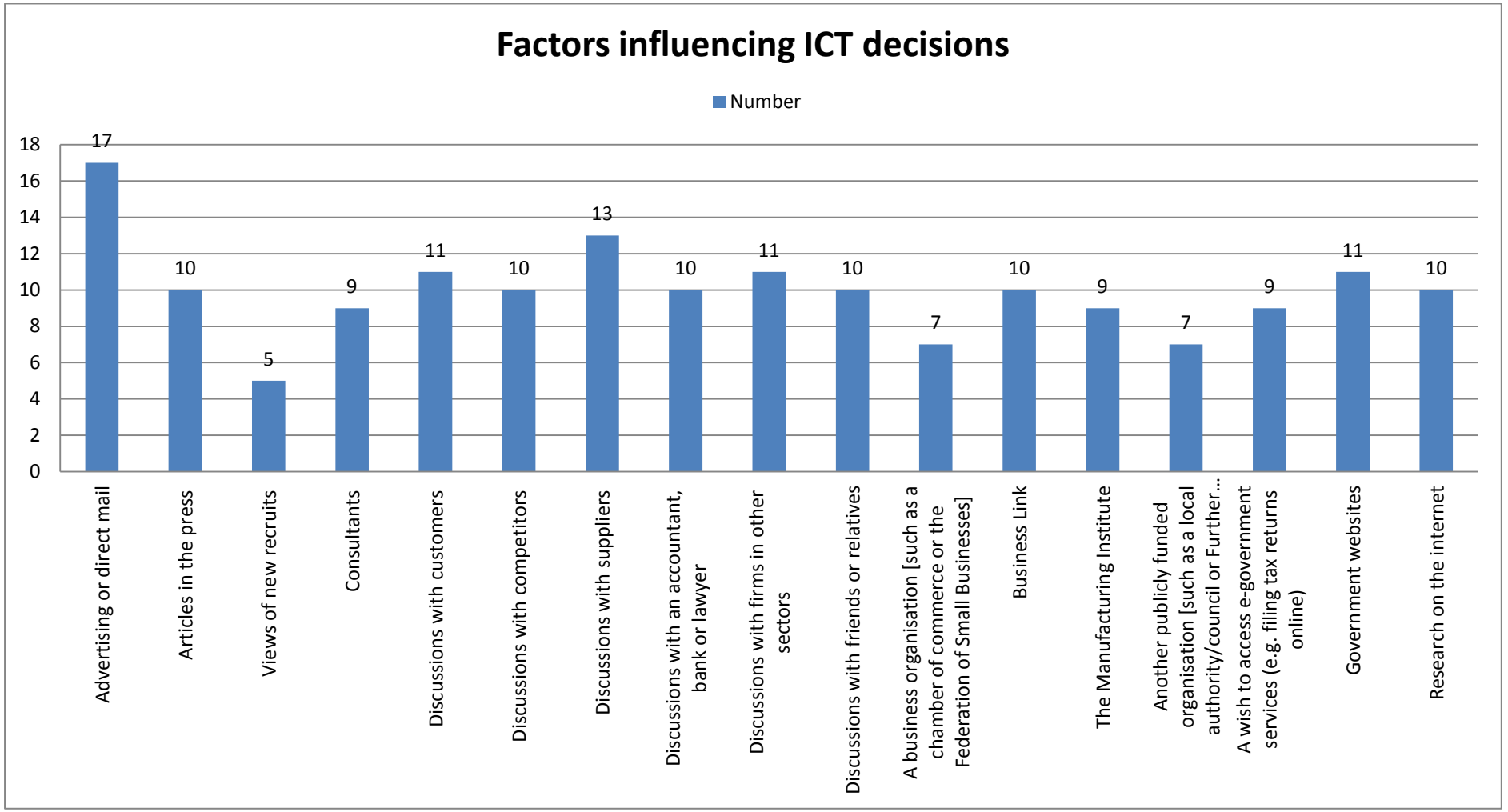


Figure 4-28: Factors that influence decisions on ICT investments

While there are a variety of factors that may influence decisions regarding investment in ICT, the research generally shows that the issue of access to available information regarding ICT solutions is critical to such an investment. Figure 4-28 shows that advertising and direct mail have the largest influence on SMEs choice of investment in ICT. This can be directly linked to the section on barriers to investment in ICT where the lack of information on available solutions was identified as one of the main barriers to ICT investment. Therefore, it can be concluded that marketing of available forms of ICT will play a crucial role in the choices that an enterprise will eventually adopt.

Furthermore a situation whereby SMEs access ICT information from advertisers is not ideal. Support programmes by government, the private sector and training institutions should focus on addressing this aspect with a view of realigning information provision to businesses. This issue is discussed further in Chapter 5.

4.11. ICT strategy

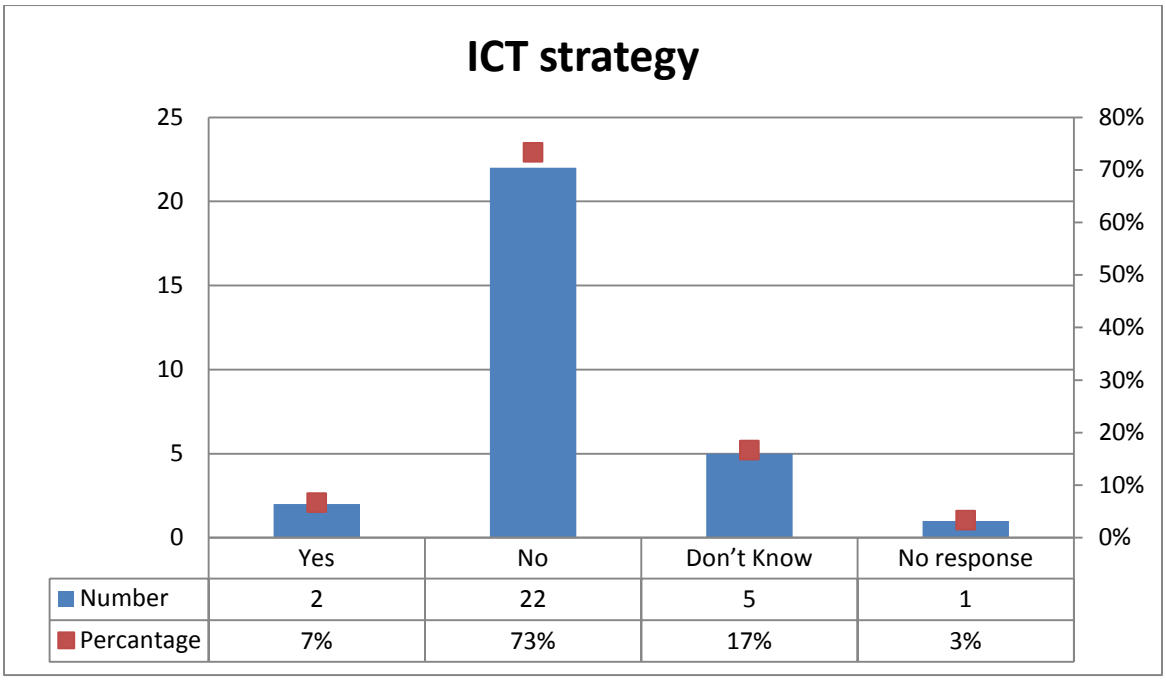


Figure 4-29: Documented ICT strategy for the firm

ICT strategies are important in giving direction to an organisation as to when new hardware or software must be acquired and how much must be spent on ICT. The

majority of respondents (73%) indicated that their respective organisations did not have a documented ICT strategy. This brings into question how ICT related expenditure is handled and prioritised in these organisations. This issue is handled further in the discussion chapter.

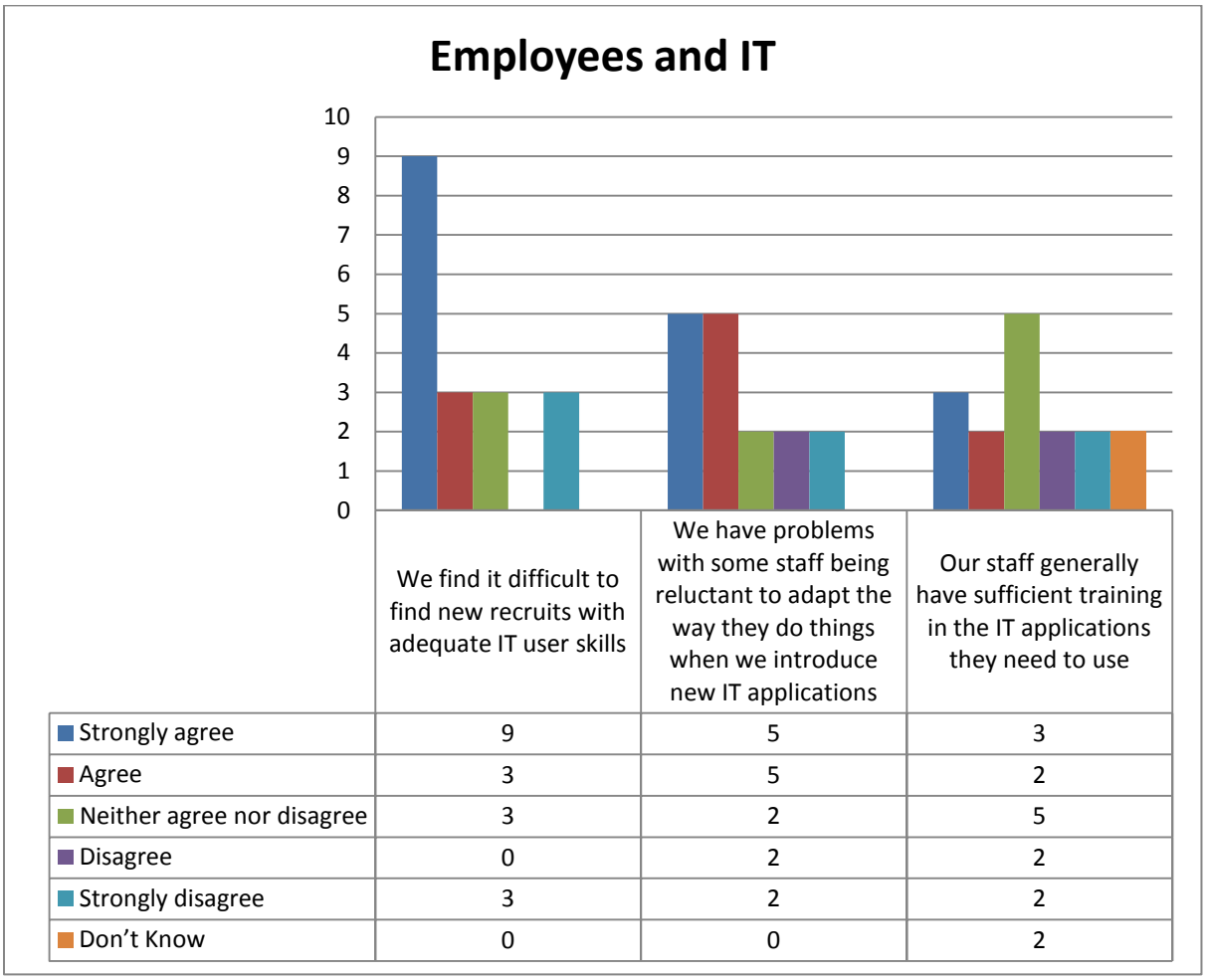
4.12. ICT and ICT support

4.12.1. Familiarity with Government initiatives on ICT

The South African government has several initiatives targeted at enhancing SME access to ICT related solutions for their businesses such as initiatives by SEDA, which are targeted at helping SMEs with ICT related problems. These initiatives were discussed in Chapter 2.

The results indicate that the majority of the 30 respondents (63%) are not aware of government initiatives that aim to familiarise SMEs with ICT tools available in the market. This is despite organisations such as the DTI and SEDA spending significant amounts of their budgets annually in trying to provide training and ICT support for SMEs.

4.12.2. Employees' IT skills



	We find it difficult to find new recruits with adequate IT user skills	We have problems with some staff being reluctant to adapt the way they do things when we introduce new IT applications	Our staff generally have sufficient training in the IT applications they need to use
Strongly agree	9	5	3
Agree	3	5	2
Neither agree nor disagree	3	2	5
Disagree	0	2	2
Strongly disagree	3	2	2
Don't Know	0	0	2

Figure 4-30: Employee use of IT

Generally construction companies surveyed find it difficult to employ new recruits with adequate IT skills. They have difficulties with staff being reluctant to adapt to new IT applications and feel that their staff has inadequate IT training. These responses must be read in conjunction with the section on government initiatives as, while these organisations have challenges with IT skills, they are still unable to access government led training initiatives that might benefit their businesses.

4.12.3. Provision of IT support

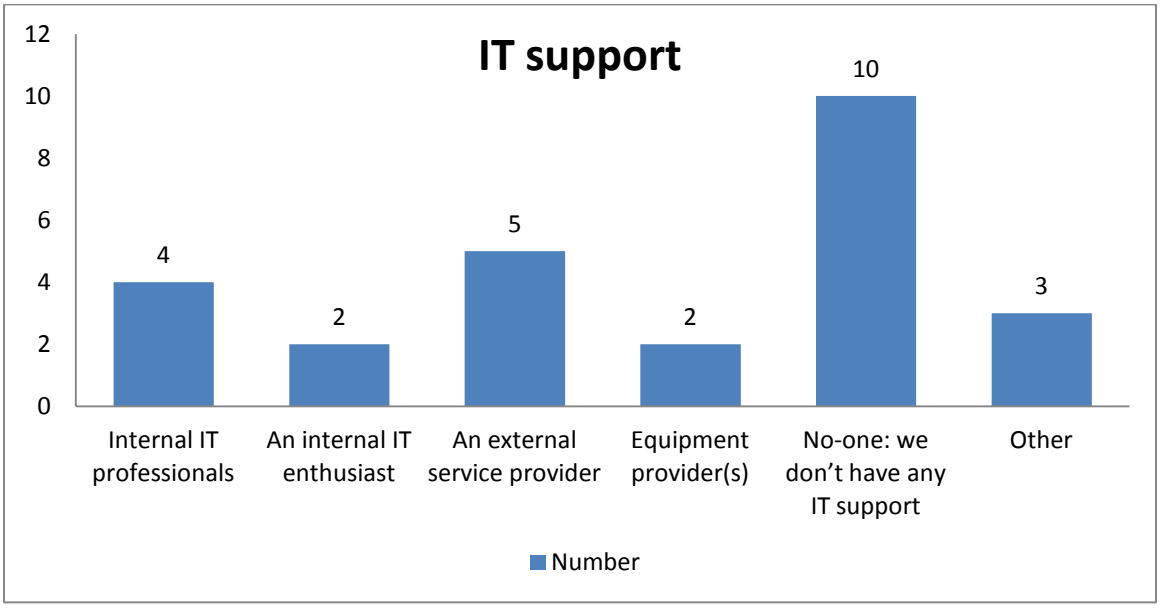


Figure 4-31: Provision of IT support

Of the respondents who answered this question, the majority (Figure 4-31) indicate that they do not have any IT support. However, of those who have IT support, they mainly utilise the services of an external IT service provider and internal IT professionals.

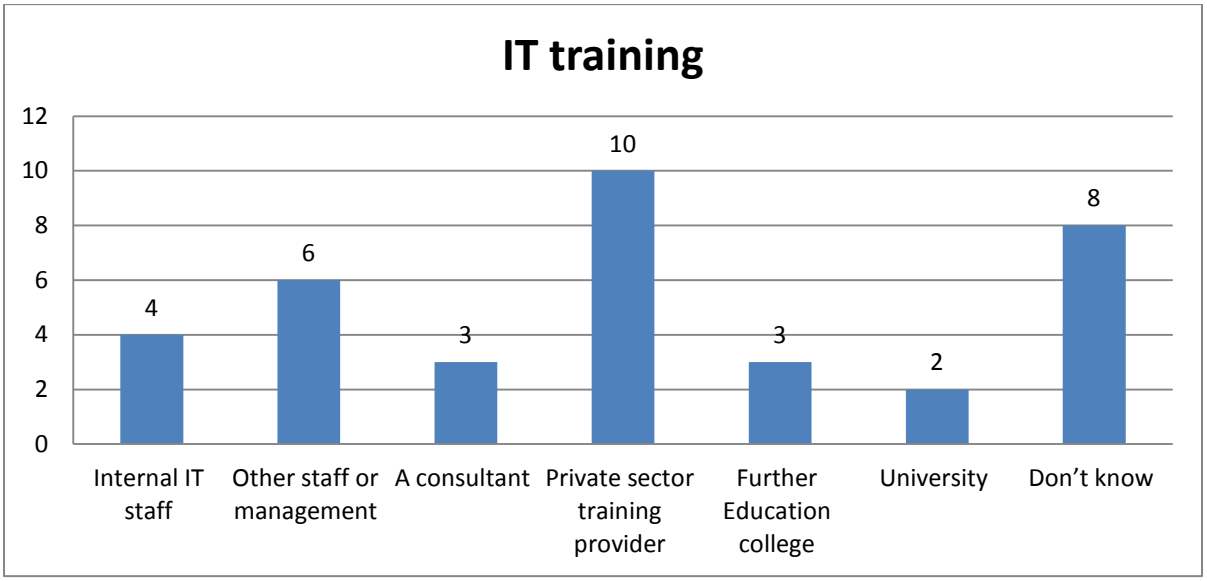


Figure 4-32: Providers of ICT training for the company

There is a spread of approaches reported on accessing IT training. The most popular approach among the respondents is to utilise a private sector training provider. A small proportion of the respondents utilise a university, while the rest are divided between internal IT staff, consultants, further education colleges and other staff or management. 8 of the respondents were not sure as to the type of service provider that their organisation utilises for IT training.

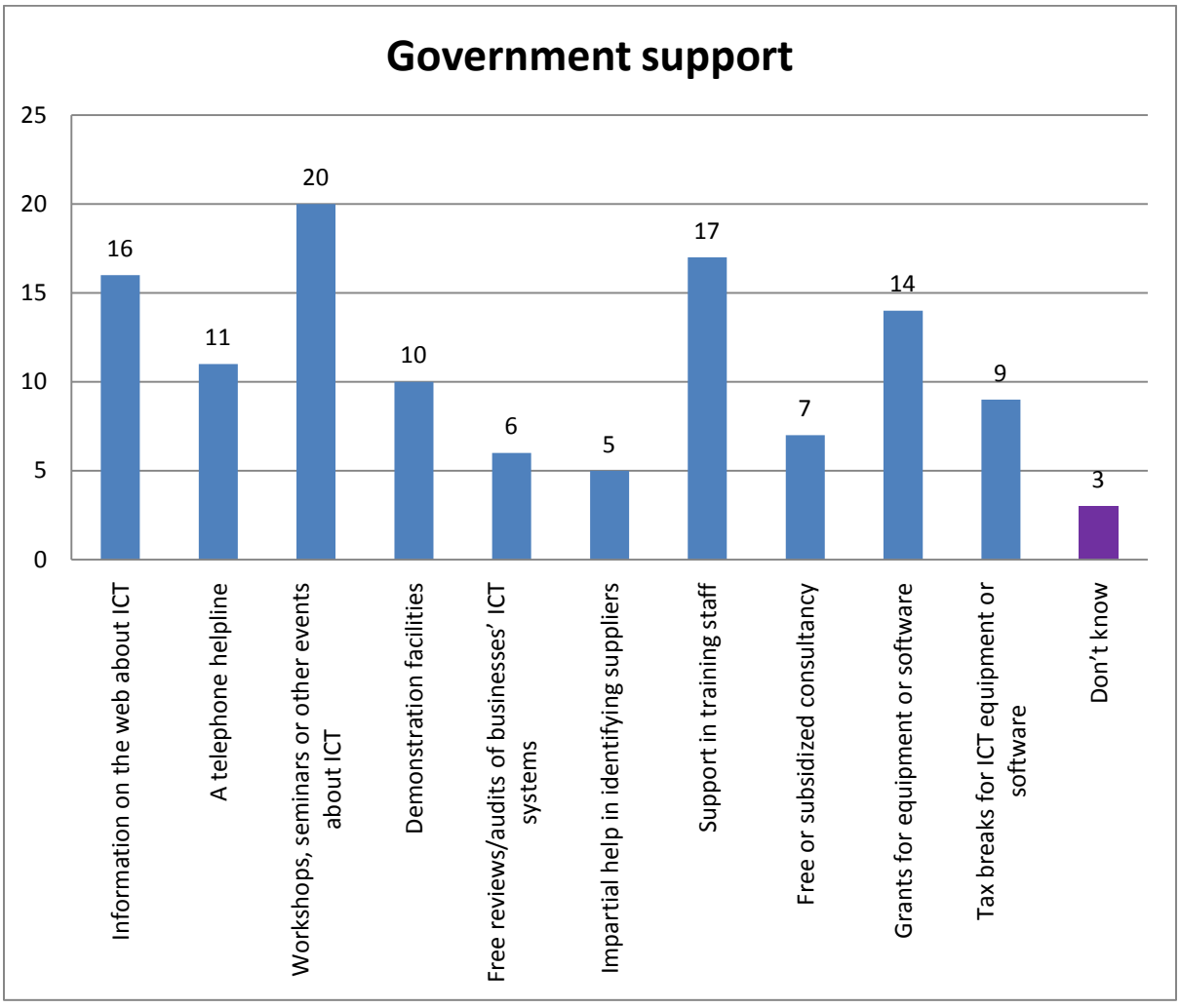


Figure 4-33: Support desired from government agencies

There was a spread as to the type of government interventions that the respondents would have liked for their organisations as summarised in Figure 4-33. The four most prominent interventions were: information on the web about ICT (16); workshops,

seminars or other events about ICT (20); support in training staff (17); and grants for equipment or software (14). The issue of the need for IT training is again highlighted. Further patterns in the data are explored in Chapter 5.

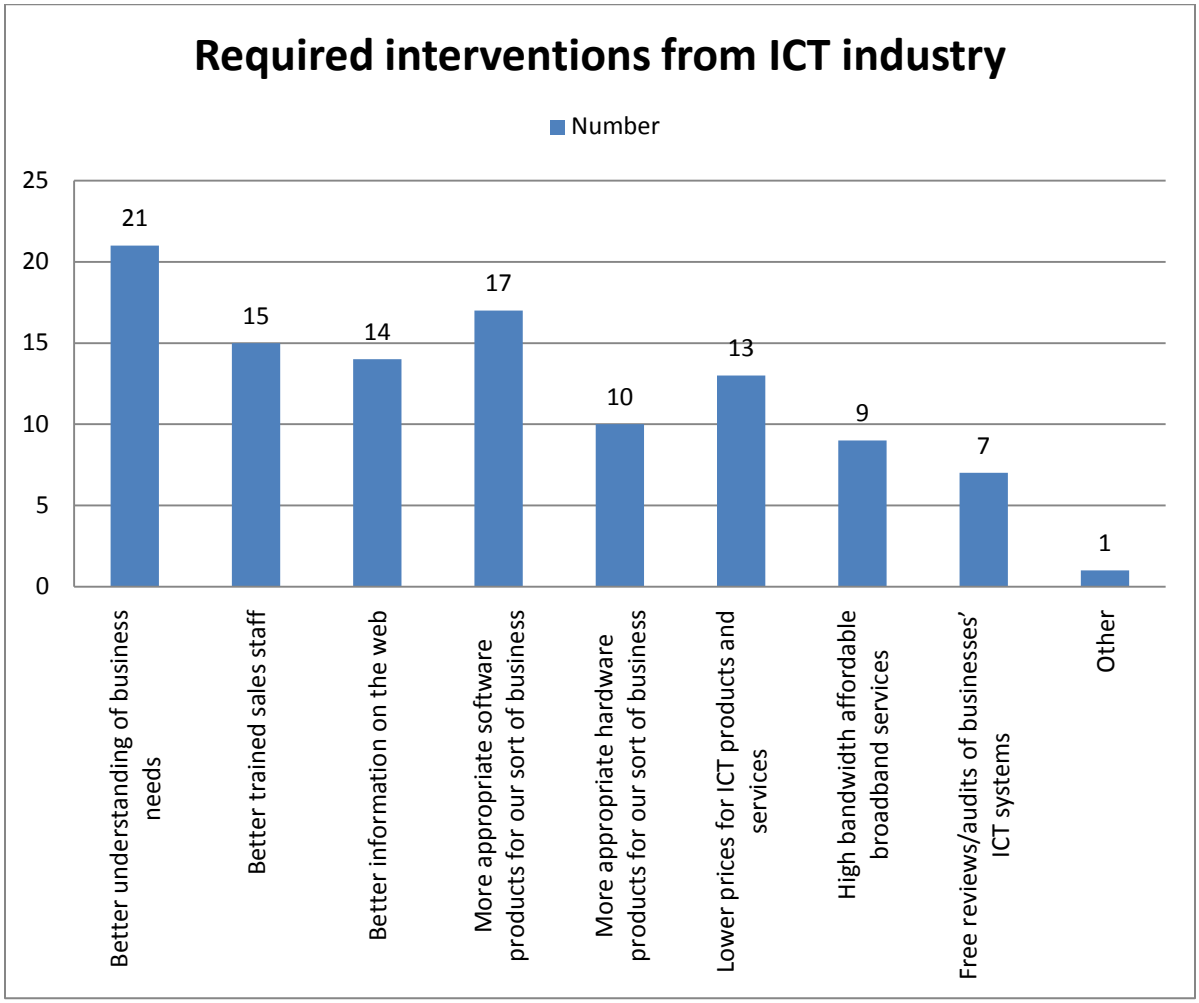


Figure 4-34: Interventions required from the ICT industry to assist the construction sector

Several interventions required from the ICT industry were highlighted in the study as captured in Figure 4-34. Respondents indicated that they required better understanding of business needs (21) from the ICT industry; followed by more appropriate software products that suit the construction industry (17), in particular SMEs in construction. Other issues raised included better trained sales staff (15) and better information on the web (14). Further patterns in the data are explored in Chapter 5.

4.13. Future business outlook

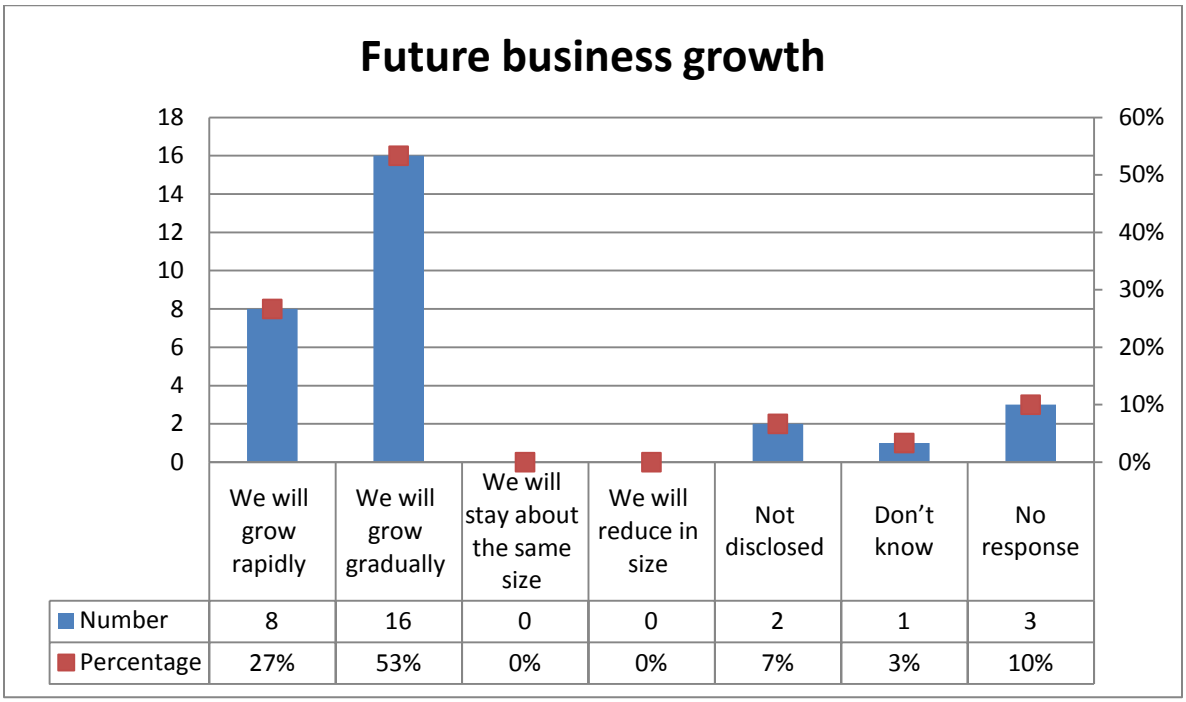


Figure 4-35: Firms' future growth outlook

Most businesses surveyed have an optimistic view of the future ahead and they indicated that they would have either gradual or rapid growth. This optimistic outlook is crucial for growth as it allows the SMEs to tackle the future with confidence. However, it cannot be a substitute for good business practice where, for example, simple factors such as the development of an ICT strategy for the organisation are overlooked. Table 4-12 below shows the link between optimistic outlook and the presence of an ICT strategy. While the majority of respondents have a positive outlook, their companies do not have a documented ICT strategy to guide them. It can be concluded that this confidence will still need to be tied to concrete interventions on the ground, otherwise, the SMEs might find themselves as a statistic among new organisations that fail.

Table 4-12: ICT Strategy against business outlook cross tabulation

		Business outlook				Total
		Not disclosed	Don't know	Grow gradually	Grow rapidly	
ICT Strategy	Yes	0	0	1	1	2
	No	0	2	16	4	22
	Don't know	1	2	0	2	5
Total		1	4	17	7	29

Table 4-13: ICT Expenditure against business outlook cross tabulation

			Business outlook				Total
			No response	Don't know	Grow gradually	Grow rapidly	
ICT Expenditure	Will be greater	Count	1	0	7	3	11
		% within ICT Expenditure	9.1%	.0%	63.6 %	27.3 %	100. 0%
	Will be the same	Count	0	0	1	1	2
		% within ICT Expenditure	.0%	.0%	50.0 %	50.0 %	100. 0%
	Will be less	Count	0	0	1	0	1
		% within ICT Expenditure	.0%	.0%	100. 0%	.0%	100. 0%
	Don't know	Count	0	2	6	1	9
		% within ICT Expenditure	.0%	22.2 %	66.7 %	11.1 %	100. 0%
Total		Count	1	2	15	5	23
		% within ICT Expenditure	4.3%	8.7%	65.2 %	21.7 %	100. 0%

Table 4-13 above gives the breakdown between a business's ICT expenditure against future growth prospects. The respondents who forecast gradual business growth also indicated that their ICT expenditure would be greater in the following year.

4.14. Conclusion

The results generally show that the respondents value the contribution of ICT to their businesses. However, the inability of the surveyed businesses to fully exploit their investment in ICT is still worrying, for example while some of the companies have websites, these are neither monitored nor updated frequently. Furthermore, the efforts by government to reach and assist SMEs through the provision of ICT information and the training of staff seems to have by and large failed to reach these organisations. This means more effort needs to be made to ensure that the target beneficiaries of such initiatives receive the assistance they require to fully exploit available forms of ICT.

5. Discussion

5.0. Introduction

ICT use has been demonstrated to be beneficial to businesses, more so to SMEs who would capitalise on its many advantages that it can offer. However, its full exploitation is often difficult and this is exacerbated by the lack of information on available technologies that would suit an SME setup. There is also the challenge of balancing expenditure on ICT with the return on such an investment. This research seeks to establish the level of penetration of ICT tools in the construction sector in Gauteng, and to achieve this, the results are discussed below.

Analysis of the data was carried out by comparing the results of the study to those recorded by other researchers who have carried out similar studies. The hypothesis for the research was also tested as illustrated in later sections in this chapter.

5.1. Communication systems and procedures

Every business relies on some form of communication method. For the construction sector, the provision of accurate, timely information is of particular importance, as the wrong information or late information can have an impact on the delivery of a project and consequently on the bottom line.

The use of e-mail, PDAs, computers and access to the internet proves to be widespread throughout the surveyed companies. This trend is in line with results reported by researchers in this field who generally agree that the use of e-mails and access to the internet is widespread throughout the sector (Rivard, 2000; Arif and Karam, 2005; Chien et al, 2010; Ballan and El-Diraby, 2011).

Table 5-1: Type of internet connectivity

Dial-up modem	27%
ISDN	7%
Broadband	30%
Don't know	23%
No response	13%

However, the use of broadband services is low with only 30% of the respondents utilising a broadband service (Table 5-1). Further scrutiny of the type of broadband used indicated that of those respondents who had broadband, 46% used wireless broadband. For the purposes of this research, no distinction was made between 3G, GPRS or Wi-Fi, since they all represent a type of wireless broadband.

A possible explanation for the low use of broadband might be the use of oral communication as a substitute for face to face communication. This, when coupled with the fact that all respondents utilise mobile phones, would result in the limited need for faster internet connectivity. This observed trend is also in line with the observation by Ballan and El-Diraby (2011) who identify face to face communication and the use of phones (landline or mobile) as being among the main means of communication in the construction industry. It can further be argued that while e-mails are important, they do not necessarily require one to have broadband in order to access them.

Recommendations:

- Continued government assistance to expand broadband coverage for underserved groups is recommended especially in areas that are underserved by private sector initiatives. However, this should be carried out without inhibiting competition in the ICT sector.

5.2. ICT applications

Familiarity with ICT applications in the surveyed respondents proved to be low, other than the use of emails and general access to the internet. On average the majority of respondents do not use ICT applications beyond emails and access to the internet.

The results obtained indicate that on average, technologies such as Voice over IP, specialist software such as CAD/CAM and remotely hosted applications and software were used by less than 30% of the respondents. This implies that there is still ample room for development for SMEs in terms of more advanced ICT solutions for their organisations, since according to researchers such as Chien and Barthorpe (2010), these advanced ICT applications can help to improve the effectiveness of construction

management. Failure by organisations to exploit these applications might be resulting in missed opportunities to improve their productivity.

Failure to utilise systems such as those to handle order processing; computerised stock control systems; supply chain management system; human resource management systems and Enterprise Resource Planning (ERP) systems also indicates lost opportunities for SMEs. Systems such as ERP are important for integrating business processes in an organisation and allow for easy access of current information on products and services. As discussed under the literature review, these systems can strengthen supply chain partnerships and improve decision making capabilities which ultimately results in reduced project completion times and lower costs (Ahmed et al, 2002:1).

However, according to the OECD (2004) the adoption of more advanced software solutions such as those outlined above is motivated by commercial considerations and the potential benefits to be realised. Therefore, as long as the cost outweighs the perceived benefits, SMEs will not be motivated to spend more on these solutions.

The applications outlined above are useful for the seamless transfer of information through electronic files and networked computer systems which improves the efficiency of business processes such as documentation and data processing (OECD, 2004). The sharing of information is important to an organisation as it allows for the storage and utilisation of information to enrich business process e.g. when employees share information on winning tenders or when information about customer preferences is shared to improve customer service (OECD, 2004). The inability of the surveyed SMEs to exploit these systems implies a missed opportunity for improving their productivity.

Recommendations:

- It is recommended that government and the private sector play a role in sensitising SMEs on the available advanced ICT tools that can potentially impact positively on their businesses. However, this must be tied to training to ensure

that the requisite skills are imparted on the SMEs to utilise the applications optimally.

5.3. The appropriate level of ICT investment

The level of ICT investment reported from this research (3.27%) is higher than that reported by Underwood and Khosrowshahi (2012) in their study of UK based companies whose investment in ICT was 0.74 to 0.76% of their annual turnover. However, Underwood and Khosrowshahi (2012) targeted 200 top construction firms in the United Kingdom and as such, while their results are included here for comparison, it is not expected that SMEs would express similar ICT spending trends.

This level of investment in ICT is also higher than that of 0.1% reported by Chien and Barthorpe (2010) in their study of SMEs in the Taiwanese construction industry.

The figures in Table 5-2 below show that investment ranges from approximately 0.5% to 10%. This represents quite a wide range. However, closer scrutiny of the figures demonstrates that companies with smaller annual turnovers are responsible for the high percentages of 8% and 10% respectively. If these were excluded, then the average investment in ICT would be much lower.

Company number six represents is a special case i.e. it has a ‘large’ workforce relative to other companies but has the lowest turnover. This can be explained by the fact that most of the employees are non permanent i.e. they are only called in when there is demand for their services.

The reason for the high figure reported for company number three is the recent upgrades to their ICT infrastructure, which distorts the expenditure on ICT.

Table 5-2: Level of ICT investment

No.	Company size	Annual turnover	Investment in ICT	Investment in ICT as a percentage of the annual turnover	ICT strategy	Next year's ICT expenditure
1	4	ZAR 300,000	ZAR 7,500	2.50%	No	Undecided
2	7	ZAR 600,000	ZAR 14,000	2.33%	No	Undecided
3	12	ZAR 4,500,000	ZAR 200,000	4.44%	No	No response
4	8	ZAR 1,900,000	ZAR 13,000	0.68%	Yes	The same
5	3	ZAR 250,000	ZAR 20,000	8.00%	No	Greater
6	11	ZAR 160,000	ZAR 16,000	10.00%	No	No response
7	15	ZAR 1,000,000	ZAR 10,000	1.00%	No	Greater
8	Not given	ZAR 5,000,000	ZAR 23,000	0.46%	No	No response
	Average			**3.27%**		

It should also be noted that almost all of the respondents above had no ICT strategy to guide their investment. This may also explain the wide range of percentages obtained as ICT expenditure decisions were made without clear guiding principles. This further emphasises the need for a company to have a clear ICT strategy to guide on the acquisition of new ICT equipment and the requisite skills.

The level of investment obtained for this research must be read in conjunction with the reported benefits of ICT recorded from the respondents which indicate that on average, respondents were satisfied with the contribution of ICT to their businesses.

While overall 37% of the respondents would increase their current level of ICT investment, only 25% of those in the table above would increase their expenditure. The rest were either undecided or did not respond to the question.

5.4. E-commerce

Despite a significant number of respondents (33%) owning a website, most are not able to fully exploit the benefits that it can offer. This is shown by both the lack of monitoring website traffic (80%) and the low frequency of updating the website at less than once a year (90%). This means that while the surveyed organisations are aware of the benefits of owning a website, they are still not able to fully exploit these benefits due to lack of diligence regarding the updating and maintenance of websites.

Websites with information on products and services offered can improve an organisation's service to existing customers and attract new ones (OECD, 2004). Furthermore, websites provide an easy access point which has 24- hour availability which allows information about a company to be available anytime online. Websites can also work as an enabler for e-commerce especially when they allow for online ordering of goods and services. E-commerce helps reduce transaction costs, and improve the speed and reliability of transactions (OECD, 2004).

The OECD (2004:10) notes that: "Internet and e-commerce enable SMEs that remain in local and regional markets because of a lack of information and marketing capability to gain access to new customers and to expand their markets geographically." (OECD, 2004:10).

Security concerns are highlighted as the leading factor as to why organisations do not allow e-commerce on their websites. The challenge of secure online transactions is a global one, and given the huge losses that businesses often suffer as a result of hacking and the subsequent cost and investment that accompanies online transactions, it would be sensible that SMEs would be concerned about online security.

Another reason cited by the respondents is the lack of skills to host and run the websites on a day to day basis. This coupled with cost of running a website work as deterrents to SMEs who may want to improve their online visibility.

The researcher has the following recommendations regarding e-commerce:

- SMEs be assisted in developing and maintaining websites as a tool for marketing their businesses;
- Assistance be provided to SMEs who already own websites to allow them to carry out secure transactions on these websites;
- Incentives be provided for adoption of e-commerce in general as it may be advantageous in terms of time savings for businesses;
- Government should continue to support e-commerce through creating an enabling environment through appropriate policies and legislation to encourage the adoption of e-commerce.

5.5. Barriers to investment in ICT

Companies are often faced with the challenge of prioritising investments in order to maximise their returns. Since all companies must surmount the challenge of limited resources, it becomes imperative to understand factors that work against investment in potentially beneficial endeavours such as ICT.

The factors identified from this research as deterring investment in ICT are not unique to the South African environment but have been demonstrated by other researchers in different regions of the world. Notably Ballan and El-Diraby (2011) and Michaloski and Costa (2010:370) have reported similar factors and these are listed in Table 5-3 below for comparison.

Table 5-3: Barriers to investment in ICT

Research	Ballan and El-Diraby (2011)and Michaloski and Costa (2010:370)
Lack of up-to-date information on what is available	Difficult in establishing the track record of the technology in terms of its reliability and durability;
Low levels of IT awareness/understanding of managers	Challenges in convincing role players in the construction industry to migrate from a culture of oral communication to methods and forms that allow for significant use of ICT;
Lack of time to assess what the firm should invest in	Loss of time due to oversupply of information resulting from poor filtering of important and non-important information;
Difficulty getting advice	Difficult in establishing the track record of the technology in terms of its reliability and durability;
Uncertainty over the benefits to the business	Difficult in establishing the track record of the technology in terms of its reliability and durability;
Uncertainty over which supplier, product or service to use	Difficult in establishing the track record of the technology in terms of its reliability and durability;
Difficulties getting agreement within the firm	Poor integration of technology across different trades involved in the implementation of the project;
Concern over the costs	High costs associated with the training of staff to utilise the technology;
Concern over the integration with existing systems	In addition, deficiencies in information and the lack of integration among the actors involved in the construction process contribute to information systems being regarded as falling short of expectations
Concern over implementing changes to business processes	Difficult in convincing workers to change to a new and often unfamiliar technology;

Concern over staff skills	High costs associated with the training of staff to utilise the technology;
Concerns over the need for training current staff	High costs associated with the training of staff to utilise the technology;
A high turnover of staff, with concerns over training new staff	High costs associated with the training of staff to utilise the technology;
Concerns over ongoing technical support	Problems with the new technology such as limited connectivity in rural areas.
ICT not seen as important for our business	Challenges in convincing role players in the construction industry to migrate from a culture of oral communication to methods and forms that allow for significant use of ICT;

Some of the barriers reported can be easily overcome by putting in place proper training for SMEs. This might require that organisations like Khuthaza and SEDA do more to reach SMEs and to sensitize them to available ICT solutions. Workshops can also be held in partnership with the private sector, especially with ICT service providers, to raise awareness on ICT tools.

The issue of the cost of ICT solutions is a challenge that may be difficult to eliminate. However, this has generally been getting lower as new technologies are developed that can be implemented cheaply. Therefore competition between the providers of ICT solutions is intrinsically working to lower the cost of acquiring this technology. An alternative solution might be for government to subsidize adoption of these technologies through organisations such as SEDA and the CIDB.

Concerns over viruses are a global issue, and while antivirus and antimalware software might assist in this regard, the security problems created have not, at this stage, been completely eradicated. It has to be accepted that this problem will persist into the near foreseeable future. This then implies that organisations must weigh the risks and the

benefits of ICT and find a balance of the risk that they are willing to take for the targeted reward that ICT would offer.

The following recommendations might assist in alleviating and even eradicating these barriers:

- Funding is provided by government to help develop ICT skills in the construction sector. This can be done by subsidising training e.g. as is currently done under the THRIP programme. There is a need to extent programmes such as THRIP to carter for basic skills as well as advanced skills. Currently THRIP only carters for training at degree level and higher;
- Training providers, NGOs and Government agencies work more closely together to raise awareness of the benefits of ICT to the construction sector. This entails that government builds closer relationships with organisations such as Khuthaza to ensure the dissipation of ICT related information;
- SMEs are encouraged to join networking organisations such as SAWEN to ensure they benefit from information on ICT solutions that can potentially benefit their organisations.

5.6. Benefits of ICT

Having discussed the barriers to ICT investment, it is also necessary to provide insight into the perceived benefits of ICT as reported by SMEs surveyed in this research.

Overall, the respondents view ICT as being beneficial to their businesses. These benefits are in line with those reported in literature by researchers such as Anumba et al (2006); Ballan and El-Diraby (2011) and Underwood and Khosrowshahi (2012). The results show the benefits as ranging from improving customer interactions through better communication and better record keeping to the management of finances. The issue of financial management is important for SMEs especially given the issue of insolvency discussed earlier and its contribution to the high failure rate of small firms.

The positive view of ICT itself is a good step towards its meaningful exploitation. This positive view of ICT appears to be contrary to views by some researchers who claim that construction companies generally believe that an investment in ICT often fails to deliver the expected benefits (Tan, 1996; Rivard, 2000; Martin, 2003; Yang, 2007).

However, while a positive outlook is important for business, proper planning to achieve the perceived benefits is also crucial. Overall, ICT is identified as beneficial to a business, through among other things, the enabling role it plays in improving the reliability and speed of transactions, and in its ability to improve data storage and data transport throughout an organisation.

5.7. Factors that influence ICT investment decisions

According to the OECD (2004:20): “SMEs generally lack the human technological resources needed for ICT and e-commerce, because they focus on day-to-day operations and lack the time to understand the benefits of new technologies.” This implies that the supply of ICT related information is important to small firms, and the lack thereof leads to lost opportunities for improved productivity.

The results obtained in this research concur with observation above as the most popular factors influencing ICT decisions were identified as advertising or direct mail and discussions with suppliers. The following tables show the link between an ICT strategy and key factors influencing ICT decisions as identified by this research. However, the link is weak since very few companies have ICT strategies.

Table 5-4: ICT strategy against advertising or direct mail cross tabulation.

		Advertising or direct mail		Total
		Yes	No	
ICT Strategy	Yes	1	1	2
	No	13	10	23
	Don't know	3	2	5
Total		17	13	30

Table 5-5: ICT strategy against discussion with suppliers cross tabulation.

		Discussion with suppliers		Total
		Yes	No	
ICT Strategy	Yes	0	2	2
	No	11	12	23
	Don't know	3	2	5
Total		14	16	30

Table 5-4 and Table 5-5 show that advertising and discussions with supplies are both important factors to companies with or without ICT strategies. However, among companies without ICT strategies, advertising is ranked higher than discussions with suppliers. This indicates that information supply through direct advertisement is important for influencing ICT related decisions, regardless of the presence of an ICT strategy.

Table 5-6: ICT Strategy against public funded organisations cross tabulation

		Public funded organisations		Total
		Yes	No	
ICT Strategy	Yes	0	2	2
	No	7	16	23
	Don't know	1	4	5
Total		8	22	30

Table 5-7: ICT Strategy against government websites cross tabulation

		Government websites		Total
		Yes	No	
ICT Strategy	Yes	0	2	2
	No	9	14	23
	Don't know	1	4	5
Total		10	20	30

Table 5-8: ICT Strategy against e-government services cross tabulation

		E-government services		Total
		Yes	No	
ICT Strategy	Yes	0	2	2
	No	8	15	23
	Don't know	2	3	5
Total		10	20	30

Table 5-6 to Table 5-8 above measure the influence of government on a company's decision to adopt ICT. This is measured through the influence of e-services, government websites and normal interaction with SMEs in the course of doing business. On average, the tables indicate that government's influence is weaker than that of the private sector (Table 5-4 and Table 5-5). This implies that there are opportunities that the government can exploit to bring ICT to SMEs. Furthermore, the role of supplying information should not be left to ICT vendors alone, but there should be greater government visibility.

As highlighted earlier under the literature review, ICT solutions, when implemented haphazardly without matching the overall business strategy will fail to realise the

benefits that are often associated with an investment in ICT (Tan, 1996; Rivard, 2000; Martin, 2003; Yang, 2007). The failure by most businesses surveyed (73%) to have a documented ICT strategy suggests that the implementation of ICT solutions may not be well organised which might result in impromptu decisions on ICT investment being taken. This in turn would then perpetuate the negative view towards ICT investments and the overall benefits to the business as has been reported by some researchers in this field.

5.8. Current use of CAD software

CAD involves the use of software such as AutoCAD and Civil 3D which can simplify the design process by carrying out many of the cumbersome calculations for the engineer/technician thereby saving time and potentially improving on accuracy. They also assist in the drafting of technical drawings for construction purposes.

In construction, CAD can be beneficial in a variety of ways. CAD can be useful for adding additional drawing overlay information on site. These overlays may contain information on temporary works that the constructor may need. Also, the contractor may have construction proposals that need to be assessed for implementation, and this assessment can be done by adding additional layers to electronic drawings. Furthermore accessing and utilising electronic drawings allows the contractors to carry out additional measurements required for construction purposes, since in practice contractors generally require additional measurements which are not always shown on drawings supplied to them (Mahoney et al, 1990). The measurements described above are not always possible in other graphic formats such as portable document format (pdf) documents.

However, while its use in professional services associated with construction is significant as demonstrated by researchers such as Arif and Karam (2005), its use in the construction sector by contractors is still under development as demonstrated by the results of this research. The results obtained in this research concurred with the observation by Tse and Wong (2004) who also noted that the use of CAD software in the construction industry was still quite low. The reason for this might be simply that

SMEs, unlike well-established contractors, do not readily design but focus on the implementation of designs they obtain from the other players in the professional services in the industry.

However, the inability to use CAD will work as a disadvantage to SMEs as they are unable to take additional measurements and add their own information to drawings such as temporary works discussed above. The outsourcing of these functions might imply extra costs that will cut on their profitability.

It is therefore recommended that SMEs be assisted in accessing CAD to help streamline their business processes and improve their productivity.

5.9. Virtual Reality

While the benefits of Virtual Reality are many, including benefits in site layout and planning; planning and monitoring of construction processes and evaluation of construction scenarios (Whyte and Bouchlaghem, 2001), the observation earlier that "Virtual Reality, like Building Information Modelling, represents quite a sophisticated technology and its application in SMEs in the developing world has not been demonstrated" proved to be accurate as half of the respondents were not familiar with the technology and a further 27% indicated that they were not utilising this technology.

Given the fact that most SMEs do not utilise CAD, which, arguably may not be as complicated and as resource intensive to utilise as VR, it is to be expected that the results for VR would indicate its lack of exploitation in the South African construction sector. Furthermore, VR development is still in its infancy as demonstrated by researchers such as Bouchlaghem et al, (1996), and therefore it might be beneficial to allow this technology to develop and be tested elsewhere before SMEs in South Africa begin to utilise it. This will assist in avoiding pitfalls that accompany the development of new technology and will allow South African SMEs to learn from the experiences of other SMEs in various parts of the world when this technology has been developed further.

Clearly, it might be too early for SMEs to start focussing on this technology despite the benefits it might offer. At this stage therefore, the adoption of this technology is not recommended by the researcher, but rather that SMEs focus on more relevant technologies to their business such as CAD, for the reasons discussed above.

5.10. ICT development programmes for SMEs

Chapter 2 discussed various initiatives aimed at bringing technology to SMEs. These initiatives included Technology for Women in Business (TWIB); Technology and Human Resources for Industry Programme (THRIP) and the South African Women Entrepreneurs' Network (SAWEN).These programmes are owned and implemented by various role players including the Department of Trade and Industry (DTI) and the Small Enterprise Development Agency (SEDA).

The results reveal that the majority of participants (76%) were unaware of these initiatives. This implies that the aim of these initiatives may not be fully realised as the target groups are not exploiting and benefiting from these programmes. The results also concur with the observation by the Department of Trade and Industry (2011) that the participation of women in these technology programmes is low especially in the SEDA led technology initiatives. Khuthaza, being composed mainly of women participants, proved not to be an exception to this rule.

The issue of poor ICT skills in the construction sector has also been highlighted by the OECD (2004:5) who note that: “Lack of ICT skills and business skills are widespread impediments to effective uptake once adoption decisions are made. Governments have major roles in providing basic ICT skills in compulsory schooling, and an important role in conjunction with education institutions, business, and individuals in providing the framework to encourage ICT skill formation at higher levels, in vocational training and in ongoing lifelong learning.”

To address this, the researcher has the following recommendations:

- Government and SEDA in particular must work closely with training organisations affiliated with construction companies to ensure that there is complete information dissemination about these programmes to all SMEs in construction;
- Organisations like the CIDB must ensure that they provide information on available government initiatives on ICT to grades one to four contractors on the CIDB rating scale;
- Registering authorities such as the Companies and Intellectual Property Commission (CIPC) must help to provide information on these programmes to new entries in the constructions business

5.11. ICT penetration analysis

5.11.1. Methodology

The analysis of ICT penetration was carried out in the following stages

- 30 questions were selected for analysis of ICT penetration in the sector. These questions directly link to ICT tools and applications being used in the construction sector.
- The questions are divided into 3 categories i.e. devices being utilised, ICT applications and ICT investment strategy.
- The tables that follow below were generated from the table of responses in Appendix D.
- The stages followed in the analysis are outlined below per category.

The tables are analysed using the colour coded cluster method. This method allows for visualisation of the results which assist in identifying the underlying patterns in the data. (Gorden, 1992; Landrebe et al, 2002; Charting Student Information, n.d.)

5.11.2. ICT devices

Six questions are used for this analysis. Land-line phones have been deleted from the analysis since all respondents have a mobile phone.

The devices are then rated based on level of sophistication with the highest rating being 3 as indicated in Table 5-9 below. A “don’t know” response is rated 0 and a “no response” is left blank.

Table 5-9 below has a high number of “don’t know” responses for advanced tools such as LAN and EDI. This is in line with the observation earlier that ICT use is widespread in the sector if one considers the use of basic tools such as mobile phones. It also indicates a low level of general awareness of the firm’s capacity in terms of available ICT tools. When Table 5-9 is read in conjunction with Table 5-10, there is a general trend indicating apparent lack of awareness of functionality of the devices as they are not being exploited to their full potential as indicated by the limited use of ICT applications.

Table 5-9: ICT devices

Respondent number	Q1.2 Mobile phones	Q1.4 Computers	Q1.6 Internet	Q1.3 PDAs	Q1.5 LAN	Q1.7 EDI	Number of devices	Device rating
1	1	1	3	0	2	3	5	8
2	1	1	3	2		0	4	7
3	1	1	3	2		0	4	7
4	1	1	3	2	0	0	4	7
5	1	1	3	2	0	0	4	7
6	1	1	3	2	0	0	4	7
7	1	1	3	2	0	0	4	7
8	1	1	3	2	2	0	5	9
9	1	1	3	2			4	7
10	1	1	3	2	2	0	5	9
11	1	1	3	2	0		4	7
12	1	1	3				3	5
13	1	1	3	2	2		5	9
14	1	1	3	2	2	3	6	12
15	1	1	3	0	2	0	4	7
16	1	1	3	2	2	0	5	9
17	1	1	3	2		0	4	7
18	1	1	3	2	2	0	5	9
19	1	1	3	2	0	0	4	7
20	1	1	3	2	0	0	4	7
21	1	1	3	0	2		4	7
22	1	1	3	2		3	5	10
23	1	1	3				3	5
24	1	1	3	2		0	4	7
25	1	1	3	2	2	3	6	12
26	1	1	3	0			3	5
27	1	1	3	2	2	3	6	12
28	1	1	3	2	0		4	7
29	1	0		0			1	1
30	1	1	3	2	0	0	4	7

Key

Very High	High	Medium	Low	Very Low
12	10	9	7	1 to 5

Indicates necessary device if other responses are correct.

5.11.3. ICT applications

For purposes of the analysis, 17 questions were selected and are arranged with those applications more related to operation of the firm to the left, and those more related to project management on right (Table 5-10)

The applications are given a rating of 1 to 4 based on their level of sophistication, “don't know” is rated 0 and “no response” is left blank.

Virtual Reality and CAD are also included in this analysis. CAD is covered under question 2.4.

- Table 5-10 indicates that respondents use more firm related applications as opposed to project management related applications.
- Table 5-10 also indicates a high number of “don’t know” responses which suggests that respondents do not fully appreciate the capacity of devices they own for example VoIP is not popular yet with applications such as Skype, it is free only requiring internet access.

Table 5-10: ICT applications

	Firm →																	←Project
Respondent number	Computerised accounting systems	Human resource management systems	Systems for sharing customer information	Computerised stock control systems	Enteprise resource planning tools	Email	VoIP	Remote software	Intranet	Systems for sharing documents	Remote access to your internal systems	Systems to handle order processing	Online ordering	Video conferencing	Supply chain management system	Use of VR	Specialist software	Number of applications	Applications ranking
	Q2.8	Q2.14	Q2.10	Q2.12	Q2.15	Q2.1	Q2.3	Q2.5	Q2.7	Q2.9	Q2.16	Q2.11	Q2.6	Q2.19	Q2.13	Q7.1	Q2.4		
1	3	3	2	2	4	1	3	2	2	1	1	2	1	0	4		4	15	35
2	0		0			1				0				0		0		1	1
3						1								0		0		1	1
4	3	0	0	0	0	1			2	0	0	0	1	0	0			4	7
5	0	3	0	0	0	1	3		0	0	0	0	1	0	4		0	5	12
6	3	0	0	0	0	1	0	0	2	0	0	0	0	0	0	0	0	3	6
7		0	0	0	0	1			2	0	0	0		0	0			2	3
8		0	2			1			2	1		2	1		0	4		7	13
9	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	2	2
10	3	3	0	0	0	1	3	0	0	1	1	0	1	1	0	0	4	9	18
11	3	0	0	0	0	1		0	0	0	0	0	1	0	0		4	4	9
12						1								0				1	1
13																		0	0

14	3	3	0		0	1				0	0	0		0	0			3	7
15	0	0	0	0	0	1				0	0	0		0	0	0		1	1
16	3	0	0	0	0	1	0	0	0	0	0	0	0	0	0		0	2	4
17						1								0				1	1
18	3					1								0				2	4
19	3	3	2	2	4	1	0	2	2	1	1	2	1	0	4		4	14	32
20	0	0	0	0		1	3	2	2	0	0	0		0	0		4	5	12
21	0		0	0		1				0		0		0	0			1	1
22	0	0	0		0	1		0	0	0	0	0	0	0	0	0		1	1
23	3	3		2		1												4	9
24						1								0				1	1
25						1								0				1	1
26	0	0	0	0		1		0	0	0	0	0	0	0	0			1	1
27	3	3		2		1				1	1		1	0	4	4		9	20
28						1								0				1	1
29						1	3							0				2	4
30						1								0		0		1	1

Key

Very High	High	Medium	Low	Very Low
32-35	18-20	12&13	6&9	1&4

5.11.4. Investment strategy

Table 5-11: ICT investment strategy

Documented ICT Strategy	**Q4.3**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**		**0**	**0**	**0**	**0**		**0**	**1**	**0**	**0**		**0**	**0**	**0**	**0**	**0**	**1**	**0**		
ICT Expenditure	Q4.2			2	2	2				2	2	2					2		2	2		2		2			2	2	2		
Investment Strategy		0	0	2	2	2	0	0	0	2	2	2	0	0	0	0	2	0	3	2	0	2	0	2	0	0	2	3	2	0	0

- The presence of an ICT strategy was given a rating of 1
- Indication of a plan to spend on ICT in the coming year was rated 2. The reason for a similar rating of 2 is that an intention to spend does not necessarily indicate a trend as a firm may carry out upgrades one year and spend nothing on ICT the following year.
- The investment strategy score is the sum of scores obtained on ICT strategy and ICT expenditure.

5.11.5. Thematic groups

Table 5-12: Thematic groups

		Thematic groups			
	Company Size	**Device**	**Applications**	**Investment Strategy**	**Total**
1		10	35	0	45
2		7	1	0	8
3		7	1	2	10
4	<10	7	7	2	16
5		7	12	2	21
6	<10	7	6	0	13
7	<10	7	3	0	10
8	<10	9	13	0	22
9	10--19	7	2	2	11
10	<10	9	18	2	29
11		7	9	2	18
12	10--19	5	1	0	6
13		9		0	9
14	<10	12	7	0	19
15	<10	7	1	0	8
16	40--49	9	4	2	15
17	50--59	7	1	0	8
18	<10	9	4	3	16
19	<10	7	32	2	41
20	10--19	7	12	0	19
21	10--19	7	1	2	10
22	10--19	10	1	0	11
23		5	9	2	16
24	10--19	7	1	0	8
25		12	1	0	13
26		5	1	2	8
27	<10	12	20	3	35
28		7	1	2	10
29	<10	1	4		5
30		7	1		8

Key

Very High	High	Medium	Low	Very Low

5.11.6. Ranking of respondents according to ICT use.

Table 5-13: Ranking of respondents

		Thematic groups			
		Device	Applications	Investment Strategy	
1		10	35	0	45
19	<10	7	32	2	41
27	<10	12	20	3	35
10	<10	9	18	2	29
8	<10	9	13	0	22
5		7	12	2	21
14	<10	12	7	0	19
20	10--19	7	12	0	19
11		7	9	2	18
4	<10	7	7	2	16
18	<10	9	4	3	16
23		5	9	2	16
16	40--49	9	4	2	15
6	<10	7	6	0	13
25					13
9	10--19				11
22	10--19				11
3					10
7	<10	7	3	0	10
21	10--19	7	1	2	10
28		7	1	2	10
13		9		0	9
2		7	1	0	8
15	<10	7	1	0	8
17	50--59	7	1	0	8
24	10--19	7	1	0	8
26		5	1	2	8
30		7	1		8
12	10--19	5	1	0	6
29	<10	1	4		5

The ranking above indicates that ICT penetration is more aligned to hardware than applications. This suggests that the respondents in this survey may not fully appreciate the capacity of their devices resulting in them failing to exploit fully the potential that these devices offer.

Furthermore, the respondents with the highest level of sophistication in terms of ICT use own companies with less than 10 employees. This suggests that the success of the firm is independent of increased sophistication. A possible explanation for this is that as the firm gets larger, it becomes more difficult for it to implement advanced ICT systems because of the issue of poor skills of the labour force alluded to earlier. Therefore, a large labour force does not necessarily imply increased sophistication of ICT use. The observation earlier that the construction sector does not utilise advanced communication tools that would benefit them is further emphasized.

5.12. Analysis of Patterns in the data

The section below discusses the patterns that were mapped from the analyses of the data collected on ICT use in construction.

The focus areas are:

- Provision of ICT support;
- Factors influencing ICT decisions;
- ICT strategy;
- ICT training.

5.12.1. Methodology

The analysis of ICT penetration was carried out in the following stages:

- 53 questions were selected for analysis of the patterns revealed in the focus areas above.
- Individual responses were entered into the spreadsheet (table 5-14 and table 5-15). Cells representing a “yes” response are blue and those representing a “no” response are red. Those representing a “don’t know” response are grey.
- A “no response” is left blank. The cells with the blue fill are then counted, and the respondents ranked.
- The patterns are then analysed by looking at the spatial distribution of blue and red cells.
- Table 5-13 above was also used in the analysis.

5.12.2. Analysis

Analysis of table 5-14 and table 5-15 below yield the following patterns:

- 83% of the 12 respondents who have medium scores on ICT strategy are influenced by advertising or direct mail in their ICT decisions.
- The 12 respondents with medium scores on ICT strategy also indicated that they would require:
    - Support in training staff (67%) from the government.
    - Better understanding of business needs (83%); more appropriate software products for their type of business (50%); and more appropriate hardware products for their type of business (50%) from the private sector.
- 17 respondents who are influenced by advertising or direct mail in their ICT decisions indicated they require information on the web about ICT (65%), workshops, seminars or other events about ICT (88%) and support in training staff from the government (76%).
- These respondents also require better understanding of business needs (100%), better trained sales staff (65%), better information on the web (59%) and more appropriate software products for their type of business from the ICT sector (71%).
- The respondents with ICT strategies indicated that they utilise internal IT staff, other staff or management and private sector training providers for their ICT training. These two respondents represent a high level of sophistication and their use of private sector training providers is expected.
- 63% of respondents who require support in training staff also require grants for equipment or software from the government.
- The bottom 10 respondents in tables table 5-14 and table 5-15 share the following characteristics:
    - 20% of the respondents have high ICT device usage and yet one of them does not have any ICT support.
    - 80% of these respondents have very low ICT application usage scores and also very low investment strategy scores.

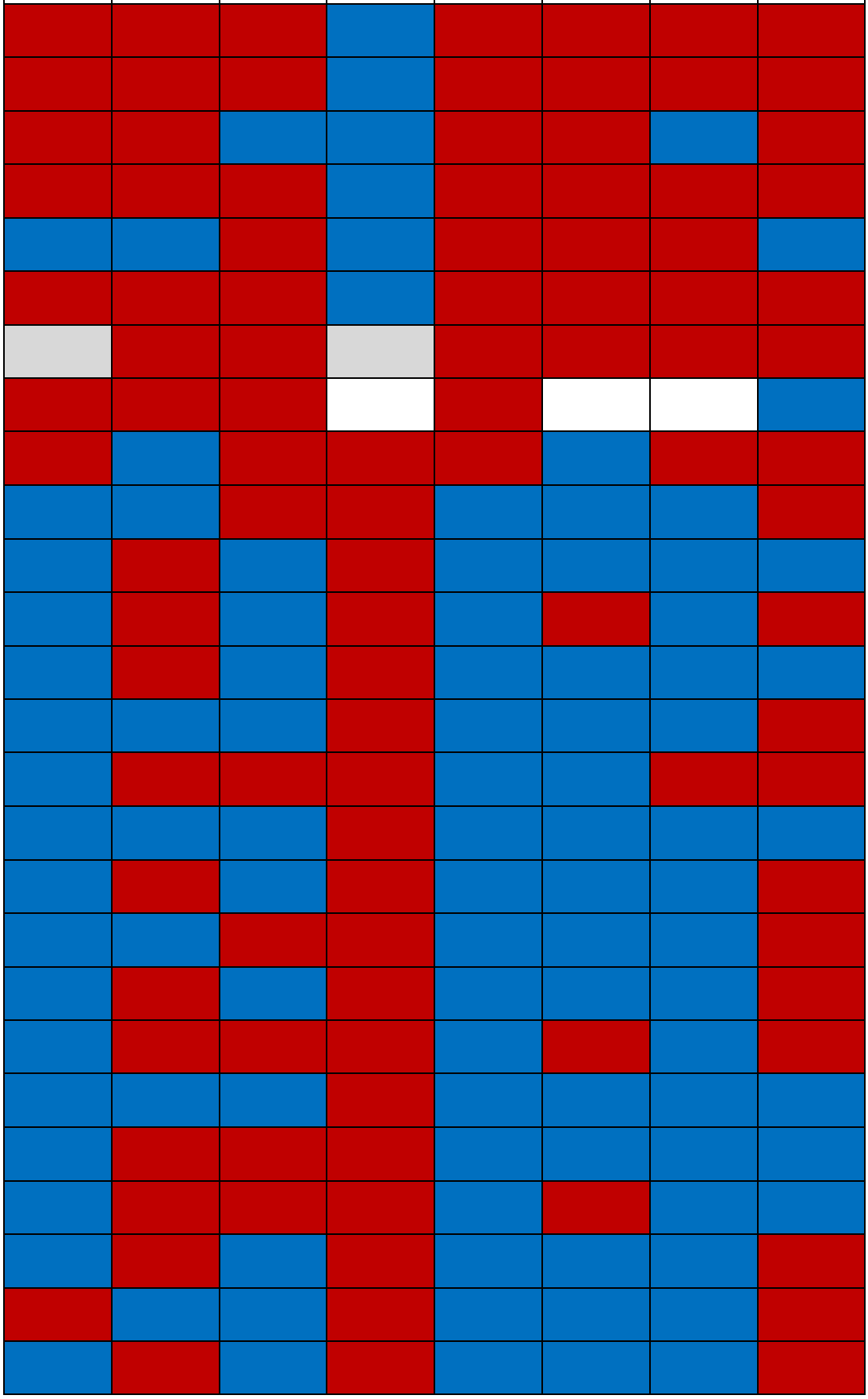
    - Only 20% indicated they would require any assistance from the private sector.
    - Only 20% indicated they have any ICT support.
- These bottom 10 respondents would benefit from interventions from the government such as ICT training even though they fail to indicate it.

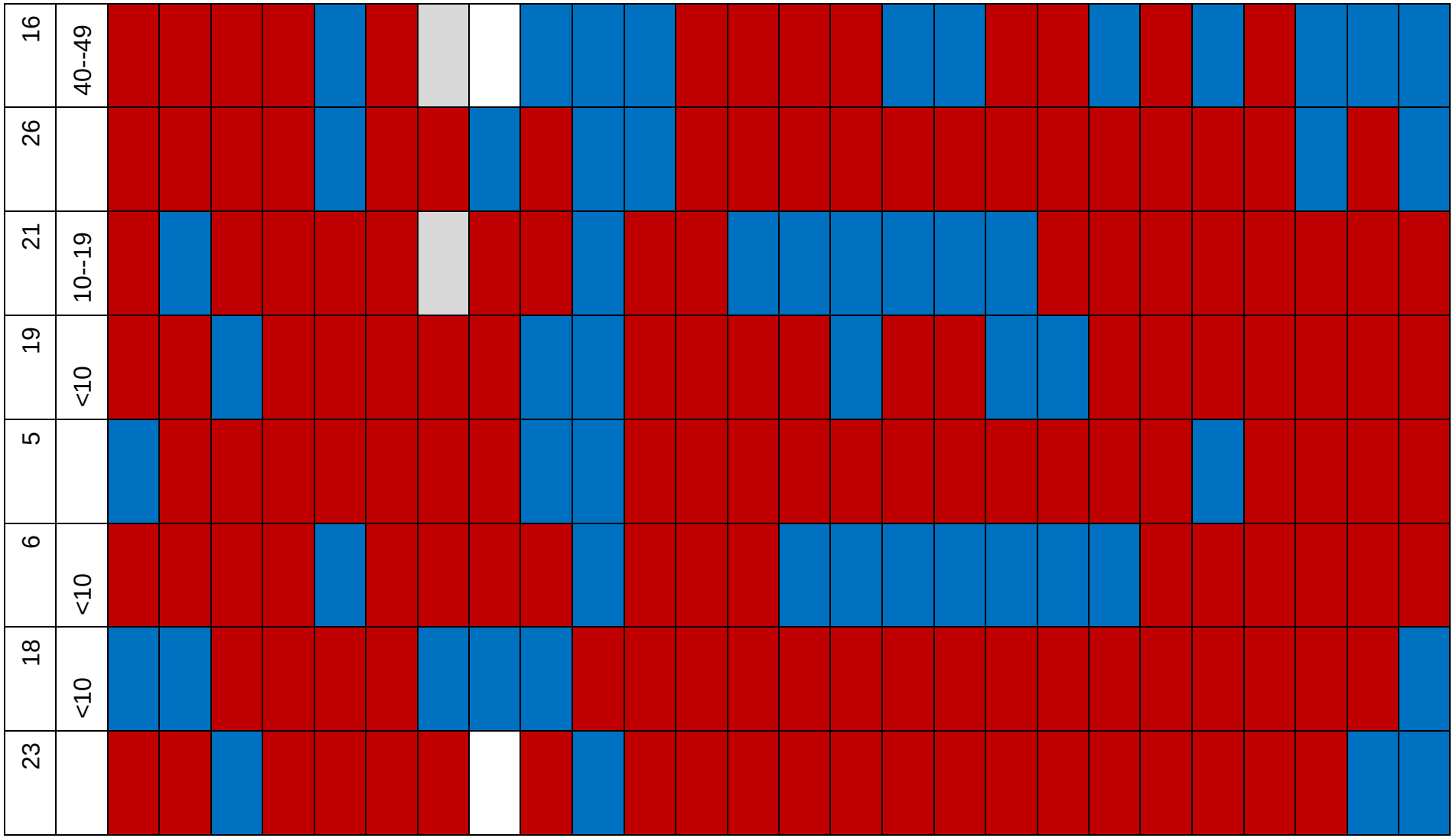
Overall, respondents have poor ICT support and have poor access to training. The issue of skills was addressed in Chapter 2 and is highlighted again. Collaboration between the government and the private sector would benefit the respondents especially in the provision of information on available ICT tools and the provision of training. Better training could result in better ICT skills reducing the use of external ICT support and thus reducing the associated costs. Furthermore, trained company staff can be used to train other staff thereby reducing the need of using external training providers and thus cutting on costs.

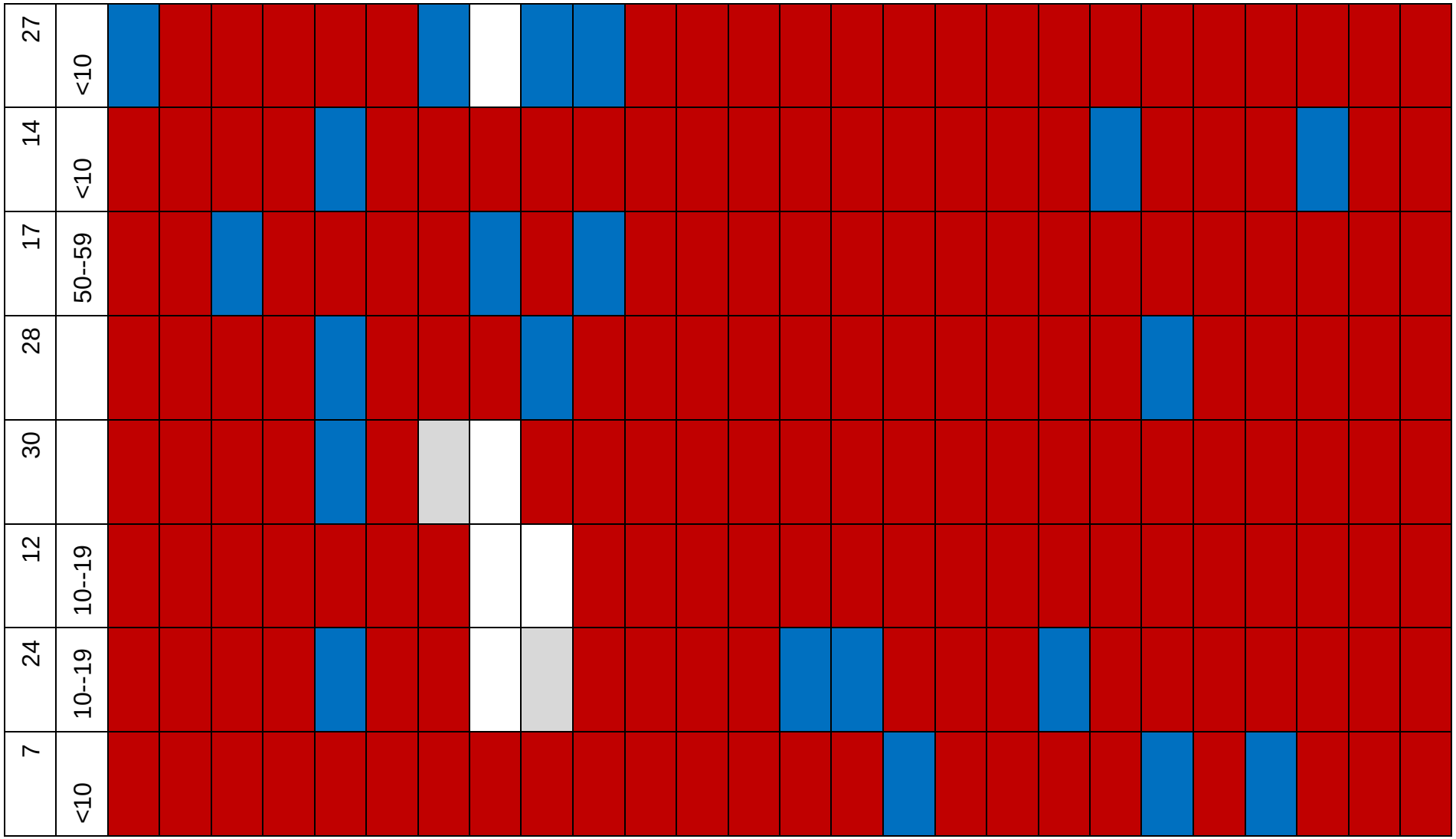
Table 5-14

		Provision of ICT support									Factors that influence ICT decisions																	
Respondent no.	Company size	Internal IT professionals	An internal IT enthusiast	An external service provider	Equipment provider(s)	We don't have any IT support	Other	ICT Strategy	Gvt initiatives	Website	Advertising or direct mail	Articles in the press	New recruits	Consultants	Customers	Competitors	Suppliers	Accountant, bank or lawyer	Firms in other sectors	Friends or relatives	Business organisation	Business links	Manufacturing institutes	Public funded organisations	E-government services	Government websites	Research on the internet
		Q2.24a	Q2.24b	Q2.24c	Q2.24d	Q2.24e	Q2.24f	Q4.3	Q5.1	Q6.1	Q8.1a	Q8.1b	Q8.1c	Q8.1d	Q8.1e	Q8.1f	Q8.1g	Q8.1h	Q8.1i	Q8.1j	Q8.1k	Q8.1l	Q8.1m	Q8.1n	Q8.1o	Q8.1p	Q8.1q
1																											
10	<10																										
8	<10																										

11	9	2	29	22	4	20	15
	10--19		<10	10--19	<10	10--19	<10




16
40--49
26
21
10--19
19
<10
5
6
<10
18
<10
23


27
<10
14
<10
17
50--59
28
30
12
10--19
24
10--19
7
<10

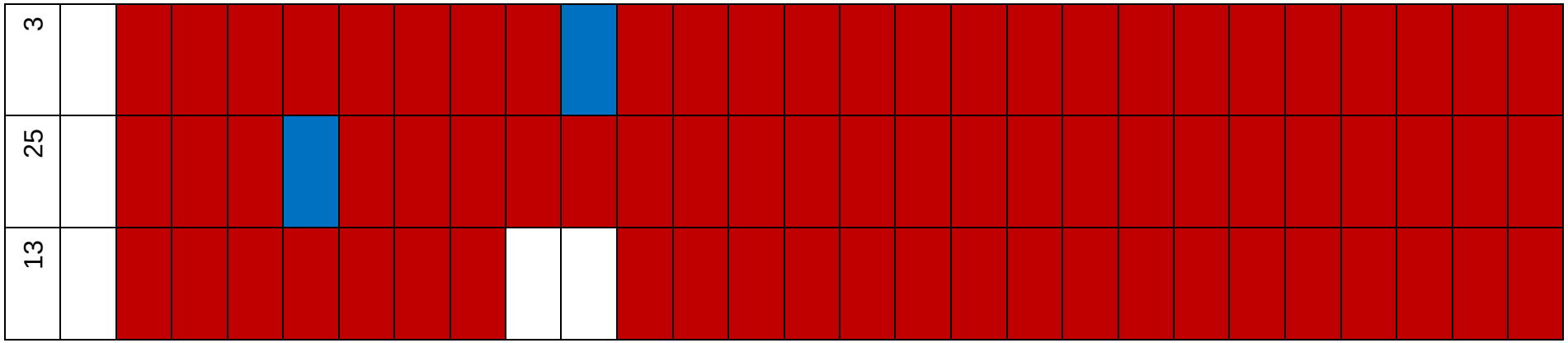
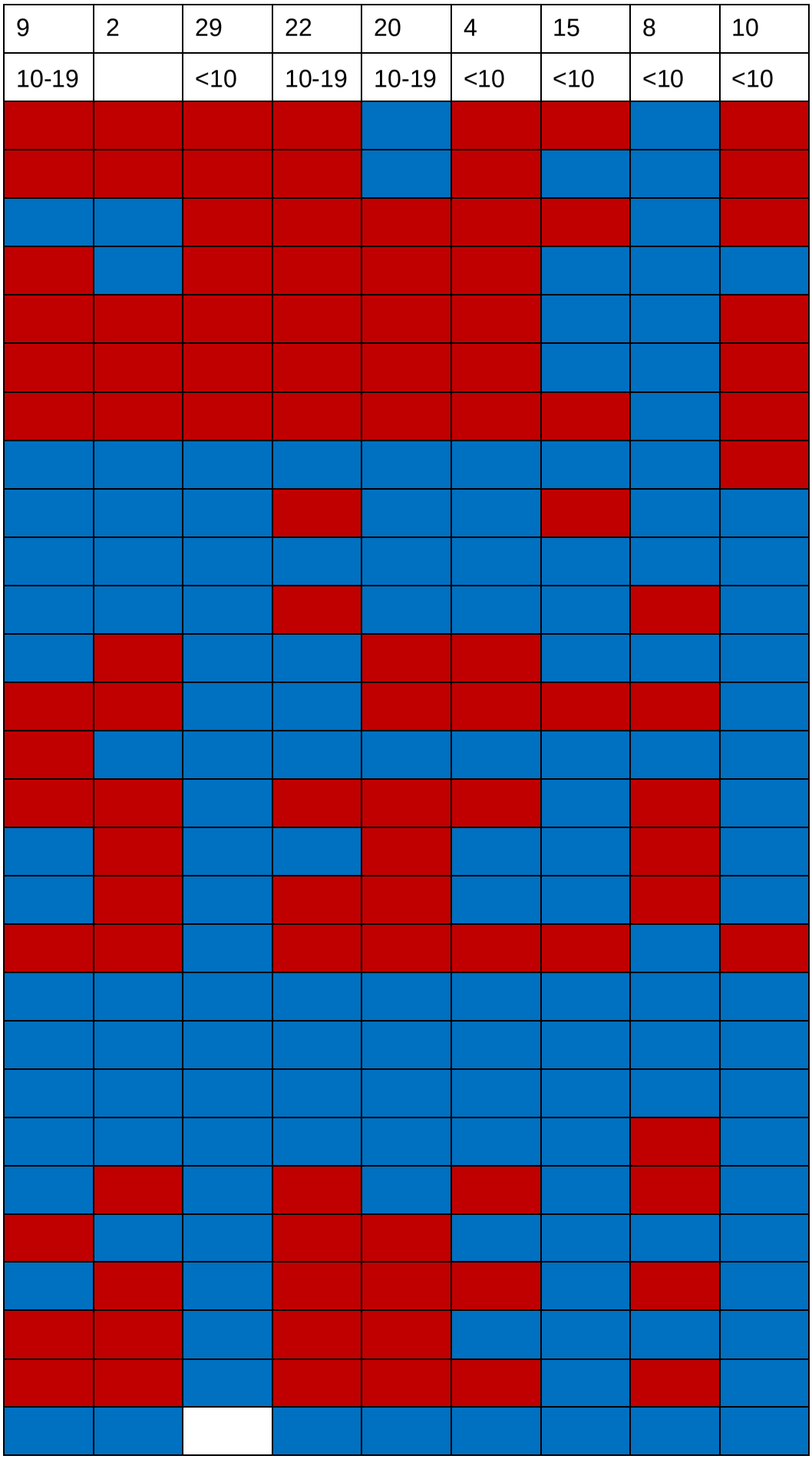

3
25
13

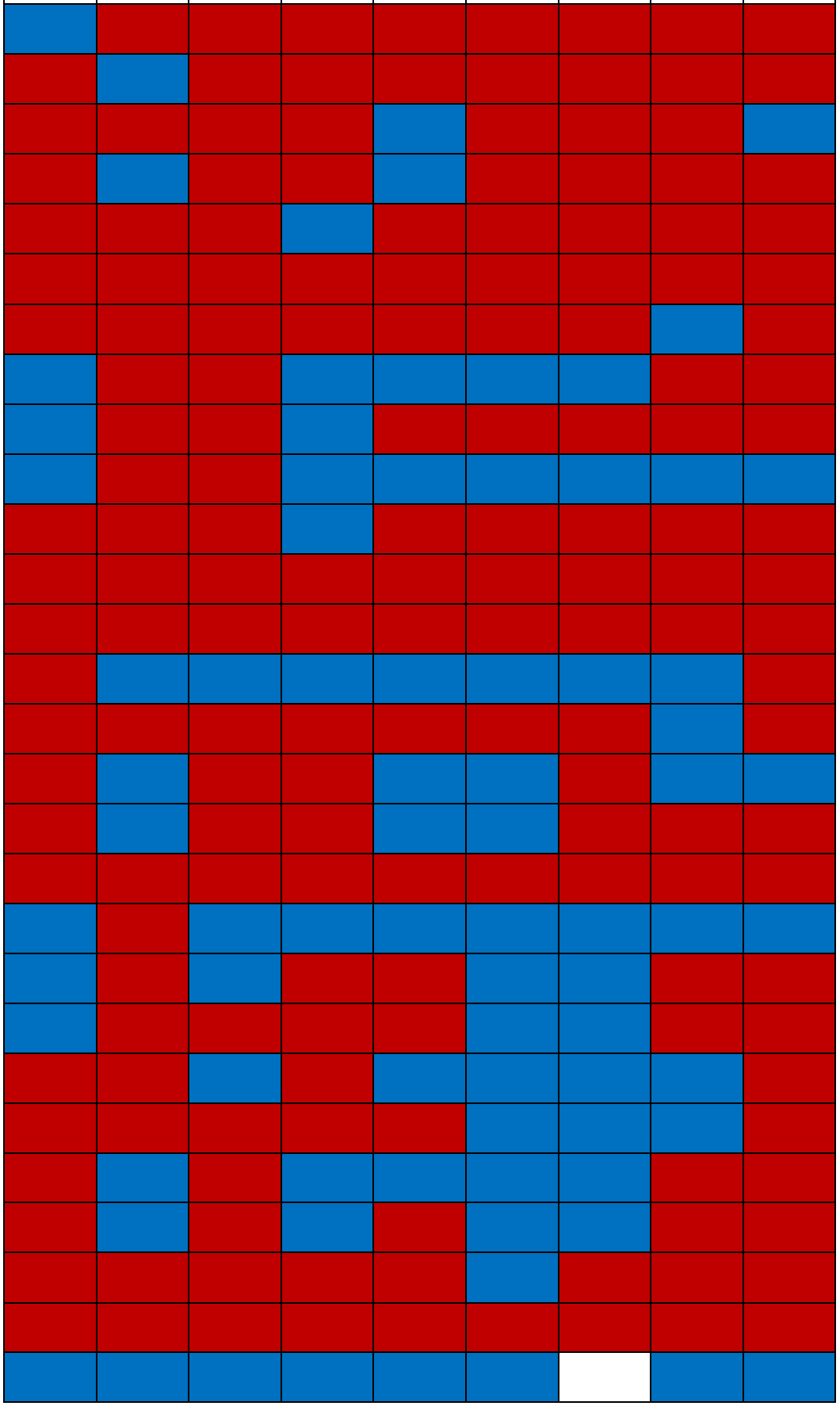
Table 5-15

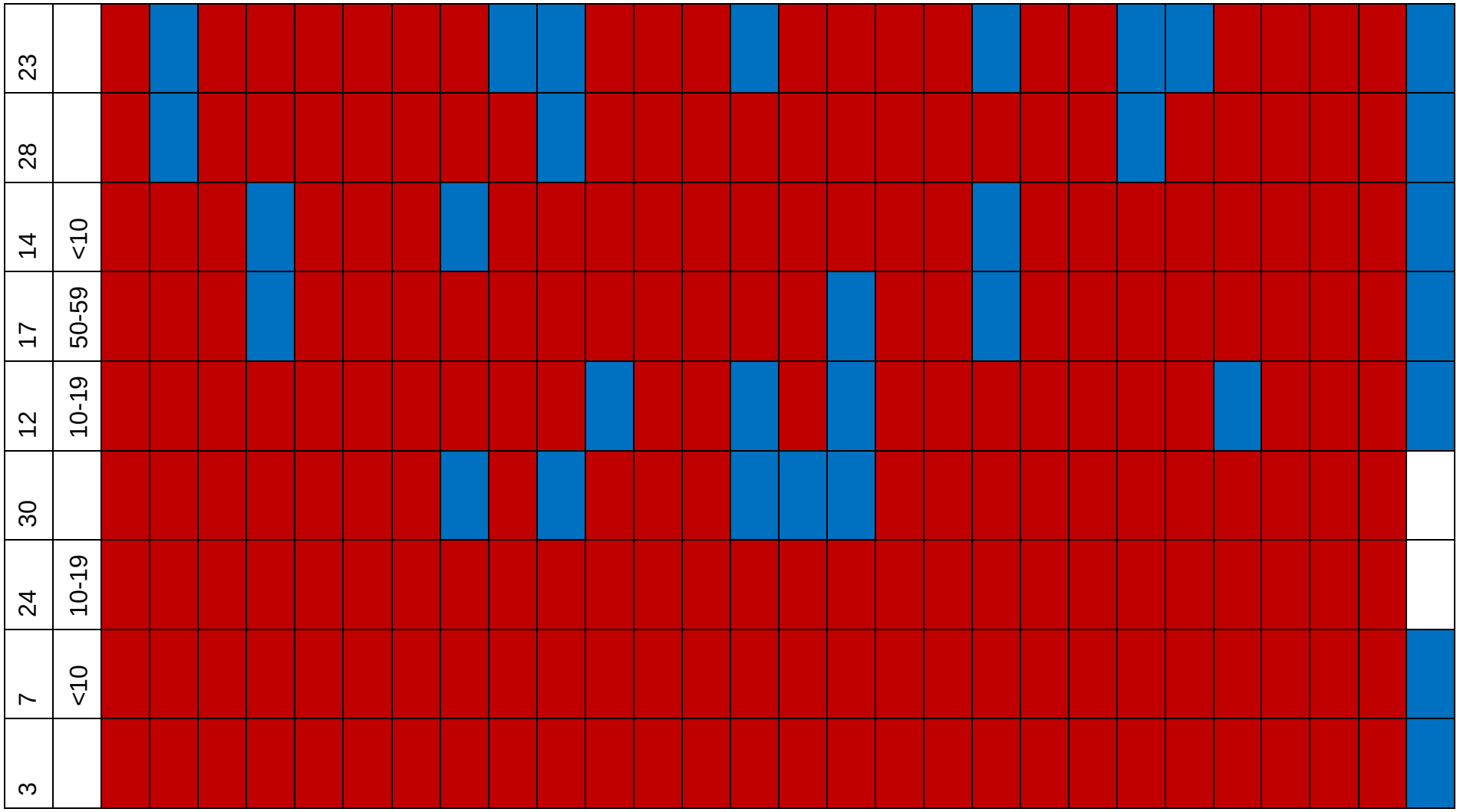
Provision of ICT training									Required interventions from Government										Required interventions from ICT industry									
1	Respondent no.	Size	Internal IT staff	Other staff or management	A consultant	Private sector training provider	Further Education college	University	Other (please specify)	Information on the web about ICT	A telephone helpline	Workshops, seminars about ICT	Demonstration facilities	Free reviews/audits of ICT systems	Impartial help in identifying suppliers	Support in training staff	Free or subsidized consultancy	Grants for equipment or software	Tax breaks for ICT equipment	Other (please specify)	Better understanding of business	Better trained sales staff	Better information on the web	More appropriate software	More appropriate hardware	Lower prices for ICT products	High bandwidth	Free reviews/audits of ICT systems	Other	Business outlook
			Q8.6a	Q8.6b	Q8.6c	Q8.6d	Q8.6e	Q8.6f	Q8.6h	Q8.7a	Q8.7b	Q8.7c	Q8.7d	Q8.7e	Q8.7f	Q8.7g	Q8.7h	Q8.7i	Q8.7j	Q8.7l	Q8.8a	Q8.8b	Q8.8c	Q8.8d	Q8.8e	Q8.8f	Q8.8g	Q8.8h	Q8.8i	Q9.7

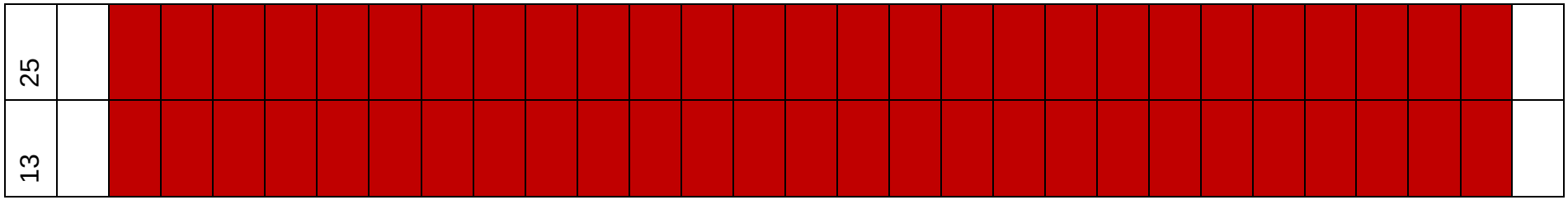
9	2	29	22	20	4	15	8	10
10-19		<10	10-19	10-19	<10	<10	<10	<10



27	18	6	19	5	26	21	16	11
<10	<10	<10	<10			10-19	40-49	




23
28
14
<10
17
50-59
12
10-19
30
24
10-19
7
<10
3


25
13

5.13. Conclusion

This research sought to establish the level of penetration of ICT in the SME segment of the construction sector, the challenges being faced and the tools currently employed by various construction companies in their day to day business processes. It also focussed on how ICT related decisions are made and the associated investment into ICT solutions that companies are currently employing in Gauteng. The research has demonstrated that the level of investment in ICT, challenges contractors face regarding ICT and the benefits that they believe an investment in ICT will bring are not significantly different to contractors in various parts of the world, as reported by the researchers discussed in the Literature Review.

The research has also identified gaps in information dissemination to contractors both on available ICT solutions and on training programmes that various institutions offer regarding the enhancement of ICT skills. Overall, the research has demonstrated that tools such as cell phones and emails are used widely, while there is a deficiency in adoption of more advanced tools and systems such as automated HR systems and ERP systems. However, this should be read in the light of the higher than expected investment I ICT, suggesting that skills programmes could focus on more efficient ways of using the systems already owned by SMEs and more strategic purchasing of hardware, software and specialised services.

The main conclusions, recommendations and areas for further research are dealt with in more detail in Chapter 6.

6. Conclusion and recommendations

6.0. Introduction

This research was aimed at evaluating the penetration of ICT in the SME segment of the construction sector in Gauteng, identifying the perceived benefits and analysing the trends in terms of ICT use in the sector. The findings of this research are important in that they identify the gaps that exist in the sector including the provision of ICT training and general lack of access by SMEs in need of training. They also demonstrate that the use of advanced forms of ICT in the sector is still very low with systems such as e-commerce not being widely adopted. This results in the potential of ICT not being fully realised for the sector.

Furthermore access to general information on ICT is still in need of improvement and the major role players including government and the private sector will need to collaborate further towards a common goal to ensure that the sector as a whole benefits. Below is an overview of the entire research, summarising the approach and the main arguments for the research.

6.1. Overview of research

This study sought to understand the level of ICT penetration in the SME segment of the construction sector. Understanding this is important in two ways. Firstly it addresses the gap in terms of research in this area. Analysis of the available literature on ICT use in the construction sector of developing countries has shown that very little research exists in this area. Addressing this gap is important for research purposes in that it highlights the strengths and weaknesses of the sector and will be useful in the development of tailor-made solutions for the industry. It also allows relevant policy makers to be more aware of the status quo regarding ICT use in the construction industry, with a view of improving its exploitation in the sector.

Secondly, ICT has a role to play in assisting SMEs in being more productive. Given the drive by government in this area, it would be useful to ensure that ICT is exploited fully by the sector. The establishment of sustainable and profitable SMEs is in line with government policy as encapsulated in acts such as the BBBEE. This research then also subliminally attempts to address the issue of empowerment of

SMEs and women in particular by investigating the extent to which these government initiatives have impacted on ICT choice of the firms under investigation.

Analysis of available literature has also shown that it is important for a firm to ensure that its choice of technology is aligned to business processes. By aligning technology to broader company strategy, a firm increases the likelihood of exploiting ICT successfully. This is particularly important given the need to lower operation costs by companies involved in the highly competitive business environment of the construction sector.

The selection of ICT must also be linked to an acceptable level of investment in ICT that a firm will choose. As with all expenditure a firm undertakes, there should always be a trade-off between the benefits that the acquisition of new technology will bring with the costs of such technology. This requires a delicate balance as generally, literature has demonstrated that investment in ICT is viewed negatively by construction firms as they believe such an investment cannot be directly linked to rewards that one would expect. Therefore, before a business invests or foregoes the opportunity to invest in potentially beneficial technology, careful analysis should be done to ensure that some form of balance can be reached.

While the general belief that an investment in ICT does not bring expected benefits has been demonstrated to be an erroneous perception, work still needs to be done to ensure attitudes to new technology can be shifted. However, it is also important to ensure that ICT is not presented as the solution to every challenge a business might face. In this respect, it is important to ensure that businesses and SMEs in particular understand that the acquisition of new technology must always be shown to be necessary before major decisions are made. This is a role that the various training initiatives discussed in this research can play.

It should be noted that ICT's role in the construction sector is not in doubt. It has been demonstrated in the literature review as presented by various authors cited in this research. The literature review has also presented various ICT tools available for SMEs, each with various degrees of complexity. The suitability of these applications has been debated, and while all are useful, some of them such as Virtual Reality may not be relevant at this stage to SMEs in a third world setting. Again, one cannot

adopt ICT without linking it to the broader business strategy of the organisation in question.

The literature review has also demonstrated the challenges of skills generally experienced in the construction industry. This has been shown to be a global challenge and not just third world country problem. By analysing the available technology programmes by government, it has been shown that they are mostly inadequate in addressing the issues that they should i.e. skills transfer. Therefore, before a company embraces new technology, it must ensure that its staff has the relevant skills necessary to exploit that technology. If not, then clear plans must be put in place to ensure that relevant training is procured to allow full exploitation.

The methodology adopted has been demonstrated to be in line with research in this area of study as demonstrated by various authors. For this study, questionnaires were used to elicit information from the participants. To further enrich the study, cross tabulation and the colour coded cluster methods have also been used. However, this research is not exhaustive on the subject; it rather acts as a pilot study that is aimed at identifying the trends in the industry. In-depth understanding can only be achieved through further research on the subject matter.

Results obtained in this study have demonstrated that the general view that ICT penetration in the construction industry is low to be generally true. This interpretation must however be read remembering that this was not a random study but consisted of a specifically targeted group. These issues are discussed in more detail in the section below.

6.2. Conclusion

In conclusion, it can be noted that ICT use has many potential benefits to a business when it is aligned to the broader business strategy of the organisation. The research has demonstrated the positive view with which ICT is regarded in the sector, with the benefits identified being directly linked with those in researched literature. While this positive outlook is important for ICT's future growth in the sector, there still remains a disparity between the use of simple and complex ICT tools in the sector. Consequently, the use of ICT in the sector is widespread, if one considers basic devices such as mobile phones or basic applications such as e-mails. However, the

use of complicated and more advanced forms of ICT such as computerised accounting systems and Enterprise Resource Planning (ERP) systems still lacks development and as a result SMEs will require assistance in their endeavours to acquire and exploit these forms of advanced ICT.

Authors who have researched ICT use in the construction sector (Anumba et al, 2006; Ballan and El-Diraby, 2011; Underwood and Khosrowshahi, 2012) have identified many of its potential benefits (Section 2.8). ICT is useful for improving communication between a contractor's internal staff and between the contractor and other project stakeholders such as the client or project sponsors. The respondents concur with this as indicated by their rating of ICT as helping their communication systems and interaction with clients and suppliers. ICT is also useful for improving customers' perception about a business especially when it is used to improve information exchange with clients.

Furthermore, faster information exchange leads to time savings as important information is quickly made available when required. Better real time communication through the use of devices such as PDAs is also useful for the handling of ad hoc onsite problems. This may also lead to improved productivity, a view which most of the respondents concur with.

Websites also benefit companies in a variety of ways including improving a company's online visibility. This can help with access to new sales opportunities. Furthermore, ICT can improve the speed of procuring goods and services especially when requests are sent electronically. ICT is also useful for record keeping and keeping better control of finances through computerised accounting systems.

The research demonstrates that participants do agree with the list of benefits above, and although most have not adopted advanced forms of ICT, they have still managed to experience some of these benefits especially on improved communication with clients and suppliers. However, this brings into question whether, for these SMEs, the adoption of more advanced forms of ICT is necessary, or whether it is just an additional cost that would not add value to their business. While there is no simple method of demonstrating this, a possible reason might be, as discussed earlier, that as long as ICT adoption is linked to business strategy, the

benefits may be realised. However, if ICT is to be linked to business strategy, then there should be a clear ICT strategy that guides the company in terms of issues such as the purchasing of new software and hardware. Furthermore, the ICT strategy would provide direction on skills training and IT support for the organisation. Without the ICT strategy, it would be a challenge to ensure full integration of ICT with business processes, leading to lost opportunities for improved productivity.

It must be noted that as organisations grow larger, their communications needs will become more complex, resulting is traditional forms of communications becoming inadequate. While the use of mobile phones, landlines, e-mails and internet access is widespread in the sector, the use of more advanced ICT tools is lagging behind. Since industries are becoming more sophisticated in the way that they communicate with each other and in the way in which information is sourced, processed and utilised, it is the researcher's view that the industry will eventually need to adopt these forms of technology, just as technologies such as e-mails and internet that were developed in the past few decades have made their entry into the construction industry.

However, since the survey reveals that one of the major barriers to ICT adoption is the lack of information on appropriate ICT solutions for the firms, the government and the private sector have a role to play. This role should not be limited to information provision only but must be extended to cover training in ICT skills as well. Furthermore, given the high use of mobile phones and high internet access, the focus now could be on enhancing these ICT tools to optimise their use and hence maximise the potential benefits to be obtained. This would be a useful step as the industry gradually moves to the adoption of more sophisticated forms of ICT as it would increase productivity through the hardware and software that they have already invested in.

More advanced ICT tools such as Virtual Reality (VR) and CAD are still not widely used for the industry. While VR may not be recommended to SMEs at this stage, CAD can potentially benefit SMEs for example through the enrichment of drawings through addition of information such as a contractor's temporary works. However, a strong need for its use in a particular organisation will have to be established

individually. Organisations cannot rush to adopt CAD just because a competitor has done the same, as this might be detrimental to the organisation since CAD is quite expensive to purchase. Furthermore, it requires specialised skills and hence it might be suited to SMEs with more experience in the sector as opposed to start-up businesses.

An area that also offers potential is e-commerce, which has room for improvement especially given the fact that SMEs are unable to carry out transactions on their websites. In the cases where respondents do have company websites, these are neither monitored nor updated regularly which results in their ineffectiveness. While there can be significant costs associated with running a website, a balance will need to be struck between the benefits that it will offer and the associated costs. OECD (2004:8) notes that "for small firms to adopt e-business and e-commerce strategies and tools, benefits must outweigh investment and maintenance costs."

While the concept of an acceptable level of ICT investment is well established, measuring it is quite difficult. The challenge is that it is very difficult to quote a figure or percentage, as it must be context driven. For example, if ICT investment is expressed as a percentage of the annual turnover of a company, one may arrive at a range (guided by empirical research) of a level that may be adequate. However, the size of a company affects this determination and so does the year in question. For large companies, while the cost of ICT might be high, it will be offset by expenditure in other areas leading to a low percentage of the annual turnover. Furthermore if the research is done in the first year, the investment might be high due to start-up costs. If done at later stage, the amount spent on ICT might be lower since it may comprise mostly of maintenance cost.

While literature provides useful guidelines in this respect, there cannot be a blanket approach to the acceptable level of ICT investment as demonstrated in the research. SMEs will have to adopt levels that suit their individual business models in order to ensure the effectiveness of their investment. Furthermore, ICT investment must be coupled with properly formulated ICT strategies that will guide the business in adoption of ICT. The principle that the benefits that ICT brings must outweigh investment and maintenance costs is equally applicable in this instance. This is an

important aspect, along with developing an ICT strategy that aligns with the business strategy, that would be beneficial to address in government-led support and training initiatives. This is perhaps more significant than the teaching of operational skills, as it speaks directly to the viability of the SME, the major reason that these government programmes were initiated.

ICT decisions appeared to be influenced by a variety of factors, but most prominent are the issues of access to information on available ICT solutions. This can be tied directly to poor communication with the SMEs by the ICT sector and the need for better cooperation between government, training institutions, the ICT industry and SMEs. There is potential for integration that should be explored to enhance the use of ICT. There are also other barriers to the adoption of ICT reported in the research and these include cost, lack of skills and general challenges in getting advice. Small businesses could benefit if ICT related information, especially on the benefits and associated costs was made readily available.

A challenge with ICT adoption in the construction sector is the difficult in quantifying its direct benefits. While in sectors such as manufacturing, the benefits advanced ICT tools such as e-commerce can easily be quantified by measuring increased demand of products or cost per unit of output against historical data, the same cannot be easily done in construction due to the nature of construction projects. This factor tends to act as a barrier to adoption of advanced forms of ICT as demonstrated in this research.

Training is a key issue and this research demonstrates the inadequacy of existing institutions to bring ICT to SMEs. While the training of SMEs in ICT related matters cannot be a government function alone, government needs to demonstrate more leadership in this regard and to cultivate an enabling environment for such training to take place. The ICT industry must also do more to ensure that their products are communicated clearly to prospective clients, especially SMEs in construction. Partnership with government might prove synergetic in this regard. Furthermore, they should ensure that part of their corporate responsibility involves the training of SMEs. This will be beneficial to all parties concerned as the private sector can access a broad client base, government has productive SMEs and SMEs

themselves can improve their efficiency and consequently their bottom line. Therefore, it is important that the use of partnerships in fostering ICT training is encouraged in the sector.

6.3. Recommendations

- SMEs are assisted in developing and maintaining websites as a tool for marketing their businesses. These websites help to make their organisations more visible on the World Wide Web. Furthermore, they can extend these websites to allow prospective clients to get quotations for their work and to provide feedback to the company on their experience.

- Assistance is provided to SMEs who already own websites to allow them to carry out secure transactions on these websites. Transacting online will save time and allows access to a larger market as geographical location will not be a limit to access required products. This is particularly important given the dispersed nature of construction projects and the need to access inputs near project sites in order to cut transport costs.

- Continued government assistance to expand broadband coverage for underserved groups is recommended especially in areas that are underserved by private sector initiatives. However, this should be carried out without inhibiting competition in the ICT sector.

- Funding is provided by government in order to help develop ICT skills in the construction sector. This funding can be tied to organisations such as SEDA and the CIDB to ensure new SMEs are familiarised with the need for ICT skills that will be beneficial to their businesses.

- Training providers, NGOs and Government agencies work more closely together to raise awareness of the benefits of ICT to the construction sector. Organisations such as Khuthaza can assist by developing an enabling environment for information exchange to take place between SMEs. Thus while mentoring may not be fully fledged, organisations will still be able to share information on their individual experiences with regards to ICT use.

- Government and SEDA in particular must work closely with training organisations affiliated with construction companies to ensure that there is complete information dissemination about ICT related training programmes to all SMEs in construction.

- The CIDB and related organisations must ensure that they provide information on available government initiatives on ICT to the lower grades of contractors on the CIDB rating scale. Furthermore, the CIDB needs to look at ways of incorporating ICT use in their grading system as a way of encouraging ICT use in lower level contractors.

- Registering authorities such as the Companies and Intellectual Property Commission (CIPC) must help to provide information on these programmes to new entries in the constructions business.

6.4. Limitations

The results obtained in this study provide insight into industry trends in the construction sector in Gauteng in terms of ICT use. However, since this study was limited to contractors in Gauteng, affiliated with the Khuthaza training programme, some of the recommendations given may apply directly only to these contractors. The recommendations may not fully represent the dynamics in other provinces and if they are adopted for other areas, then similar research must be carried out to ensure their adaptation to the target group.

Furthermore, this research concentrated on SMEs with the bulk of the respondents having less than 20 employees (93% of respondents). Further research will be necessary to establish the trends associated with larger companies in the SME segment of the construction sector.

6.5. Further study

There is a need to further explore ICT utilisation in other provinces in the country. The role of advanced forms of ICT such as Virtual Reality, need to be explored to evaluate whether it can be recommended for SMEs especially during their training phase.

7. References

Adriaanse, A. & Voordijk, V., 2005. *Interorganizational communication and ICT in construction projects: a review using metatriangulation*. Netherlands: Emerald Group Publishing Limited.

Ahmed, SM., Ahmad, I, Azhar, S. & Mallikarjuna S., 2002.*Implementation Of Enterprise Resource Planning (ERP) systems in the construction industry*, Florida International University, Miami, USA.

Arif, A A & Karam, A H., 2005. 'Architectural Practices and IT: Local vs International.' *Journal of Engineering, Design and Technology.* Vol. 3, no. 2, pp. 155-163.

Alexiades, M.N., 1996. Editor of *Selected Guidelines for Ethnobotanical Research: A field manual*. The New York Botanical Garden, New York.

Anumba,C.E.H., Dainty, A., Ison, S., & Sergeant, A.,2006,'Understanding structural and cultural impediments to ICT system integration: A GIS-based case study', *Engineering, Construction and Architectural Management*,Vol. 13 Iss: 6 pp. 616–633.

Ballan, S. & El-Diraby, T.E., 2011. 'A Value Map for Communication Systems in Construction.' *Journal of Information Technology in Construction.* Vol. 16, pg. 745-760.

Bernard, H.R., Pelto, P.J., Werner, O., Boster, J., Romney, A.K., Johnson, A., Ember, A. & Kasakoff, C.R. 1986. 'The construction of primary data in cultural anthropology.' *Current Anthropology 27*: 382-396.

Betcherman, G , Olivas, K, & Dar, A .,2004. "Impacts of Active Labor Market Programs: New Evidence from Evaluations with Particular Attention to Developing and Transition Countries." World Bank, *Social Protection Discussion Paper Series*, Paper No. 402.

Björk, CB., 2002. 'Electronic Document Management in Construction – Research Issues and Results.' *Journal of Information Technology in Construction (ITcon)*. Vol 8, pp. 105-117.

Bouchlaghem. N., Thorpe, A & Liyanage, I. G.,1996. *Virtual Reality applications in the UK's Construction industry*. Retrieved 6 June 2012 from http://itc.fgg.uni-lj.si/bled96/papers/bouchlag.pdf cited 28 April 2012.

Brewer,GJ, Gajendran, T & Chen, S.E., 2011. *The use of ICT in the construction industry: critical success factors and strategic relationships in temporary project organisations*. Research paper, University of Newcastle, Australia.

Bruggemans, C., 2006. 'Infrastructure take-off.' In Rust, C, Ittmann, H, Van Wyk, L, and Kistan, K (2009) 'Technology for infrastructure development: is South Africa well positioned?.' Retrieved 9 April 2012 from http://www.sabinet.co.za/abstracts/civeng/civeng_v17_n9_a4.html

Bruwer, J.P., 2010. 'Sustainability of South African FMCG SMME retail businesses in the Cape Peninsula.' MTech Thesis, Cape Peninsula University of Technology cited 18 June 2012 from CPUT Theses & Dissertations: Digital Knowledge.

Chien, H.J., & Barthorpe, S., 2010. 'The current state of information and communication technology usage by small and medium Taiwanese construction companies.' *Journal of Information Technology in Construction (ITcon).*Vol 15 pp 75-85.

Choudhury, A., 2009. *Mann-Whitney U-Test*. Retrieved 16 June 2012 from http://www.experiment-resources.com/mann-whitney-u-test.html

Construction Industry Development Board, 2011a. *Construction Industry Financial Modeling Options for Contractor Support and Developmen*t. Pretoria: CIDB.

Construction Industry Development Board, 2011b. *The CIDB Quarterly monitor.* Pretoria: CIDB.

Cork, R., 2010. *Examining the construction industry's move from point solutions towards Project-based ERP*, IFS UK.

Charting Student Information, n.d. Retrieved 26 February from http://www.collegestar.ecu.edu/modules/csi/description

Cross tabulation analysis, n.d., retrieved 26 May 2013 from http://www.qualtrics.com/university/researchsuite/docs/CrosstabulationAnalysis.pdf

Davies, L., Jupe, J & Perry, D., 2000. 'No Bits - No Nothing.' *The Journal of Design and Technology Education.* Vol. 5, no1, pp. 52-54. D and B Special Report. (2011) 'Global Business Failure Report.' USA: Dun & Bradstreet Limited.

Department of Public Works, 1999. *White Paper: Creating an enabling environment for reconstruction, growth and development in the construction industry.* South Africa.

Department of Trade and Industry, 2011. *Towards an Enabling Environment For Women Economic Empowerment In South Africa.* Pretoria: DTI.

Esselaar, S., Gillwald, A. , Moyo, M. & Naidoo, K. (2010) 'South African ICT Sector Performance Review 2009/2010.' *Towards Evidence-based ICT Policy and Regulation Journal.* Vol. 2, no6, pp 1-45.

Godambe, V.P., 1982. Estimation in survey sampling: robustness and optimality. *Journal of the American Statistical Association* 77:393-403.

Gordhan, P., 2012. *Minister of Finance: Budget Speech,* National Treasury, Pretoria.

Gorden, R., 1992. *Basic Inteviewing Skills*. Peacock.

Greener, S., 2008. *Business Research Methods.* Ventus publishing.

Hamilton, I., 2002. 'The Big Issues in Construction IT.' *Construction News IT Report.* No. 5346, March 26.

Hendrickson, C. & Au, T., 2008. *Project Management for Construction :Fundamental Concepts for Owners, Engineers, Architects and Builders*, http://pmbook.ce.cmu.edu/

Hewage, KN., Ruwanpura, J.Y. & Jergeas, G.F., 2008. 'IT usage in Alberta's building construction projects: Current status and challenges.' *Automation in Construction Journal.* Vol 17, No. 8, pp. 940–947.

Hussey, J. & Hussey, R.. 1997. *Business Research A Practical Guide for Undergraduate and Postgraduate Students.* London: Macmillan Press Ltd.

International Telecommunication Union, 2011. *ICT facts and Figures*. Retrieved 10 April 2012 from.http://www.itu.int/ITU-D/ict/facts/2011/material/ICTFactsFigures2011.pdf

International Telecommunications Union, 2011. *Measuring the information society.*, Geneva retrieved 10 June 2012 from http://www.itu.int/ITU-D/ict/publications/idi/material/2011/MIS_2011_without_annex_5.pdf

ILO, 2001.*The construction industry in the twenty-first century: Its image, employment prospects and skill requirements*, Geneva.

Irtishad, A. &Maung, K.S., 2008. 'Transformational Capabilities of ICT: A Technology Management Perspective in Construction' *Proceedings of the PICMET 2008*, 27-31 July, Cape Town, South Africa. Retrieved 30 September 2012 from PICMET online database.

Jackson, S.L., 2010. *Research Methods: A modular approach*. Second edition, Jacksonville university, USA.

Kandie, W, Ngassam, EK, & Dlungwana, S., 2009. 'Enhancing the Quality of Service Delivered by South Africa's Small Contractors through e-Mentoring.' *Proceedings of the ICL conference* Villach, Austria, pp398-406.

Karmel, T.S. & M. Jain., 1987. 'Comparison of purposive and random sampling schemes for estimating capital expenditure.' *Journal of the American Statistical Association* 82:52-57.

Kenny T C, Wong, A.K. & Wong F., 2005. *The utilisation of building information models in nD modelling: a study of data interfacing and adoption barriers*, retrieved May 2012 from http://www.itcon.org/2005/08/

Landrebe J.,Wurst, W. & Welzl, G.,2002. *Permutation-validated principle components analysis of microarray data*. Retrieved 26 February from http://www.readcube.com/articles/10.1186/gb-2002-3-4-research0019

Mahoney, J.J., Tatum, C.B & Kishi, K., 1990*. Construction Site Applications of CAD*. Centre for Integrated facility management, Stanford University.

Manseau, A.& Seadon, G., 2001. *Innovation in construction: an international review of public policies*. London: Spon Press.

Martin, J., 2003. 'E-Procurement and Extranets in the UK Construction Industry.' *TS6 Current Developments in Construction Economics,* FIG Working Week 2003, April 13-17, 2003, Paris.

Martin, L & Root, D., 2010. 'Emerging contractors in South Africa: interactions and learning.' *Journal of Engineering, Design and Technology,* Vol. 8 no.: 1, pp.64-79.

May, A, Mitchell, V, Bowden, SL and Thorpe, T. (2005) Opportunities and challenges for location aware computing in the construction industry. Retrieved 14 April 2012 from http://hdl.handle.net/2134/2803 cited 14 April 2012.

McCrea, A., 2003a. 'Different Look at the Knowledge Management in Construction', IT Construction Best Practice Programme (ITCBP). *Intelligence Weekly Newsletter*, Published on February 18, London UK.

McCrea, A., 2003b. 'Technology Attempts to 'Resolve' KM.' IT Construction Best Practice Programme (ITCBP).' *Intelligence Weekly Newsletter*, Published on February 27, London UK.

Meth.,C. 2011. "Employer of Last Resort? South Africa's Expanded Public Works Programme (EPWP)" *Southern Africa Labour and Development Research Unit Working Paper Series*, Paper No. 58.

Michaloski, A.O. & Costa, A.P.C.S., 2010. 'A survey of IT use by small and medium-sized construction companies in a city in Brazil.' *Journal of Information Technology in Construction (ITcon).* Vol. 15, pp. 369-390.

Mutesi, T.E. & Kyakula, M., 2009. *Application of ICT in the Construction Industry in Kampala*, Kyambogo University, Uganda.

National Planning Commission, 2011. *National Development plan: vision for 2030.* The presidency, South Africa

OECD, 2004. *ICT, E-BUSINESS AND SMEs* .OECD, Paris.

Oxford Dictionaries, 2010. Oxford University Press, retrieved 10 November 2012 from http://oxforddictionaries.com/definition/english/sample.

Ramesys, 2001. 'A question of IT', *Contract Journal,* August 8, p22.

Rivard, H., 2000. 'A survey on the impact of information technology on the Canadian AEC industry.*' Electronic Journal of Information Technology in Construction*, Vol. 5, pp. 37-56.

Roux, E., Dlungwana, W.S., Setswalo, L., & Lazarus., 2007. *Implementation of the Integrated Emerging Contractor Development Model: Towards enhanced competition for small construction firms.* INTERNET. http://www.csir.com cited 12 April 2012.

Rust, C., Ittmann, H., Van Wyk, L & Kistan, K., 2009. *Technology for infrastructure development: is South Africa well positioned?* INTERNET. http://www.csir.com cited 10 August 2012.

Rust, F.C., Botha, C., Van Wyk, L., Steyn, W., Du Plessis, C., Landman, K & Coetzee, M., 2008a. *South African Construction Industry Technology Foresight Study: Summary report of desktop study*, CSIR Technical Report: CSIR/BE/SRM/ER/2008/0063/B, October2008, CSIR, Pretoria.

Rust, F.C & Koen, R.,2011. 'Positioning technology development in the South African construction industry: a technology foresight study.' *Journal of the South African Institution of Civil Engineering*, Vol 53 No 1, April 2011, Pages 2–8, Paper 759.

Sarshar, M. & Isikdag, U., 2004. ‘A survey of ICT use in the Turkish construction industry.’ *Engineering, Construction and Architectural Management,* Volume 11, Number 4, pp. 238–247.

Saunders, M., Lewis, P. & Thornhill, A., 1997*. Research Methods for Business Students.* London: Pitman Publishing.

Shen, Q.P. & Fong, P.S.W., 2002. ‘A Study of Information Technology Applications Among Contractors in Hong Kong.’ *International Journal of Construction Information Technology,* Vol. 7, No. 1, pp 1-19.

Small Enterprise Development Agency, 2011. *Annual report 2010-2011*. Pretoria.

Small Enterprise Development Agency, 2009. *Ehlanzeni SMME development and support plan (2009-2014).* SEDA Pretoria.

Smith, M.D, 2007. *Northwest Business ICT Survey 2007 A Final Report to the NWDA* retrieved April 2012 from www.sqw.co.uk

Smith, P., 2011. ‘Building confidence down sharply in Q1, index shows.’ *Engineering news,*10 March 2011 retrieved 10 May 2012 from http://www.engineeringnews.co.za/article/building-confidence-down-sharply-in-q1-index-shows-2011-03-10

Snedecor, G.W., 1939. ‘Design of sampling experiments in the social sciences.’ *Journal of Farm Economics* 21:846-855.

The Department of Women, Children and People with Disabilities, 2000. *South Africa's National Policy Framework for Women's Empowerment and Gender Equality*, Pretoria.

Statistics South Africa, 2007. *Mid-year population estimates 2007.* Statistics South Africa, Statistical release P0302, 3 July 2007.

Statistics South Africa, 2011. *Midyear Population Estimates.* Statistical release P0302 StatsSA, Pretoria.

Statistics South Africa, 2011. *Statistics of liquidations and insolvencies (Preliminary)* Statistical release P0043, StatsSA, Pretoria.

Tan, R.R., 1996. ‘Information technology and perceived competitive advantage: an empirical study of engineering consulting firms in Taiwan’, *Journal of Construction Management and Economics*, Vol. 14, No. 3, pp.227–240.

The benefits of e-tendring. (undated) retrieved 20 May 2012 from http://www.etenderer.com/benefits.aspx

Tongco, M.D.C., 2007. ‘Purposive sampling as a tool for informant selection.’ *Journal of Ethnobotany Research & Applications* Vol. 5, pp.147-158.

Topp, L., Barker, B. & Degenhardt, L., 2004. ‘The external validity of results derived from ecstasy users recruited using purposive sampling strategies.’ *Drug and Alcohol Dependence* 73:33-40.

DTI, 2011.*Towards an Enabling Environment for Women Economic Empowerment in South Africa.* Version no.1.

Trochim, W.M.K., 2006 *Research Methods: Knowledge base.* Second Edition, Cornel l University.

Tse, T.K, Wong, A.K., & Wong, FK., 2005. ‘The utilisation of building information models in nD modelling: a study of data interfacing and adoption barriers.*’ Journal of Information Technology in Construction (ITcon).* Vol. 10 pp 1-26.

Tse, T.C. &Wong, K.D., 2004. ‘A Case Study of the ISO 13567 CAD Layering Standard for Automated Quantity Measurement in Hong Kong.*’ Journal of Information Technology in Construction (ITcon).* Vol. 9, pp. 1-20.

Thwala, D.W. & Phaladi, M.J., 2009. ‘An exploratory study of problems facing small contractors in the North West province of South Africa.’ *African Journal of Business Management.* Vol. 3, no. 10, pp. 533-539.

Underwood, J., & Khosrowshahi, F., 2012. ‘ITC expenditure and trends in the UK construction industry in facing the challenges of the global economic crisis.’ *Journal of Information Technology in Construction (ITcon),* Vol. 17, pp. 25-42.

UNPF., 2007. *State of the world population 2007:Unleashing the potential of urban growth.* United Nations Population Fund.

Woksepp, S. & Olofsson, T.,2008. ‘An evaluation model for ict investments in construction projects’ *Journal of Information Technology in Construction (ITcon),* Vol. n (200n), pp. 1-19.

Whyte, J. & Bouchlaghem, D., 2001. ‘IT Innovation within the Construction Organisation’ *The Proceedings of CIB-78 International Conference, IT in Construction in Africa,* p.32-32.

Whyte, J., Bouchlaghem, N., Thorpe, A. & McCaffer, R., 1999. ‘A Survey of CAD and Virtual Reality within the House Building Industry’, *Journal of Engineering, Construction and Architectural Management,* Vol. 6, No 4,pp.371-379.

Yang, LR., 2007. ‘Exploring the links between technology usage and project outcomes.’ *Journal of Construction Management and Economics.* Vol. 25, No. 10, pp. 1041 – 1051.

Young, JD., 2002. *The Benefits of Online Tender Management*. International Management Consultants & Project Managers, UK: INDECO Ltd.

Appendix A: Questionnaire

INTERVIEWEE DETAILS FROM SAMPLE

Interviewee name & surname _____

Age _____

Firm name _____

Telephone number _____

Postcode _____

Employee size _____

[Square brackets] indicate text to be read out only if further explanation of a question is required

INTRODUCTION

Good morning/afternoon. My name is Progress Hlahla, I am a student at the University of the Witwatersrand. As part of my research project, I am undertaking a study on the current levels of ICT usage in the construction industry in Gauteng. The survey is looking at businesses' use of Information and Communications Technology such as computers, the internet, mobile phones and fixed landlines. I would very much appreciate hearing your views. This work will help to increase the body of knowledge on ICT use and might help businesses to get the most out of these technologies through understanding the appropriate levels of ICT investment, the way ICT is utilised to add value to construction processes and the challenges that businesses face in its implementation. Is it possible to speak to the person responsible for making decisions about Information Technology and telecommunications [for example the managing director or the IT director]?

If already speaking to the correct person add: The interview should take about 30 minutes.

If the IT/telecoms decision maker is at a different site, add: In that case, could I speak to the person who manages your business at this site?

Code (tracking)……

Questionnaire

Code (tracking)……..

SECTION 1: COMMUNICATIONS SYSTEMS AND PROCEDURES

Does your firm use the following equipment or facilities?

		Yes	No	Don't Know
Q1.1	Telephone landline			
Q1.2	Mobile phones,			
Q1.3	Personal Digital Assistants e.g. Blackberrys, tablet computers			
Q1.4	Computers (Laptops and Desktops)			
Q1.5	A Local Area Network [linking up computers at this site]			
Q1.6	Internet access			
Q1.7	EDI (Electronic Data Interchange) [a way of exchanging data between different companies' computer systems in a standard format, typically used for automating purchase orders and invoices between customers and suppliers]			

If yes at Q1.6, then ask Q1.8: How do you connect to the internet from this site? (read out, allow more than one selection)

Dial-up modem	
ISDN	
Broadband	
Don't know	

If answer is broadband at Q1.8 then ask Q1.9-Q1.11

Q1.9 How is the broadband connection provided to this site by your internet service provider?

(prompt only if necessary)

ADSL [a broadband service provided over a phone line, with higher downstream than upstream speeds]	
SDSL [a broadband service provided over a phone line, with equal upstream and downstream speeds]	
Cable modem [a broadband service provided by a cable TV operator]	
Leased line	
Wireless	
Satellite	
Other	
Don't Know	

Q1.10 At what speed does your internet connection allow you to download? (prompt only if necessary)

Less than 250 kilobits per second	
Between 250k and 499k [kilobits per second]	
Between 500k and 999k [kilobits per second]	
Between 1 Meg [megabits per second] and 1.9Meg	
Between 2 Meg and 4.9 Meg [megabits per second]	
Between 5 Meg and 9.9 Meg [megabits per second]	
Over 10 Meg [megabits per second]	
Don't know	

Q1.11 How likely are you to need a faster broadband connection in the next 18 months?

Very likely	
Likely	
Unlikely	
Very unlikely	
Don’t know	

If answer is don’t know at Q1.8, ask 1.12

		Yes	**No**	**Don’t Know**
Q1.12	Is broadband currently available in your area?			

If no at Q1.12 then ask Q1.13

		Yes	**No**	**Don’t Know**
Q1.13	If broadband was available in your area, would you			

If Code yes at Q1.12 or Code no at Q1.13 then ask Q1.14

Q1.14What are your reasons for not using broadband connectivity? (do not prompt, code all that apply)

Wasn’t available until recently	
Not needed for the business	
Too expensive	
Lack of time (management or staff)	
Lack of skills (management or staff)	
Uncertainty over which supplier or service to use	
Concern over the integration with existing	
Reluctance to change (management or staff)	
Security concerns (viruses, hackers etc.)	
Other	

SECTION 2: ICT APPLICATIONS

Which of the following information technology applications does your firm use at this site?

		Yes	No	Don't Know
Q2.1	Email			
Q2.2	The internet [the worldwide web]			
Q2.3	Voice over IP [which allows you to use an internet connection for cheap or free telephone calls]			
Q2.4	Specialist software such as CAD/CAM [Computer Aided Design/Manufacture] applications, project management software or geographic mapping software			
Q2.5	Remotely hosted applications and software			
Q2.6	Online ordering of products or services from suppliers			
Q2.7	An intranet [internal websites for firm's own use]			
Q2.8	Computerised accounting systems [systems for recording and monitoring your firm's finances]			
Q2.9	Systems for sharing documents [for example, on a shared drive or on an intranet]			
Q2.10	Systems for sharing customer information [for example customer relationship management or contact management systems]			

Q2.11	Systems to handle order processing [systems for recording and monitoring customer orders]			
Q2.12	Computerised stock control systems [systems for recording and monitoring stock levels]			
Q2.13	Supply chain management system [systems controlling the flow of products, information and finances between you and your suppliers or between you and your customers]			
Q2.14	Human resource management systems [including in-house payroll systems]			
Q2.15	Enterprise Resource Planning systems [integrated software packages with various modules for managing activities such as customer service, stock control, supply chain management etc.]			
Q2.16	Remote access to your internal systems [e.g. allowing staff to access systems from home]			

Q2.17 Approximately what percentage of people at this site use computers every day, as a routine part of their job?

Percentage _____

Don't know _____

If yes at Q1.6 then ask Q2.18

Q2.18 Approximately what percentage of people at this site use the internet [that is the web or email] every day, as a routine part of their job?

Percentage _____

Don't know _____

Ask all

		Yes	No	Don't Know
Q2.19	Does your firm use video conferencing?			

If Code no at Q1.4 then ask Q2.20

Q2.20 How likely is your firm to start to use computers at this site in the next 18 months?

Very likely	
Likely	
Unlikely	
Very unlikely	
Don't know	

If Code if unlikely or very unlikely at Q2.20 then ask Q2.21

Q2.21 Why are you unlikely to use computers? (do not prompt, code all that apply)

Not needed for the business	
Too expensive	
Lack of time (management or staff)	
Lack of skills (management or staff)	
Reluctance to change (management or staff)	
Security concerns (viruses, hackers etc.)	
Other	

If yes at Q1.4 and no at Q1.6 then ask Q2.22

Q2.22 How likely is your firm to get internet access at this site in the next 18 months?

Very likely	
Likely	
Unlikely	
Very unlikely	
Don't know	

If unlikely or very unlikely *at Q2.22 then ask Q2.23*

Q2.23 Why are you unlikely to get internet access? *(do not prompt, code all that apply)*

Not needed for the business	
Too expensive	
Lack of time (management or staff)	
Lack of skills (management or staff)	
Reluctance to change (management or staff)	
Security concerns (viruses, hackers etc.)	
Other	

If Code yes at Q1.4 then ask Q2.24

Q2.24 Who provides your IT support? *(prompt only if necessary, code all that apply)*

Internal IT professionals	
An internal IT enthusiast	
An external service provider	
Equipment provider(s)	
No-one: we don't have any IT support	
Other	

SECTION 3: CURRENT USE OF CAD SOFTWARE

		Yes	No	Don't Know
Q3.1	Do you personally use CAD?			

			Don't Know
Q3.2	What brand(s) of CAD does your office use?		
Q3.3	What release(s) of this software does your office use?		
Q3.4	Did you first learn to draw manually or using CAD?		
Q3.5	What do you like about CAD?		
Q3.6	What do you dislike about CAD?		
Q3.7	Do you think or design with CAD?		
Q3.8	How has CAD changed your work?		
Q3.9	How has CAD changed your profession?		
Q3.10	How will CAD change the construction industry in the next 20		

If no at Q3.1 Then ask Q3.11, Are you planning to get CAD any time soon?

……

Q3.12 How soon?.....

SECTION 4: LEVELS OF ICT INVESTMENT

The next few questions are about the costs and benefits of ICT for your firm.

By "ICT" we mean Information and Communications Technologies including computers, software, IT support, internet access connectivity (including broadband), websites and fixed and mobile telephony.

Q4.1 Approximately how much has your firm spent on ICT equipment, software, support and services at this site over the last 12 months?

Investment in ICT hardware Rs _____

Investment in ICT software solutions Rs _____

Not disclosed _____

Don't know _____

		Next year's expenditure will be greater	Next year's expenditure will be about the same	Next year's expenditure will be less	**Don't Know**
Q4.2	Do you expect your ICT expenditure over the next 12 months to be greater or less than the expenditure over the last 12 months?				

		Yes	**No**	**Don't Know**
Q4.3	Does your firm have a documented ICT strategy?			

Considering the benefits of your use of ICT, to what extent do you agree with the following?

		Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree	**Don't Know**
Q4.4	It is helping us to access new sales opportunities						
Q4.5	It is helping us to access markets outside the country						
Q4.6	It is helping us to improve the way we interact with customers						
Q4.7	It is helping to improve customers' perceptions of our business						
Q4.8	It is helping us to improve the products/services delivered to customers						

Q4.9	It is helping us to improve the way we interact with suppliers/partners						
Q4.10	It is helping to make our staff more productive						
Q4.11	It is enabling us to reduce the number of staff we need						
Q4.12	It is helping us to keep better control of our finances						
Q4.13	If we had invested significantly less effort and money in ICT our competitive position would have suffered						
Q4.14	We could do more to exploit the ICT investment we've already made						
Q4.15	If we were better at exploiting ICT our profits would be higher						

Q4.16 Overall, how important do you consider Information Technology to be to your business, on a scale of 1 to 10 (where 1 is not at all important, and 10 is critically important) ? _____

SECTION 5: Government Initiatives

Q5.1 Which government ICT initiatives are you aware of that targets SMEs in construction?

……..

……..

……..

……..

……..

Q5.2 On a scale of 1 to 10 (1 being poor and 10 very effective) how would you rank their effectiveness?

_____

SECTION 6: e-commerce/TENDERING ONLINE

		Yes	No	Don't Know
Q6.1	Does your firm have a website?			

If yes at Q6.1then ask Q6.2– Q6.3

		Yes	No	Don't Know
Q6.2	Does your website allow customers to order and/or pay for your Products/services online?			

If yes at Q6.2 then ask Q6.3

Q6.3 Approximately what percentage of your annual turnover at this site is generated through orders placed online?

Percentage _____

Don't know

		Less than once a year	More than once a year, but less than once a month	Once a month to once a Week	More than once a week, but not daily	Daily or more frequently	**Don't Know**
Q6.4	How frequently is your firm's website updated? (do not read responses, probe to code)						

		Yes	**No**	**Don't Know**
Q6.5	Does your firm monitor the usage of its website? (for example the number of hits, page impressions, visitors, sales)			

If no at Q6.1 then ask Q6.6

Q6.6 How likely is your firm to develop a website in the next 18 months?

Very likely	
Likely	
Unlikely	
Very unlikely	
Don't know	

If unlikely or very unlikely *at Q6.6 then ask Q6.7*

Q6.7 Why are you unlikely to develop a website? *(do not prompt, code all that apply)*

Not needed for the business	
Too expensive	
Lack of time (management or staff)	
Lack of skills (management or staff)	
Reluctance to change (management or staff)	
Security concerns (viruses, hackers etc.)	
Other	

Q6.8 Why do you not allow orders or payments via your website? *(do not prompt, code all thatapply)*

Not needed for the business	
Too expensive	
Lack of time (management or staff)	
Lack of skills (management or staff)	
Reluctance to change (management or staff)	
Security concerns (viruses, hackers etc.)	
Other	

SECTION 7: VIRTUAL REALITY

		Yes	No	Don't Know
Q7.1	Do you personally use Virtual Reality applications			

			Don't Know
Q7.2	What brand(s) of Virtual Reality software does your office use?		
Q7.3	What release(s) of this software does your office use?		
Q7.4	What do you like about Virtual Reality		
Q7.5	What do you dislike about Virtual Reality		
Q7.6	Do you find VR useful for your company?		
Q7.7	How has Virtual Reality changed your work?		
Q7.8	How has Virtual Reality changed your profession?		
Q7.9	How will Virtual Reality change the construction industry in the next 20 years?		

If no at Q7.1 Then ask Q7.10, Are you planning to get VR any time soon?

……

Q7.11 How soon?.....

SECTION 8: FACTORS THAT INFLUENCE ICT DECISIONS

Q8.1 Which of the following tend to inform or influence your investment decisions on ICT? Just to remind you: “ICT” includes computers, software, IT support, internet access connectivity (including broadband), websites and fixed and mobile telephony. (read out, code all that apply)

Advertising or direct mail	
Articles in the press	
Views of new recruits	
Consultants	
Discussions with customers	
Discussions with competitors	
Discussions with suppliers	
Discussions with an accountant, bank or lawyer	
Discussions with firms in other sectors	
Discussions with friends or relatives	
A business organisation [such as a chamber of commerce or the Small Enterprise Development Agency]	
Business Links	
The Manufacturing Institute	
Another publicly funded organisation [such as a local authority/council or Further Education college]	
A wish to access e-government services (e.g. filing tax returns online)	
Government websites	
Research on the internet	

Q8.2 Which of the following tend to deter you from making investments in ICT, or delay your ICT investment decisions? (read out, code all that apply)

Lack of up-to-date information on what is available	
Low levels of IT awareness/understanding of managers	
Lack of time to assess what the firm should invest in	
Difficulty getting advice	
Uncertainty over the benefits to the business	
Uncertainty over which supplier, product or service to use	
Difficulties getting agreement within the firm	
Concern over the costs	
Concerns on security (hackers, viruses etc.)	
Concern over the integration with existing systems	
Concern over implementing changes to business processes	
Concern over staff skills	
Concerns over the need for training current staff	
A high turnover of staff, with concerns over training new staff	
Concerns over ongoing technical support	
ICT not seen as important for our business	

Thinking about the way your staff at this site use ICT, to what extent do you agree with the following?

		Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree	**Don't Know**
Q8.3	We find it difficult to find new recruits with adequate IT user skills						
Q8.4	We have problems with some staff being reluctant to adapt the way they do things when we introduce new IT applications						
Q8.5	Our staff generally have sufficient training in the IT applications they need to use						

Q8.6 When your staff need ICT training who would typically undertake this? (do not prompt, code all that apply)

Internal IT staff	
Other staff or management	
A consultant	
Private sector training provider	
Further Education college	
University	
Don't know	
Other (please specify)	

Q8.7 What sort of support do you think government agencies could provide that would help firms like yours get the most out of ICT ? (, code all that apply)

Information on the web about ICT	
A telephone helpline	
Workshops, seminars or other events about ICT	
Demonstration facilities	
Free reviews/audits of businesses' ICT systems	
Impartial help in identifying suppliers	
Support in training staff	
Free or subsidized consultancy	
Grants for equipment or software	
Tax breaks for ICT equipment or software	
Don't know	
Other (please specify)	

Q8.8 What could the ICT industry itself do better, to help? (do not prompt, code all that apply)

Better understanding of business needs	
Better trained sales staff	
Better information on the web	
More appropriate software products for our sort of business	
More appropriate hardware products for our sort of business	
Lower prices for ICT products and services	
High bandwidth affordable broadband services	
Free reviews/audits of businesses' ICT systems	
Other	
Don't know	

SECTION 9: CLASSIFICATION

Ask all

The last few questions are to enable us to classify the data from the survey.

Q9.1 How many people work for your firm at this site?

[include full time, part time and contractors, but exclude temporary/seasonal staff]_____

		Yes	No	Don't Know
Q9.2	Does your firm have any sites elsewhere?			

If yes at Q9.2 then ask Q9.3

		Yes	No	Don't Know
Q9.3	Is this site the headquarters for the firm?			

Q9.4 Where is your firm's headquarters?

Town	
City	
Province	

Ask all

Q9.5 Approximately how many years has the firm been trading?

[firm as a whole, not just this site]

Q9.6 What was your firm's approximate turnover at this site in the last financial year?

Turnover in Rs _____

Not disclosed _____

Don't know _____

Q9.7 Which of the following would best describe your views of the firm's turnover growth prospects over the next two years?

We will grow rapidly	
We will grow gradually	
We will stay about the same size	
We will reduce in size	
Not disclosed	
Don't know	

THANK AND CLOSE

Appendix B: Participant information sheet and the consent form

The Participant Information Sheet

This is the participant information sheet for owners and/managers of SMEs involved in the construction industry to participate in the research titled: **The use of Information and Communications Technology (ICT) in the construction sector in Gauteng: a case study of Khuthaza affiliated contractors.**

1. Introduction

My name is Progress Hlahla and I am a Masters of Science in Engineering student at the University of the Witwatersrand. I am doing research on the use of ICT in the construction industry in Gauteng. I am going to provide information and invite you to be part of this research. Participation in this research is voluntary.

This consent form may contain words that you may not understand. You are welcome to stop me at any point of the interview for me to explain the unfamiliar terms. If you have questions later during the implementation of this research you are welcome to ask me.

2. Purpose of the research

Information and Communications Technology (ICT) involves the use of devices like telephones, mobile phones and computers for personal or business purposes. The use of this technology has been argued to help companies to be more productive for instance by making communication between individuals and organisations quicker. The purpose of this study is to learn the types of ICT that your organisation currently utilises and to obtain information on your experience in the use of these devices.

3. Participation

This research will take the form of structured interviews where open and close end questions will be used to obtain information from the participants. The duration is estimated to be 30 minutes. You are being invited to take part in this research because your organisation can be classified as an SME and your experience can help understand the trends involving ICT use in the construction sector. Understanding these trends will allow responsible organisations and government departments to match their technological interventions to these trends.

Your participation in this research is entirely voluntary. It is your choice whether to participate or not. If you choose not to participate, no penalties or negative consequences will follow. You may choose to stop participation at any point in the interview and you may choose not to answer any part of the interview that you are not comfortable with.

4. **Procedure of the interview**

I will sit with you during the interview in a comfortable place to ask you the questions from the questionnaire. To make the interview quicker, I will record the answers on your behalf onto the questionnaire. If you do not wish to answer any of the questions asked you may indicate and I will move to the next one. The information obtained is confidential and will only be used for the purposes of the study.

5. **Risks and benefits**

Sensitive information provided during the research will be kept confidential and will only be used for the purpose of the research. When such information is made public, steps will be taken to ensure that the information is anonymised and that it cannot be traced to individual organisations. The potential benefit to your organisation may arise from the fact that understanding how the use of ICT differs in South Africa as compared to the developed world might help your organisation to better position itself in the sector for example by understanding the preferred level of ICT investment.

6. Sharing of results

The results obtained for this research will be shared with your organisation and will be in the public domain. However, none of the responses will be traceable to your individual organisation in the final report.

For any enquiries/clarification please contact:

Progress Hlahla

Cell: 071 851 2143

Email:progresshlahla@yahoo.co.uk

Or my supervisor

Dr. Anne Fitchett

Tel: 011 717 7107

Email: Anne.Fitchett@wits.ac.za

1. **The consent form**

I have been invited to participate in the research on ICT use in the construction Industry. The information contained in the participant information sheet has been read to me and I have had the opportunity to ask questions and they have been answered to my satisfaction. I consent voluntarily to be a participant in this study

Print Name of Participant_____

Signature of Participant _____

Date _____

Day/month/year

Statement by the researcher/person taking consent

I have accurately read out the information sheet to the potential participant, and to the best of my ability made sure that the participant understands the information contained in the consent form.

I have given the participant opportunity to ask questions and I have answered all questions to the best of my ability. I confirm that no form of coercion was used to obtain consent and that the consent was given freely and voluntarily.

Print Name of Researcher/person taking the consent_____

Signature of Researcher /person taking the consent_____

Date _____

Day/month/year

Appendix C: Khuthaza clearance letter

women • construction • talent • business

Attention: Mr. Progress Hlahla

Dear Progress,

APPROVAL FOR MR PROGRESS HLAHLA TO UNDERTAKE A STUDY ON THE USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY IN THE CONSTRUCTION SECTOR IN GAUTENG FOCUSSING ON KHUTHAZA AFFILIATED CONTRACTORS

The Khuthaza organisation has approved your request to undertake a study on the use of Information and Communications Technology in the construction sector in Gauteng focussing on Khuthaza affiliated contractors for your Masters of Science in Engineering degree.

All interviews and questionnaires shall only be carried out with the consent of the participants and the data so obtained shall solely be for the purposes of this research and shall not form part of any publication except the research report for the Masters of Science in Engineering degree. The findings, conclusions and recommendations of the research report shall be made available to the Khuthaza organisation.

Yours sincerely

.....

ELIZABETH O'LEARY
EXECUTIVE DIRECTOR
KHUTHAZA
DATE: 13 July 2012

Appendix D: Summary of results from key questions in this study.

The data is summarised based on the keys below:

Questions: 1.1 to 1.7 & 2.1 to 3.1	
Key	
Yes	1
No	2
Don’t know	3
Missing data	

Question: 1.8	
Key	
Dial-up modem	1
ISDN	2
Broadband	3
Don't know	4
Missing data	

Question: 4.2	
Key	
Next year's expenditure will be greater	1
Next year's expenditure will be about the same	2
Next year's expenditure will be less	3
Don't Know	4
Missing data	

Questions: 4.3 to 4.15	
Key	
Strongly agree	5
Agree	4
Neither agree nor disagree	3
Disagree	2
Strongly disagree	1
Don't know	0
Missing data	

Questions: 5.1 to 8.8	
Key	
Yes	1
No	2
Don’t know	3
Missing data	

Questions: 9.7	
Key	
We will grow rapidly	5
We will grow gradually	4
We will stay about the same size	3
We will reduce in size	2
Not disclosed	1
Don’t know	0

Respondent	Gender	Age of Respondent	Company size	Telephone landline	Mobile phones	PDAs	Computers	LAN	Internet	EDI	Type of internet connection
		Age	Size	Q1.1	Q1.2	Q1.3	Q1.4	Q1.5	Q1.6	Q1.7	Q1.8
1	Male	30--39		2	1	2	2	1	1	1	4
2	Female	30--39		2	1	1	1		1	2	2
3	Female			1	1	1	1	3	1	2	3
4	Female	20--29	<10	1	1	1	1	2	1	2	3
5	Female	30--39		2	1	1	1	2	1	2	3
6	Female	40--49	<10	1	1	1	1	2	1	2	
7	Male	50--59	<10	1	1	1	1	2	1	2	1
8	Female	30--39	<10	1	1	1	2	1	1	2	
9	Female	30--39	11--20	1	1	1	1		1		3
10	Female	30--39	<10	1	1	1	1	1	1	2	3
11	Female	30--39		1	1	1	1	2	1	3	3
12	Female		11--20	1	1		1		1		
13	Female	40--49		2	1	1	2	1	1		
14	Male	40--49	<10	1	1	1	1	1	1	1	2
15	Male	40--49	<10	2	1	2	1	1	1	2	1
16	Female	50--59	41-50	1	1	1	1	1	1	2	1
17	Female	40--49	>50	1	1	1	1		1	2	3
18	Female	40--49	<10	1	1	1	1	1	1	2	3
19	Female	20--29	<10	1	1	1	1	2	1	2	4
20	Female	50--59	11--20	1	1	1	1	2	2	2	4
21	Female	50--59	11--20	1	1	2	1	1	1	3	4

22	Female	50--59	11--20	2	1	1	1	3	1	1	
23	Female	50--59		1	1		1		1		1
24	Female	50--59	11--20	1	1	1	1		1	2	4
25	Female	30--39		1	1	1	1	1	1	1	1
26	Female	40--49		2	1	2	1		1	3	4
27	Male	40--49	<10	1	1	1	1	1	1	1	3
28	Male	50--59		1	1	1	1	2			1
29	Female	50--59	<10	2	1	2	2	3		3	1
30	Female	30--39		1	1	1	1	2	1	2	1

Respondent	Email	Internet	VoIP	Specialist software	Remote software	Online ordering	Intranet	Computerised accounting systems	Systems for sharing documents	Systems for sharing customer information	Systems to handle order processing	Computerised stock control systems
	Q2.1	Q2.2	Q2.3	Q2.4	Q2.5	Q2.6	Q2.7	Q2.8	Q2.9	Q2.10	Q2.11	Q2.12
1	1	1	1	1	1	1	1	1	1	1	1	1
2	1	1						2	2	2		
3	1	1										
4	1	1	3	3	3	1	1	1	2	2	2	2
5	1	1	1	2		1	2	2	2	2	2	2
6	1	1	2	2	2	2	1	1	2	2	2	2
7	1	1	3	3	3	3	1	3	2	2	2	2
8	1			3		1	1	3	1	1	1	
9	1	1	2	2	2	2	2	2	2	2	2	2
10	1	1	1	1	2	1	2	1	1	2	2	2
11	1	2		1	2	1	2	1	2	2	2	2
12	1											
13	3											
14	1							1	2	2	2	
15	1							2	2	2	2	2
16	1	1	2	2	2	2	2	1	2	2	2	2
17	1											
18	1	1						1				
19	1	1	2	1	1	1	1	1	1	1	1	1
20	1	1	1	1	1		1	2	2	2	2	2

21	1	1	3	3	3	3	3	2	2	2	2	2
22	1	3	3	3	2	2	2	2	2	2	2	
23	1	1						1				1
24	1											
25	1											
26	1	1		3	2	2	2	2	2	2	2	2
27	1	1				1		1	1			1
28	1	1										
29	1	1	1	3	3	3	3	3	3	3	3	3
30	1	1										

Respondent	Supply chain management system	Human resource management systems	Enteprise resource planning	Remote access to your internal	Video conferencing	Internal IT professionals	An internal IT enthusiast	An external service provider	Equipment provider(s)	No-one: we don't have any IT	Other	Use of CAD
	Q2.13	Q2.14	Q2.15	Q2.16	Q2.19	Q2.24a	Q2.24b	Q2.24c	Q2.24d	Q2.24e	Q2.24f	Q3.1
1	1	1	1	1	2	2	2	2	1	2	2	3
2					2	2	2	1	2	2	2	3
3					2	2	2	2	2	2	2	2
4	2	2	2	2	2	2	2	2	2	2	2	2
5	1	1	2	2	2	1	2	2	2	2	2	2
6	2	2	2	2	2	2	2	2	2	1	2	2
7	2	2	2	2	2	2	2	2	2	2	2	3
8	2	2	3	3	3	2	2	2	2	2	1	1
9	2	2	2	1	2	2	2	2	2	1	2	
10	2	1	2	1	1	2	2	1	2	2	2	3
11	2	2	2	2	2	2	2	2	2	1	2	2
12					2	2	2	2	2	2	2	
13					3	2	2	2	2	2	2	3
14	2	1	2	2	2	2	2	2	2	1	2	2
15	2	2	2	2	2	2	2	2	2	1	2	2
16	2	2	2	2	2	2	2	2	2	1	2	
17					2	2	2	1	2	2	2	3
18					2	1	1	2	2	2	2	2
19	1	1	1	1	2	2	2	1	2	2	2	2
20	2	2	3	2	2	2	2	1	2	2	2	3
21	2	3	3	3	2	2	1	2	2	2	2	3

22	2	2	2	2	2	2	2	2	2	2	2	2
23		1				2	2	1	2	2	2	2
24					2	2	2	2	2	1	2	
25					2	2	2	2	1	2	2	2
26	2	2		2	2	2	2	2	2	1	2	3
27	1	1		1	2	1	2	2	2	2	2	2
28					2	2	2	2	2	1	2	2
29	3	3	3	3	2	1	1	1	1	1	1	3
30					2	2	2	2	2	1	2	3

	Provision of ICT support					
Respondent	Internal IT professionals	An internal IT enthusiast	An external service provider	Equipment provider(s)	No-one: we don't have any IT support	Other
	Q2.24a	Q2.24b	Q2.24c	Q2.24d	Q2.24e	Q2.24f
1	2	2	2	1	2	2
2	2	2	1	2	2	2
3	2	2	2	2	2	2
4	2	2	2	2	2	2
5	1	2	2	2	2	2
6	2	2	2	2	1	2
7	2	2	2	2	2	2
8	2	2	2	2	2	1
9	2	2	2	2	1	2
10	2	2	1	2	2	2
11	2	2	2	2	1	2
12	2	2	2	2	2	2
13	2	2	2	2	2	2
14	2	2	2	2	1	2
15	2	2	2	2	1	2
16	2	2	2	2	1	2
17	2	2	1	2	2	2
18	1	1	2	2	2	2
19	2	2	1	2	2	2
20	2	2	1	2	2	2

21	2	1	2	2	2	2
22	2	2	2	2	2	2
23	2	2	1	2	2	2
24	2	2	2	2	1	2
25	2	2	2	1	2	2
26	2	2	2	2	1	2
27	1	2	2	2	2	2
28	2	2	2	2	1	2
29	1	1	1	1	1	1
30	2	2	2	2	1	2

	Rating of Benefits of ICT											
Respondent	Access new sales	External markets	Customer relations	Perception	Products	Interactions	Productivity	Staff reduction	Finances	Competition	Exploit ICT more	Profits
	Q4.4	Q4.5	Q4.6	Q4.7	Q4.8	Q4.9	Q4.10	Q4.11	Q4.12	Q4.13	Q4.14	Q4.15
1	5	5	5	5	55	5	5	5	5	5	5	5
2	5	2	5	5	5	5	3	3	5	3	3	1
3	5		5	5	5	5	4	5	5	5	5	5
4	5	3	5	5	5	5	5	5	5	5	5	5
5	1	3	5	4	3	5	2	2	5	4	4	3
6	5	5	5	5	5	5	5	5	5	1	5	5
7	5	5	5	5	5	5	5	5	5	5	5	5
8	5	5	5	5	5	5	5	4	1	1	1	
9	5	5	5	5	5	5	5	3	5	5	5	5
10	5	5	5	5	5	5	5	5	5	5	5	5
11	5	3	5	5	5	5	5	5	5	5	5	5
12	5		5	5	5	5			5			
13												
14	5	5	5	5	5	5	5	5	5	5	5	5
15	5	5	5	5	5	5	5	5	5	5	5	5
16	5	2	5	5	3	5	2	2	5	5	5	5
17	0	0	0	0	0	0	0	0	0	0	0	0
18	5		5	4	3	4	3	2	4	4	4	4
19			5	5	5	5	5			1	5	5
20	5	5	5	5	5	5	5	1	5	5	1	1

21	5	5	5	5	5	5	5	5	5	5	5	5
22	5	5	5	5	5	5	5	5	5	3	3	5
23			5	5	5		5	2	5		2	2
24												
25												
26												
27	5	1	5	5	5	5	5	5	5	5	5	5
28			5		5	5	5	5	5	3	3	3
29	5	5	5	5	5	5	5	5	5	5	5	5
30	5											

					Factors that influence ICT decisions															
Respondent	Gvt initiatives	Website	Online purchases	Use of VR	Advertising or direct mail	Articles in the press	New recruits	Consultants	Customers	Competitors	Suppliers	Accountant, bank or lawyer	Firms in other sectors	Friends or relatives	Business organisation	Business links	Manufacturing institutes	Public funded organisations	E-government services	Government websites	Research on the internet
	Q5.1	Q6.1	Q6.2	Q7.1	Q8.1a	Q8.1b	Q8.1c	Q8.1d	Q8.1e	Q8.1f	Q8.1g	Q8.1h	Q8.1i	Q8.1j	Q8.1k	Q8.1l	Q8.1m	Q8.1n	Q8.1o	Q8.1p	Q8.1q
1	1	2		3	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
2	2	2		2	2	1	1	1	1	2	1	1	2	1	2	1	2	2	1	1	1
3	2	1	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
4		1	2	3	1	1	2	1	1	1	1	1	1	1	2	1	1	2	1	1	1
5	2	1	1	3	1	2	2	2	2	2	2	2	2	2	2	2	1	2	2	2	2
6	2	2		2	1	2	2	2	1	1	1	1	1	1	1	2	2	2	2	2	2
7	2	2			2	2	2	2	2	2	1	2	2	2	2	1	2	1	2	2	2
8	1	2		1	1	1	1	1	1	1	1	2	1	1	1	1	1	1	2	1	2
9	2	1	2	2	1	2	2	2	1	2	1	2	1	2	2	1	2	2	2	1	2
10	2	1	2	2	1	1	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1
11	2	2		3	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	1
12					2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
13					2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2

14	2	2		3	2	2	2	2	2	2	2	2	2	2	1	2	2	2	1	2	2
15	1	2		2	2	1	2	1	2	2	1	2	2	2	2	1	1	1	2	2	2
16		1	1	3	1	1	2	2	2	2	1	1	2	2	1	2	1	2	1	1	1
17	1	2		3	1	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
18	1	1	1		2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	1
19	2	1	2	3	1	2	2	2	2	1	2	2	1	1	2	2	2	2	2	2	2
20		2		3	1	1	1	1	1	2	1	1	1	1	1	1	1	1	1	1	1
21	2	2		3	1	2	2	1	1	1	1	1	1	2	2	2	2	2	2	2	2
22	2	2		2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
23		2		3	1	2	2	2	2	2	2	2	2	2	2	2	2	2	2	1	1
24		3	3		2	2	2	2	1	1	2	2	2	1	2	2	2	2	2	2	2
25	2	2			2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
26	1	2		3	1	1	2	2	2	2	2	2	2	2	2	2	2	2	1	2	1
27		1	1	1	1	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
28	2	1	2	3	2	2	2	2	2	2	2	2	2	2	2	1	2	2	2	2	2
29		2			2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
30		2		2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2

	Provision of ICT training							
Respondent	Internal IT staff	Other staff or management	A consultant	Private sector training provider	Further Education college	University	Don't know	Other (please specify)
	Q8.6a	Q8.6b	Q8.6c	Q8.6d	Q8.6e	Q8.6f	Q8.6g	Q8.6h
1	2	2	2	2	2	2	1	2
2	2	2	1	1	2	2	2	2
3	2	2	2	2	2	2	2	2
4	2	2	2	2	2	2	1	2
5	2	2	1	1	2	2	2	2
6	2	2	2	2	2	2	1	2
7	2	2	2	2	2	2	2	2
8	1	1	1	1	1	1	1	1
9	2	2	1	2	2	2	2	2
10	2	2	2	1	2	2	2	2
11	2	2	1	2	2	2	2	2
12	2	2	2	2	2	2	1	2
13	2	2	2	2	2	2	2	2
14	2	2	2	1	2	2	2	2
15	2	1	2	1	1	1	2	2
16	2	2	2	2	2	2	2	1
17	2	2	2	1	2	2	2	2
18	2	1	2	1	2	2	2	2
19	2	2	2	2	1	2	2	2
20	1	1	2	2	2	2	2	2

21	2	2	2	2	2	2	1	2
22	2	2	2	2	2	2	1	2
23	2	1	2	2	2	2	2	2
24	2	2	2	2	2	2	1	2
25	2	2	2	2	2	2	2	2
26	2	2	2	2	2	2	2	2
27	1	2	2	2	2	2	2	2
28	2	1	2	2	2	2	2	2
29	2	2	2	2	2	2	2	2
30	2	2	2	2	2	2	2	2

	Required interventions from Government											
Respondent	Information on the web about ICT	A telephone helpline	Workshops, seminars or other events about ICT	Demonstration facilities	Free reviews/audits of businesses' ICT systems	Impartial help in identifying suppliers	Support in training staff	Free or subsidized consultancy	Grants for equipment or software	Tax breaks for ICT equipment or software	Don't know	Other (please specify)
	Q8.7a	Q8.7b	Q8.7c	Q8.7d	Q8.7e	Q8.7f	Q8.7g	Q8.7h	Q8.7i	Q8.7j	Q8.7k	Q8.7l
1	1	1	1	1	1	1	1	1	1	1	2	1
2	1	1	1	1	2	2	1	2	2	2	2	2
3	2	2	2	2	2	2	2	2	2	2	2	2
4	1	1	1	1	2	2	1	2	1	1	2	2
5	1	2	1	2	2	2	1	2	1	1	2	2
6	2	2	2	2	2	2	1	2	2	2	2	2
7	2	2	2	2	2	2	2	2	2	2	2	2
8	1	1	1	2	1	2	1	2	2	2	1	1
9	1	1	1	1	1	2	2	2	1	1	2	2
10	2	1	1	1	1	1	1	1	1	1	2	2
11	2	2	1	2	2	2	2	2	1	2	2	2
12	2	2	2	1	2	2	1	2	1	2	2	2
13	2	2	2	2	2	2	2	2	2	2	2	2
14	1	2	2	2	2	2	2	2	2	2	2	2
15	1	2	1	1	1	2	1	1	1	1	2	2
16	2	2	1	2	2	2	1	1	1	2	2	2
17	2	2	2	2	2	2	2	2	1	2	2	2
18	2	2	2	2	2	2	1	2	1	1	2	2

19	1	1	1	1	2	2	1	2	2	2	2	2
20	1	1	1	1	2	2	1	2	2	2	2	2
21	1	2	1	2	2	2	1	2	2	2	1	2
22	1	2	1	2	1	1	1	2	1	2	2	2
23	2	1	1	2	2	2	1	2	2	2	2	2
24	2	2	2	2	2	2	2	2	2	2	2	2
25	2	2	2	2	2	2	2	2	2	2	2	2
26	1	2	1	2	2	2	1	2	1	1	2	2
27	1	1	1	2	2	2	2	2	2	2	2	2
28	2	2	1	2	2	2	2	2	2	2	2	2
29	1	1	1	1	1	1	1	1	1	1	1	1
30	1	2	1	2	2	2	1	1	1	2	2	2

	Required interventions from ICT industry										
Respondent	**Better understanding of business needs**	**Better trained sales staff**	**Better information on the web**	**More appropriate software products for our sort of business**	**More appropriate hardware products for our sort of business**	**Lower prices for ICT products and services**	**High bandwidth affordable broadband services**	**Free reviews/audits of businesses' ICT systems**	**Other**	**Don't know**	**Business outlook**
	Q8.8a	**Q8.8b**	**Q8.8c**	**Q8.8d**	**Q8.8e**	**Q8.8f**	**Q8.8g**	**Q8.8h**	**Q8.8i**	**Q8.8j**	**Q9.7**
1	1	1	1	1	1	1	1	1	1	2	4
2	1	1	1	1	2	1	2	2	2	2	5
3	2	2	2	2	2	2	2	2	2	2	4
4	1	1	1	1	2	1	2	1	2	2	5
5	1	2	2	1	2	1	2	2	2	2	4
6	1	1	2	1	2	2	2	2	2	2	4
7	2	2	2	2	2	2	2	2	2	2	5
8	1	1	1	2	2	1	2	1	2	2	5
9	1	1	1	1	1	2	1	2	2	2	4
10	1	1	1	1	1	1	1	1	1	1	4
11	1	2	2	2	2	2	2	2	2	2	5
12	2	2	2	2	2	1	2	2	2	2	4
13	2	2	2	2	2	2	2	2	2	2	
14	1	2	2	2	2	2	2	2	2	2	4
15	1	1	1	1	1	1	1	1	1	1	4

16	1	2	2	1	1	2	2	2	2	2	5
17	1	2	2	2	2	2	2	2	2	2	4
18	2	2	2	2	2	1	1	2	2	2	4
19	1	2	2	2	2	1	1	2	2	2	4
20	1	1	1	1	1	2	2	2	2	2	4
21	1	1	1	1	1	1	1	2	2	1	0
22	1	1	1	1	2	2	2	2	2	2	4
23	1	2	2	1	1	2	2	2	2	2	4
24	2	2	2	2	2	2	2	2	2	2	1
25	2	2	2	2	2	2	2	2	2	2	1
26	1	1	1	1	1	1	1	1	2	2	4
27	1	1	1	2	2	2	2	2	2	2	5
28	2	2	2	1	2	2	2	2	2	2	4
29	1	1	1	1	1	1	1	1	1	1	1
30	2	2	2	2	2	2	2	2	2	2	1