

**APPLICATION OF COMMUNICATION MANAGEMENT TECHNOLOGIES ON
CONSTRUCTION PROJECTS**

By

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DECLARATION

I hereby declare that this submission is my own work and that, to the best of my knowledge and belief, it contains no material previously published or written by another person nor material which to a substantial extent has been accepted for the award of any other degree or diploma at Kwame Nkrumah University of Science and Technology, Kumasi or any other educational institution, except where due acknowledgement is made in the thesis.

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ABSTRACT

The use of technology has become necessary in all human endeavours because of the benefits it brings as the world continues to experience globalisation. The construction industry is one of the industries that is most reliant on information to successfully execute its activities. However, it has over the years been realised that the uptake of technologies is relatively low in construction as compared to other industries. With the rapid innovations in technology in the world, participants of the construction industry still do communicate with each other through conventional approaches such as hardcopy printouts and face to face meetings. Construction projects have however been evolving over the years from simple structures to complex projects and to that effect, a lot of project communication must be done efficiently, which is one of the major benefits that Information and Communication Technologies (ICT) provide. Although there are a good number of communication technologies which present numerous benefits to the user including increased productivity, it is still under-utilized on construction projects. Against this background, this research was initiated to find out the communication technologies that are used for project communication management. The research further sort to find out the barriers that have hindered the successful adoption of communication technologies on construction projects over the years so that tailored measures can be put in place to enable their successful implementation which was one of the objectives of this study. This thesis thus set the aim to identify factors that promote the adoption of communication management technologies on construction projects in a bid to contribute towards the increased use of technologies for communication in construction in Ghana. A survey was thus conducted using a close-ended questionnaire to elicit responses from Project Managers on construction projects who were chosen through a purposive sampling technique. The collected data was analysed using the mean score and the Relative Importance Index. The findings of the research show that mobile devices and the internet, Microsoft Office Suite Products (Word, Excel, PowerPoint, MS Project) and electronic mail are the most used technologies. Lack of legal enforcement support for the use of ICT, poor internet connectivity and inadequate ICT content in construction education systems were found as the major barriers to the successful adoption of technology for project communication. The results also show that the most important enablers for the adoption of technologies for project communication management include the development of a realistic and reliable electronic database in the organisations and good organizational management support. Upon these findings, the study suggested the development of a database that is very reliable in organisations to boost the ease of project information tracking. It was also suggested that organisational management support should be increased to encourage the use of technologies as well as increasing the technology content of academic courses so that graduates would come out ready to use technologies in handling activities and more specifically project communication management.

Keywords: Technology, Information Technology, Communication technology

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DEDICATION

I dedicate this work first to the Almighty God. This work is also dedicated to my parents and family for the immense support throughout this study.

CHAPTER ONE

INTRODUCTION

1.1 BACKGROUND OF THE STUDY

The essence of construction projects is to provide the hard infrastructure needs that meet the highest quality standards in quick time. Productivity, however, which is a measure of efficiency and continuous improvement is low for the construction industry despite being a major focus area for improvement over the years (Hasan et al., 2018). These efficiencies have not been achieved in construction due to the industry's nature of employing unskilled workers and lags behind in the adoption and the use of modern technologies (Hasan et al., 2018). According to Ahuja et al. (2009), this nature of the construction industry thus necessitates the adoption of information and communication technologies to achieve coordination and to enhance the flow of information. Information technology has also been identified in recent times as a tool for improving communication management in construction (Peansupap & Walker, 2005).

Although industries depend on the relay of information and effective communication for their activities and processes, the construction industry is one of the industries that is most reliant on information and as said by Ahsan et al. (2007), ineffective communication practices among other factors usually lead to poor performance on projects in the construction industry. According to Tai et al. (2009), the usefulness of communication as a core of management towards the success of construction projects cannot be undervalued. Tai et al. (2009) also commented on the fact that due to the difference in location of project team members as well as the varying responsibilities of various parties on a project, effective communication is of the essence for construction project management. Technologies enhance communication between project team members thus provide a way to bridge the gap in geographical locations and also avail a means to send information to project participants in quick time. Senaratne and Ruwanpura (2015) commented on the fact that bringing in information and communication technologies (ICTs) to manage communication on projects helps to make communication effective.

“Technology is the making, modification, usage, and knowledge of tools, machines, techniques, crafts, systems, methods of organization, in order to solve a problem, improve a pre-existing

solution to a problem, achieve a goal or perform a specific function” (Skibniewski and Zavadskas, 2013). The introduction of technology into the construction industry, however, has provided simpler ways of undertaking works. This is evident in Hasan *et al.* (2018) which indicates that contemporary technologies have the potential to resolve some prevalent construction productivity issues by enhancing coordination and transfer of shared knowledge among all project participants. As noted by Sun and Howard (2004), a lot of software packages which provide support for a broad range of activities including communication on projects are available to for use at all stages of the construction process.

Information and communication technologies (ICTs) have the capacity to reduce the time for data processing and communicating information and to improve communications for effective decision-making among construction participants which enhances construction productivity (Zachiang, 2017). Furthermore, technology can provide a system for storing knowledge while it can facilitate the collection of information via the use of the internet on construction projects (Arayici *et al.*, 2012). Given the immense role technology can play in advancing communication between project team members today, communication technology tools are a need that must be satisfied in order to bring harmony in communication to all project members and stakeholders.

1.2 STATEMENT OF THE PROBLEM

The effect of technology in enhancing communication roles and processes in construction is very important and in fact cannot be ignored or understated since communication technologies enable increased volume of information transfer to meet the increasing demand of immediate information in recent years among construction project’s participants (Rimmington *et al.*, 2015). Notwithstanding, the availability of communication management technologies, participants of the construction industry do communicate with each other on information exchange pertaining to drawings, specifications, changes in design through conventional approaches such as hardcopy printouts and phone calls which makes it difficult and expensive due to the extra cost of travelling (Paudyal and Prakriti, 2018). To manage communication effectively on construction projects, the construction sector is required to move towards processes that foster efficiency with products and methods (Sekou, 2012).

The productivity of the construction industry over the last 40 years has largely remained unchanged fundamentally due to slow technology adoption while other industries have made gains through technology (Holt *et al.*, 2015). The slow adoption of technology is due to many reasons such as variability of company’s expertise, uniqueness of the product, the nature of the industry itself as well as cost (Sepasgozar and

Bernold, 2012). The industry has experienced a change in an approach aimed at increasing productivity, quality, sustainability and reduced lifecycle costs and lead times through effective collaboration and effective communication between stakeholders on construction projects (Nour, 2007).

As construction projects are becoming more complex in recent times, the number of project participants increase, which causes an increase in the communication process making it complicated, difficult to control and organize hence the need to for an advanced project information management and sharing system to control the dissemination of information to the appropriate project participants (Paudyal and Prakriti, 2018). The benefits of technologies for communication management seem well written about in literature however its incorporation for regular use in the construction process is still low with contractors being cited as the least ICT users (Peansupap and Walker, 2005).

In the study of Ikediashi and Ogwueleka (2016) concerning the use of Information and communication Technologies (ICT) in the Nigerian construction industry, it was reported that the adoption, application and usage has been lethargic. ICT tools and systems offer a lot of benefits when adopted and duly used for communication activities, however the adoption of new ICT technologies has been comparatively low as said by Azzam (2019) on construction projects when compared to other industries.

In adopting communication technologies in construction organisations, it is usually accompanied by some barriers that prevent the easy adoption of the communication technologies (Azzam, 2019). These barriers hinder the successful adoption and application of various ICT tools and applications and thus identifying, as well as understanding these barriers can prove to be a major step in the right direction to help project managers of construction organisations overcome them and increase the tendency of the success of the technology adoption and application process through the right enablers (Sepasgozar and Davis, 2018). Ikediashi and Ogwueleka's study in 2016 argues that in literature, extensive research has been carried out across construction projects in developed countries about barriers to the successful adoption of communication technologies, however further research within the context of developing countries like Nigeria and Ghana must be done to come out with their major challenges since there might be differences in the challenges of developed nations and developing nations.

One of the significant factors that have been found to influence the adoption of Information and communication Technologies through research according Kannabiran and Dharmalingam (2012)

is the enablers for the adoption and application of the technologies. Kannabiran and Dharmalingam (2012) further mentioned previous research studies than in developed and developing countries to identify possible enablers for the adoption and application of ICT tools.

From above, studies have been done to identify the fact that adoption of ICT tools and applications for management and communication of project information has been sluggish on construction projects in general worldwide with little progress made. This, in addition to the fact that major challenges exist which are different from that of developed economies when it comes to barriers to communication technologies adoption has caused this study to be initiated to identify the technologies used for communication management on construction projects in Ghana; find the barriers to communication technologies adoption in a developing country like Ghana and also to identify possible enablers to enhance the adoption of communication technologies in Ghana. It is against this premise that the research questions have been asked in section 1.3 of this study.

1.3 RESEARCH QUESTIONS

The study seeks to find answers to the following relevant questions in order to achieve the research objectives.

- What are the technologies used for communication management on construction projects?
- What are the challenges to the adoption of technologies for communication management?
- What are the enablers for the adoption of technologies for communication management on construction projects?

1.4 AIM OF THE STUDY

The main aim of this research is to identify factors that promote the adoption of communication management technologies on construction projects.

1.5 RESEARCH OBJECTIVES

To achieve the research aim, the study will focus on the following objectives:

- To identify the technologies used for communication management on construction projects.
- To identify the barriers to the adoption of technologies for communication management.
- To identify the enablers for the adoption of technologies for communication management on construction projects.

1.6 RESEARCH METHODOLOGY

The study adopted a quantitative approach with an elaborate literature review conducted on communication technologies adoption in the construction industry. Data was collected primarily through a survey conducted by the administration of questionnaires. The choice to use a questionnaire was backed by Kothari (2004) which says that a questionnaire as a data collection method is used in cases of big enquiries and by private individuals to seek a response to questions posted or mailed and has the merit of being fast and cost-effective. The respondents for the study comprised of Project Managers managing construction projects who were selected through the purposive sampling technique. Retrieved questionnaires were coded and analysed with the aid of the Statistical Package for Social Sciences (SPSS) version 20 and Microsoft Excel using descriptive statistics. At the end of the study, the conclusion and recommendations were drawn.

1.7 SCOPE OF THE STUDY

This study is aimed at identifying factors that promote the adoption of communication management technologies on construction projects in Ghana. The study was carried out in Kumasi, Ghana. The region was chosen because of its close proximity to the researcher, making it quicker for the researcher to retrieve questionnaires from the respondents to enhance further work on the study to be done.

1.8 SIGNIFICANCE OF STUDY

The outcome of this research is expected to be beneficial to project stakeholders in the construction industry since strategies to aid the use of communication technologies on projects would be known so that with their implementation, their benefits can be gained. The study would contribute to the project communication management knowledge area of project management which mentions communication technology as part of its list of tools and techniques for the management process. The academic environment will also benefit from the findings of this study since more knowledge will be brought to light on the technological applications that can be used to enhance communication on construction projects and will be of motivation for others to carry out further studies into the field of technology in construction.

1.9 OUTLINE OF THE THESIS

The research study would be organized into five separate chapters as follows:

Chapter One

The chapter deals with the background of the study, problem statement, research aim and objectives, research questions, methodology, the scope of the study, methodology, significance of the study, structure of the study.

Chapter Two

This covers the literature review related to the subject matter. Furthermore, the review shall endeavour to link related literature and the subject matter.

Chapter Three

This chapter would examine the details of the methodology used in the research to achieve the stated objectives. It provides a detailed discussion on the sampling technique and data collection tool that would be used and the data analysis tools.

Chapter Four

This chapter would analyze the data collected with the graphical presentation of findings where necessary. Data collected would be analysed to answer all research questions to achieve the stated research objectives.

Chapter Five

This being the final chapter summarizes the findings of the study, conclusion and recommendation of the research study.

1.10 SUMMARY

This chapter of the research serves as the introduction to the study giving an insight into how the research will be conducted and provides an overview of the communication state in the construction industry and its associated technology use. It also throws light on the aim and objectives of the study as well as the research methodology. The content of each chapter included in the study has been highlighted as well.

CHAPTER TWO

LITERATURE REVIEW

2.1 INTRODUCTION

The presentation for this chapter considers the essential literature review for this study. It reviews the literature on the need for communication and technology adoption for communication management in construction. To achieve this, the researcher delves into various forms of literature including journals, conference proceedings, books, among others that have written about communication and information technology use in construction. The chapter also reviews the literature on Information and Communication Technology (ICT) use for project communication management as well as the challenges in their use and measures to enhance its use on construction projects.

2.2 OVERVIEW OF INFORMATION AND COMMUNICATION ON CONSTRUCTION PROJECTS

2.2.1 Information and Communication Technology (ICT)

Information Technology (IT) as explained by Sekou (2012) can be said to be a technology whose use is to enhance the processing of data as well as for the handling of information and knowledge resources. A look at IT on a larger scope shows it comprises computerised hardware and software utilisation as well as auxiliary automated control services that create, store, retrieve information for further working and processing which would then produce an information output to be transferred or stored (Rahman, 2008).

Communication technology as said by Singh (2001) is defined as technologies that enhance dealings with the broadcast of information to intended receivers and provide the sustenance that enables the information exchange process as desired by the user. Communication technology is also defined by Forcada (2005) as the technology that deals with information transmission and by so doing support the information exchange process. Communication technology has become such an essential part of Information Technology (IT) in recent times which has led to the development of the name Information and Communication Technology (ICT) (Sekou, 2012).

ICT is simply defined as the tools and applications used for processes such as gathering, processing, storage, transmission and dissemination of information (Ebijuwa, 2005). ICT in construction in the view of Perkinson and Ahmad (2006) entails the use of computing systems which enable capturing, storing, analysing, exchanging, transmitting and sharing information with project stakeholders. Examples of the ICT tools and applications for construction projects include teleconferencing modes such as video conference as well as web-based project management applications among others (Perkinson and Ahmad, 2006).

2.2.2 Information and Communication Requirements in Construction

The construction industry like many other industries is reliant on information for its activities, however, it falls under the category of industries most reliant on the relay of information and effective communication to achieve success in their activities and processes (Ahsan et al., 2007). On construction projects, an instance of reliance on information and effective communication to carry out an agreed instruction between parties is where Emmitt and Gorse (2003) reported that communication breakdown has accounted for problems on every construction project regardless of the size of the project, location or even enough drawings and good site management. A construction project may require a number of professionals, consultants and stakeholders, the majority of which demand a regular update on project information at equal intervals or upon request (Murray et al., 2001).

The inference from this is that access to correct information is key to enhancing good decision making which would later transfer into physical progress on the construction project. Timely updating of project stakeholders with project information as agreed is also necessary to ensuring harmony in project coordinating activities. Currently, drawings, specifications, schedules and programmes which constitute construction project documents are usually exchanged through conventional means through the use of papers copies and face to face meetings which making communication slow and tedious (Hore and West, 2005). Face to face mode of communication according to Emmitt and Gorse (2003) ranks higher than other forms of communication media which shows how the construction industry professionals and players rely on face to face communication for their daily activity information exchanges.

According to Ahsan et al. (2007), the poor recorded performance in construction is associated often to a lack of design and production processes integration, the fragmented organisation of the

industry and the lack of effective communication practices. Thus effective collaboration among stakeholders in the presence of effective communication on a construction project would lead to success being achieved when the construction project is completed. Construction projects being large in recent times with a corresponding increase in stakeholders make a communications management plan that spells out periodic meetings and other means of communicating project data very vital to ensuring adequate and effective communication with stakeholders (Chinyio and Olomolaiye, 2010).

2.2.3 The Need for Communication in Construction

Effective communication on construction projects is very vital since it can alleviate most of the factors that result in cost escalation and schedule delays on construction projects according to Kaliba et al. (2009). Communication is very much needed on construction projects as noted by Kwofie et al. (2015) which said that the effectiveness of construction project teams is attributed ten percent (10%) to effective communication. As a result of this finding, it has become a focus area for researchers and construction industry practitioners to make improvement in communication so that the construction industry can make gains that come along with communicating effectively.

Good communication between project stakeholders and construction project parties enhances project success and with electronic communication being increasingly used, it has enhanced project communication management efficiently and effectively (El-Saboni et al., 2009). According to Moniem (2000), the dominant use of paper copies of documents has held back effective communications and further states that electronic production and exchange of information and communication should alleviate the problem.

2.2.4 The Need to Adopt Technologies for Communication on Construction Projects

For many years the challenge of communicating effectively with parties to a construction contract has persisted for the construction industry, however with the emergence and use of ICT tools and applications on construction projects, the construction process has been aided and made easier with a corresponding improvement in communication for construction businesses (Wong and Sloan, 2004). According to Hassanain et al. (2000), the implementation of these ICT tools and applications on construction projects is done to support and enhance information sharing and

communication among project team members and stakeholders because the construction industry needs, demand systems that are enabled for information and communication technologies.

As a part of future plans for construction is communication technologies to be installed on construction job sites which will be wirelessly networked with the aim to enhance construction workers on-site to carry out their work quickly and correctly (Bowden et al., 2005). Thus, technologies that are used for communication purposes are to be employed on construction sites to aid communication between workers on-site and their supervisors which would go a long way to alleviate communication challenges between supervisors who sometimes are at the office and need to communicate to workers on site and vice versa.

Communication in the construction industry according to Tone et al. (2009) is very vital since it impacts on the credibility and integrity of the management and success of the projects and provides the means to effect required necessary changes and achieve projects goals as said by Howes and Tah (2003), hence the need for the adoption of information and communications technology so that construction managers and foremen can make use them to schedule and report on work (Bowden et al., 2005). Due to rapid changes in our modern world, construction projects have become increasingly diverse and large and has hence demanded effective communication from project managers to manage their projects very well. Thus according to Alshawi and Ingirige (2003), this emphasis on communication to make projects successful has caused new technologies to be developed for networking and information sharing emphasising technology's importance for effective communication.

The role of technology on construction projects has been immense with Peansupap and Walker (2005) saying that Information Technology (IT) and Information and Communication Technology (ICT) have created new business opportunities in recent times after it was identified as essential tools for improving upon communication in various construction projects. As noted by Peansupap and Walker (2005), information technology applications present an operational improvement to construction processes through reducing the processing and communication of project information which enhances quick and effective decision-making for coordination and improved productivity.

Construction projects have increasingly become larger in recent times and hence Peansupap and Walker (2005) reiterated the fact that Information and Communication Technology (ICT) has been

identified as being absolutely necessary or a requisite when it comes to measures that must be taken to ameliorate communication in construction processes. Thus from above, the need to adopt technologies for communication on construction projects cannot be said to have been overemphasised since technologies present numerous benefits including improved information flow and faster communication between project team members and stakeholders. Some of the ICT benefits that are gained when used in construction according to Zachiang (2017) are:

- It makes complex tasks much easy to perform.
- It is time-saving and increases the rate at which work is done.
- Improves productivity.
- It helps to save cost.
- Facilitates decision making.
- Increases document quality.
- Reduces mistakes in documents.
- Reduces construction error.

Ahuja et al. (2009) also wrote about the benefits of technologies for managing construction projects which include increasing the rate at which information is transferred, cost-effectiveness and being able to transfer large data and information across vastly separated geographical areas as well as the added advantage of the integration of project information, uninterrupted access to stored project information and document (lessons learned) and archiving for further use and reference.

2.3 INFORMATION AND COMMUNICATION TECHNOLOGY (ICT) TOOLS AND APPLICATIONS IN CONSTRUCTION

Technology is helping to improve a number of different industries and industrial process of which the construction industry is of no exception. A lot of processes involved in construction necessitates extensive exchange of information and data between the stakeholders frequently however according to Peansupap and Walker (2006) it has been observed that the construction industry has been slow to the take-up of new Information and Communication Technologies and also has a nature in opposition to change favouring the conventional ways of doing things. Though the adoption of ICT innovations has been slow recent studies by Dave and Koskela (2009) shows

that the construction industry has over the years taken strides worth noting to adopt ICT solutions for its works and activities.

According to Peansupap (2004) over the past two decades, there has been a steady increase in technologies that enhance communication with more professionals of the industry getting involved to introduce a collaborative software solution to support their specific operations. Construction ICT as explained by Perkinson and Ahmad (2006) necessitates the use of computer software and applications that do not only organise, storing and capturing information or data but further analyse and transmit information enhancing exchanging and sharing of information. Thus through ICT tools and applications, various project participants and stakeholders are able to communicate and share project information and data to enhance coordination. In the view of Gaith et al. (2009), the use of Information and Communication Technology systems on construction projects can be naturally grouped into two systems being communication systems and technical decision support systems.

Doherty (1997) as cited by the work of Gaith et al. (2009) explains the two system classification of communication technology by saying that the communication system encompasses all the common conventional mediums of communication now computerized whereas the technical decision support systems involve all other forms of computer applications and support systems except those used for communication. Against this background of ICT tools and applications in construction, the section that follows reviews major ICT tools and applications for construction purposes.

2.3.1 Electronic Communication and Data-Exchange Systems in Construction

Information and Communication Technology (ICT) has acted as a means of general management and processing of project as well as company information (Harris and McCaffer, 2013). The construction industry has taken up ICT and used it in several ways, one of such areas is communication which is perhaps the most noteworthy effect that technology has impacted in construction (Harris and McCaffer, 2013). ICT has helped the construction industry in transferring information very quickly and also to exchange project information with project partners in real-time through internet aided means.

According to Sekou (2012), this advanced use of ICT has rendered the internet and computer-aided information exchange and communication crucial for a closer collaboration to exist between construction project participants to supplement the traditional communications means which include face-to-face interaction, paper-based drawings as well as telephone calls and letters.

Electronic communication is defined as a system of communication in which data communications are carried over both wired and wireless systems and include the transfer of writings, images, sounds or intelligence of any nature through means such as electronic mail and telegraph (Black, 2002). Over the years, there has been the introduction of different electronic communication tools thus altering firm operations to provide different avenues for impacting managerial processes for communication purposes. As said by Zachiang (2017), common softwares used in construction include the Microsoft office suite word processing, spreadsheet, and Computer-Aided Design in addition to the internet software. The following catalogue highlights some of the communication tools that are finding increasing use within construction.

2.3.1.1 The Internet and The Use of Electronic Mails (e-mail)

The use of the internet is founded on a set of rules that have been established for data exchange and communication called the TCP/IP protocol suite (which stands for Transmission Control Protocol and Internet Protocol), an agreed medium of communication that is existing between all parties associated with the internet (Harris and McCaffer, 2013).

According to a study carried out by Frits (2007), mobile internet was found to be the most promising technology among technologies enlisted for the study with uses including the exchange of drawings and access to expert knowledge. According to Harris and McCaffer (2013), some of the main common use of the internet include information sharing, interaction and communication and further proceeds to say that the internet is of great value to construction companies and on construction projects since it aids companies and project teams to easily connect globally which would have otherwise taken a lot of time and financial resources to organise. Some of the benefits that the internet and its resources bring to construction firms as said by Harris and McCaffer (2013) include:

- A reduction in the cost of communication.
- An enhanced coordination and communication on construction projects.

- Acceleration in the distribution of not only knowledge resources but project-related data and resources.

In a bid to use the internet to aid communication and to reduce costs, the e-mail comes in as perhaps the most popular platform of transferring data from one person to another via the internet through the use of a computer. In the view of Zachiang (2017), e-mails in construction are of great value as they present a very fast and convenient medium to send and receive documents (not only text and pictures but also video programs). That is to say, that project documents can be sent and received by parties on a construction project in a very short time simply by connecting to the internet and attaching relevant files. By means of the e-mail, details of works and other project-related activities can be exchanged between designers with the inclusion of contractors in a very short time span (Harris and McCaffer, 2013).

2.3.1.2 Intranets

“The intranet as a communication infrastructure is based on communication and content standards of the Internet, which is internal to an organization” (Harris and McCaffer 2013, p.616). With intranets, the general idea is to restrict and control information access on projects and other company only documents to the company alone or performing organisation’s personnel only. According to Hore and West (2005), intranets are established by construction companies to provide access to project managers on information from all sources possible to make access to project data very easy. An intranet is identical to the internet; however, their development was in direct response to concerns raised by businesses regarding data security which was not readily provided by the internet. In the research work of Ingirige and Sexton (2007), intranet roles have changed to a more advanced role from the passive role of just providing company employees information to a stage where it provides knowledge capturing and sharing avenues/options.

2.3.1.3 Extranets

Extranets are explained to be a web-based application that provides the avenue for a collaborative effort through ICT investment platforms to carry out specific management duties for projects including the storing and management of project-based information (Becerik, 2004). Extranets are internet-based tools that provide the user with functions to monitor and control construction project information as well as to make to store and make available the information to enhance the management of construction projects (Ruikar et al., 2006).

The operation system of project extranets provides the avenue for professionals in the construction industry including Architects, Contractors and suppliers to share information in a secure, private network. According to the work of Bowden et al. (2005), this construction technology may allow for some instances where contractors are able to share part of their company resources with other contractual parties including subcontractors, clients and other companies, therefore, they introduce an additional feature to intranets as mentioned earlier in this work. Main benefits associated with the use of extranets on construction projects according to Harris and McCaffer (2013) include :

- Acceleration of construction business between different companies.
- A cheaper and more efficient way for contractors to connect with their project partners.
- Facilitates the sharing of large volumes of data between trade partners and other project partners.

2.3.1.4 Teleconferencing

The use of the internet has enhanced transmission of information and has made communication in forms such as text, audio and visual formats possible through means like teleconferencing which is a communication technology that permits a number of people to consult and discuss all at once from different distinct locations (Harris and McCaffer, 2013). In Sekou's work (2012), the construction industry employs the teleconferencing technology to allow all parties of a construction project to become a virtual community which enhances project related discussions and effective administration. The technology of teleconferencing has evolved since its introduction with present forms including data conferencing and video conferencing with Singh (2001) also saying voice and video conferencing form a part of tools and services that support communication.

The data conferencing resource permits communication only between parties to talk/exchange information over text and graphic documents with Harris and McCaffer (2013) further citing some of its application in construction being designers sited in different places being able to work on the same drawings simultaneously.

Video conferencing on the other hand, as said by Harris and McCaffer (2013) is the live connection of two or more people which enhances interaction using some combination of video, audio and data to create a face-to-face communication environment which in many ways help to reduce travel costs and improve project communications. This interactive means integrates audio, video and

computing technologies in addition to communications technologies to create the avenue for people in different places to work together face-to-face and in real-time through electrical support systems and share all types of information including data, documents, sound and picture essentially eliminating the barrier of distance that separates us (Sekou, 2012).

2.3.1.5 Building Information Modelling (BIM)

BIM according to Dzambazova et al. (2010) is a type of software that has information management as its core function throughout a building project life cycle and has modernize the construction industry by significantly increasing productivity through better information display. According to Ganah and Godfaurd (2015), BIM offers a new way of communication which is an additional function that it has over currently used communication tools to allow for information to be fed forward and backward.

“A BIM is a digital representation of physical and functional characteristics of a facility” thus making it serve as a “shared knowledge resource for information about a facility forming a reliable basis for decisions during its lifecycle from inception onward” (Breu et al. 2007, p.22). BIM provides its users with the avenue to collaborate at different stages of a facility or project so that users and stakeholders can insert, extract, update or even modify designs with the input of stakeholders’ information to support and reflect the expectations of the stakeholder when designs are complete as such bring harmony between designers thoughts and the expectations of the end-user (Breu et al., 2007).

The BIM software has the ability to directly and interactively present concepts of design in a three dimensional digital form which represent physical and real images of the building and its essential characteristics to allow designers to identify clients’ needs, and to promptly and effectively provide solutions to these needs consistently and in a total coordinated view (Zachiang, 2017). The benefit of BIM on communication is emphasised in the work of Fan et al. (2014, p.157) which says that BIM and 4D approaches are able to “provide faster and more effective communication of information between interested project parties and yield improved and innovative solutions stemming from better design, along with many other benefits”. Through BIM options project owners are able to walk virtually through all the virtual models which enhances their decision making on the best option that fits their requirement which also helped improve communication and trust between stakeholders to enable decision making early on projects (Azhar, 2011).

2.3.1.6 Electronic Document Management Systems (EDMS)

The construction industry is subject to a high degree of variability and uncertain factors of which the construction team is a part of, due to its composition on projects changing over time because the professionals change from one job to the next before a single project completes (Forcada, 2005). Due to the construction process and projects being typified by complexity and diversity in addition to its non-standardised nature of production, a huge amount of project and organisational information is formalised but unstructured in a collective form to facilitate easy search and retrieval for information in event of reuse and referencing (Forcada, 2005). Due to the information-intensive nature but an unstructured collective form of information for construction projects, a system which is known as Electronic Document Management Systems create an avenue where different but connected forms of information can be linked within the context of a project to achieve easy access and control (Forcada, 2005). Due to current technology, the use of electronic means for the management of project information is growing.

Electronic document management systems (EDMS) as said by Harris and McCaffer (2013) provides a combined tools set that enhances full organisation of project data or information and documents which essentially entails the functions of creating and revising project information and documents, and the features that enables distribution, storage and retrieval of the documents till end of project's life cycle. Harris and McCaffer (2013) wrote on some of the technologies involved in electronic document management systems which include:

- The technology that facilitates easy transforming of paper documents into a digital format using scanners;
- Ability to retrieve and access archived project documents;
- The ability to track and control the route of documents movement within the organisation;
- Multimedia for managing audio and graphic information, particularly progress reports for site activities;
- Computer-Aided Design for creating and editing documents.

2.3.1.7 Mobile Devices and Wireless ICT Applications

A number of different communication technologies that have found their application in project management have proven their value to the improvement of firms and the construction industry. This improvement as said by the e-Business MarketWatch (2005) includes not only standardization and work coordination but also includes streamlining work processes as well as communication and information sharing. According to e-Business MarketWatch (2005), mobile devices have been found as ICT solutions relevant to the construction industry for project management and communication among others. Mobile devices (Pocket PCs, Tablets PCs, Mobile Phones, etc.) are aimed to share documents, access data and control project details with the aid on-site wireless network applications causing engineers to use mobile voice systems to receive/transmit information, the implementation of mobile ICT applications thus thought off as enhancing the extension of communication systems (Adwan and Al-Soufi, 2018). According to Groff (2015), most construction sites have equipped their job sites with internet connectivity, to allow sharing of documents with construction site-based professionals as well as editing them in real-time.

2.4 FACTORS HINDERING ICT ADOPTION AND SUCCESSFUL USE IN CONSTRUCTION

Information and Communication Technology (ICT) is an area where according to Sekou (2012) investment is key to attaining competitiveness in the construction market, increasing efficiency, reducing the cost of activities, as well as raising the level for a contracting business among other benefits. The benefits that ICT presents on construction projects is a lot which should drive a massive acceptance of ICT for communication management activities however you find it a normal thing today that many construction firms invest little in ICT tools and applications and in general terms, the construction industry is slow to adopting and exploiting the potential benefits of ICT compared to other industries (Egbu and Botterill, 2003). This slow uptake of ICT tools in the view of Peansupap and Walker (2005) and its applications is as a result of:

- The construction industry being complex and having a conservative nature;
- Information and Communication Technology immaturity levels;
- Financial constraints;
- Poor availability of tools for evaluating benefits of using ICT; and

- A lack of understanding of the ICT implementation process.

In view of these nature of the construction industry and firms, Zachiang's study in 2017 indicates the following as factors that determine and affect the use and deployment of Information and Communication Technologies by firms and on construction projects.

Internal Factors

- Size of firm/organization
- The business of the firm
- Age of the firm
- Ownership (Foreign and /or indigenous}
- Business organization (Partnership, limited liability, etc.)
- Academic qualification of CEO
- Years of professional experience
- Years of computer literacy
- Level of computer literacy
- The attitude of CEOs/senior managers to ICT
- Construction industry demands

External Factors

- Customer/client demands
- Technological demands
- Influence of competition
- Availability/affordability of hardware/software
- Changing trends in the global construction industry
- Level of competition

In addition to factors affecting the implementation of ICT in the construction industry, owner organisations in recent times demand frequent access to project data and information for their consumption and further action hence these owners and clients expect a continual access to project information for their use which has increased the pressure on contractor organisations to adopt new technologies which enhance information and communication in order to remain competitive

and meet project requirements (Perkinson and Ahmad, 2006). With many organisations and firms having already begun implementing some form of ICTs in their activities, there is the need for construction professionals to expand their company and organization technology platforms to include communication technologies to improve communications management and decision making (Hampton, 2005). According to Perkinson and Ahmed (2006), some of the notable potential advantages of implementing ICT for use in communication and Jobsite management include:

- Real-time monitoring and documenting of construction operations,
- Reduced paperwork.
- Improved project management capabilities in terms of tracking people, equipment, and assets,
- Standardization of data collection and management.

The strategic ICT adoption and implementation within a construction organization and at large use on projects by the company is directly influenced by the company's vision and policy (Peansupap and Walker, 2006).

2.5 ICT ADOPTION AND IMPLEMENTATION BARRIERS IN CONSTRUCTION

The lack of a policy on information management in companies, cultural issues, slow and cumbersome information management processes and barriers to the adoption of Information and Communication Technology in the construction domain has formed a part of most problems with information management challenges in companies according to Gyampoh-Vidogah et al. (2003). One reason why the advent of ICT in the construction industry is difficult to implement is the lack of synchrony or mismatch that exists between the current organizational/industry needs and the ICT systems for integrated work environments (Nielsen et al. 2006). This current state of things pertaining to construction is largely due to the fact that the construction industry is of a decentralised nature in activities and composed of separate organisations participating as a unit on a project by project basis (Nielsen et al. 2006).

From the work of Nielsen et al. (2006), the condition of the multi-participant, multi-organisational framework is a hindrance to the successful implementation of information and communication technologies in the construction industry and on construction projects. According to Roadcon

(2003), the pursuit to take up and advance the use of different ICT tools and applications in the construction industry has been restrained by different barriers which need to be overcome by the construction industry to progress further in the exploitation of ICT to support its business activities. Kumaş in his study in 2004 about the Turkish construction industry indicated the most common problems experienced with information technology which are:

- Lack of training associated with its implementation and systems knowledge
- Cost of technology
- Conservative nature of the industry
- Security of hardware at the site
- Legal Support for use of ICT
- Incompatibility/interoperability problems
- Lack of technical support

It was thus said by Kumaş in his work in 2004 that contractors are not aware of the impact that the potential advanced applications of ICT could have on the competitive position of their firms and organization. Nielsen et al. (2006) said with the use of ICT becoming vital in the Turkish construction industry, the lack of a significant legal and contractual support to compel and enforce the use has been a significant negative consequence to the adoption and use of ICT on construction projects. Samuelson also concludes his work in 2002 saying one of the explanations for the low use of ICT tools and applications by contractors is the lack of effective technological applications for their core businesses as compared to other role players and professionals in the construction industry. Ahuja et al. (2009) in their study and review of the relevant literature identified some perceived barriers hampering the successful adoption and implementation of ICT in the construction industry which includes:

- The separation of the various project processes/phases
- Lack of strategic direction or framework within the construction industry to guide any ICT investment decision
- The fragmented complex construction industry nature making it have different levels of ICT knowledge among its participants
- The high cost of keeping up to date with the hardware/software updates
- The initial cost of ICT infrastructure installation is high making it a constraint

- Non-availability of a critical mass of organisations/projects in the industry that adopt ICT
- The cost associated with the training of project/organizational staff for technological developments in hardware/software or procuring staff to handle activities with the updated technology
- Lack of technical standards for a communication interface between different software.
- Information Security
- Senior organizational management unwilling to adopt ICT due to peculiar reasons
- The uniqueness of each construction project
- Unwillingness to invest and adopt ICT due to high staff turnover
- Non-dependability of IT infrastructure
- Information overflow because of the use of the Internet as a communication tool
- Uncertainty of benefit from the use of IT-based communication

Zeng et al. (2007), further went ahead to state in his study that organizational structures, individual behaviours and the technical requirements of data in the industry are some of the barriers that hinder the flow of technology in the construction industry. Summary of the barriers as categorized by Zeng et al. (2007) are as follows;

- **Financial Barriers:** High cost of ICT investments, lack of finance, budget constraints, maintenance cost, etc
- **Organizational Barriers:** Poor ICT strategies, lack of business incentives, lack of training, lack of appropriate support.
- **People Barriers:** Lack of enthusiasm to changes in business processes, lack of personnel drive, little education/continuous professional development, cultural issues.
- **Legal Barriers:** Lack of legal support for use of some technologies, risks for liability, Issues for electronic information and documentation.

Isikdag et al. (2007) however stated on the other hand that, the most critical factors to successfully implement ICT is the importance given to the training of personnel on ICT among other technologies, creation of a match between activities and communication technologies by re-designing of current processes and the support offered by software vendors.

2.6 MEASURES OF ENHANCING TECHNOLOGY IN THE CONSTRUCTION INDUSTRY

Information and Communication Technologies (ICT) have been of immense benefit to the construction sector with many firms and organisations being currently motivated to adopt and implement technologies on their construction projects since information technology and ICT, as said by Peansupap and Walker (2005), has been identified as essential tools that enhance the development of new business opportunities and further improve the communication process in construction and its related activities. In the view of Anumba (1998), the construction industry stands to gain significantly from information technology innovations hence the urgent need to improve the uptake of construction IT innovations. According to Peansupap (2004), some of the use related to ICT include:

- Improve productivity in construction through improved operational efficiency, reduce cost and project cost.
- Support information integration and this in turn can help to reduce the volume of information processed and reduce data re-entry by transferring information through internet/Intranet protocols.

Ahuja et al. (2009) conducted research into the study of ICT adoption for building project management and having conducted his analysis enumerated the following as perceived enablers to the adoption of ICT which includes the following as stated below:

- Information flow planned in standardized formats with improved IT support to construction site processes
- Development of a realistic and reliable electronic database in the organization
- All project team members use the same IT systems for the project as well as common internet services
- Education of the users for effective use of ICT and its Benefits
- Systems for better communication between office and project sites
- Each project to have a champion for the adoption of ICT and acting as the team leader. It could be the Project Manager/owner's project representative.

- Senior management should create an environment for the adoption of ICT within the organization
- Project Scope requiring the use of ICT for communication on the project.
- Shared use of common database by project team members
- Standardised drawing formats for presentation and content
- ICT training to be more accessible and less costly
- Increased use of 3D visualization techniques as a communication tool
- Education of the users that ICT does not increase isolation but enhances team working
- Widespread adoption of ICT in the construction industry
- Measuring benefits accrued by utilization of IT-based communication
- Software to be user-friendly and flexible
- Organisation structures to be re-engineered for the use of ICT
- Development of data communication and exchange standards
- Availability of indigenously developed software incorporating the specific construction industry requirements of the country

Peansupap and Walker (2005) further enumerated eleven (11) ICT factors that have been found in the Australian construction sector contractors as factors that influence the diffusion of ICT within the construction sector. They are:

- Professional development and technical support.
- Clear benefits of use.
- Supporting individual characteristics.
- Supporting technology characteristics.
- Supporting supervisor and organization.
- Supporting an open discussion environment.
- Supporting rewards.
- Frustration with ICT use.
- Colleagues help.
- Positive feeling towards ICT use.
- Negative feeling towards ICT use.

2.7 CHAPTER SUMMARY

The presentation in this chapter has covered and discussed literature on the Information and Communication Technology (ICT) in the construction industry, the need for communication in construction and the need to adopt technologies for communication on construction projects. Also, major Information and Communication Technology (ICT) tools and applications in construction have been reviewed with factors affecting the use of ICT in construction and the measures of enhancing information and communication technology use also discussed.

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 INTRODUCTION

This chapter discusses the research methodology adopted for this study to answer the research questions raised in the first chapter of this research in order to achieve the set aim and objectives of this research. The research methodology as said by Dawson (2007) is the principle or philosophy that will generally guide your research and it is the first thing to think about when deciding on how to do your research. The research methodology is explained further as “the overall approach to studying” one’s chosen research topic (Dawson 2007, p.14).

The chapter addresses the research design, how the samples size was determined as well as the sampling techniques employed. It also covers the data collection procedure, the administration of designed questionnaires and how collected data was analysed and presented. The research is based on a quantitative analysis of collected data with its purpose to provide direction in a way that is most likely to help achieve the intended goal.

3.2 RESEARCH DESIGN

Research design is said to be the “plans and the procedures for research that span the decisions from broad assumptions to detailed methods of data collection and analysis” (Creswell 2009, p.3). Three research designs have been advanced as said by Creswell (2009), however, this study makes use of the quantitative research approach as its research design because the data gathered from the randomly selected respondents would be generalised for the population (MacDonald and Headlam, 2008).

The choice of the quantitative approach is also due to the relatively large number of cases that could be chosen from randomly for respondents, which would represent the population of interest (MacDonald and Headlam, 2008). Quantitative research generates statistics through the use of large-scale survey research using data collection methods such as self-administered questionnaires (Creswell, 2009).

This research used designed closed ended questionnaires as the method for primary data collection for this study. The reasons being that respondents would have adequate time to give well thought

out answers, a large number of respondents can be reached for their opinions to enhance the study results and the use of questionnaires requires low cost and saves time (Kothari, 2004). The resulting data statistics from the survey were further analysed and presented in descriptive statistics.

3.3 QUESTIONNAIRE DESIGN FOR DATA COLLECTION

On a review of existing literature, a well-structured questionnaire was prepared to aid the primary data collection process. All the questions were designed to be closed-ended to enhance consistency in the respondents' feedback. The questionnaires were designed specifically to solicit responses from construction professionals who are engaged in construction project management in Kumasi in the Ashanti Region of Ghana. The questionnaire was categorized in one section and three parts.

The section sort information on the respondent details pertaining to their experience in a number of years in which they have been managing construction projects as well as that of the company in which they are employees. This was necessary to establish the respondents and their organisation's credibility in being able to provide good information on the barriers and possible enablers for the adoption of communication management technologies on construction projects. The first part (Part A), dealt with questions pertaining to the first objective of the research which sort to find out the technologies used for communication management on construction projects. Respondents were required to express their views on the level of use of the ICT Tools and Applications that have been listed using a five-point Likert rating scale of 1-5 where: 1 = Never, 2 = Not always, 3 = Average, 4 = Quiet always, 5 = Always.

The second part (Barriers hindering ICT adoption and implementation for communication management processes in construction) asked responding individuals to show their level of agreement to the identified barriers using the five-point Likert rating scale of 1-5 where 1 = Strongly disagree, 2 = Disagree, 3 = Neutral, 4 = Agree, 5 = Strongly agree. With the same five-point Likert rating scale of 1-5, the respondents expressed their views on the last part using 1 = Strongly important, 2 = Not important, 3 = Neutral, 4 = Important, 5 = Strongly important. Part C of the questionnaire sort the views of respondents on the level of importance that they attach to identified measures to enable the use of communication management technologies on construction projects.

3.4 SAMPLE TECHNIQUE AND SAMPLE SIZE

Limited time frame and a large pool of respondents on this topic under study made it difficult to seek the view of every person involved hence the need for a sample which would help the researcher overcome this difficulty by choosing a smaller more manageable number of respondents carefully (sample size) to carry out the research using a correct sampling procedure (Dawson, 2007). This procedure is used so that when the research is completed, the findings can be generalised to the whole research population although it could just provide an insight into the results of the whole research population (Dawson, 2007).

Purposive sampling technique according to Teddlie and Yu (2007) is a type of non-probability sampling technique where units thus respondents are selected based on specific purposes/characteristics that they possess that would enable them with answering the research study's questions. The sampling technique adopted in this study is the purposive sampling since it allows the researcher to select respondents who have certain characteristics that would best enable the researcher to answer the research questions.

The respondents chosen for this research are Project managers on construction projects. This is due to the fact that they have the overall professional responsibility for the successful execution of a construction project and as such, they have the onus of overall project communication to their team members and project stakeholders. This legal responsibility of Project Managers makes them prudent to be used as respondents for the study questionnaire since they should; have had a good educational level, be computer literates to be fully functional in the 21st century as Project Managers. Their communication skills, knowledge and experience in the construction industry should also best place them to give relevant inputs as respondents which is in-depth to make it possible for the research questions asked earlier in the work to be answered. The target personnel for the study are Project Managers on construction projects in Kumasi in the Ashanti Region of Ghana.

The total Project Managers population as at October, 2019 who have indicated to be into managing construction projects was found by the researcher to be 95 after he contacted the PMI Ghana chapter secretariat for the said detail. A total sample size of 49 was reached and used as a guide for the research study after the researcher used the Kish (1965) formula shown below.

$$n = \frac{n_1}{(1+n_1/N)} \quad - \quad (\text{Kish, 1965})$$

Where n = Sample size

$$n^1 = S^2 / V^2$$

N = Population size = 95

V^2 = Standard error of sampling distribution = 0.05

$$S^2 = P (1-P) = (0.5) (0.5) = 0.25$$

P = the proportion of standard deviation in the population element (total error = 0.1 at 95% confidence level).

$$\text{Since } n^1 = S^2 / V^2$$

$$= 0.25 / 0.052$$

$$n^1 = 100$$

$$n = \frac{100}{(1+\frac{100}{95})}$$

$$n = 49$$

3.5 QUESTIONNAIRE ADMINISTRATION

3.5.1 Pilot Questionnaire Survey

With the questionnaire design completed, a pilot survey of the draft questionnaire was conducted to test the questionnaires for ease of understanding (understanding without the aid of the researcher). This was done to check that the questions are not ambiguous, the instructions were clear and to eliminate questions that would not yield usable data. This step was necessary as it is prudent to conduct a pilot study to test designed questionnaires to bring to light any weakness if any in the questionnaire designed so that the experience gained in this way would be used to make improvement in the questionnaire for the actual survey (Kothari, 2004).

3.5.2 Main Questionnaire Administration

The questionnaire was administered and collected by the researcher and with the aid of some volunteer correspondents to expedite the administration and collection of responses. Other electronic means were resorted to in reaching the respondents which included electronic mails and google form links to also aid the questionnaire administration process. Furthermore, the researcher had to visit the offices of chosen respondents on multiple occasions before questionnaires could

be administered or filled and returned. After the main questionnaire administration, a total of 42 responses was collected and analysed.

3.6 DATA ANALYSIS AND PRESENTATION

With structured questionnaires, primary data collected by the researcher was analysed using statistics that were generated with the aid of coded questionnaires using Statistical Package for Social Sciences (SPSS) version 20. “Statistics is the scientific discipline that provides methods to help us make sense of data” (Peck et al. 2015, p.1).

The Statistical Package for Social Sciences (SPSS) version 20 and Microsoft excel were used for coded data entry, with statistics generated for the results of data collected done using the SPSS version 20 and Microsoft Excel. Data collected from the questionnaires were analysed using the Relative Importance Index (RII) and the mean score.

Relative Importance Index (RII)

The relative importance index was used in analyzing and generating rankings for the variables (factors) for the various objectives that were listed with the help of literature review in the questionnaire. This is because the RII allows for identifying the most important factors that answer the research questions based on the respondents’ replies and it is an appropriate tool which helps to rank variables for barriers and enablers for the adoption and use of communication technologies on construction projects in terms of their importance. The computing is done using the equation below.

$$\frac{(5n_5 + 4n_4 + 3n_3 + 2n_2 + n_1)}{(5(n_5 + n_4 + n_3 + n_2 + n_1))}$$

Where: n_1 = number of respondents who choose ‘1’ on the 5-point rating scale

n_2 = number of respondents who choose ‘2’ on the 5-point rating scale

n_3 = number of respondents who choose ‘3’ on the 5-point rating scale

n_4 = number of respondents who choose ‘4’ on the 5-point rating scale

n_5 = number of respondents who choose ‘5’ on the 5-point rating scale

The results from the importance index calculation were ranked; 1st, 2nd, 3rd, 4th, etc. in order to know their level of importance per the respondents' replies.

MEAN SCORE

The mean score was calculated based on the data gathered for each research objective's variables and used to determine if averagely the variables are considered in the view of the respondents as being technologies used for communication in their company/firm, barriers and enablers for communication technologies adoption on construction projects.

3.7 CHAPTER SUMMARY

The key aim of this chapter was to explain the research methodology adopted for the study, the research design and data collection techniques. This was exhaustively discussed and gave details on the sampling technique and how the sample size was reached. It also talks about how questionnaires were administered and how retrieved questionnaires are going to be analysed using the data obtained for further discussion in the subsequent chapter.

CHAPTER FOUR

ANALYSIS AND DISCUSSION OF RESULTS

4.1 INTRODUCTION

This chapter reports on the findings from data collected using the survey questionnaire by discussing and presenting the data analysis. After the questionnaire survey was conducted, data collected was analysed using the methods spelt out in chapter three of this study, which includes the mean score ranking and the Relative Importance Index (RII) with the interpretations drawn from it to report on the research objectives that were stated in first chapter of this study so that meaningful conclusions can be drawn at the end of the study to answer the research questions. Results were generally displayed in tables with each result appropriately discussed.

The analyses begin with a discussion on information from the respondent profile which includes the working experience of the respondent and that of their organisation in project management. This discussion is followed by a discussion on the various communication technology tools and applications used by the respondents in their communication and management of project information.

Furthermore, the mean score and the Relative Importance Index were used to analyse and tabulate the variables of the barriers and enablers for the adoption of communication management technologies according to their ranking using the Relative Importance Index. With a response of 42 (representing 85.71% response rate) out of the administered questionnaires using the purposive sampling technique, the analyses were done based on the results of the questionnaires that were completed and retrieved.

4.2 BACKGROUND OF RESPONDENTS

4.2.1 Work Experience of Respondents

In a bid to collect reliable data and generate confidence in the data collected from the respondents, the researcher sort information on the working experience of the respondents' in their capacity as Project Managers who have been managing construction projects. This was to determine the number of years they have been in the position as Project Managers on construction projects. This is also to ensure that with a good number of years as Project Managers, data would be collected

from respondents who have been in the profession of managing construction projects for a long time to be in a good position to provide first-hand information to help find answers to the research questions to achieve the research objectives.

Drawing from Table 4.1 below and in view of the above written, the majority of the respondents (54.76%) have had 5 -10 years of working experience as Projects Managers. With a percentage of 38.10%, the respondents also had a working experience of fewer than five years. With a working experience of 11 – 15 years and 16 – 20 years, the percentages were 4.80% and 2.40% respectively. Thus, over sixty percent of the respondents have knowledge and working experience of five years and above in managing projects in construction and its related activities.

This result does give a strong indication that the respondents have been in their capacity for a long time enough to have adequate knowledge about the communication state on construction projects and also be in a good position to provide answers to enhance the process of identifying the barriers to the adoption of technologies for communication management and to identify the enablers for the adoption of technologies for communication management on construction projects. Thus, their long period of service best places them to give reliable responses for meaningful analysis to be made.

Table 4.1: Working Experience of Respondents as Project Managers

How many years have you been managing construction projects	FREQUENCY	PERCENTAGE
Less than 5 years	16	38.10
5 – 10 years	23	54.76
11 – 15 years	2	4.76
16 – 20 years	1	2.38
TOTAL	42	100.00

Source: Field Data (2019)

4.2.2 Organisation's Experience with Project Management

In order to gather first-hand data on barriers to communication management technologies adoption and on ways of enabling the adoption of communication management technologies, the researcher sort information on the experience of the respondents organisations in Project Management to ensure that the respondent's firms have fairly been in existence to be able to present the respondent with a reliable basis to rate the barriers and enablers to the adoption of technologies in their firms to manage construction project information.

Also, the firm presents them with a good ground to be able to establish a good usage rate of the listed communication tools and applications to help identify the Information and Communication Technology tools and applications used for communication on construction projects. As shown in Table 4.2 below, most of the organisations of the respondents have been managing construction projects for a long time enough to make them realise their barriers to communication technologies adoption and also the possible enablers for the technology's adoption.

With a combined percentage of 69.05%, the firms of the respondents have been into construction project management for a period of eleven years and above. This gives a good representation of the organisations of the respondents and thus provides a good base and platform for the respondents to rate the listed variables for the various research objectives.

Table 4.2: Organisation's Working Experience in Project Management

What is your organisation's years of experience in Project Management on construction projects	FREQUENCY	PERCENTAGE
Less than 5 years	3	7.14
5 – 10 years	10	23.81
11 – 15 years	10	23.81
16 – 20 years	11	26.19
More than 20 years	8	19.05
TOTAL	42	100.00

Source: Field Data (2019)

4.3 INFORMATION AND COMMUNICATION TECHNOLOGY (ICT) TOOLS AND APPLICATIONS USED FOR COMMUNICATION

In a bid to analyse the ICT tools and applications that are used by the respondents and in their respective organisations, it was necessary to conduct a survey to ascertain the level of use of the ICT tools and applications enumerated in Table 4.3 from literature as shown below. Respondents were asked to rate the various ICT tools and applications according to their level of use in their firms for communications on construction projects.

Respondents were asked to do the rating of the use of the tools and applications using the scale definitions as 1 = Never, 2 = Not always, 3 = Average, 4 = Quite always, 5 = Always. Responses for these set of variables were collected and ranked using their respective mean score to identify those technology tools and applications which in the view of the respondents were frequently used or not used for communication purposes on construction projects.

Table 4.3: Information and Communication Technology (ICT) Tools and Applications Used for Communication

ICT Tools and Applications for Communication	TOTAL	ΣW	MEAN	RANK
Mobile Devices and the Internet	42	196	4.667	1st
Microsoft Office Suite Products (Word, Excel, Powerpoint, MS Project)	42	194	4.619	2nd
Electronic Mail (E-mail)	42	180	4.286	3rd
Intranet	42	133	3.167	4th
Audio Conference	41	114	2.780	5th
Building Information Modelling (BIM)	42	83	1.98	6th
Extranet	42	66	1.57	7th
Video Conference	42	59	1.405	8th

Source: Field Data (2019)

With a mean score of 3.00 and above representing a technology that is being used for communication on construction projects frequently and a with score less than 3.00 representing a technology that is rarely used, it was realised from the output of the results as shown in Table 4.3 that, the common technology that is used often for communication on construction projects per respondents view is mobile devices and the internet since it had the highest of mean (4.667) among the technologies. This is followed by the use of Microsoft Office Suite Products (Word, Excel, PowerPoint, MS Project) as the tool/application that is mostly used for communication activities on construction projects with a mean score of 4.619. The use of the Electronic mail and the Intranet ranked 3rd and 4th with a mean score of 4.286 and 3.167 respectively as the next most used technology after the mobile devices and the Internet and the Microsoft Office suite products.

The audio conference, Building Information Modelling (BIM), Extranet and Video Conference were not ranked as technologies that are used frequently since they all had a mean score less than 3.00 with the video conference being the least used communication technology. Although the video conference eliminates the barrier of distance that usually separate construction professionals on projects as said by Sekou (2012), the cost of setting up such technology is very expensive which deter and prevent construction organisations from purchasing them although they speed up communication processes. In addition to that, the use of these technologies are usually dependent on the information and communication requirements of the project since they are not expected to be very important on the project because they are used for the the basic communication activities like the first four ranked technologies.

The Mobile Devices and the Internet, Microsoft Office Suite Products and the Electronic Mail (E-mail) were the first three ranked most used technologies and probably so due to the fact that the cost involved in their use and ownership is fairly moderate and as a matter of fact, their purchase and use comes in handy on most computer devices. This makes them an everyday technology that can be employed for communication activities on construction projects and thus most organisations would go in such technologies to handle their project communication requirements since they are less cost-intensive. As said according to the e-Business MarketWatch (2005), mobile devices have been found to be relevant to the construction industry for project management and communication purposes among others.

4.4 BARRIERS TO COMMUNICATION TECHNOLOGIES ADOPTION ON CONSTRUCTION PROJECTS

In a bid to identify factors that promote the adoption of communication management technologies on construction projects, it became necessary to identify those factors that act as barriers and as matter of fact hinder the successful adoption of these technologies. This was necessary to identify the most significant barriers so that efforts to promote or enable the use of these technologies could be tailored to tackle the most significant barriers that would be found from the study.

Respondents were thus asked to rate the barriers listed on a five-point Likert rating scale using the definitions of 1 = Strongly disagree, 2 = Disagree, 3 = Neutral, 4 = Agree, 5 = Strongly agree. The mean of all the barriers listed was calculated and presented in Table 4.4 below after responses were collected from respondents to identify the variables which were viewed as important or not. The Relative Importance Index (RII) was also calculated to rank the barriers in their order of severity according to the results gathered from the respondents.

Just as was explained in the earlier discussion for the identification of communication management technologies on construction projects, a mean score of 3.00 and above means that the barriers listed are ranked collectively as a very significant hindrance to the successful adoption of communication management technologies on construction projects. A mean score less than 3.00 would mean the barrier is not viewed as a significant hindrance and as a matter of fact, in order to boost the adoption of technologies to manage construction project communications, it should be of less priority with a higher priority to be given to those barriers that would score a mean of 3.00 or above.

From Table 4.4, the mean value and the ranking of the various barriers identified in literature have been presented with the ranking done based on the RII score. After analyses, all barriers were ranked as challenges to the successful adoption of the technologies for project communication management since they all scored a mean of 3.00 or above. The greatest challenge was identified to be the lack of legal enforcement support for the use of ICT on construction projects. This was keenly followed by poor internet connectivity and inadequate ICT content in construction education systems as they ranked second and third respectively. These three barriers were agreed to as important barriers that must be overcome by the construction industry to enable the easy adoption and exploitation of the functions of the various ICT tools and applications to enhance communication on construction projects.

It was found that difficulties in using new technologies and limited benefits/low return on investment in technology were last based on the ranking system since they scored the least mark of RII. Although they were not viewed as very significant barriers, they are viewed as barriers since they scored a mean of 3.21 and 3.00 respectively. This means that they (difficulties in using new technologies and limited benefits/low return on investment in technology) cannot be ignored in the fight to promote the adoption of communication management technologies on construction projects for project communication management.³

Table 4.4: Barriers to Communication Technologies Adoption on Construction Projects

BARRIERS	MEAN	RII	RANK
Lack of legal enforcement support for the use of ICT	4.29	0.857	1st
Poor internet connectivity	4.17	0.833	2nd
Inadequate ICT content in construction education systems	4.14	0.8286	3rd
High cost of keeping up to date with the hardware/software updates	3.88	0.776	4th
Budget constraint for ICT investment	3.79	0.757	5th
Inadequate knowledge about return on ICT investment	3.69	0.738	6th
Problem of ICT integration/compatibility in the organization	3.62	0.724	7th
Cost of training professionals in ICT	3.57	0.714	8th
Lack of awareness of the technology among industry stakeholders	3.36	0.6714	9th
Difficulties in using new technologies	3.21	0.643	10th
Limited benefits/Low return on investment in Technology	3.00	0.600	11th

Source: Field Data (2019)

Thus, a lot needs to be done to enable Project Managers to stay updated with the use of new technologies on the market so that in this period of fast technology evolution, Project Managers can capitalise on the technological advancement to make project information communication a lot easier and less stressful. The identification of ‘Lack of legal enforcement support for the use of ICT in construction projects’ as the biggest challenge supports the findings of Nielsen et al. (2006),

which says the lack of a significant legal and contractual support to compel and enforce the use of communication management technologies has been a significant negative consequence to the adoption and use of ICT on construction projects.

4.5 ENABLERS FOR COMMUNICATION TECHNOLOGIES ADOPTION ON CONSTRUCTION PROJECTS

Table 4.5: Enablers for Communication Technologies Adoption on Construction Projects

ENABLERS	MEAN	RII	RANK
Development of a realistic and reliable electronic database in the organization	4.50	0.900	1st
Good organizational management support	4.48	0.895	2nd
Legal enforcement support for use of ICT on projects	4.45	0.890	3rd
ICT training to be more accessible and less costly	4.45	0.890	3rd
Widespread adoption of ICT in the construction industry	4.40	0.881	5th
Organisation structures to be re-engineered for the use of ICT	4.36	0.871	6th
Education of the users on the effective use of ICT and its benefits	4.31	0.862	7th
Awareness of the technology among industry stakeholders	4.26	0.852	8th
Employment of construction professionals with ICT skills	4.17	0.833	9th
Proof of cost savings by ICT adoption	4.00	0.800	10th

Source: Field Data (2019)

As indicated earlier in the introduction to this chapter, the mean score was employed to determine which of the possible listed enablers for communication management technologies adoption were indeed scored as very important to enhancing the strive for the use of technologies to manage project communications on construction projects. The Relative Importance Index was calculated for all the perceived enablers to the adoption of communication technologies which were identified through literature review to aid the ranking of the enablers according to their importance, so that the high-ranking measures to enabling the adoption of communication management technologies on construction projects can be identified as it was the third objective of the research study. The questionnaire survey required the respondents to assess the variables (perceived enablers) by rating

it on a five-point scale according to their level of importance from 1 to 5 where 1 represented ‘Strongly not important’ and 5 represented ‘Very important’.

According to the field data used for Table 4.5, all suggested enablers for the adoption of technologies for communication management on construction projects were rated as important to enhancing the course for the adoption. This is so because, from Table 4.5, all the possible enablers had a mean score of above 3.00 which means that averagely all respondents viewed/rated them as processes that must be satisfied to achieve the adoption been fought for.

Although all variables very important to achieving a growth in the technology adoption for project communication management, the most important enabler to enhancing the use of communication management technologies on construction project management per the findings of the study is for organisations to develop a realistic and a very reliable electronic database where files can easily be categorised and tracked to enhance easy access to information when the need arises since it was ranked 1st with an RII score of 0.900. The next most important enabler is for good organizational management support to provide an environment where these innovative means for technology use and project communication management can be brought on board.

With an RII of 0.890, ‘Legal enforcement support for use of ICT on projects’ and ‘ICT training to be more accessible and less costly’ both ranked 3rd. The finding of ‘Legal enforcement support for use of ICT on projects’ as a 3rd ranked enabler must in line with the respondents rating ‘Lack of legal enforcement support for the use of ICT’ as the most extreme barrier and hence in order the combat that, measures must be put in place to ensure that where the need be, the relevant technologies are given a legal and contractual support to compel their use to make project communication management easy for all project stakeholders.

As shown in Table 4.5, the penultimate enabler was found to be the employment of construction professionals with ICT skills with the least of the enablers been proof of cost savings by ICT adoption. The shows that these two enablers are not seen as enablers which should be given high priority when focusing on committing resource and measures to enhance the technology adoption rate. The finding of Legal enforcement support for use of ICT on projects as a high ranking enabler is in line with the findings of the work of Ahuja et al. (2009) where it was said that one of the perceived enablers to the adoption of Information and Communication Technology (ICT) for

construction project management is for a project scope which would require the use of ICT to carry out project communications.

4.6 CHAPTER SUMMARY

This chapter summarizes all responses in the survey that was carried out to enable the researcher to find answers to research questions raised earlier in this research and also to achieve the research objectives. It further went ahead to analyse and discuss the results obtained from the field survey, which were presented in this chapter in the tables using mean scores and the Relative Importance Index (RII).

First up, the respondent's background was analysed to validate the credibility of the data retrieved from the survey. Further, the first objective of this study which is the identification of technologies used for communication management on construction projects was then analysed using the mean score. The other two objectives were also analysed using mean score ranking and the Relative Importance Index (RII) to rank the variables in their order of importance per the results gathered from the respondents. The findings of each objective were subsequently discussed to enable conclusions and recommendations to be made in the next chapter.

CHAPTER FIVE

CONCLUSIONS AND RECOMMENDATIONS

5.1 INTRODUCTION

This chapter concludes the research work by summarizing the results and the findings on the various objectives so that conclusions and recommendations can be drawn. Clarification is given on how the research objectives were met and how research questions were answered to aid the attainment of the research aim. With conclusions drawn based on the research findings, recommendations were also made to enhance the process of widespread adoption for communication management technologies on construction projects. Future research into related study areas was subsequently suggested.

5.2 REVIEW OF OBJECTIVES

The main objectives of this research as noted earlier in the study was to identify factors that promote the adoption of communication management technologies on construction projects in Ghana. In relation to that, a number of research questions were asked with answers sort so that collectively, the research objectives which were developed earlier in the first chapter of this work would be achieved. This section revisits the objectives to highlight the extent to which they were achieved.

5.2.1 Information and Communication Technology (ICT) Tools and Applications Used for Communication

In this research objective, the researcher sort to identify the technologies used for project communication management on construction projects. In so doing, the research question “What are the technologies used for communication management on construction projects?” was asked. In seeking answers to that question, the researcher thoroughly reviewed literature to identify technologies that have been put to use in the construction industry for project communication management. Upon identification of such communication technologies, they were used in a questionnaire survey to seek the view of respondents on the level of use of the technologies identified in literature when they communicate project information to project stakeholders to ascertain the technologies used for communication management on construction projects in Ghana.

Upon analyses of collected data, it was found from Table 4.3 that not all the identified technologies from literature were frequently used for project communication management in Ghana. It was however found from Table 4.3 that the technology that is used often for communication on construction projects is mobile devices and the internet. The Microsoft Office Suite Products (Word, Excel, PowerPoint, MS Project) were also found to be technology tools and applications that are used usually for communication on construction projects. The Electronic mail and the Intranet were also found to be among technologies were used for communication management on construction projects.

After analysis and identification of the technologies used for communication management, the research question asked in relation to the objective can thus be said to have been answered and hence the technologies used for project communication management on construction projects have been identified as demonstrated.

5.2.2 Barriers to Communication Technologies Adoption on Construction Projects

The researcher in this objective sort to find the barriers to the adoption of technologies for project communication management on construction projects. The research question “What are the challenges to the adoption of technologies for communication management?” was thus asked. In a bid to seek answers to this question, a review of existing literature was conducted to identify barriers to the adoption of technologies for communication management in other parts of the world so that those identified barriers could be used for a survey to find out their level of hindrance in the Ghanaian environment. Upon identification of the perceived barriers from literature, they were used in a questionnaire survey to seek the view of respondents on the level to which they agree that the identified barriers from the literature were a barrier or hindered the successful adoption of technologies for project communication management.

The barriers were analysed, ranked and presented in a table as seen in Table 4.4. Upon analyses of collected data, it was found from Table 4.4 that all barriers identified from literature were rated as challenges or hindrance to the successful adoption of the technologies for project communication management. That notwithstanding, the three most significant barriers from 1st to 3rd appeared to be:

- Lack of legal enforcement support for the use of ICT.
- Poor internet connectivity.

- Inadequate ICT content in construction education systems.

The research question has thus been answered after the analysis since barriers to the adoption of technologies for project communication management have been identified and, in that regard, the research objective has been achieved.

5.2.3 Enablers for Communication Technologies Adoption on Construction Projects

The objective “To identify the enablers for the adoption of technologies for communication management on construction projects” was also set to be achieved to help in achieving the aim of the research. In order to achieve that, perceived enablers for technologies adoption for project communication management were identified from the literature review and used to conduct a survey using a questionnaire where respondents were asked to rank the perceived enablers according to their level of importance in enabling the adoption of technologies to support project communication management.

After analysis, it was identified from Table 4.5 that all identified enablers from the literature were agreed to as enablers for promoting the use of technologies for project communication management. Development of a realistic and reliable electronic database in the organizations came out as the highest-ranked enabler after calculating the Relative Importance Index for all enablers used for the survey. The next most important enabler is for good organizational management support to provide an environment for the use of these technologies to reap the benefits that come along with using them. The results of the findings also suggest that legal enforcement support for use of ICT on projects and ICT training to be more accessible and less costly are equally important to promote the use of technologies for project communication management.

Having identified these four enablers as very important enablers to promoting the adoption of technologies for communication management on construction projects, the research objective has been achieved.

5.3 RECOMMENDATIONS AND CONCLUSION

The aim of this research as stated in the first chapter of this study is to identify factors that promote the adoption of communication management technologies on construction projects. This would be achieved if all research objectives stated for the study is achieved. After data collection and analysis, all research objectives were demonstrated to have been achieved as shown in chapter 5,

section 5.2. It was realized that the three technologies usually used for project communication management are:

- Mobile Devices and the Internet
- Microsoft Office Suite Products (Word, Excel, PowerPoint, MS Project)
- Electronic Mail (E-mail)

Some barriers to the successful adoption of technologies for project communication management were tested to identify the barriers so that measures can be put in place to overcome them. The most significant barriers were identified after the analysis to be:

- Lack of legal enforcement support for the use of ICT.
- Poor internet connectivity.
- Inadequate ICT content in construction education systems.

Notwithstanding the barriers, identified enablers include the development of a realistic and reliable electronic database in the organisations, good organizational management support, Legal enforcement support for use of ICT on projects and ICT training to be more accessible and less costly.

After the results of the analysis, the following recommendations and factors that would promote the adoption of communication management technologies on construction projects have been concluded upon and they are:

- The provision of a database that is very reliable in various organisations so that electronically stored information can be easily retrieved and worked upon or distributed to the appropriate stakeholders with little difficulty is a key factor to motivating the use of technology for project communications. This also suggests a problem with records keeping in most organisations and hence efforts must be made to improve upon the current state of information records keeping in organisations.
- Organisational management support should be increased to expedite moves by industry professionals to make their offices and activities technology-based since a lot of benefits would be gained. Management of various organisations must also take steps to provide good internet access for their employees since the use of the internet is very essential to

enhancing a good experience with the smooth use of current technologies. Their absence would cripple the move to make technologies a core part of project communication management.

- The provision of legal support for the use of ICT on projects for communication management is a key factor as it would compel professionals on a construction project to adhere to the contract regulations. This can be done by requesting specific information to be produced in a specific format that involves the use of some technology which would in a long run boost the adoption of technology for project communication management.
- One very essential factor that cannot be set aside in the efforts to promote the adoption of communication management technologies on construction projects is the educational system in which professionals are groomed. Course content that exposes new, trending as well as already existing technologies to students should be augmented so that students who graduate from their respective project/construction-related courses would come out ready to use technologies in handling activities and more specifically project communication.

5.5 RECOMMENDATION FOR FUTURE RESEARCH

A future research study can be undertaken to identify the effective ways of using legal structures to promote the use of Information and Communication Technology on construction projects. Further study can also look at finding out reasons why there is a budget constraint for investment into technologies in organisations.

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APPENDIX: QUESTIONNAIRE

**KWAME NKRUMAH UNIVERSITY OF SCIENCE AND TECHNOLOGY, KUMASI,
GHANA**

COLLEGE OF ARTS AND BUILT ENVIRONMENT

DEPARTMENT OF CONSTRUCTION TECHNOLOGY AND MANAGEMENT

QUESTIONNAIRE

INTRODUCTION

This research is being undertaken by Albert Tamatey Bawah, a postgraduate student pursuing MSc. Project Management at Kwame Nkrumah University of Science and Technology, Kumasi. This research questionnaire has been designed to solicit your view and information regarding the topic: **“ADOPTION OF COMMUNICATION MANAGEMENT TECHNOLOGIES ON CONSTRUCTION PROJECTS”**.

The study is aimed at identifying factors that promote the adoption of communication management technologies on construction projects in Ghana.

The objectives of the research are as follows:

- To identify the technologies used for communication management on construction projects;
- To identify the barriers to the adoption of technologies for communication management;
- To identify the enablers for the adoption of technologies for communication management on construction projects.

The questionnaire is in three parts:

- **Part A - Technologies for communication management**
- **Part B - Barriers to communication technologies adoption**
- **Part C - Enablers for communication technologies adoption on construction projects.**

All information provided is strictly for academic purposes and shall be kept confidential.

Incase of any clarifications and contributions, contact:

Tel: 0240457998/0267772492

Email: bawatam13@gmail.com

I appreciate your assistance and time spent in completing this questionnaire.

Thank you.

SECTION 1 – RESPONDENT DETAILS

1. How many years have you been managing construction projects?
 - a. Less than 5 years []
 - b. 5 – 10 years []
 - c. 11 – 15 years []
 - d. 16 – 20 years []
 - e. More than 20 years []
2. What is your company/firm years of experience in Project Management in the Ghanaian construction industry?
 - a. Less than 5 years []
 - b. 5 – 10 years []
 - c. 11 – 15 years
 - d. 16 – 20 years []
 - e. More than 20 years []

PART A

In the table below are ICT tools and applications for communication

Please indicate [√] the extent of their use by your organization/company on a scale of 1-5

Scale: 1 = Never 2 = Not always 3 = Average 4 = Quiet always 5 = Always

ICT Tools and Applications for Communication	Scale				
	1	2	3	4	5
a. Electronic Mail (E-mail)					
b. Building Information Modelling (BIM)					
c. Audio Conference					
d. Video Conference					
e. Mobile Devices and the Internet					
f. Microsoft Office Suite Products (Word, Excel, Powerpoint, MS Project)					
g. Intranet					
h. Extranet					

PART B

In the table below are reasons hindering ICT adoption and implementation for communication management processes in construction. Please tick [✓] using the scale below to indicate your level of agreement with the enumerated barriers.

Scale: 1 = Strongly disagree 2 = Disagree 3 = Neutral 4 = Agree 5 = Strongly agree

Barriers	Scale				
	1	2	3	4	5
a. Inadequate knowledge about return on ICT investment					
b. Limited benefits/Low return on investment in Technology					
c. Inadequate ICT content in construction education systems					
d. Budget constraint for ICT investment					
e. Cost of training professionals in ICT					
f. High cost of keeping up to date with the hardware/software updates					
g. Problem of ICT integration/compatibility in the organization					
h. Difficulties in using new technologies					
i. Lack of awareness of the technology among industry stakeholders					
j. Poor internet connectivity					
k. Lack of legal enforcement support for the use of ICT					

PART C

In the table below are possible measures to enable the use of communication technologies on construction projects. Please indicate how important they are to enabling the use of communication technologies on construction projects using the scale below.

Scale: 1 = Strongly not important 2 = Not important 3 = Neutral 4 = Important 5 = Very important

POSSIBLE ENABLERS	Scale				
	1	2	3	4	5
a. ICT training to be more accessible and less costly					
b. Education of the users on the effective use of ICT and its benefits					
c. Employment of construction professionals with ICT skills					
d. Proof of cost savings by ICT adoption					
e. Development of a realistic and reliable electronic database in the organization					
f. Good organizational management support					
g. Awareness of the technology among industry stakeholders					
h. Widespread adoption of ICT in the construction industry					
i. Organisation structures to be re-engineered for the use of ICT					
j. Legal enforcement support for use of ICT on projects					

END OF QUESTIONNAIRE