INFLUENCE OF INFORMATION COMMUNICATION TECHNOLOGY APPLICATIONS ON PERFORMANCE OF ARCHITECTS IN CONSTRUCTION PROJECTS IN PUBLIC SECTOR: THE CASE OF DIRECTORATE OF PUBLIC WORKS, KENYA

BY

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DECLARATION

This research project is my original work and has never been submitted for any award in any other university.

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DEDICATION

I dedicate this research project to my family especially my wife Mary Nyambura and children Monicah, Dan and Victor for the support and encouragement that they accorded me towards the completion of this research project and to all my friends for assistance they gave me.

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ACRONYMS AND ABBREVIATIONS

2D	Two-Dimensional
3D	Three-Dimensional
4D	Four-Dimensional
5D	Five-Dimensional
ArPM	Architect project manager
AEC	Architecture, Engineering & Construction
BIM	Building Information Modeling
CAD	Computer Aided Drafting
CASBEE	Comprehensive Assessment System for Built Environment Efficiency
CEG	Council for Excellence in Government
CI	Construction Industry
CIM	Construction Information Modeling
DR	Disaster Recovery
GIS	Geographic Information Systems
IAI	International Alliance for Interoperability
ICT	Information and Communication Technology
IFCs	Industry Foundation Classes
IJVs	International Joint Venture
IOPs	Information Integration Opportunities
IPD	Integrated Project Delivery
KM	Knowledge Management
LAN	Local Area Network

MIS	Management Information System
NACOSTI	National Commission for Science, Technology and Innovation
PC	Personal Computer
RA	Research Assistant
ROM	Read Only Memory
TRA	Theory of Reasoned Action
TAM	Technology Acceptance Model
UK	United Kingdom
USA	United States of America
VR	Virtual Reality
WAN	Wide Area Network

ABSTRACT

Many studies regard the construction industry's failure to keep pace with ICTs as a major problem affecting its performance. The purpose of this study was to explore the influence of ICT applications on the performance of architects in construction projects. The objectives of the study were; to establish the extent to which ICT Infrastructure, how efficiency of ICT Hardware systems, the extent to which ICT Software capability, to assess the influence of Communication systems and to examine how human resource (ICT Support staff) influences the performance of architects in construction projects in public sector. Methodology used was descriptive survey design and targeted a population of 78 architects of the Directorate of public works, Ministry of Lands Housing &Urban Development (MOLH&UD). The study used census sampling method and used a 5 point likert scale. The study's hypotheses testing confirmed acceptance of alternative hypotheses (H1): The correlational analysis indicated that ICT Infrastructure had a correlation coefficient of 0.867, Hardware Efficiency 0.763, Software Capability 0.932, which showed a strong relationship while Communication Systems 0.667 and human resource(Support staff) 0.567 showed moderate relationship to performance. From the study findings 93.75% agreed that ICT application help architects increase productivity, 84.375% agreed that ICT applications help increase architects efficiency, 71.875%, agreed that ICT application help architects produce quality information, 81.25% agreed that ICT applications help architects produce quality work and output, 84.375% agreed that ICT applications help in reduction of working time while 46.87% agreed that their organization had modern ICT applications equipments which implied that availability of modern equipments in institution was highly determined by availability of resources. Based on the findings of the study the following recommendations were made: Increase training and development of the ICT Support staff. Install ICT applications systems relevant to the architects' needs, Architectural departments need to install ICT infrastructure related to construction projects, Architects to use efficient ICT hardware and ICT software capable of accomplishing the architectural tasks, greater stakeholder's participation in the development to promote ownership and organizations to upgrade their ICT equipments to conform to the ever changing technology environment. Further research were suggested on; the influence of organizational culture on architects' performance, the influence of leadership skills on architects' performance, the implementation of computer-integrated design and construction, the development of new tools to support concurrent practice and to assist architects in the conceptual stages.

CHAPTER ONE

INTRODUCTION

1.1 Background of the Study

Information and communication technology (ICT) plays a great role in the building construction industry today and is responsible for the entire construction process from information being generated, transmitted and interpreted to enabling the project to be built, maintained, reused and eventually recycled. The everyday life of individuals is increasingly being affected by the use of information and communication technology which has totally transformed individuals and organizations due to its wide spread use. According to Sun and Howard (2004) “The impact of IT on modern society is profound”, and its growing speed has enabled globalization especially through the introduction of a global system of interconnected computer networks known as the ‘Internet’, used for communication between individuals, companies and institutions for sharing and exchanging information and data.

The construction industry is faced with the ongoing challenge of changing and improving current work practices in order to become more client-orientated; more competitive as well as productive through adoption of ICT as an integral part of the construction process (Weippert *et al.* (2003).

Much effort has been directed toward improving construction productivity and the use of information and communication technology (ICT) in construction and this is an area worth concentrating upon because it can decrease the time for data processing, communicating information and increase overall productivity. Modern structural design software applications, such as computer aided draughting and design (CADD), 3D modeling and Building Information Modelling (BIM), provide an example where designing complex structures and organizing the electrical mechanical, site, structural and quantifying of a project can be achieved in minimum time and increase the efficiency all in one data framework whereas in the past this was almost impossible (Peansupap and Walker (2005). Other applications such as Word Processors, Spreadsheet, Database, Presentation Graphic, Multimedia (Ikechukwu *et al.*, 2011) allows users to create, edit documents, perform calculation, store and retrieve vast amount of data, create visual presentation and also to create image, audio and video. The understanding of ICT and its role is therefore important for the realization of improved communications between participating organizations in construction projects.

In the Middle Ages design was never handled as an isolated theme but was always part of the construction process. The old craftsmanship of the past has been replaced by new modern form of craftsmanship, namely one of electronic machine. Buildings are not anymore labor intensive but have become automated. (Veer, P.van der and Sariyildiz , 1997). The role of an architect today in Construction projects has become that of modern craftsmanship and is characterized by the use of large amounts of information during the design, implementation and construction phases of a project. The architectural discipline therefore needs to adapt the relevant ICT application tools to assist it deliver efficiently taking cognizance of the systemic complexity of the construction industry.

The development of ICT applications has led to several changes in the architectural design industry. The network technologies, advanced visualization tools such as BIM (Building Information Modelling) and CAD (Computer Aided Design) are some examples of ICT tools, which represent powerful potential of facilitating change and improvement. The ICT helps the architects to increase their performance of services and carry out the desired functions with ease and professionalism (Almarabeh & Buali, 2010). These applications ensure increased efficiency and effectiveness of architects in construction projects (AlMansoori, 2010). Under these prevailing conditions, the national government should put in place ICT systems that are designed to achieve productivity and efficiency of the architects in construction projects; by providing better and more easy-to-use services and providing the required information in a timely and highly accurate fashion (OECD, 2003, Yesser, 2005).

On the global scene, architects have embraced ICT tools as reliable partners to architecture by using computer as a medium of knowledge integration tool, decision support tool and design tool. Global coalitions of construction industry practitioners have developed collaborative initiatives seeking to introduce interoperable data exchange standards within the construction sector. Since 1990s, there has been significant progress in development of ICT applications for performance efficiency in the construction industry globally (Vivarelli, Piga & Piva, 2004).

In (USA), enhanced ICT application tools allow architects in construction projects to access status of information integration (Azhar, 2008) and improve communication between the architects in construction projects and the stakeholders. In (UK), architects in construction projects commonly use BIM to accomplish tasks more efficiently than ever before and pave the way for future construction professionals, where professional work by architects in construction projects has become digitally communicated and distributed (Zhang, 2010). Japan government has advocated for Construction Information Modeling (CIM) to introduce the BIM method to large construction projects and it has also upgraded 2D drawings to 3D, thereby leading to improvement on accuracy of design by architects in construction projects (Tahara *et al.*, 2012).

ICT applications in Africa are viewed as a foreign concept based on imported designs (Heeks, 2002). The growing numbers of modern ICT applications by architects in construction projects contribute to delivering gains of efficiency and/or effectiveness in the sector. However, according to Heeks (2001) ICT application by architects in construction projects is slowly diffusing within Africa. African countries that have adopted use of ICT applications in construction projects experience high performance. Egypt has taken the longest strides with advances in ICT applications in the construction industry, improving productivity, service quality, and enabling more sustainable designs of buildings (Eastman *et al*., 2011; Azab, Kamel & Dafoulas, 2009). In South Africa, Construction industry is currently shifting from traditional paper-based information sharing to ICT applications (Rivard *et al*., 2004). This has greatly impacted on the performance and result in change in construction industry processes, working methods and culture (Ruikar *et al.*, (2005). In Nigeria, the construction industry has greatly benefited from the importance and use of modern ICT applications. This has raised productivity of architects in construction projects (Liston et al, 2000) and led to an increase in the quality and speed of work, communications, and access to common data (Peansupap & Walker, 2005). However, Ghanaian construction industry is facing challenges since up to now, the architects in the construction projects use paper-based transaction. This approach has raised communication difficulties between project partners (Hinson, 2011).

In Kenya, ICT applications for use by the architects in construction projects and other related areas have failed to take permanent roots in the country since the Kenya leadership has failed to strategically leverage the technology explosion in order to catalyze opportunity for growth and development. It has also failed in disseminating information about ICT applications by the architects in construction projects and providing incentives to encourage use of ICT applications effectively and for intended purpose (Njuru, 2011). ICT applications by Kenyan architects in construction projects are widely used in areas such as Computer Aided Design (CAD) systems which are used to automate the production of design drawing and design change and also used to assist in the creation, modification analysis or optimization of a design. Although Kenya is leading in adoption of ICT in the East African region (Gichoya 2006, IDRC, 2008), it should re-engineer the ICT applications required by architects in construction project and therefore improve their performance by harnessing the potential of the available ICT tools to its fullest extent. The ICT applications by the architects in construction projects are currently more active in urban areas, resulting in wide regional disparities in the distribution of ICT facilities. Although ICT applications are increasingly becoming powerful tools for participating in global markets and improving performance of architects in construction projects (Shollei, 2011), the use of ICT application tools are limited mainly by lack of resources, lack of skilled personnel and a slow diffusion rate of technological knowhow from the developed countries.

1.2 Statement of the Problem

Most of the Construction projects in the public sector are undertaken by the national government due to huge capital outlay required. Directorate of Public Works in the Ministry of Lands, Housing and Urban Development is the government departmental agency charged with this responsibility. Despite the high quality of training of architects in the construction projects in Kenya and regulation of the construction industry, most of the construction projects do not always meet key performance goals due to deficiency of the designs, poor project planning, inefficient project control and lack of project management competency which often results to high costs overruns, high maintenances costs, arbitrations or litigations cases, stalled projects, extended contractual periods and sometimes collapse of buildings and this is attributed to either lack of proper training, skills, or lack of appropriate technology available to architects in construction projects.

The government of Kenya has heavily invested in ICT to improve service delivery to the public by introducing ICT (e-services) platforms through which the public can access government services easily and have also proposed introduction of lap-tops to children in primary school to encourage earlier adoption of ICT knowledge but little has been done on the building sector as shown by the Kenya National ICT Master plan (2013/18) which identified the key social and economic sectors whose performance could be enhanced through the use of ICT (e-services). Health, Education, Security, Agriculture, Financial services, Trade, Transport and Logistic were selected but the building sector was missed out.

Few prior studies have identified the importance of ICT applications by architects in construction projects and have mentioned the critical prerequisite of ICT applications by architects in construction projects but there is no sufficient information to show that performance of architects in construction projects in public sector in Kenya is influenced by ICT applications. To overcome the deficiencies and challenges that the architects' face there is need to equip them with the relevant modern ICT applications to help improve on their performance in construction projects. Although Kenya is leading in adoption of ICT in the East African region (Gichoya 2006, IDRC, 2008), it should re-engineer the ICT applications required by architects in construction project and therefore improve their performance by harnessing the potential of the available ICT tools to its fullest extent. The construction industry is faced with the ongoing challenge of changing and improving current work practices in order to become more client-orientated; more competitive as well as productive through adoption of ICT as an integral part of the construction process (Weippert *et al.* (2003).

1.3 Purpose of the study

The research sought to assess the influence of information communication technology (ICT) applications on performance of architects in construction projects in public sector a case of Directorate of public works.

1.4 Objectives of the Study

The study was guided by the following objectives;

i. To establish the extent to which ICT infrastructure influences the performance of architects in construction projects in public sector.

ii. To determine how efficiency of ICT hardware systems influences the performance of architects in construction projects in public sector.

iii. To establish the extent to which ICT software capability influences the performance of architects in construction projects in public sector.

iv. To assess the influence of Communication systems on the performance of architects in construction projects in public sector.

v. To examine how ICT Support Staff influence the performance of architects in construction projects in public sector.

1.5 Research Questions

The study endeavored to seek responses to the following research questions;

i. To what extent does ICT infrastructure influence performance of architects in construction projects in public sector?

ii. How does efficiency of ICT hardware systems influence the performance of architects in construction projects in public sector?

iii. To what extent does ICT software capability influence the performance of architects in construction projects in public sector?

iv. How does Communication system influence the performance of architects in construction projects in public sector?

v. How does ICT support staff influence the performance of architects in construction projects in public sector?

1.6. Research Hypotheses

In order to answer the research questions, the study tested for the following hypotheses

i. Ho - Application of ICT infrastructure does not influence performance of architects in construction projects in public sector.

Hi - Application of ICT infrastructure influence performance of architects in construction projects in public sector.

ii. Ho - Efficiency of ICT hardware systems does not influence performance of architects in construction projects in public sector.

Hi - Efficiency of ICT hardware systems influence performance of architects in construction projects in public sector

iii. Ho - Software capability does not influence performance of architects in construction projects in public sector

Hi - Software capability influence performance of architects in construction projects in public sector.

iv. Ho - Communication systems do not influence performance of architects in construction projects in public sector.

Hi - Communication systems influence performance of architects in construction projects in public sector.

v. Ho - ICT Support Staff training and skills does not influence performance of architects in construction projects in public sector

Hi - ICT Support Staff training and skills influence performance of architects in construction projects in public sector

1.7 Significance of the Study

The findings from the study will significantly enhance the performance of architects by increasing efficiency and effectiveness in construction projects, from planning, designing, contract administration, project management and in overcoming other architects' critical challenges. The study also hopes to benefit the National and County government constructional services delivery at all levels in Kenya and to provide a good reading material for students of project planning including other related professionals. Finally the study may lead to exposure of other possible areas of research.

1.8 Delimitations of the Study

This study focused on assessing the influence of information communication technology application on performance of architects in construction projects in the public sector in Kenya. The study scope targeted architects undertaking construction projects in Kenya Public Sector in the case of Ministry of Lands, Housing and Urban Development, Directorate of Public works. The choice was made owing to the fact that it has a wide diversity of architects and is charged with a huge responsibility of Documenting, Designing, Implementing and Management of new projects as well as Maintenance of all public buildings in Kenya.

1.9 Limitations of the study

This study was limited in a number of ways. First the researcher relied on behavior of the respondents of whom some felt that they were being disturbed and therefore refused to participate or gave wrong information. To overcome this, the researcher conducted an orientation before the administration of the research tools to the respondents. The researcher had to tell the truth about the research to allay any fears that would have resulted in respondents being uncooperative. Secondly, some of the respondents took longer time to respond to the data collection by taking long time to fill the questionnaire and the researcher had to assist respondents fill the questionnaire and make frequent follow-ups. However, this led to the delay in completion of the study on time as previously planned. The last limitation was the study time, which was deemed too short. The researcher had to work extra time and seek the services of a research assistant where necessary.

1.10 Assumptions of the study

Now the assumptions are that that all respondents would be truthful in their answers, they would fill the questionnaires and return them within a reasonable time for data analysis, that the outcome of the study will be a representation of other public institutions in Kenya and that all the respondents are aware about the use of ICT applications in construction projects.

1.11 Definitions of Significant Terms used in the study

ICT Connectivity: This is the state of being or being able to be connected to the network system with and outside the firm.

ICT Hardware: Efficiency is the level of delivery of the ICT devices to produce the desired at all times and serves the users as per the user requirements. It is the tangible part of an information system. It consists of all physical devices used in the system that is what can be seen.

ICT Infrastructure: This is a collection of physical or virtual resources that supports an overall IT environment: server, storage and network components and offers a range of technologies to assist organizations in running efficiently. These include hardware, software, networking and implementation.

ICT Support Staff: This is qualification of IT staff within the public organizations required to achieve the goals of the organization through attaining successful knowledge as well as the ability to effectively use their roles and responsibilities.

Performance of Architect in construction projects: This is the ability and competence of these architects to meet their professional obligations.

Software capability: This is the operational ability of the ICT applications to deliver. It determines the level of delivery of the procedures in operations.ICT software also known as the intangible system; consist of procedures used in the system.

1.12 Organization of the Study

The study was organized into five chapters. Chapter one included the introduction and the background of the study, statement of the problem, purpose of the study, objectives of the study, research questions, research hypotheses, significance of the study, limitations, assumptions and definition of terms. Chapter two consist of introduction and the review of literature lending support to the crafting of cogent questionnaires for data collection, concept of ICT application, ICT Infrastructure, efficiency of ICT hardware, ICT Software capability, Communication systems and ICT support staff training and skills and performance of architects in construction projects and conceptual framework and summary. Chapter three consists, research methodology that is the introduction, research design, target population, sampling procedures, validity and reliability, methods of data collection data analysis techniques, operational definition of variables. Chapter four consists of data analysis, presentation and interpretation. Chapter five consists of summary findings, discussion conclusion, recommendations and suggestions for further studies.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

In this section the researcher reviewed related literature in ICT applications and performance of architects in construction projects. The section was intended to acquaint readers with the literature on the influence of; ICT infrastructure, efficiency of ICT hardware systems, ICT Software capability, Communication systems and human resource (ICT support staff) on the performance of architects in construction projects which would be beneficial to the present study. The study critically analyzed the empirical studies which were useful in identifying the research gaps. The study also reviewed various theories, which were found useful in the design of a conceptual framework for the study.

2.2 ICT Infrastructure and Performance of Architects in Construction projects

The ICT infrastructure is a key element to architects in construction projects. This infrastructure is composed by a set of hardware, software, services, procedures, processes and persons. ICT Infrastructure has a great number of elements, with persons that interact with these elements and with other persons, with complex processes, and a great number of procedures. This infrastructure should interact with its environment, should adapt to it and should evolve. Although the ICT infrastructure is a complex system, the present study develops a methodological framework to model and to design an ICT infrastructure concept that relates to the performance of architects in construction projects (Dillon & Pelgrin, 2002). While governments continue to modernize ICT infrastructure, they should also work to leverage the ICT infrastructure within the public sector and for architects in construction projects in order to better share information, internally and externally, and to deliver integrated services. The ICT infrastructure can be offered reliably and effectively to the architects in construction projects (McClure, 2000) and the key to success in the construction projects is to implement an adequate IT infrastructure that would support an architects' experience and offer easy and reliable electronic access.

The ICT infrastructure include systems containing; web servers, application servers, storage devices, PCs, printers, scanners, routers, switches, firewalls, hardware, operating systems, data and application development tools (IBM, 2011, Macasio, 2009). The concept of the ICT infrastructure is not only a set of equipment or elements, but enables architects to share the ICT capabilities which provide services for other systems of the organization (Broadbenta *et al.*, 1999). According to Broadbenta *et al.* (1999) these capabilities require the complex combination of the technical infrastructure (cabling infrastructure, hardware platform, base software platform) and ICT shared services (as communications services). ICT infrastructure should be flexible to support the operation among different applications and to facilitate the communication of the information inside and outside of the construction project. Building a flexible infrastructure would consider the variety of user necessities that architects can handle without modifying the infrastructure. ICT infrastructure needs to respond more rapidly to changes in the environment and between the different functional units of the architectural design. The integration increases the importance of relations among services and information used by the architects in construction projects. In this way, the ICT infrastructure would attain unique and shared, rather than separate ICT platforms (IBM, 2011).

The conception of ICT infrastructure in this study will consider the complex dynamic system (variable environment, organizational system, a great number of other elements). The first step in the analysis of this complex system will be to use the method of decomposing the whole system in subsystems with smaller complexity degree. In the study's framework, each subsystem can be treated independently, although in each subsystem, the whole integration and the synergy with the other subsystems have been considered and one subsystem is responsible of the integration of all the parts (IBM, 2011). There are five systems in ICT infrastructure; Operation, Coordination, Integration, Intelligence and Policy. These five systems can be summarized as follows: Operation realizes the primary activities; Coordination regulates and coordinates the different subsystems of Operation; Integration is the controlling unit of the operational level (Operation, Coordination and Integration). It has to ensure the operation of all the systems and to optimize the allocation of resources. Intelligence is the link between the primary activities and its environment. Just like the normal infrastructure of a countries economy ICT infrastructure offers a platform on which development can take place. Good infrastructure ensures better delivery of services.

2.3 Efficiency of ICT Hardware and Performance of Architects in Construction projects

Hardware is the physical part of a computer, including the digital circuitry, as distinguished from the computer software that executes within the hardware. The hardware of a computer is infrequently changed. Firmware is a special type of software that rarely, if ever, needs to be changed and so is stored on hardware devices such as read-only memory (ROM) where it is not readily changed (IBM, 2011). Hardware can affect the speed of data processing. Newer processors will process faster, and newer devices such as hard discs will operate faster and with greater reliability. However it should be noted that all hardware eventually fails. The hardware may not be up to the specifications that the software requires. The hardware installed for use by architects in construction projects must be the correct type and useful in data processing activity. When wrong hardware is put in place, then the required performance is not achieved.

Efficiency of ICT hardware can be determined from several aspects that is energy consumption, speed, durability and its reliability to perform the designated tasks. When ICT hardware consumes less energy during its performance, its data processing speed is high, meets the performance requirement as per the technical specifications and proves reliable over time, then we can infer that the hardware is efficient. Other factors that may affect ICT Hardware efficiency would include the input and output devices. Input and Output devices may be too slow or the computer may find it difficult to handle the data from them. For example, a OMR (Optical Mark Recognition) device - that is the process of capturing human-marked data from document forms such as surveys and tests, may read thousands of forms which would take a long time and lots of memory. The computer may not have the memory to cope. On the other hand if the organization has access to old machines then data processing will be slow and this would reduce efficiency.

Efficiency of ICT hardware may be affected by other forces that may directly or indirectly impact on the overall hardware performance such as: The Power of the Hardware which gives you a greater frequency and a larger word size, the expandability of the hardware that accommodate greater number of board slots for additional RAM (Random access memory), the number of Ports in your hardware facilitate ports for printer, external hard disk, communication devices and other peripherals, the Ergonomics of the hardware avail comfort and safety, compatibility of the hardware with other computers and peripheral devices, as well as software packages, the Carbon footprint area, that is how much carbon is emitted by the hardware, availability of telephone and on-line support for troubleshooting and genuineness of the hardware and its conformity to technical specification as set out by the manufacturer. All these factors are proponents of efficiency and greatly affect the usage of the hardware which leads to enhancement in performance.

2.4 ICT Software Capability and Performance of Architects in Construction projects

Software is designed for specific clients or packaged software for general use, ranging from educational software to programs for desktop publishing and financial planning. It can be readily created, modified or erased on the computer. Architectural software such as CAD, BIM, programming of packaged software constitutes one of the most rapidly growing segments of the construction industry. The software provides the day-to-day work needed to monitor and maintain a continuous ICT infrastructure and operating systems (Patrizio *et al.*, 2004). A number of the jobs are associated with the processes such as job scheduling, data management (including backup and recovery management), enterprise command center, physical database administration and proactive hardware maintenance.

Furthermore, the increased demand in recent years for continuous operation of applications and database in the presence of disasters (Garcia-Molina & Polyzois, 2002). In addition, the rise of the Internet has made Web software development a huge part of the ICT applications available to architects in construction projects. More and more software applications nowadays are Web applications that can be used by anyone with a Web browser. Another very important issue that must be addressed by the software functionalities is the security. The correct Software Systems must be acquired; the user needs to identify the most suitable software required by architects. The architects in construction projects must have the appropriate hardware systems (machinery and equipment) to be used in carrying out various functions or performing certain operations in information processing event. The common types of software used in by architects in construction projects include word processing, spreadsheet, CAD and Internet software (Goh, 2005). This software is used for administration, communication, desktop publishing, presentation and project management The architects in construction projects use CAD mostly for design, drawing and presentation (Rivard, 2000;). With 3D modeling capacity in modern structural design software, designing complex structures will be facilitated (Walker &Hampson, 2003).

2.5 Communication Systems and Performance of Architects in Construction projects

Good communication is essential to every organization; Communication between organizations and communication between parts of a single organization for example between offices in different countries. Communication systems offer necessary technology such as, E-Mails, Video Conferencing, Mobile Telephone, Fax, Internet either Local Area Network (LAN) or Wide Area Network (WAN). A local area network (LAN) is a computer network that spans a relatively small area. Most LANs are confined to a single building or group of buildings. LANs allows integration of hardware resources such as PCs, laptops, and mobile phones straight forward, which support the construction industry existing IT provision (Ibrahim & Irani 2005). LANs also support the provision of user-friendly and innovative online services involving the transmission of data of various formats such as text, graphics, audio and video (Ibrahim & Irani, 2005).

WAN is a communications network that makes use of existing technology to connect local computer networks into a larger working network that may cover both national and international locations (IBM, 2011, Macasio, 2009). This is in contrast to LAN which provides communication within a restricted geographic area. The aim of these technologies is to support and integrate the operations of business processes and information systems dimension across architectural environment by providing the necessary standards and protocols all the way through ICT network and communication infrastructure solutions such as the intranet, extranet, Internet, and so on. ICT has emerged as an intermediary in assisting successful communication between architects in construction projects and stakeholders (Abdalla, 2006). While extant research predominantly focuses on functionality factors and e-services delivery prospect (Becker &

Nowak, 2003, Carter & Belanger, 2005), little attention has been placed on factors such as usability, accessibility and the availability of public e-services from the perspective of ICT applications by architects in construction projects (Alsobhi *et al*., 2009).

ICT applications for architects in construction projects need to be driven by user demand. These user requirements include time savings, increased convenience and accessibility (World Bank, 2005, Yesser, 2005). The increasing growth of ICT applications by architects in construction projects has promoted the need to provide web-based systems and ICT portals (Maheshwari *et al*., 2009). Moreover, accessibility, which the ease of attaining information and services offered through an ICT application portal (Criado and Ramilo, 2003) has drastically increased. In fact, connectivity services are important for ICT applications by architects in construction projects and have improved highly. This means that architects in construction projects can obtain different architectural services (Ebrahim and Irani, 2005). Access channels comprise online and offline channels of delivery through which products, services and information are utilized, accessed and communicated by various technologies such as Internet, ATMs, PCs, fixed-line and mobile phones (WAP), and kiosks in public places (Ebrahim & Irani, 2005, IDA, 2004).

2.6 ICT Support staff and Performance of Architects in Construction projects

The area of human resources focuses on the roles and responsibilities required to achieve the goals of the architectural section (Macasio, 2009b). Human resources are one of the most important factors in the success of ICT applications by architects in construction projects (Azab *et al*., 2009, Bakry, 2004). In addition, a number of constructs need to be considered such as adaptation to change, use of technology, integration, customer service and training and development (Azab *et al*., 2009). Human resources factors which contributes towards government goals include; training and support system which maintains the current personnel skills sets in keeping with firm developments; IT assistance; such as help desks; suitably qualified IT staff within the public organizations; IT governance; and technical experience. The majority of public sector organizations implement knowledge management (KM) based predominantly on physical ICT infrastructure. Such behaviour may lead to inadequate short-term advantages as successful knowledge management depends on cultural changes and promoting an environment in which people are agreeable to share their experiences with others (StarkeyK *et al*., 2004). KM is focused on improving knowledge, capabilities and skills; and achieving a change of attitude (Rampersad, 2002).

The users of the system requires adequate training to understand the procedures, data, policies, functions and information needs of the architect. This training requires being all round and effective and should be both on job training and off job training. This is necessary to provide the architects with the knowledge of current information Systems (IS) and other architectural related ICT needs. Lack of effective training yields unqualified staff that mess the system or maintain outdated system which do not serve the current needs of the architects. This often leads to lack of the correct information favourable for management functions and hence ineffectiveness in management. The public sector needs to create conducive working environment for its architects in construction projects. There is the need of staff motivation to produce better results. The architects in construction projects should be made part of the management, for them to work effectively in producing good information. This is an input provided for by the management by treating the architects in construction projects with integrity especially during the introduction of a new information system (Rampershad, 2002).

There is usually resistance to change is such a case and for them to work effectively in producing good information they should be made to accept the system honorably not by coercion. For them to work effectively in producing good information to work effectively the architects in construction projects must be recognized and treated fairly so that they do not hinder the success of the new information system. In a case where the architects in construction projects provide resistance that is not overcome, the new system is not successfully introduced and the information obtained from such a system is sub-standard eventually leading to inadequate information for their service delivery (Azab *et al.*, 2009; Rampershad, 2002).

2.7 Theoretical Framework - Theory of Reasoned Action (TRA)

The study reviewed the theories on technology adoption and use which explain adoption and use of ICT applications. The theory and methods that any ICT applications researcher will rely on are determined by the problems being addressed and the context in which the problem arises. A theory playing a very central role in addressing the adoption and use of ICT application is Theory of Reasoned Action (TRA), which postulates that an one's desire to adoption is a result of his/her attitude towards performing the behavior and the perceived usefulness. In the context of the current study, the positive adoption of ICT applications creates a stronger intention to adopt or continue using ICT, as a negative desire would lead to failure to adopt ICT. It should however be realized that adoption of ICT by architects in construction industry would lead to effectiveness in their performance. The TRA family theories are central to the factors considered in organization attitude on adoption of ICT (Cheung et al., 2005).

The main classes of TRA include; Technology Acceptance Model (TAM), and Unified. However, the study found TAM was very useful in identifying the study variables about ICT applications. TAM declares that when users are satisfied with a technology the technology adoption is likely to be higher. TAM is concerned with the determinants of ICT acceptance and explains user behavior across a broad range of end-user computing technologies and user populations. Specifically, TAM argues that the use of ICT applications is determined by individual's intention to use the technology and that one's intention is determined by the person's attitude as well as perceived usefulness and perceived ease of use (AbHamid, 2008). This theory is very useful in proposing that the adoption of ICT applications is determined by perceived usefulness and perceived ease of use.

The TRA theories were very beneficial in identifying the indicator of ICT applications. TRA exposed usefulness of ICT applications, TAM showed that consumer awareness on ICT applications impacted on adoption of ICT applications.

2.8 Conceptual Framework

The study proposes that performance of architects in construction projects in Kenyan public sector is influenced by ICT infrastructure, ICT Hardware Efficiency, ICT Software Capability, Communication systems and the Support Staff as captured in Figure1.

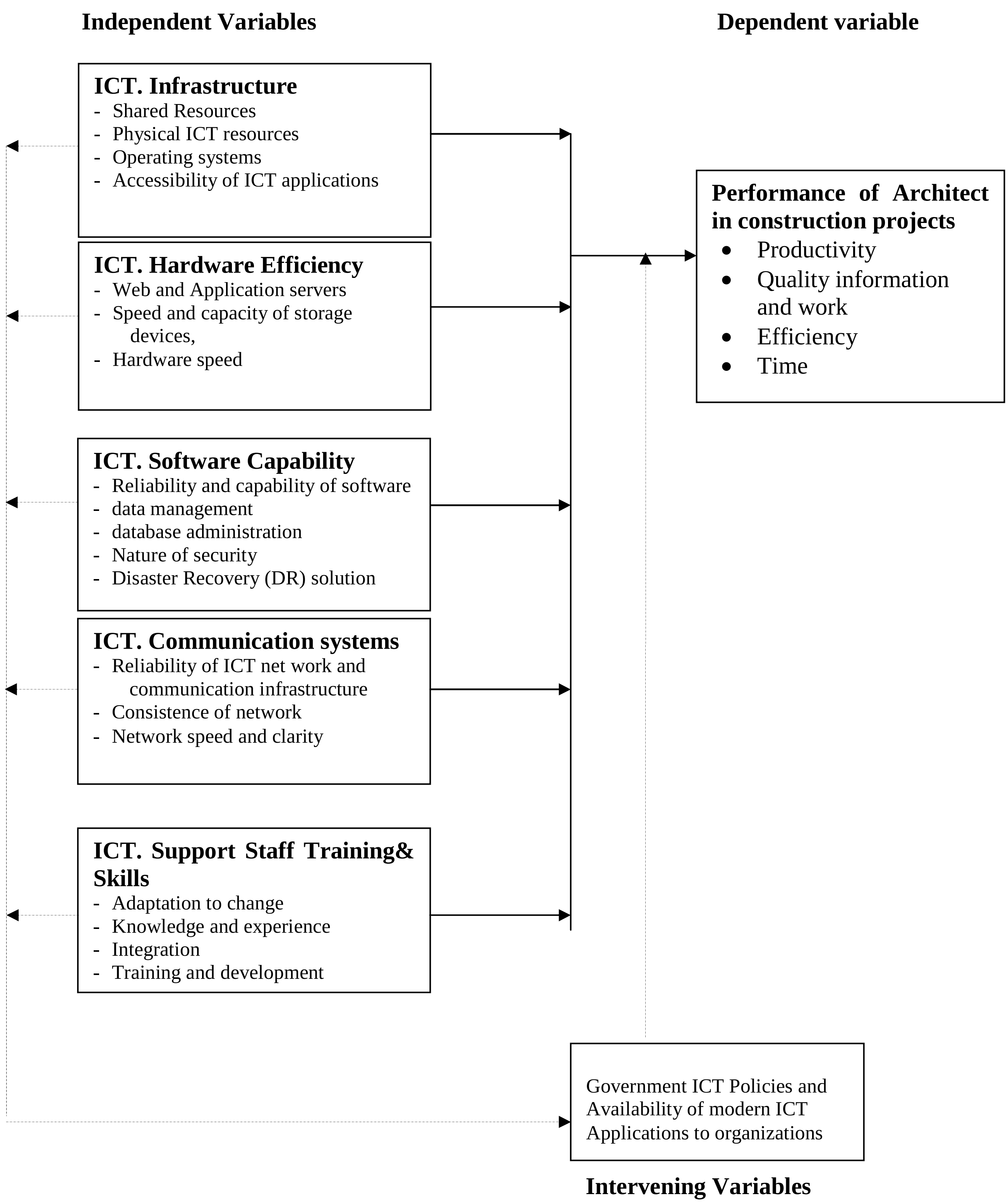

Figure 2.1: Conceptual Framework

2.9 Summary of Literature reviewed

Table 2.1: Summary of Studies Reviewed

Variable	**Author (year)**	**Title of the Study**	**Findings**	**Knowledge Gap**
ICT infrastructure and performance of architects in construction projects	Otike, A. (2010).	The Doctrine of Fair Use and its role in the provision of Information in Kenya	A review of trends in current and latent demand as well as future supply of government services, underlying technologies and infrastructures	No relation was shown between the findings and performance of architects
	IBM. (2001)	Creating an Infrastructure for e-Government: Enabling Government Innovation	Successful ICT application strategy that requires that government organizations establish a suitable IT infrastructure to support information systems and applications	The study failed to show how the ICT application would influence the performance of architects
	IBM. (2011)	ICT Infrastructure	ICT design relies on the service oriented architecture model implemented with web-services	No relation was shown between the findings and performance of architects
	Bakry, S. H. (2004)	Development of e-Government: A STOPE view	Organization's ICT infrastructure must focus technology components	It was not shown how the ICT application would influence the performance of architects
Efficiency of ICT Hardware and Performance of Architects in construction projects	World Bank. (2006)	Information and Communications for Development 2006: Global Trends and Policies	ICT infrastructure includes a group of shared, physical ICT resources. These resources include: hardware and software security;	The study fell short of showing how the components mentioned influenced the performance of

			and operations	architects
ICT Software Capability and Performance of Architects construction projects	McClure, D. (2000)	Electronic government: federal initiatives are evolving rapidly but they face significant challenges	Investing in the best available ICT software and tools is worthwhile, as a shortage of them could lead to failure of the entire ICT system	It was not shown how this affects the performance of architects
	Gefen, *et al.* (2002)	E-government adoption	Citizens will know what personal information may be collected and how will be used	It was not explained how this affects the performance of Architects
Communication systems and Performance of Architects in construction projects	Layne, K. and Lee, J. (2001)	Layne, K. and Lee, J. (2001), "Developing fully functional e-government: a four stage model	Emphasize the importance of network capacity and communication Infrastructure as an important foundation for integrating information systems across government organizations.	The study did not talk on anything about performance of architects
	Dillon, J. and Pelgrin, W. (2002)	E-Government/Commerce in New York State	Found the importance of network capacity and communication infrastructure as an important foundation for integrating information systems across government organizations.	The study did not talk on anything about performance of architects
ICT Support staff Training, skills and performance of architects in construction projects	Rampersad, H. K. (2002).	Improving knowledge, capabilities and skills; and achieving a change of attitude. by using ICT	Training improves the effectiveness of the staff as it communicates values and inspires appropriate work culture in the organization	No mention of performance effects on architects
	Bonham, G., Seifert, J. and	The transformational potential of e-	Lack of IT training programmes in	It was not shown how the

	Thorson, S. (2001)	government: the role of political leadership	government	lack of IT related to performance of architects
	Ho, A.T-K. (2002)	Reinventing local governments and the e-government initiative	Study revealed shortage of well-trained IT staff in market and the study by Ho (2002) showed lack of employees with integration skills.	It was not shown how the lack of IT related to performance of architects
	Chen and Gant (2001)	Transforming e-government services	Identifies the shortage of IT skills as a potential barrier that confronts some demanding challenges concerning government's ability to provide the next ICT application government services	It failed to show how this relates to performance of architects
	NECCC (2000)	E-Government Strategic Planning	Developing web site by unskilled staff and unqualified project manager affected the ICT user performance	There was no mention of these findings influence on performance of architects
	Moon, M. J. (2002)	Technology Enabled Transformation of public sector	The study found the government require more and highly trained technical staff without fully developing staff capabilities, the government sector stand to miss out on the potential customer service benefits presented by technology.	The study failed to show how this would lead to improved architects performance

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 Introduction

This chapter describes the research methodology that was followed in achieving the objectives of the study. The subsections covered here are research design, target population, sample size, sample procedures, instruments, validity, reliability, data collection, data analysis techniques and ethical consideration.

3.2 Research Design

The research design applied for this study is descriptive survey design to answer the research questions. According to Cooper et al (1994) a descriptive study design is a method of collecting information by interviewing or administering of a questionnaire to a sample of individuals (Orodho, 2003). It can be used to collect information about people's attitudes, opinion, habits or any of the varieties of educational and social issues (Orodho and Kombo, 2002).

3.3 Target Population

According to (Mugenda & Mugenda, 1999) target population is a whole group covered by the study. In this study the architects in the Directorate of public works in the Ministry of Lands, Housing and Urban (MOLHUD) are the target population. There are 78 architects who form the sampling frame.

3.4 Sample size and Sampling Procedures

The study will use census sampling procedure and according to (Mugenda & Mugenda, 2003) a population is an entire group of individuals or events or objects having common observable characteristics that conform to a given specification theory of sampling, a form of nonprobability sampling in which decisions concerning the individuals to be included in the sample are taken by the study. Usually, the sample being investigated is quite small, especially when compared with probability sampling techniques. The main goal of census sampling is to focus on particular characteristics of a population that are of interest, which will best enable you to answer your research questions.

3.4.1 Sample Size

The sample size of the study was the 78 architects who were the respondents. The sample size took into account the heterogeneity and quality of information desired (Trochim, 2006).

3.4.2 Sampling Procedures

The study used census sampling based on (Mugenda and Mugenda, 2003), which states that where the sample population is less than on hundred (100) census sample is appropriate. In such cases, the entire population was chosen because the size of the population that had the particular set of characteristics the researcher was interested in was 78 less than 100 and therefore the study proceeded.

3.5 Research Instruments

The study collected data from primary sources using a structured questionnaire containing closed ended questions. The questionnaire was designed to address the study objectives; to establish the extent to which ICT infrastructure influences the performance of architects in construction projects in public sector, to determine how efficiency of hardware systems influences the performance of architects in construction projects in public sector, to establish the extent to which software capability influences the performance of architects in construction projects in public sector, to assess the influence of Communication systems on the performance of architects in construction projects in public sector and to examine how ICT training and skills of Support staff influence the performance of architects in construction projects in public sector.

3.5.1 Pilot Testing of Instruments

The researcher conducted a pilot test on data collecting instrument before administering it. Such tests helped identify possible problems, clarify on the instrument and appropriateness of the language during the main study (Kvale, 2007). By so doing, the study assessed the relevance of the research objectives as it tested the understandability of the research tools. The study prepared a copy of the questionnaire, which was then delivered to the pilot testing professional (supervisors). The researcher verified to his satisfaction that the questionnaire could address the study objectives and that the questions were correct, meaningful, and useful to the study and the study proceeded.

3.5.2 Validity of Instruments

Validity is the accuracy and meaningfulness of inferences which are based on research result as defined by (Mugenda & Mugenda, 2003). Validity is the degree to which obtained results from analysis data actually represent the phenomenon under study. The assessment of validity was carried out by the two research supervisors who verified the items in the questionnaire against the research objectives and research questions and focused on the way were required to indicate their views on a scale of 1 to 5 questions were phrased in the questionnaire. The questionnaire design was in the form of likert scale where respondents

3.5.3 Reliability of Instruments

Reliability is the measure of the degree to which research instruments yields consistent results or data after repeated trials (Mugenda & Mugenda, 2003).The test for reliability was to establish the extent to which results would be consistent over time. The researcher used the split-halves method to test for reliability where the total number of items was divided into halves, and a correlation taken between the two halves. In order to achieve this, the researcher administered the instrument himself in order to assess clarity.

3.6 Data Collection

The study utilized primary data. Primary data was obtained through the use of structures and semi structured questionnaires which were issued to the respondents in the Directorate of public works and picked later by the researcher. Closed ended questions were used to capture the respondents' views on the various variables indicators. As the respondents were all selected from directorate of public works and had knowledge of the research concerns, the responses was of good quality, and a high response rate was ensured.

3.7 Data Analysis Techniques

The researcher used descriptive correlational analysis technique to analyze the data. Descriptive statistics was used to arrange order and manipulate the data to provide descriptive information. To allow easy punching and computation and storage of information using a computer Statistical Package for Social Sciences (SPSS), the researcher assigned a code number to each of the research questions. The data was presented in form of tables showing frequency and percentage distribution (Aneshensel, C.S 2012).

3.8 Ethical Considerations

The researcher sought clearance for this study from the University of Nairobi. For ethical considerations the study took into consideration the respondents' voluntary participation and confidentiality. The respondents were assured that information obtained would be kept confidential and in safe custody and be used for the purpose of the study. The respondents were not required to write their names on the questionnaire to avoid their exposure.

3.9 Operationalization of the variables

This sub-section identifies and operationalizes the key variables; independent and dependent variables of the study. It further highlights the criteria of measurement that the researcher used as illustrated in Table 3.1

Table 3. 1: Operational Definition of Variables

Objective	Variable	Indicators	Measure	Scale of Measurement	Data collection tool	Analysis Technique
	Performance of Architects	Productivity Quality Output Timeliness	Efficiency and Effectiveness	Ordinal using 5 point Likert Scale	Questionnaire	Descriptive Correlational Analysis
To establish the extent to which ICT infrastructure influences the performance of architects in construction projects in public sector.	ICT Infrastructure	Shared Resources Physical ICT resources Operating systems Accessibility of ICT applications	Effects of ICT Infrastructure and Performance of Architects	Ordinal using 5 point Likert Scale	Questionnaire	Descriptive Correlational Analysis
To determine how efficiency of hardware systems influences the performance of architects in construction projects in public sector.	ICT Hardware Efficiency	Web servers Application servers Storage devices, Hardware speed	Effects of Hardware Efficiency and Performance of Architects	Ordinal using 5 point Likert Scale	Questionnaire	Descriptive Correlational Analysis
To assess the extent to which software capability influences the performance of architects in construction projects in public sector.	ICT Software Capability	Operations set of processes data Management Physical database Administration Disaster Recovery (DR)solution	Influence of Software capability and Performance of Architects	Ordinal using 5 point Likert Scale	Questionnaire	Descriptive Correlational Analysis
To establish the influence of Communication systems on the performance of architects in construction projects in public sector.	Communication systems	ICT network and communication infrastructure solutions Efficiency Effectiveness Network Clarity	Effects of Communication systems and Performance of Architects	Ordinal using 5 point Likert Scale	Questionnaire	Descriptive Correlational Analysis
To examine support staff training and skills on the performance of architects in construction projects in public sector.	ICT support staff training and skills	Adaptation to change Use of technology Integration Training and development	Effects of ICT Support staff training and skills and performance of architects	Ordinal using 5 point Likert Scale	Questionnaire	Descriptive Correlational Analysis

Source: Researcher (2015)

CHAPTER FOUR

DATA ANALYSIS, PRESENTATION AND INTERPRETATION

4.1 Introduction

This chapter comprises of data analysis, presentation and interpretation of primary data. The chapter also discusses the findings from the research questions that are an investigation on the influence of ICT applications on the performance of architects in construction projects. The findings were presented using frequency and percentages.

4.2 Questionnaire Return rate.

Self-administered questionnaires were distributed to 78 respondents. From 78 questionnaires issued, 64 were returned. 14 were not returned as the respondent had travelled outside the working station and failed to meet the collection deadline. The overall percentage of the response was fair as most of the information was collected from the respondents. This is well represented statistically in Table 4.1

Table 4. 1: Questionnaire return rate

Description	Frequency	Percentage
Questionnaires returned	64	82.
Questionnaires not returned	14	18
Total	**78**	**100**

The results from Table 4.1 indicate that the respondents' response rate was 82%. Mugenda and Mugenda (1999) assert that a response rate of 50% is adequate for analysis and reporting; 60% response rate is good while over 70% response rate is excellent. Given that the return rate was over and above the 50% required the study proceeded.

4.3. Demographic characteristics of respondents

This section analyses the gender distribution, age and years of working experience of the respondents in the organization. These are discussed in the following sub-thematic areas

4.3.1 Distribution of respondents by gender

The respondents were asked to indicate their gender; this was expected to guide the researcher on the composition of the architects working in the public sector and establish if any gender had any significant influence on the outcome of the study. The findings are illustrated in Table 4.2

Table 4. 2: Distribution of respondents by gender

Gender	Frequency	Percentage
Male	57	89.06
Female	7	10.94
Total	**64**	**100**

The results in Table 4.2 indicate that there were 89.06% male and 10.94% female. The study shows that the population was dominated by more experienced male with long exposure in projects within the public sector. The finding also indicates that there is gender disparity which falls way below the one third gender rule that stipulates that a third of the employees should be women. This disparity may be explained by the fact that women still shy away from technical related works as they consider it to be a male domain. Also most of the girls tend to shun science oriented subject and are inclined to art subjects while in school. In respect to architects performance gender would be an insignificant factor.

4.3.2 Distribution of Respondents by age

The researcher sought to establish the age bracket of the respondents. This was to enable the researcher obtain the age difference of the employees and the age to which most employees fall into. This is illustrated statistically in Table 4.3.

Table 4. 3: Distribution of respondents by age

Age bracket	Frequency	Percentage
18 – 29 years	4	6.25
30 – 39 years	22	34.375
40 – 49 years	20	31.25
50 – 59 years	16	25.00
Over 59 years	2	3.125
Total	**64**	**100**

The results in Table 4.3 indicate that 96.875% of the respondents were 50 years and below which implies that majority of the respondents were productive employees and therefore in respect to architects performance, age of the respondents would be an insignificant factor. However it should be noted that the younger generation is more absorptive to new technologies and this can be translated to the benefit of the organization in that it has the capacity to undertake any major ICT technological challenges or changes.

4.3.3 Distribution of Respondents by years of working experience.

Working experience is considered as a positive factor when it comes to job performance. A person with more years of work experience is considered a valuable asset to an organization. The skills and experience of architects in construction projects affects their performance. The researcher sought to understand this phenomenon by asking the respondents to indicate the number of years they have worked in the organization. This is illustrated in Table 4.4

Table 4. 4: Distribution of Respondents by years of working experience

Working experience	Frequency	Percentage
Less than 1 year	4	6.25
1 – 5 years	16	25.00
6 – 10 years	14	21.875
11 – 15 years	4	6.25
16 – 20 years	6	9.375
Over 20 years	20	31.25
Total	**64**	**100**

The results in Table 4.4 indicate that 4(6.25%) had working experience of less than one year, 16(25%) between one and five years, 14(21.875%) between six and ten years, 4(6, 25%) between eleven and fifteen years, 6(9.375%) while 20(31.25%) had over twenty years of working experience. The findings show a normal distribution of experienced staff in the organization that has had exposure to ICT applications. In this regard therefore dismal performance of architects in construction project cannot be related to ICT but from other factors.

4.4. ICT Infrastructure and Performance of Architects in construction projects

ICT infrastructure was one of the variables under investigation and the objective of the study was to establish to what extent ICT infrastructure influenced the performance of architects in construction projects. The study was based on the following sub-themes; Nature of shared resources, Performance of physical ICT resources, Operating systems, Type of Operations functions and Security.

4.4.1 Nature of shared resources such as storage devices, networks, printers used by architects

ICT Infrastructure offers a range of technologies to assist organizations in running efficiently. Architects in construction projects use these services for their everyday mechanics of which some are shared and are integral part to effective service delivery. To further understand this relationship the researcher asked the respondents to rate the extent to which the nature of shared resources influences the performance of architects in construction projects. The findings of the study are illustrated in Table 4.5

Table 4.5: Nature of shared resources

Nature of shared resources	Frequency	Percentage
Very high	18	28.125
High	18	28.125
Moderate	12	18.75
Low	8	12.50
Not at all	8	12.50
Total	**64**	**100**

The results in Table 4.5 indicate that an equal number of the respondents 18(28.125%) rated very high and high, 12(18.75%) rated moderate, while an equal number 8(12.50%) rated low and not at all the extent to which the nature of shared resources influences performance of architects. 36(56.25%) support the view that the nature of shared resources highly influence the performance of architects due to search ability and manipulability of information and data while 28(43.75%) were indifferent due to the general application of these resources to all in the organization.

4.4.2 Performance of physical ICT resources available to the architect

Performance can be described as the accomplishment of a given task measured against preset known standards of accuracy, completeness, cost, and speed. Architects in construction projects operate under these constraints to meet their objectives. To further understand this relationship the researcher asked the respondents to rate the extent to which the performance of physical ICT resources influences the performance of architects in construction projects. The findings of the study are illustrated in Table 4.6

Table 4. 6: Performance of physical ICT resources

Performance of ICT resources	Frequency	Percentage
Very high	20	31.25
High	20	31.25
Moderate	14	21.875
Low	6	9.375
Not at all	4	6.25
Total	**64**	**100**

The results in Table 4.6 indicate that an equal number of the respondents 20(31.25%) rated very high and high, 14(21.875%) rated moderate, 6(9.375%) rated low while 4(6.25%) rated not at all the extent to which the performance of physical ICT resources influences the performance of architects in construction projects. 40(62.50%) of the respondents appreciate that performance of physical ICT resources do improve architects performance. The ICT hardware consumes less energy during performance; high data processing speed; meets the performance requirement as per the technical specifications; proves reliable over time and at the same time performs its intended work.

4.4.3 Effectiveness of operating systems.

Effectiveness is the capability of producing a desired result. When something is deemed effective, it means it has an intended or expected outcome. Architects in construction projects have set objectives and standards to meet for any successful completion of a project. To meet this objectives and standard they need effective operating systems in their computers to run the applications. To further understand this relationship the researcher asked the respondents to rate the extent to which effectiveness of operating systems influences the performance of architects in construction project. The findings of the study are illustrated in Table 4.7

Table 4. 7: Effectiveness of Operating systems

Effectiveness of operating systems	Frequency	Percentage
Very high	24	37.50
High	12	18.75
Moderate	16	25.00
Low	8	12.50
Not at all	4	6.25
Total	**64**	**100**

The results in Table 4.7 indicate that 24(37.50%) of the respondents rated very high, 12(18.75%) high, 16(25%) rated moderate, 8(12.50%) rated low while 4(6.25%) rated not at all the extent to which effectiveness of operating systems influences the performance of architects in construction projects. 36(56.25%) appreciate that effectiveness of operating systems improve architects performance in that data processing is very fast as well as communication of the information produced. In addition, stable operating systems ensure that the information produced is reliable.

4.4.4 Accessibility of ICT applications

Architects in construction projects need accessibility to the relevant ICT applications without any limitations or barriers to enhance their performance. To further examine this relationship the researcher asked the respondents to rate the extent to which accessibility of ICT applications influences the performance of architects in construction projects. The findings of the study are illustrated in Table 4.8

Table 4.8: Accessibility of ICT applications

Accessibility of ICT applications	Frequency	Percentage
Very high	28	43.75
High	18	28.125
Moderate	16	25.00
Low	2	3.125
Not at all	0	0
Total	**64**	**100**

The results in Table 4.8 indicate that 28(43.75%) of the respondents rated very high, 18(28.125%) rated high, 16(25%) rated moderate while only 2(3.125%) rated low, the extent to which accessibility of ICT applications influences performance of architects in construction projects. 46(71.875%) of the respondents aver that accessibility of ICT influences the performance of architects in construction projects this can be related to the fact that these applications are directly used by architects. However, 25% of the respondents have no idea about the impact of the ICT applications given small portion of the institutions have fully embraced the use of ICT applications

4.5 Influence of ICT Hardware Efficiency on Performance of Architects in the Construction Projects in Public Sector

The second objective of the study was to determine how ICT hardware efficiency influences the performance of architects in construction projects. The study was based on the following sub-themes; Stability of web and application servers, Capacity and speed of storage devices, Speed of hardware, and the accessibility of ICT applications used in construction projects by architects.

4.5.1 Stability of web and application servers

Architects need stable web and applications servers for easy communication and transmission of information and data. For further insight the researcher asked the respondents to rate the extent to which stability of web servers influences performance of architects in construction projects. The findings of the study are illustrated in Table 4.9

Table 4. 9: Stability of web and application servers

Web and application servers	Frequency	Percentage
Very high	21	32.8125
High	12	18.75
Moderate	22	25.00
Low	4	6.25
Not at all	5	7.8125
Total	**64**	**100**

The results in Table 4.9 indicate that 21(32.8125%) of the respondents rated very high, 12(18.75%) rated high, 22(25.00%) rated moderate, 4(6.25%) rated low, while 5(7.8125% rated not at all the extent to which stability of web and application servers influences the performance of architects in construction projects. 33(51.5625%) of the respondents appreciate that stable web servers ensure that the information flow is continuous with minimal interruption while, effective application servers provide the much needed software and data to facilitate the architectural work. This ensures reliability due to the consistency of the web and application servers.

4.5.2 Capacity and speed of storage devices

The large amount of data and information handled by architects in construction projects requires devices that have the capacity and speed of storage. To further understand the relationship the researcher asked the respondents to rate the extent to which capacity and speed of storage devices influences performance of architects in construction project. The findings of the study are illustrated in Table 4.10

Table 4. 10: Capacity and speed of storage devices

Capacity and speed	Frequency	Percentage
Very high	12	18.75
High	26	40.625
Moderate	16	25.00
Low	8	12.50
Not at all	2	3.125
Total	**64**	**100**

The results in Table 4.10 indicate that 12(18.75%) of the respondents rated very high 26(40.625%) rated high, 16(25%) rated moderate, 8(12.5%) rated low, while 2(3.125%) rated not at all the extent to which capacity and speed of storage devices influences performance of architects in construction projects. 38(59.375%) appreciate that capacity and speed of storage devices improve architects performance in that data transfer is very fast as well as large volume of data can be stored which would otherwise be left out.

4.5.3 Speed of hardware

Architects applications involve visualization, graphics, 3D, 2D and other complex features that require faster to process. To understand this further the researcher asked the respondents to rate the extent to which the Speed of hardware influences the performance of architects in construction project. The findings of the study are illustrated in Table 4.11

Table 4. 11: Speed of hardware

Speed of hardware	Frequency	Percentage
Very high	24	37.50
High	22	34.375
Moderate	16	25.00
Low	2	3.125
Not at all	0	0
Total	**64**	**100**

The results in Table 4.11 indicate that 24(37.50%) of the respondents rated very high 22(34.375%) rated high, 16(25.00%) rated moderate, while 2(3.125%) rated low the extent to which speed of hardware influences the performance of architects in construction projects. 46(71.875%) of the respondents support that speed of hardware influence architects performance; high speed enables fast processing of data as well as transmission. At the same time the architects can simulate and visualize the building in a nearly realistic way at a faster rate.

4.6 Influence of ICT Software Capability on Performance of Architects in the Construction Projects in Public Sector.

The third objective was to establish to what extent ICT software capability influence the Performance of Architects in the Construction Projects in Public Sector**.** The study was based on the following sub-themes; Reliability of software, Nature of data management in the system, the capability of software in the computer systems, effectiveness of the database administration and software, Nature of security provide for the software and the effectiveness of disaster recovery solution for data recovery after data is destroyed or corrupted.

4.6.1 Reliability and capability of software

Architect in construction project handle a lot of information from design to completion which require them to use applications that are reliable throughout. To investigate this relationship further the researcher asked the respondent to rate their views on the on the extent to which reliability of software influence the performance of architects in construction project. The findings of the study are illustrated in Table 4.12

Table 4. 12: Reliability and capability of software

Reliability of software	Frequency	Percentage
Very high	25	39.06
High	20	31.25
Moderate	13	20.31
Low	6	9.38
Strongly Disagree	0	0
Total	**64**	**100**

The results in Table 4.12 indicate that 25(39.06%) of the respondents rated very high 20(31.25%) rated high, 13(20.31%) rated moderate, 6(9.38%) rated low the extent to which reliability and capability of software influences performance of architects in construction projects. 45(70.31%) of the respondents approve that software reliability and capability influence performance architects in construction projects in that consistency in data processing enables prediction of the possible outcome. This gives relatively acceptable work and authenticity of the information produced which in the long run facilitates architects performance. Software that that can perform the intended function enables the architects to carry out his or her architectural work

4.6.2 Nature of data management in the system used by architects

The purpose of data management is to ensure that data is of high quality, is secure, has longer preservation and accessible. The architect in construction projects would benefit from a system that observes high standards of data management since there are many players in a construction project who actively share information. In pursuit of understanding this further the researcher asked the respondents to rate their views on the extent to which the nature of data management influence the performance of architects in construction project. The findings of the study are illustrated in Table 4.13

Table 4. 13: Nature of data management

Nature of data management	Frequency	Percentage
Very high	16	25.00
High	18	28.125
Moderate	24	37.50
Low	6	9.375
Not at all	0	0
Total	**64**	**100**

The results in Table 4.13 indicate that 16(25.00%) of the respondents rated very high, 18(28.125%) rated high, 24(37.50%) rated moderate while 6(9.375%) rated low the extent to which the nature of data management in the system influences performance of architects in construction projects. 34(53.125%) approve that nature of data management influence architects performance. This include improved data sharing, improved data security, better data integration, minimized data inconsistency, improved data access, improved decision making and increased end-user productivity. These reduce application development time and optimize database access as well as ease loading of data from the external format without writing programs.

4.6.3 Effectiveness of the database administration

Database administration refers to the whole set of activities performed by a database administrator to ensure that a database is always available as needed. Architects in construction need information all the time. Effective administration of database would ensure that the information is available. The researcher sought for further insight by asking the respondents to rate the extent to which effectiveness of the database administration and software influences the performance of architects in construction project. The findings of the study are illustrated in Table 4.14

Table 4. 14: Database administration

Database administration	Frequency	Percentage
Very high	16	25.00
High	16	25.00
Moderate	22	34.375
Low	8	12.50
Not at all	2	3.125
Total	**64**	**100**

The results in Table 4.14 indicate that an equal number 16(25%) of the respondents rated very high and high, 22(34.375%) rated moderate, 8(12.5%) low, while only 2(3.125%) rated the extent to which effectiveness of the database administration and software influences the performance of architects in construction projects. Data administration determines what data needs to be present in the system and how this data has to be presented, organized, managed, and how different groups of users use it. Thus, several users sharing the data and centralizing offer significant improvements that minimize data redundancy and perform fine tuning which reduces retrieval time as supported by 50% of the respondents.

4.6.4 Nature of security provided for the software used by architects.

The architects in construction projects and being employees of the government undertake projects that are of sensitive nature that requires safeguarding from unauthorized person. For further understanding the researcher asked the respondents to rate the extent to which the nature of security provided for the software influences the performance of architects in construction project. The findings of the study are illustrated in Table 4.15

Table 4. 15: Nature of security

Nature of security	Frequency	Percentage
Very high	14	21.875
High	18	28.125
Moderate	18	28.125
Low	12	18.75
Not at all	2	3.125
Total	**64**	**100**

The results in Table 4.15 indicate that 14(21.875% of the respondents rated very high 18(28.125) rated high, 28.125% rated moderate, 12(18.75%) rated low while 2(3.125%) rated not at the extent to which the nature of security provide for the software influences performance of architects in construction projects. The nature of security restricts groups of users to specified parts of the overall ICT applications. Their programs and procedures can access only the data in their subschema. Multiple levels of password protection, encoding of the data so that it is readable only if passed through appropriate decoding routines create security system that enforces user security and data privacy as supported by 50% of the respondents.

4.6.5 Effectiveness of Disaster recovery solution for data recovery after data is destroyed or corrupted.

What would happen if the information technology stopped working? The impact of data loss or corruption from hardware failure, human error, hacking or malware could be significant. A plan for data backup and restoration of electronic information is essential. The researcher investigated this further by asking the respondents to rate their views on the extent to which the effectiveness of disaster recovery solution influence the performance of architects in construction project. The findings of the study are illustrated in Table 4.16

Table 4. 16: Disaster recovery solution for data recovery

Disaster recovery	Frequency	Percentage
Very high	18	28.125
High	10	15.625
Moderate	16	25.00
Low	16	25.00
Not at all	4	6.25
Total	**64**	**100**

The results in Table 4.16 indicate that 18 (28.125%) of the respondents rated very high, 10(15.625%) rated high, 16(25%) rated moderate, 16(25%) rated low, while only 4(6.25%) rated not at all the extent to which effectiveness of disaster recovery solution for data recovery after data is destroyed or corrupted influences the performance of architects in construction projects. Reconstructing the correct state of database from the backup and history of transactions ensure data safety and integrity. Therefore, the architects work can progress with no back and forth stagnation as supported by 28(43.75%) of the respondents. However, 20(31.25%) of the respondents disagree given that data recovery is a rare phenomenon.

4.7 Influence of Communication Systems on Performance of Architects in the Construction Projects in Public Sector

The fourth objective was to assess how Communication Systems influence the Performance of Architects in the Construction Projects in Public Sector**.** The study was based on the following sub-themes; Reliability of Communications systems, Consistency of ICT network and communication infrastructure and speed and clarity of the network connection system that architects use in the construction projects.

4.7.1 Reliability of Communications Systems

Communication systems would include Email, telephone, internet, mobile phones, fax and teleconferencing. Architects in construction projects need reliable communication systems to communicate effectively to different stakeholders. For further insight on the study the researcher asked the respondents to rate the extent to which reliability of Communications Systems influences the performance of architects in construction project. The findings of the study are illustrated in Table 4.17

Table 4. 17: Reliability of Communications Systems

Communication systems	Frequency	Percentage
Very high	30	46.875
High	14	21.875
Moderate	10	15.625
Low	8	12.50
Not at all	2	3.125
Total	**64**	**100**

The results in Table 4.17 indicate that 30(46.875%) of the respondents rated very high, 14(21.875) rated high, 10(15.625%) rated moderate, 8(12.5%) rated low, while only 2(3.125%) rated not at the extent to which reliability of Communications systems influences the performance of architects in construction projects. 44(68.75%0 of the respondents appreciate that reliability of ICT Communications Systems improve the performance architects in that communication is faster and reliable.

4.7.2 Consistency of ICT Network and Communication Infrastructure

Architects in construction projects need the flexibility of working anywhere using the available network and communication infrastructure this is possible when there the network is consistent. The researcher sought to find out more by asking the respondents to rate the extent to which the consistency of ICT network and communication Infrastructure influences the performance of architects in construction project. The findings of the study are illustrated in Table 4.18

Table 4. 18: Consistency of ICT Network

Consistency of ICT Network	Frequency	Percentage
Very high	18	28.125
High	26	40.625
Moderate	10	15.625
Low	10	15.625
Not at all	0	0
Total	**64**	**100**

The results in Table 4.18 indicate that 18(28.125%) of the respondents rated very high, 26(40.625%) rated high, and equal number10(15.625%) rated moderate and low the extent to which consistency of ICT network and communication infrastructure solutions influences the performance of architects in construction projects. 44(68.75%) of the respondents appreciate that consistency of ICT network and communication infrastructure solutions of computers improve performance of architects in that data processing is very fast as well as communication of the information produced. This smooth flow of information accelerates completion of the architectural work. In addition, this provides data integrity and data consistency.

4.7.3 Speed and clarity of the Network

Architects require networks that are fast and have clarity in order to facilitate smooth communication and transmission of information to various stake holders. High speed will enable faster downloading and uploading while allowing for multitasking and uninterrupted streaming. To seek further understanding on this the researcher asked the respondents to rate the extent to which the speed and clarity of the Network influences the performance of architects in construction project. The findings of the study are illustrated in Table 4.19

Table 4. 19: Speed and clarity of the Network Communication systems

Speed of the Network	Frequency	Percentage
Very high	18	28.125
High	19	29.687
Moderate	15	23.438
Low	9	14.063
Not at all	3	4.687
Total	**64**	**100**

The results in Table 4.19 indicate that 18(28.125%) of the respondents rated very high 19(29.687%) rated high, 15(23.438%) rated moderate, 9(14.063%) rated low and 3(4.687) rated not at all the extent to which speed and clarity of the network connection system influences the performance of architects in the construction projects. A faster network connection system enables the architect to reduce development time and greatly improves efficiency as supported by 37(57.812%) of the respondents. Faster networks mean that information can be received and transmitted on time and with clarity.

4.8 Influence of ICT Support staff (training and skills) on performance of architects in construction projects

The fifth objective was to examine how ICT support staff training and skills influences the performance of architects in the construction projects in public sector**.** The study was based on the following sub-themes; the ability of ICT support staff in handling computer systems to adapt to changing ICT environment, Knowledge and experience of the ICT staff, ability of ICT supports staff to handle and integrate the ICT applications and other software and the training and development provided to ICT support staff.

4.8.1 The ability of the ICT support staff handling computer system (used by architects in the construction projects) to adapt to changing in ICT environment.

The ICT support staff is an important part of the human resource that is used to operate the architectural related ICT applications used by architects in construction projects. They need to be regularly updated with the current trending technologies to keep them at par with the ever changing ICT technological environment. For further insight into the study the researcher investigated this by asking the respondents to rate their views on the extent to which the ability of the ICT support staff in handling computer systems to adapt to changing ICT environment influences the performance of architects in construction project. The findings of the study are illustrated in Table 4.20

Table 4. 20: The ability of the ICT support staff to handle computer system

Ability of the ICT support staff	Frequency	Percentage
Very high	10	15.625
High	20	31.25
Moderate	14	21.875
Low	18	28.125
Not at all	2	3.125
Total	**64**	**100**

The results in Table 4.20 indicate that 10(15.625%) of the respondents rated very high, 20(31.25%) rated high, 14(21.875%) moderate, 18(28.125%) rated low, while only 2(3.125%) rated not at the extent to which the ability of the ICT support staff in handling computer system to adapt to changing ICT environment influences the performance of architects in construction projects. ICT environment is an ever changing industry, effective technology today is obsolete tomorrow. ICT support staffs that effectively adapt to changing environment ensure that the architects get the latest information and are up-to date with the latest technologies resulting in quality architectural designs as supported by 30(46.875%). However, 20(31.25%) of the respondents do not see the influence of adaptation to the ever changing ICT environment as it has been tested and proven ICT applications work regardless of time lapse. Additionally, 20(31.25%) of the respondents felt that ICT applications are just beginning to take root and its influence is yet to be felt.

4.8.2 Knowledge and experience of the ICT staff in charge of ICT applications and hardware used by architects in the construction projects.

The kind of knowledge and experience that the support staff has is important to architects in construction projects since they always work as partners. Being in the same line of profession means they have to share some attributes that connects them. The research endeavored to investigate this further to seek a deeper insight by asking the respondents to rate the extent to which knowledge and experience of the ICT staff influences the performance of architects in construction project. The findings of the study are illustrated in Table 4.21

Table 4. 21: Knowledge and experience of the ICT staff

Knowledge of the ICT staff	Frequency	Percentage
Very high	14	21.875
High	16	25.00
Moderate	22	34.375
Low	10	15.625
Not at all	2	3.125
Total	**64**	**100**

The results in Table 4.21 indicate that 14(21.875%) of the respondents rated very high, 16(25.00%) rated high, 22(34.375%) rated moderate, 10(15.625%) rated low, while only 2(3.125%) rated not at all the extent to which knowledge and experience of the ICT staff in charge of ICT applications and hardware influences the performance of architects in the construction projects. Adequate knowledge and skills aid understanding of the procedures, data policies, functions and information needs of the architect. Thus, the architects get reliable, accurate and timely information regarding a project work. 30(46.875%) see the need to ICT staff competencies as a crucial factor to architects performance. However, 12(18.75%) disagree given that the knowledge of ICT staff is hardly incorporated in the architectural work.

4.8.3 Ability of ICT supports staff to handle and integrate the ICT applications and other software.

Architects in construction project use other software applications that may not be related to architectural work but forms an important input to their performance such as management information systems and financial systems. In pursuit to understand the relationship further, the researcher asked the respondents to rate the extent to which ability of ICT supports staff to integrate the ICT applications and other software influences the performance of architects in construction project. The findings of the study are illustrate in Table 4.22

Table 4. 22: Handling and integration of ICT applications.

Integration of ICT applications	Frequency	Percentage
Very high	13	20.3125
High	13	20.3125
Moderate	17	26.5625
Low	18	28.1250
Not at all	3	4.6875
Total	**64**	**100**

The results in Table 4.22 indicate that that an equal number 13(20.3125%) of the respondents rated very high and high, 17(26.5625%) rated moderate, 18(28.125%) low, while only 3(4.6875%) rated not at all the extent to which the ability of ICT supports staff to handle and integrate the ICT applications and other software influences the performance of architects in construction projects. 26(40.625%) believe that ICT support staff ability to handle and integrate the ICT applications influences performance of architects in construction projects. However, 21(32.8125%) feel otherwise given that many architects rely on individual ICT applications.

4.8.4 Training and development provided to ICT support staff in charge of ICT applications and hardware used by architects

Training and development is a planned process to modify attitude, knowledge or skills behavior through a learning experience. The purpose of the training is to develop the current and future manpower needs of the organization, (manpower service commission, 1981). The training that is provided to the ICT support staff must be relevant to the needs of the architects in construction projects. To interrogate this relationship further the researcher asked the respondents to rate their views on the extent to which training and development of ICT support staff influence the performance of architects in construction project. The findings of the study are illustrated in Table 4.23

Table 4. 23: Training and development of ICT support staff

Training of ICT support staff	Frequency	Percentage
Very high	10	15.625
High	12	18.75
Moderate	22	34.375
Low	16	25.00
Not at all	4	6.25
Total	**64**	**100**

The results in Table 4.23 indicate that 10(15.625%) of the respondents rated very high, 12(18.75%) rated high, 22(34.375%) rated moderate, 16(25.00%) rated low, while only 4(6.25%) rated not at all the extent to which training and development provided to ICT support staff in charge of ICT applications and hardware influences the performance of architects in construction projects. The results shows a dived opinion on the matter as 22(34.375%) of respondents appreciate that the training and development provided to the ICT support staff would influence the performance of architects while almost an equally number 20(31.25%) do not see the need for training and development of the ICT staff given that they always seeks latest technologies in the industry. Moreover, some of the ICT staff activities do not necessarily impact the architect performance explaining why 22(34.375%) are not sure.

4.9 ICT applications on performance of architects in construction projects

The researcher sought to find out the effects of ICT applications on performance of architects in construction projects. The study was based on the following sub themes: increase productivity, increase efficiency, produce quality information, produce quality work, reduces working time and availability of modern ICT applications in the organization.

4.9.1 ICT applications and productivity

Productivity understood to mean the ratio of output to input. The researcher asked the respondents to indicate their level of agreement that the use of ICT applications assist architects increase their productivity. The findings of the study are illustrated in Table 4.24

Table 4. 24: Architects productivity

Architects' productivity	Frequency	Percentage
Strongly Agree	48	75.00
Agree	12	18.75
Neutral	4	6.25
Disagree	0	0
Strongly Disagree	0	0
Total	**64**	**100**

The results in Table 4.24 indicate that 48(75%) of the respondents strongly agreed, 12(18.75%) agreed, 4(6.25%) were neutral while none disagreed or strongly disagreed that the ICT applications in the work place helps increase architects productivity. 60(93.75%) agrees that ICT greatly improves productivity. This indicates that the use of ICT applications immensely unlock the full potentials of the architects and offers better and more easy-to-use services.

4.9.2 ICT applications and efficiency

The researcher sought to find out if the architect's efficiency increased upon the use of ICT applications. Efficiency being defined as the extent to which time is well used for the intended task; the ratio of useful work to energy expended or simply means reducing the amount of wasted inputs. The respondents were asked to indicate their level of agreement that the use of ICT applications help increase architects efficiency. The findings of the study are illustrated in Table 4.25

Table 4.25: Architects efficiency

Architects' efficiency	Frequency	Percentage
Strongly Agree	42	65.625
Agree	12	18.75
Neutral	10	15.625
Disagree	0	0
Strongly Disagree	0	0
Total	**64**	**100**

The results in Table 4.25 indicate that 42(65.625%) of the respondents strongly agreed, 12(18.75%) agreed, 10(15.625%) were neutral while none disagreed or strongly disagreed that the current ICT applications assist in increasing efficiency. With 54(84.375%) giving a nod that ICT applications enhance efficiency is a clear indication that the ICT applications reduce wastage of resources which would otherwise been inevitable if relying on hand-based drawing and techniques.

4.9.3 ICT applications and quality information.

The researcher sought to find out the effect of ICT applications on quality of information produced by architects in construction projects. The respondents were asked to indicate their level of agreement that the use of ICT applications assist architects produce quality information. The findings of the study are illustrated in Table 4.26

Table 4.26: Quality information

Quality information	Frequency	Percentage
Strongly Agree	24	37.50
Agree	22	34.375
Neutral	8	12.50
Disagree	8	12.50
Strongly Disagree	2	3.125
Total	**64**	**100**

The results in Table 4.26 indicate that 24(37.50%) of the respondents strongly agreed, 22(34.375%) agreed, 8(12.50%) were neutral, 8(12.50%) disagreed, while 2(3.125%) strongly disagreed that ICT applications helps production of quality information. A significant majority of the respondents 46(71.875%) attests that ICT applications help architects produce quality information. The ICT applications ensure that information is made available whenever wanted. At the same time ensures that the information is accurate, timely, reliable and reusable over a long period. The use of ICT applications thus improves communication between the architects in construction projects and the stakeholders for effective decision-making and coordination among construction participants. This greatly reduces the possibility of scope creep.

4.9.4 ICT applications and quality work and output.

The researcher sought to find out the effect of ICT applications on architects production of quality work, quality being defined as "meeting the requirements of the customer." The respondents were asked to indicate their level of agreement that the use of ICT applications assist architects produce quality work. The findings of the study are illustrated in Table 4.27

Table 4. 27: Quality work and output

Quality work	Frequency	Percentage
Strongly Agree	26	40.625
Agree	26	40.625
Neutral	10	15.65
Disagree	2	3.125
Strongly Disagree	0	0
Total	**64**	**100**

The results in Table 4.27 indicate that an equal number 26(40.625%) of the respondents strongly agreed, 26(40.625%) agreed, 10(15.65%) were neutral, 2(3.125%) disagreed while none strongly disagreed that the use of ICT applications helps in production of quality output. The use of ICT applications improves client's satisfaction due to high quality. This is supported by 52(81.25%) of the respondents due to improved quality as a result of the ICT applications.

4.9.5 ICT applications and time.

The researcher sought to find out the effect of ICT applications on working time. Time as a factor of production greatly determines the output. The respondents were asked to indicate their level of agreement that the use of ICT applications help reduce working time. The findings of the study are illustrated in Table 4.28

Table 4. 28: Reduces working time

Reduces working time	Frequency	Percentage
Strongly Agree	34	53.125
Agree	20	31.25
Neutral	8	12.50
Disagree	2	3.125
Strongly Disagree	0	0
Total	**64**	**100**

The results in Table 4.28 indicate that 34(53.125%) of the respondents strongly agreed, 20(31.25%) agreed, 8(12.50%) were neutral, 2(3.125%) disagreed while none strongly disagreed that the use of ICT applications reduces working time. 54(84.375%) of the respondents believe that use of ICT applications reduce working time. The use of ICT applications speed up and ease the preparation of drawings as well as modifications of the drawings.

4.9.6 Our organization has the modern ICT applications for use by architects in the construction projects.

The researcher sought to find out if the organization had the modern ICT applications for use by architects. Modern ICT applications being referred to as the latest versions of The ICT applications in the market. The findings of the study are illustrated in Table 4.29

Table 4. 29: Modern ICT application

Modern ICT applications	Frequency	Percentage
Strongly Agree	6	9.375
Agree	24	37.50
Neutral	12	18.75
Disagree	12	18.75
Strongly Disagree	10	15.65
Total	**64**	**100**

The results in Table 4.29 indicate that 6(9.375%) of the respondents strongly agreed, 24(37.50%) agreed, 12(18.75%) were neutral, 12(18.75%) disagreed while 10(15.65%) strongly disagreed that their organization had the modern ICT applications for use by architects in the construction projects**.** It is evident that only a handful of architectural institutions have invested in ICT applications mainly due to cost implications. The understanding of the term Modern ICT applications may also have contributed to the 12(18.75%) who were unsure due to lack of exposure.

4.10 Correlational Analysis

Correlational analysis using spearman rho was conducted to determine the relationship between the independent and dependent variables.

4.10.1 ICT Infrastructure and performance of architects

Correlation analysis was conducted to determine the relationship between ICT Infrastructure and performance of architects in construction projects as illustrated in Table 4.30

Table 4. 30: Correlational analysis for ICT Infrastructure

Correlation			Infrastructure	Performance
Spearman' rho	Infrastructure	Correlation Coefficient	1.000	0.867*
		Sig. (2-tailed)	.	0.133
		N	64	64
	Performance	Correlation Coefficient	0.867*	1.000
		Sig. (2-tailed)	0.133	.
		N	64	64

*. Correlation is significant at the 0.05 level (2-tailed).

The analysis indicates that ICT Infrastructure has correlation coefficient of 0.867. This is a strong relationship that shows that ICT Infrastructure determines the level of architects' performance. Therefore, the null hypothesis is rejected and the alternative hypothesis accepted that application of ICT Infrastructure influence architects' performance. The architects needs effective ICT infrastructure to facilitate their work.

4.10.2 Hardware Efficiency and performance of architects

Correlation analysis was conducted to determine the relationship between Hardware Efficiency and performance of architects in construction projects as illustrated in Table 4.31

Table 4. 31: Correlational analysis for Hardware Efficiency

Correlation		Hardware	Performance
Spearman' rho	Hardware Correlation Coefficient	1.000	0.763*
	Sig. (2-tailed)	.	.237
	N	64	64
	Performance Correlation Coefficient	0.763*	1.000
	Sig. (2-tailed)	.237	.
	N	64	64

*. Correlation is significant at the 0.05 level (2-tailed).

The analysis indicates that Hardware Efficiency has correlation coefficient of 0.763. This is a strong relationship that shows that Hardware Efficiency determines the level of architects' performance. Therefore, the null hypothesis is rejected and the alternative hypothesis accepted that application of Hardware Efficiency influence architects' performance. The architects need to use efficient hardware to improve on their performance.

4.10.3 Software Capability and performance of architects

Correlation analysis was conducted to determine the relationship between Software Capability and performance of architects in construction projects as illustrated in Table 4.32

Table 4. 32: Correlational analysis for Software Capability

Correlation		Software	Performance
Spearman' rho	Software Correlation Coefficient	1.000	0.932*
	Sig. (2-tailed)	.	.068
	N	64	64
	Performance Correlation Coefficient	0.932*	1.000
	Sig. (2-tailed)	.068	.
	N	64	64

*. Correlation is significant at the 0.05 level (2-tailed).

The analysis indicates that Software Capability has correlation coefficient of 0.932. This is a strong relationship that shows that Software Capability determines the level of architects' performance. Therefore, the null hypothesis is rejected and the alternative hypothesis accepted that application of Software Capability influence architects' performance. The architects must use architectural software to greatly improve their performance.

4.10.4 Communication Systems and performance of architects

Correlation analysis was conducted to determine the relationship between Communication Systems and performance of architects in construction projects as illustrated in Table 4.33

Table 4. 33: Correlational analysis for Communication Systems

Correlation		Communication	Performance
Spearman' rho Communication	Correlation Coefficient	1.000	0.667*
	Sig. (2-tailed)	.	.333
	N	64	64
Performance	Correlation Coefficient	0.667*	1.000
	Sig. (2-tailed)	.333	.
	N	64	64

*. Correlation is significant at the 0.05 level (2-tailed).

The analysis indicates that Communication Systems has correlation coefficient of 0.667. This is a moderate relationship that shows that Communication Systems determines the level of architects' performance. Therefore, the null hypothesis is rejected and the alternative hypothesis accepted that application of Communication Systems influence architects' performance. The architects should use Communication Systems to improve their performance.

4.10.5 Support staff and performance of architects

Correlation analysis was conducted to determine the relationship between Support staff and performance of architects in construction projects as illustrated in Table 4.34

Table 4. 34: Correlational analysis for Support staff

Correlation			Staff	Performance
Spearman' rho	Staff	Correlation Coefficient	1.000	0.567*
		Sig. (2-tailed)	.	.433
		N	64	64
	Performance	Correlation Coefficient	0.567*	1.000
		Sig. (2-tailed)	.433	.
		N	64	64

*. Correlation is significant at the 0.05 level (2-tailed).

The analysis indicates that ICT Support staff has correlation coefficient of 0.567. This is a moderate relationship that shows that ICT Support staff determines the level of architects' performance to a little extent. Therefore, the null hypothesis is rejected and the alternative hypothesis accepted that application of ICT Support staff influence architects' performance. The ICT support staff needs on-job training and development to acquire the appropriate skills and knowledge to enhance the architects' performance.

CHAPTER FIVE

SUMMARY OF FINDINGS, DISCUSSIONS, CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction

This chapter represents the summary of findings, conclusions and appropriate recommendations in line with the objectives and elements of the study. It also gives suggestions on areas for further research.

5.2 Summary of findings

The study was intended to investigate the influence of information communication technology (ICT) applications on performance of architects in construction projects in public sector, a case of Directorate of public works (MOLH & UD). The study was guided by five main objectives which were: to establish the extent to which ICT infrastructure, determine how efficiency of ICT hardware systems, assess how ICT software capability, Communication systems and examine how ICT Support Staff, influence the performance of architects in construction projects in public sector.

5.2.1 Influence of ICT infrastructure on the performance of architects in construction projects.

The study found out that 56.25% of the respondents felt that the shared resources had a high influence on the performance of architects. However, 18.75% had no idea on the impact of such resources on the performance of architects, while 25% rated that these resources had very low influence on the performance of architects. 62.50% of the respondents appreciated that performance of physical ICT resources had a high influence on the performance of architects' while 56.25% averred that effectiveness of operating systems had a high influence on the performance in that data processing is very fast as well as communication of the information produced. In addition, stable operating systems ensure that the information produced is reliable. Majority of respondents, 65.625% asserted that the type of operation functions had a high influence on the performance of architects in construction projects.

5.2.2 Influence of Hardware efficiency on the performance of architects in construction projects.

The study revealed that 51.56% of the respondents appreciate that stability of web and application servers had a high influence on architects' performance as it improves data processing and dissemination. In addition, stable web servers ensure that the information flow is continuous with minimal interruption. The study also showed that effective application servers provide the much needed software and data to facilitate the architectural work. 59.375% asserted that capacity and speed of storage devices had a high influence on the performance of architects in construction projects in that data transfer is very fast as well as large volume of data can be stored which would otherwise be left out.

The study revealed that 71.875% of the respondents approved that the speed of hardware enables faster processing of data as well as transmission and thus had a high influence on the performance of architects. 71.875% of the respondents averred that accessibility of ICT applications used in construction projects by architects help automate the production of design drawing, design change and also used to assist in the creation, modification analysis or optimization of a design and thus had a high influence on the performance of architects. However, 25% of the respondents had no idea about the impact of the ICT applications given that only a few of the institutions have fully embraced the use of ICT applications.

5.2.3 Influence of Software capability on the performance of architects in construction projects.

The study showed that 68.75% of the respondents approved software reliability highly influences architects performance in that consistency in data processing enables prediction of the possible outcome. 53.125% accepted that data management improved data sharing, improved data security, better data integration, minimized data inconsistency, improved data access, improved decision making and increased end-user productivity and thus had a high influence on the performance of architects . The results indicated that 71.875% of the respondents support that software capability highly influenced the performance of architects by enabling them to carry out their architectural work. 50% of the respondent highly rated high the influence of data administration since it determines what data needs to be present in the system and how this data has to be presented organized, managed, and how different groups of users use it.

The study also revealed that 50% of the respondents highly rated the nature of security influenced the performance of architects. The security restricts groups of users to specified parts of the overall ICT applications. 43.75% of the respondents agreed that disaster recovery solution had a high influence on the performance of architects and also showed that reconstructing the correct state of database from the backup and history of transactions ensure data safety and integrity. However, 31.25% of the respondents disagree given that data recovery is a rare phenomenon since most of the architects operate on their own laptops or PCs and are not networked.

5.2.4 Influence of Communication Systems on the performance of architects in construction projects.

The study revealed that 68.75% of the respondents rated the reliability of communication system as having a high influence on the performance of architects this is due to efficient communication between the various stake holders. 68.75% of the respondents recognized that consistency of ICT network and communication infrastructure solutions of computers improves the performance architects. In addition, reliable web servers, networks ensure that the information flow is continuous with minimal interruption. 57.812% of the respondents showed that faster, clear networks and communication system enables the architect to reduce development time and greatly improves his performance.

5.2.5 Influence of Human resource - Support staff on the performance of architects in construction projects.

The study revealed that 46.875% of the respondents affirmed that ability of (ICT) support staff to adapt to changing IT environment had a high influence on the performance of architects as it ensures that the architects get the latest information and are up-to date with the latest technologies which results into quality architectural designs. However, 31.25% of the respondents do not see the influence of Support staff ability to adapt to the ever changing ICT environment having any significant influence on the performance of architects since as tested and proven ICT applications work regardless of time lapse. Additionally, ICT applications are just beginning to take root and its influence is yet to be felt. 45.875% saw the need of ICT staff competencies as a crucial factor to architects performance. However, 18.75% disagree given that the knowledge of ICT staff is hardly incorporated in the architectural work.

The study also showed that 40.25% of the respondents approved that handling and integrating ICT applications with other software helps in understanding the inter-relationships between data stored in different applications and had a high influence on performance of architects. However, 32.812% felt otherwise given that many architects rely on individual ICT applications. Barely 34.375% felt training and development to the support staff was necessary to equip them with the knowledge of current information Systems (IS) and architectural section needs. The study also showed that 31.25% had a low influence rating on training and development need for ICT support.

5.2.6 ICT applications and the performance of architects

The findings revealed that 93.75% of the respondents supported that ICT applications greatly improves productivity. 84.375% agreed that ICT applications enhance efficiency by reducing wastage of resources which would otherwise been inevitable if relying on hand-based drawing and techniques. 71.875% attested that ICT applications produce quality information by providing accurate, timely, reliable and reusable over a long period as well as making the information available whenever wanted. 81.25% agreed that the use of ICT applications improved quality work (service delivery) while 84.375% of the respondents believed that use of ICT applications reduce working time, speeding up and easing the preparation of drawings as well as the modification of the drawings while at the same time offers the possibility to simulate and visualize the building in a nearly realistic way. However, only 46.875% of architectural institutions have invested in modern ICT applications mainly due high cost.

5.3 Discussion of the findings

The findings confirm that ICT applications improve efficiency by reducing wastage of resources which would otherwise have been inevitable if relying on hand-based drawing and techniques.

The study confirms the findings by Almarabeh & Buali (2010) that ICT applications help architects to increase their performance and to carry out the desired functions with ease and professionalism. Moreover, the use of ICT applications aids cost estimations before the concept has reached the required level of precision since reference can always be made based on previous works which is readily available.

The study has also shown that ICT applications ensure the information is accurate, timely, reliable, readily available and reusable over a long period. This guarantees improved communication between the architects in construction projects and the stakeholders for effective decision-making and coordination among construction participants which greatly reduce the possibility of scope creep. The findings therefore reinforces the observations by Ruikar et al. (2005) that the use of ICT by architects in construction projects can impact on the traditional processes of organization in construction projects which can result to changes in organizational processes, working methods and culture.

The study also showed that ICT applications helps in increasing the quality of work and output and reduce the development time by speeding up and easing the preparation of drawings as well as the modification of the drawings while at the same time offers the possibility to simulate and visualize the building in a nearly realistic way. These findings aver the assertions by AlMansoori (2010). The study also showed that ICT applications ensure increased efficiency and effectiveness of architects in construction projects. Additionally, only a few architectural institutions have invested in ICT applications mainly due to cost implications as huge sum of money is usually required to install. This has resulted in a few architectural institutions with financial muscle investing in ICT applications. .

The study showed that the shared resources have very little impact on the architect performance since they do not have direct bearing on the architectural work. These resources are normally used for general applications in the institution to facilitate the operations. Thus, these shared resources as claimed by Broadbenta et al. (1999) enable architects to share the ICT capabilities which provide services for other systems of the organization. Performance of physical ICT resources is important for high data processing speed, less energy consumption, reliability, perform the intended purpose and improves communication of the information produced. Data security regulates access to information hence, limiting interference with the information. Effective and stability web servers provide the much needed software and data to facilitate the architectural work. Web servers accelerate data processing as well as communication of the information produced and at the same time ensure that the information flow is continuous with minimal interruption. This smooth flow of information hastens completion of the architectural work. Web servers ensure reliability and enable large volume of data to be stored which would otherwise be left out. These attest to the findings by Peansupap & Walker, (2005) that the use of ICT application by architects in construction projects reduces the time for data processing and communicate information, and improve communications for effective decision-making and coordination among construction participants. This enhances construction productivity as suggested by Liston et al (2000). The use of ICT applications in construction projects automate the production of design drawing and design change and also used to assist in the creation, modification analysis or optimization of a design.

The use of software in data processing enables prediction of the possible outcome. The use of software in architectural work improve data sharing, improve data security, ensure better data integration, minimize data inconsistency, improve data access, improve decision making and increase end-user productivity. These reduce application development time and optimize database access and enable the architects to perform the intended architectural work. Data administration determines what data needs to be present in the system and how this data has to be presented, organized, managed, and how different groups of users use it. These support Patrizio et al. (2004) that software provides the day-to-day work needed to monitor and maintain a continuous ICT infrastructure and operating systems. Thus, data sharing and centralizing minimize data redundancy and perform fine tuning which reduces retrieval time. The data security through password protection restricts groups of users to specified parts of the overall ICT applications which minimize data interference. Reconstructing the correct state of database from the backup and history of transactions ensure data safety and integrity. This is echoed by Garcia-Molina & Polyzois (2002) software applications ensure continuous operation of applications and database in the presence of disasters.

The consistency of ICT network and communication infrastructure solutions of computers accelerate data processing as well as communication of the information produced. For this reason Abdalla (2006) assert that ICT has emerged as an intermediary in assisting successful communication between architects in construction projects and stakeholders. A faster network connection system enables the architect to reduce development time and greatly improves efficiency. These findings resonate with World Bank (2005) and Yesser (2005) that these ICT applications save time, increase convenience. Clear network system enables the architects to easily carry out their architectural work.

ICT environment is an ever changing industry, effective technology today is obsolete tomorrow. Thus, the ability of the ICT support staff to adapt to changing environment ensure that the architects get the latest information and are up-to date with the latest technologies resulting in quality architectural designs. Moreover, outdated system is sub-standard and is likely to give inadequate information. Staff with outdated information is ineffective and is likely to maintain outdated systems which do not serve the current need of the architects. However, ICT applications are just beginning to take roots and its influence is yet to be felt. ICT support staff with adequate knowledge and skills aid understanding of the procedures, data policies, functions and information needs of the architect. Thus, give the architects reliable, accurate and timely information regarding a project work. Integrated ICT applications help in understanding the inter-relationships between data stored in different applications. The ability of ICT support staff to handle ICT applications helps in draughting, detailing and 3D visualization.

5.4 Conclusion

The study sought to assess the influence of information communication technology (ICT) applications on performance of architects in construction projects in public sector. The research objectives were used to guide the collection of required data from the respondents. The study examined five aspects of ICT applications and was guided by five objectives. Research objective one in this study was to establish the extent to which ICT infrastructure influences the performance of architects in construction projects in public sector. The study showed that the shared resources moderately influence architect performance since they make the architectural work easy since they are normally used for general applications in the institution to facilitate the operations. The ICT infrastructure consumes less energy, speeds up data processing, effective. Thus, the ICT infrastructure reduces the development time as well as ensures customer satisfaction by meeting the performance requirement as per the technical specifications. Data security regulates data access which reduces interference with the information. This ensures data reliability and authenticity of the information.

Research objective two in this study was to determine how efficiency of ICT hardware systems influences the performance of architects in construction projects in public sector. The study revealed that ICT hardware efficiency improve architects performance in that data processing is very fast as well as communication of the information produced. In addition, it ensures that the information flow is continuous with minimal interruption. This smooth flow of information accelerates completion of the architectural work. ICT hardware efficiency ensure more information can be stored which would otherwise been left out while ensure that the same data can be retrieved whenever needed. Moreover, the data can be recovered in case of hardware crash.

Research objective three in this study was to establish the extent to which ICT software capability influences the performance of architects in construction projects in public sector. The study found out that the ICT applications automate the production of design drawing and design change and also used to assist in the creation, modification analysis or optimization of a design which greatly reduce development time and ensure client satisfaction. Additionally, the software ensures consistency in data processing and prediction of the possible outcome. This gives relatively acceptable work and authenticity of the information produced which in the long run facilitates architects performance.

Research objective four in this study was to assess the influence of Communication systems on the performance of architects in construction projects in public sector. The study found out that Communication systems improve architects performance in that data processing is very fast as well as communication of the information produced. In addition, stable Communication systems ensure that the information flow is continuous with minimal interruption. This smooth flow of information accelerates completion of the architectural work. Moreover, Communication systems improve stakeholders' participation in the development process which ensure clients satisfaction and reduce discrepancies.

Research objective five in this study was to examine how ICT Support Staff influence the performance of architects in construction projects in public sector. The ICT environment is an ever changing industry, effective technology today is obsolete tomorrow. Effective ICT support staff adapts to changing environment and that the architects get the latest information and are up-to date with the latest technologies resulting in quality architectural designs.ICT support staff with adequate knowledge and skills aid understanding of the procedures, data policies, functions and information needs of the architect. They ensure that the architects get reliable, accurate and timely information regarding a project work. Moreover, the ability of the ICT support staff to integrated ICT applications help in understanding the inter-relationships between data stored in different applications. This improves data sharing and centralizes data to minimize data redundancy and reduce retrieval time.

5.5 Recommendations

Based on the findings of this study and the conclusion made, the study makes the following recommendations for policy action by architects on construction project in public sector given that ICT application have a bearing on their program performance:

There is need to increase training and development of the ICT Support staff to make them

more effective.

There is need to install Communication systems and infrastructure relevant to the architects

The architects need to use efficient ICT hardware

The architects need to use ICT software capable of accomplishing the architectural work

The study recommends that there should be greater stakeholder's participation in the development to promote ownership.

The study recommends that the organizations upgrade its ICT equipments to conform to the ever changing technology environment

5.6 Suggestions for further research

The empirical study has specified a number of relevant issues that the research project did not investigate, but which might be important for further research on the influence of information communication technology (ICT) applications on performance of architects in construction projects in public sector. The following areas are suggested for further research:

The influence of organizational culture on architects' performance

The influence of leadership skills on architects' performance

The implementation of computer-integrated design and construction

REFERENCES

Abdalla, K. A. (2006). *Stakeholder Perceptions of Issues for Successful Information Technology Transfer in a Developing Country: A Case Study of the United Arab Emirates.*

Abdullah, W. M. W., & Ramly, A. (2006).*Does successful project management equates to project success*. Paper presented at the ICCI - 2006.

Abhamid, N. R. (2008). Consumers' Behaviour towards Internet Technology and Internet Marketing Tools. *International Journal of Communications.*

Adriaanse, A. & Voordijk, H. (2005) Inter organizational communication and ICT in construction projects: A review using meta triangulation. *Construction innovation*,

Aigbavboa, C.O., Thwala W.D., Lesito, K.P. (2013). Information Communication Technology (ICT) usage in the South African Construction Professional Practice: Lessons Learnt .*Journal of Economics and Behavioral Studies*.

Ali, S. & Green, P. (2009).*Effective Information Technology (IT) Governance Mechanisms: An IT Outsourcing Perspective*. Information Systems Frontiers. Special issue on Governance, Risk and Compliance: Application in Information Systems.

Almansoori, R. (2010). *Abu Dhabi e-Government Program*.

Almarabeh, T. & AbuAli, A. (20101).A general framework for e-government: definition maturity challenges, opportunities, and success. *European Journal of Scientific Research,*

Alshihi, H. (2005). *Critical factors in the Adoption and Diffusion of e-government initiative in Oman*.

Alsobhi, F., M. & Weerakkody, V. (2009). *Current IT State of E-services in Saudi Arabia: The Case of Intermediaries in Facilitating Government Services in Madinah City*.

Altman, C. (2002). *Converging Technologies: The Future of the Global Information Society*.

Aneshensel, C. S. (2012).Theory-based data analysis for the social sciences. Thousand Oaks CA: Sage.

Andersen, K. V. & Henriksen, H. Z. (2005). The First Leg Of E-Government Research: Domains And Application Areas 1998 – 2003. *International Journal of Electronic Government Research.*

Azab, N. A., Kamel, S. & Dafoulas, G. (2009).A Suggested Framework for Assessing Electronic Government Readiness in Egypt. *Electronic Journal of e-Government* 7, 11 – 28.

Bakari, J.B. (2007). *A Holistic Approach for Managing ICT Security in Non-Commercial Organizations: A case in a developing country*.

Bakry, S. H. (2004). Development of e-Government: A STOPE view. *International Journal of Network Management*, 14, 339-350

Bjork B.C. (1999). Information Technology in construction: domain definition and research issues, *International Journal of Computer Integrated Design and Construction*, SETO, London, May 1999.

Bowen, P.L., Cheung, M. D. & Rohdeb, F. H. (2007). Enhancing IT governance practices: A model and case study of an organization's efforts. *International Journal of Accounting Information Systems*.

Bretschneider, S., Gant, J. & Ahn, M. (2003).*A General Model Of E-Government Service Adoption: Empirical Exploration*. Public Management Research Conference. Washington, DC: Georgetown Public Policy Institute

Carter, L. & Belanger, F. (2005). The utilization of e-government services: citizen trust, innovation and acceptance factors. *Information Systems Journal*.

Chen, Y. & Gant, J. (2001), Transforming local e-government services: the use of application service providers. *Government Information Quarterly*.

Council for Excellence in Government [CEG] (2000). E-*Government: The Next American Revolution. Creation 2003-2007*. Nairobi: Government Printer.

Criado, J. I. & Ramilo, M. C. (2003). E-Government in practice: an analysis of website orientation to citizens in Spanish municipalities. *International Journal of Public Sector Management*.

Dace, A. C. (2007) *Building Information Modeling*: The web3d application for AEC. Perugia, Italy: ACM.

Dahl, C., Kongsted, H. & Sørensen, A., (2011). "ICT and productivity growth in the 1990s: panel data evidence on Europe. *Empirical Economics*, Springer.

Day, A., Faulkner, A. & Happold, E. (1986) *Communications and computers in the building industry* Cambridge: CICA.

Davenport, T., D. Delong, & M. Beers (1998). Successful Knowledge Management Projects. *Sloan Management Review*.

Dillon, J. & Pelgrin, W. (2002), *E-Government/Commerce in New York State, Office of Technology*, New York, NY.

Doherty J. M. (1997). A Survey of Computer Use in the New Zealand Building and Construction Industry, *Electronic Journal of Information Technology in Construction.*

Eastman, C., Teicholz, P., Sacks, R. and Liston, K. (2008) *Bim handbook : a guide to building information modeling for owners, managers designers, engineers, and contractors.*

E. N. (2012). *IT Governance In Tanzanian Public Sector Organisations*.US-AB: Stockholm, Sweden .

Ebrahim, Z. & Irani, Z. (2005). E-government adoption: Architecture and Barriers. *Business Process Management Journal*.

Eurexemp, (November, 2004). *Does e-government pay off ?* Capgemining.

Eurostat (2001). *Handbook of price and volume measures in national accounts*, European Commission.

Gakunu, P. (2004). *The status of ICTs and their utilization in Kenya*. A statement on policy reforms in the cabinet Office.

Garcia-Molina, H. & Polyzois, C. A. (2002). In: *Thirty-Fifth IEEE Computer Society International Conference*, 2002 San Francisco, CA, USA.

Gathungu, J. & Mungai, A. N. (2011). Contextual Factors Affecting E-Government Strategy Implementation And Its Impact On Public Sector Performance In Kenya. Journal of Arts and Humanities (JAH), 1(1),

Gefen, D. & Pavlou, P. et al. (2002). *Egovernment adoption*. paper presented at Americas Conference on Information Systems, Tampa, FL.

Gichoya, D. (2006). *Implementing E-administration in Kenya: Education and Development in the common wealth: comparative perspectives.*

Githenya, M. S. & Ngugi, K. (2014). Assessment of the Determinants of Implementation of Housing Projects in Kenya. *European Journal of Business Management*.

Goh, B. (2005). IT Barometer: Survey of the Singapore Construction Industry and a Comparison of Results. Journal of Information Technology in Construction.

Guy Peters D. B. & Pierre, J., (2003). *Handbook of public administration*, Sage Publications Ltd.

Heeks, R. (2005). *Implementing and Managing E-Government*: An International Text. Sage Publishers.

Heeks, R. (Ed.) (1999). *Reinventing Government in the Information Age: International Practice in IT-Enabled Public Sector Reform*. Routledge, London.

Ho, A.T-K. (2002). Reinventing local governments and the e-government initiative. *Public Administration Review*.

Howard R., Kviniemi A. and Samuelsson O. (1998). Surveys of IT in the Construction Industry and Experience of the IT barometer in Scandinavia, *Electronic Journal of Information Technology in Construction*.

IBM. (2001). *Creating an Infrastructure for e Government: Enabling Government Innovation.* Available online

IDA. (2004). *Multi-channel delivery of e Government services. Interchange of Data between Administrations.*

Ikechukwu, O. Chinedu, C. N. & Onyegiri, J. (2011). Information and communication technology in the construction industry. *American journal of scientific and industrial research.*

Imran, A. & Gregor, S. (2005). *Strategies for ICT Use in the Public Sector in the Least Developed Countries: A Cross-Country Analysis.* In B. Campbell,

ITGI & PwC. (2008). *IT Governance Global Status Report*. Available online at www.itgi.org.

ITGI (2007). *IT Governance Implementation Guide: Using COBIT and Val IT*, 2nd Edition by IT Governance Institute.

Kamar, N., & Ong'ondo, M., (2007). *Impact on Management and use of of e-Government Government Information in Kenya.*

Kiviniemi A. (1999) . *IAI and IFC - State-of-the-Art. 8th International Conference on Durability of Building Materials and Components,* Volume 4 - Information Technology in Construction, CIB W78 Workshop, (Lacasse).

Layne, K. & Lee, J. (2001).Developing fully functional E-government: A four stage model. *Government Information Quarterly*.

Linna P., Pekkola S., Ukko J.,&Melkas H. (2010). Defining and measuring productivity in the public sector: managerial perceptions", *International Journal of Public Sector Management*.

Liston, K., Fischer, M. & Kunz, J. (2000). Designing and Evaluating Visualization Techniques for Construction Planning. Computing in Civil and Building Engineering.

Macasio, J. (2009a). *ICT Services Management Practitioner's Not E-enterprise Architecture [Online].Onecitizen*. Available online at: www.onecitizen.net

Maheshwari, B., Vinod Kumar, Uma Kumar & Sharan, V. (2009).*E-Government Portal Effectiveness: Managerial Considerations for Design and Development. Computer Society of India*.

Maimu, D. (2010). *Tanzania finally getting National IDs, East African Business Week*. Available online. Retrieved on 14th March 2014.

Mambo, S. & Charagu, S. (2013). *Collapse of Housing Structures*. IEK presentation.

Manzione, L. & Melhado, S. B. (2007). Why is design delivery always behind schedule? A critical review of the design planning techniques adopted for Real Estate projects in São Paulo - Brazil. CIB World Building Congress,2007, Cape Town, South Africa.

Marshall-Ponting A.J &Aouad G. (2005). ―An nD modelling approach to improve communication processes for construction: *Automation in Construction*, 14, 311-321

Mahony, M., Timmer, M.& Van Ark, B., (2010). ICT and productivity growth in Europe: an update and comparison with US, in Cimoli, M.

McClure, D. (2000). *Electronic government: federal initiatives are evolving rapidly but they face significant challenges*. Accounting and Information Management Division.

Modesitt, C. (2002). Bridging the gap between citizens and local government with Manpower.

Moodley, S. (2003). The challenge of e-business for the South African apparel sector.*Technovation*, 23, 557-70.

Moon, M. J. (2002). The evolution of e-government among municipalities: rhetoric or reality? *Public Administration Review*.

Mugenda M.O. & Mugenda A.G (2003) *Research Methods, Quantitative and Qualitative Approaches.* Nairobi: Acts Press

Nfuka, E.N. (2012). *IT governance in Tanzanian public sector organisations*. Stockholm, Sweden: US-AB.

Nfuka, E.N., Rusu, L., Johannesson, P. &Mutagahywa, B. (2009).*The state of IT governance in organizations from the public sector in a developing country.* In Proceedings of the 42nd Hawaii International Conference on System Sciences in Hawaii, 2009.Computer Society Press. Los Alamitos, CA.

Nicoll, P. (2005). *What lies ahead for public sector governance? Keeping Good Companies,* 57, 19–26.

Njuru, J. W. (2011). Implications of E-Government on Public Policy and Challenges of Adopting Technology: The case of Kenya. *Journal of Global Affairs and Public Policy*, 1(1).

O'neill, R. (2009). *E-government: Transformation of Public Governanace in New Zealand?.*Victoria University of Wellington.

Odongo, W. O. (2010). *E-Government in Kenya: A Conceptual Framework to Increase Public Participation. School of Computing & Informatics Building. Nairobi:*Chiromo Campus, off Riverside Drive. University of Nairobi.

Oladapo, A. A. (2006). Impact of ICT on Professional Practice in the Nigerian Construction Industry. The Electronic Journal on Information Systems in Developing Countries.

OECD 2009.*OECD e-Government Studies: Rethinking e-Government Services: user centred approaches,* OECD, Paris.

Okong'o, V. (2007).*The e-government experience Chapter 9: Sectoral and thematic case studies. in Kenya: the story so far*. IDRC review

Omwoyo, B. O. (2005). *E-governance in eastern and southern Africa: A webometric study of the governments' websites*. PhD thesis at the University of Zululand, Private Bag x1001, KwaDlangezwa 3886, South Africa.

Orodho A. J. & Kombo D.K (2002). Research methods .Nairobi Kenyatta University institute of open learning

Otike, A. (2010). The *Doctrine of Fair Use and its role in the provision of Information in Kenya. A paper presented at the Kenya Library Association (KLA)* Conference held in Nairobi, Kenya, June 17 – 19, 2010.

Pathak, R.D., Naz, R. Singh, G. & Smith, R.F. (2010). ICT for Improved Public Service Delivery in Papua New Guinea Governance.

Patrizio, D. N., Isabella, M., Rocca, G. L. & Valentina, T. (2004). *ICT Infrastructure - the Regional Dimension. Benchmarking the Information Society*: e-Europe Indicators for European Regions. BISER.

Peansupap, V. & Walker, D. (2005). Factors affecting ICT diffusion: A case study of three large Australian construction contractors. *Engineering, Construction and Architectural Management,* 12(1), 21-37.

Pfleeger, C. P. & Pfleeger, S. L. (2003). *Security in Computing.* NJ, USA, Prentice Hall.
Rahman, H. (2007). *E-Government Readiness: from the Design Table to the Grass Roots*. ACM 978-1-59593-822 -0/07/12.

Rampersad, H. K. (2002). *Total Performance Scorecard; eenspeurtochtnaarzelfkennis en competentieontwikkeling van lerendeorganisaties*, Scriptum Management, Schiedam.

Rantanen, H., Kulmala, H., Lo¨nnqvist, A. & Kujansivu, P. (2007). Performance measurement systems in the Finnish public sector.*The International Journal of Public Sector, Management*.

Rantanen, H., Leva¨, K. & Pekkola, S. (2007b). Performance measurement implementation in a knowledge-based public organization. *International Journal of Business and Systems, Research*.

Reddick, C. G. (2005). Citizen Interaction with E-government: From the Streets to Servers? *Government Information Quarterly*.

Republic of Kenya (2004). *E-government strategy: The strategic framework, administrative structure, training Requirements and standardization framework. Nairobi*: Government Printer.

Rizk, N. (2004). *E-readiness assessment of small and medium enterprises in Egypt: A micro study [*Online]. Cairo: American University.

Ruikar, K., Anumba, C. J. and Carrillo, P. M. (2005). End user perspectives on use of project extranets in construction organizations. *Engineering construction & architectural management*.
Sanchez, A. &Koh, C. et al. (2003). *The relationship between IT for communication and e-government barriers*. Paper presented at Americas Conference on Information Systems, Tampa, FL.

Segalas, J., Ferrer-Balas, D., & Mulder, K. (2010). What do EESD “experts” think sustainability is? Which pedagogy is suitable to learn it? Results from interviews and Camps analysis that were gathered at EESD 2008.In: *Engineering Education in Sustainable Development, Gothenburg, Sweden, September*.

Sethibe, T., Campbell, J. & McDonald, C. (2007)..*IT Governance in Public and Private Sector Organizations: Examining the Differences and Defining Future Research Directions*. In Proceedings of 18th Australasian Conference on Information Systems (ACIS).

Shollei, G. B (2007). Use of Technology to Improve Service Delivery In The Public Sector. Nairobi: Interim Independent Electoral Commission.

Starkey.K.,Tempest. S & A, M. K. (2004). *How Organizations Learn, Managing the Search for Knowledge*. Second Edition, Thomson

Strover, S. & Straubhaar, J. D. (2000). Assessing Citizen Utilization of E-Government Services: A Survey of Issues and Attitudes in Texas. *Government Finance Review*.

Takashi, T. Tatsuya, K. & Mitsuru, S. (2012). Approach to Building a Construction Project Delivery System Utilizing 3D Models. *Concrete Journal*, 50(9), 804 – 809.

Tam, C. M. (1999). use of the internet to enhance construction communication: total information transfer system. *International journal of project management*.

Tanzania (2010). *The United Republic of Tanzania*. Available online at www.tanzania.go.tz.

Thompson, F. & Jones, L. R. (2008). Reaping the Advantages of Information and Modern Technology: Moving from Bureaucracy to Hyperarchy and Netcentricity. *International Public Management Review*.

TzITpolicy (2003). *Tanzania National ICT Policy*. Available online at http://www.tanzania.go.tz/policiesf.html

Sun, M., Howard, R. (2004). *Understanding IT in construction*. London:Spoon Press US department of education, office of educational research and improvement (2002) *classification of industrial programs.*

UN (2010). *United Nations (UN).E-Government Survey 2010*.

Underwood, J. & Bunker (Eds.), *Proceedings of the 16th Australasian Conference on Information Systems,* University of Technology, Sydney, Australia.

United Nations (2008).*UN E-Government Survey 2008 - From E-Government to Connected Governance, United Nations*, New York.

Veer, P. Vander & Sariyildiz ,I.S., "Integrated Building Design Decision Support Systems", in: *Proc. Applications of Artificial intelligence in Engineering.*

Vee, C. & Skitmore, R. M. (2003). Professional ethics in the construction industry. *Engineering Construction and Architectural Management*, 10(2):pp. 117-127.

Vivarelli, M., Piga, C., & Piva, M., (2004). 'Il triangolocompetitivo: innovazione, organizzazione e lavoroqualificato'.*L'industria*, 25, 655-674.

Walker, D. H. T. & Hampson, K. (2003) *Procurement Strategies - A Relationship-based Approach*. Oxford: Blackwell Science Ltd.

World Bank. (2006). *Information and Communications for Development 2006: Global Trends and Policies*. World Bank Publications.

Weerakkody, V., Janssen, M. & Dwivedi, Y. K. (2009). *Handbook of Research on ICT-enabled Transformational Government: A Global Perspective*. Hershey, PA: Idea Group Publishing.

Weill, P. & Ross J.W. (2004)..*IT Governance: How Top Performers Manage IT Decision Rights for Superior Results.* Harvard Business School Press.

Weippert, A., Kajewski, S. L. & Tilley, P. A. (2003). The implementation of online information and communication technology (ICT) on remote construction projects. *Logistics information management*.

World Bank. (2006). *Information and Communications for Development 2006: Global Trends and Policies*. World Bank Publications.

Yesser. (2005). *Supporting plans and methodologies*: E-Readiness assessment methodology for government organizations. Riyadh, Saudi Arabia: E-government Program, Ministry Communications and Information Technology (MCIT).

APPENDICES

APPENDIX I

LETTER TO RESPONDENTS

Gituthu P. Maina

University of Nairobi

Main Campus,

NAIROBI.

Dear Respondent,

<u>RE: ACCEPTANCE LETTER</u>

I am a student at University of Nairobiundertaking a degree of master of project planning and management. I have chosen you to participate in this research on influence of information communication technology applications on performance of architects in construction projects in public sector: the case of directorate of public works, Kenya. Your responses will be used for the research purpose only and your identity treated with a lot of confidentiality.

Kindly respond sincerely to the issues in the questionnaire. Please read and answer the questions by ticking the correct answer (choice) to the questions given.

Thanking you in advance of your response.

Yours truly,

Gituthu P. Maina

University Of Nairobi

APPENDIX II:

QUESTIONNAIRE FOR ARCHITECTS IN CONSTRUCTION PROJECTS IN PUBLIC SECTOR

Instructions

Please answer the following questions as accurately as possible.

Tick the correct answer in the boxes provided against the questions where necessary.

Write brief answers where explanation is required.

You need not write your name on the questionnaire.

Information will be treated with confidentiality.

SECTION A: DEMOGRAPHIC CHARACTERISTICS OF RESPONDENTS

1. **Please state your Sex** Male ☐ Female ☐

2. **Select the Age bracket you belong to by ticking the appropriate**

   18 – 29 ☐ 30-39 ☐ 40 49 ☐ 50 59 ☐ Over 59 ☐

3. **How long have you been in the Construction Projects of Public Sector of Kenya? Please tick as appropriate**

Less than a year ☐ 1 – 5 Years ☐ 6 – 10 Years ☐

11 – 15 Year ☐ 16 – 20 Years ☐ Over 20 Years ☐

SECTION B: INFLUENCE OF ICT INFRASTRUCTURE ON PERFORMANCE OF ARCHITECTS IN THE CONSTRUCTION PROJECTS.

4. Please indicate the extent to which each of the following ICT infrastructure elements would influence the performance of Architects in the Construction Projects to you as an architect. For each indicator indicate the level of influence by ticking (√) on the space corresponding to the correct answer in each question below.

Scale: Not at All = 1; Low = 2; Moderate = 3; High = 4; Very High = 5

ICT Infrastructure	**1**	**2**	**3**	**4**	**5**
Nature of shared resources such as storage devices, networks, printers among others. used in the organization by architects					
Performance of physical ICT resources such as computers, printers among others available to the architect					
Effectiveness of operating systems installed in the computers					
Accessibility of ICT applications used in construction projects by architects					
ICT infrastructure influences the performance of Architects in the construction projects in public sector					

SECTION C: INFLUENCE OF ICT HARDWARE EFFICIENCY ON PERFORMANCE OF ARCHITECTS IN THE CONSTRUCTION PROJECTS.

5. Please indicate the extent to which each the following efficiency of hardware elements would influence performance of architects in the construction projects. For each indicator indicate the level of influence by ticking (√) on the space corresponding to the correct answer in each question below.

Scale: Not at All = 1; Low = 2; Moderate = 3; High = 4; Very High = 5

Efficiency of ICT Hardware	**1**	**2**	**3**	**4**	**5**
Stability, reliability, speed, accuracy of web and application servers					
Capacity and speed of storage devices used to store architectural data					
Speed of hardware					
Efficiency of ICT Hardware influence the performance of Architects in the construction projects in public sector					

SECTION D: INFLUENCE OF ICT SOFTWARE CAPABILITY ON PERFORMANCE OF ARCHITECTS IN THE CONSTRUCTION PROJECTS.

6. Please indicate the extent to which each the following elements of software capability would influence performance of architects in the construction projects. For each indicator indicate the level of influence by ticking (√) on the space corresponding to the correct answer in each question below.

Scale: Not at All = 1; Low = 2; Moderate = 3; High = 4; Very High = 5

ICT Software Capability	**1**	**2**	**3**	**4**	**5**
Reliability and capability of software available to the architects for use in architectural design					
Nature of data management in the system used by architects					
Effectiveness of the database administration and software used by the architects					
Nature of security provided for the software used by architects					
Effectiveness of disaster recovery solution for data recovery after data is destroyed or corrupted					
ICT software capability influence the performance of Architects in the construction projects in public sector					

SECTION E: INFLUENCE OF COMMUNICATION SYSTEMS ON THE PERFORMANCE OF ARCHITECTS IN THE CONSTRUCTION PROJECTS.

7. Please indicate in your own opinion the extent to which each the following elements of Communication System would influence performance of architects in the construction projects. For each indicator indicate the level of influence by ticking (√) on the space corresponding to the correct answer in each question below.

Scale: Not at All = 1; Low = 2; Moderate = 3; High = 4; Very High = 5

Communication systems	1	2	3	4	5
Reliability of Communications systems used by architects for example Computers, Mobile, Wi-Fi, Scanners and others					
Consistency of ICT network and communication infrastructure solutions of computers used by architects in the construction projects					
Speed and clarity of the network connection system used by architects in the construction projects					
Communication systems influence the performance of Architects in the construction projects in public sector					

SECTION F: INFLUENCE OF ICT SUPPORT STAFF ON PERFORMANCE OF ARCHITECTS IN THE CONSTRUCTION PROJECTS.

8. Please indicate the extent to which each the following elements of ICT support staff would influence performance of architects in the construction projects. For each indicator indicate the level of influence by ticking (√) on the space corresponding to the correct answer in each question below.

Scale: Not at All = 1; Low = 2; Moderate = 3; High = 4; Very High = 5

ICT Support staff	1	2	3	4	5
The ability of the ICT support staff in handling computer system to adapt to changes in ICT environment					
Knowledge and experience of the ICT staff in charge of					

ICT applications and hardware used by architects in the construction projects					
Ability of ICT support staff in handling and integrating the ICT applications and other software					
Training and development provided to ICT support staff in charge of ICT applications and hardware used by architects					
ICT support staff influence the performance of Architects in the construction projects in public sector					

SECTION G: ICT APPLICATIONS AND PERFORMANCE OF ARCHITECTS IN CONSTRUCTION PROJECTS.

9. Please indicate the level of agreement or disagreement on the following statements in regards to performance of architects in the construction projects in public sector. Please tick **(√)** the space corresponding to the correct answer in each question below.

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

Statements	**1**	**2**	**3**	**4**	**5**
The ICT applications in our work place helps architects in construction projects to increase their productivity					
The current ICT applications assist in increasing efficiency of Architects in the Construction Projects					
Architects in the construction projects have been producing quality information through use of the ICT applications provided to them					

The ICT application in the workplace helps architects in the construction projects to produce quantity of output					
The ICT applications provided to architects in the construction projects allows them to take shorter time in doing their work					
Our organization has the modern ICT applications for use by architects in the construction projects					