AN APPRAISAL OF COST-BASED INFORMATION MANAGEMENT METHODS AT THE DESIGN STAGE OF BUILDING PROJECTS IN NIGERIA

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A DISSERTATION SUBMITTED TO THE POSTGRADUATE SCHOOL, AHMADU BELLO UNIVERSITY, ZARIA. IN PARTIAL FULFILLMENT FOR THE AWARD OF MASTERS OF SCIENCE IN CONSTRUCTION MANAGEMENT DEPARTMENT OF BUILDING FACULTY OF ENVIRONMENTAL DESIGN.

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DECLARATION

I declare that the work in the thesis entitle “An appraisal of Cost-Based Information Management Methods at the design Stage of Building Projects in Nigeria” has been performed by me in the Department of Building under the supervision of Prof. I. Mbamali and Mal. M.S. Saleh. The information derived from the literature has been duly acknowledged in the text and a list of references provided. No part of this thesis was previously presented for another degree or diploma at any institution.

LELEJI, E. AKPOVIRORO	________________ SIGNATURE	____________ DATE

CERTIFICATION

This project/thesis entitled "AN APPRAISAL OF COST-BASED INFORMATION MANAGEMENT METHODS AT THE DESIGN STAGE OF BUILDING PROJECTS, IN NIGERIA" by LELEJI, E. AKPOVIRORO meets the regulations governing the award of the degree of Masters of Science (M.Sc) in Construction Management of Ahmadu Bello University, and is approved for its contribution to knowledge and literary presentation.

Prof. I. Mbamali **(Chairman, Supervisory Committee)**	**Date**
Mal. M.S. Saleh **(Member, Supervisory Committee)**	**Date**
Prof. K. Bala **(Head of Department)**	**Date**
Prof. A.A Joshua **(Dean, Postgraduate School).**	**Date**

DEDICATION

This work is dedicated to my parents, late Prof. O.I Leleji and Dr. (Mrs.) E.U. Leleji.

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ABSTRACT

This study assessed the methods that the design team members use to manage the information that is based on the cost (client's budget) of the project, and also their efficacy. It also examined factors limiting members of the design team from adopting modern cost-based information management methods. In addition, it examined the attitudes of design team members towards Information and Communication Technology (ICT) and sought to discover how the design team members rated the local industry's ICT standards against ICT standards of foreign industries. Structured questionnaires captured data, which were analyzed using percentages. In addition, the mean value of the responses was also calculated based on the weighting attached to the responses provided by each category of design professionals studied. The findings of this research indicated that design team members (84.44%), store their information via a combination of hard and soft copy. Also, the design professionals (71.11%) are not hindered from adopting modern cost based information management practices, and they are proficient (approximate mean value of 3) in using computerized cost based information management tools. More facts obtained from this research showed that design professionals (approximate grand mean value of 3) believe that modern cost based information management tools are effective and efficient in managing information. They (approximate grand mean of 4), also rate the domestic industry's ICT standards as poor. The work concludes that the ICT standards in the domestic construction industry is low and needs to be brought to par with the standards possessed by industrialized nations. To achieve this, it is recommended that design professionals should be encouraged to fully automate their information management and shift away from "paper based" information management practices.

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CHAPTER ONE

INTRODUCTION

1.1 BACKGROUND

Information is data that has been transformed into a form that has meaning and is useful to human beings. Data on the other hand, are streams of raw facts that depict current events taking place in an organization or environment, before they have been organized and arranged in a form that is understandable and useful for people .An information system is a system that processes, stores and moves information within an organization (Bytheway, 2003). Information Management is the gathering of information from one or more sources, and then the distribution of this information to the audiences who have a stake or right to this information. The term “management” implies the organization and control over structure, processing and delivery of information.

ICT is an acronym for information communications technology, and refers to any product that has the purpose of storing, retrieving, manipulating, transmitting or receiving information electronically in a digital form. These products include personal computers and email (Anonymous, 2008). It is important to note that digital communication is the mainstay of ICT.

In business, ICT can be utilized in two ways:

1) Traditional computer-based technologies – that enable individuals perform tasks on computers at home or work; and
2) Digital communication technologies- that permit individuals and organizations to communicate and share information digitally. Taking this a step further, the specific areas that traditional computer technologies can be utilized are in the use of word processing packages, spreadsheets, databases, presentation software and auto-computer aided design (auto-CAD).

According to Doherty (1997) the construction industry utilizes computers in the following ways:

i. As communication systems
ii. As technical decision support systems

Communication can be achieved via connecting a desktop or laptop computer into the digital communication network, and exchanging short textual messages. For technical decision support systems, computer application software forms the basis of computer use. These applications carry out various tasks (e.g. computing estimating) that aid in arriving at various diverse decisions.

Goh (2005), observed that the construction industry is experiencing a shift from "traditional" paper based methods of storing and managing information, to a more modern approach that entails digital information management. While this change is yet to be totally embraced, construction design teams have begun to utilize software that can be applied to all three professions (Engineering, Quantity Surveying, and Architecture). These software are applied in the areas of word processing, computer aided design (CAD) and spreadsheets. They aid administration, marketing, communication, presentation and project management. (Doherty, 1997; Arif and Karam, 2001). The CAD software is used by engineers and architects for design, drawing and presentation, while quantity surveyors use it for measurement, estimation and preparing bills of quantities.(Rivard ,2000; Arif and Karam,2001, De Lapp *et al*; 2004, Oladapo, 2006). The availability of 3D modeling capacity in modern structural design software makes it easier to design complex structures. (Walker and Hampson, 2003). For quantity surveyors, the QsCAD, Masterbill,WinQs32 software(among others), speed up and enhance the accuracy of quantity surveying functions beginning from approximate estimating to final accounts.(Willis *et al*; 1994; Adetola, 1998, Murray *et al*; 2001, Oladapo, 2006). The impact of information management tools on construction design teams is also seen in the way computers have revolutionized the process by which documents are generated, hence leading to a new way in which information and documents are exchanged. Other areas of utilization include adopting the internet as a vehicle to communicate among team members, use of the telephone, email, websites (that contain information relevant to the project at hand, where design team members can post requests for information, where architect/engineer instructions can be posted, and where general progress of the project can be ascertained at a glance. (Rivard, 2000).

The construction industry is composed of individuals and organizations that interdependently work together, and require close co–ordination to achieve project success and client satisfaction (Toole, 2003). This composition requires that the construction process places a heavy demand for exchange of data and information between the project participants (Maqsood *et al*; 2004). This fact now results in a demand for efficient information management, which is the exchange of massive volumes of information at high speed and relatively low cost (Deng *et al*; 2001). Information management encompasses people, processes, technology and content (Robertson, 2004).

Design is a process in which building projects confront an extraordinary wide range of complex issues. These issues include decisions about layout, form, appearance, materials and methods of construction (Cooper, *et al;* 2005).In addition; design is also a process whose end product yields a solution that does not map neatly unto the problem. The relationships between the solutions and the problems are usually not predictable in a case of good design (Lawson, 1997).

Design is very important to the success of construction projects, as 50% of the problems encountered during the construction phase are related to deficient management of information during the design phase. Furthermore, the primary source of rework in construction projects is attributed to the documentation on which construction activities are based (Love and Toole; 1999). It has been reported that rework increases construction costs by adding about 10 – 15% to the expected contract value, and about 7% to the expected project duration (Construction Industry Development Agency, 1995; Josephson and Melberg; 2002).

For construction projects however, the design costs constitute a small fraction of the construction costs. However, the efficiency of the design process remarkably affects the successful execution of the post-design phases of construction projects (McGeorge, 1988). The decisions taken during the planning and design stage are of greater significance to the project's overall cost, than those made during the construction phase. Changes made to the design during the construction phase results in time and cost overruns.

Buildings comprise four major systems: structure, envelope, services and interior; the human needs in relation to a building are physiological, psychological, sociological and economical; and the performance mandates that must be met concern functional/spatial, thermal, air, acoustic, visual and integrity. Hence the design of a structure needs to take the preceding factors into account.

While each building requires the above named systems to be fully functional, and has to meet the human/client's needs and performance mandates, the level at which they are met can vary. This refers to the availability of different solutions to solve client problems. Cost-based design information is used by the design team to provide solutions that satisfy the clients' requirements, with regards to the cost/budget they wish to expend on the project. This can include the quality of finishes, materials used for constructing various elements of the building, and even the size and shape of the building.

1.2 STATEMENT OF THE PROBLEM

While it is desirable to efficiently manage the design phase, hindrances to this objective arise in the form of inaccurate, incomplete or untimely information. In addition, building design is normally done by teams, comprising of individuals from different firms that are geographically dispersed. This fact presented a problem in setting up face-to-face meetings to achieve design collaboration (Sanvido and Norton, 1994). To cope with this, more modern methods of information management were adopted to take the place of face–to–face meetings. These included the use of the telephone and e-mail. However, other means such as videoconferencing by which information can be managed currently enjoy low patronage (Egbu and Botherill, 2002).

The concept of ICT is developing rapidly in the world. However, the construction industry has been slow in adopting its numerous benefits. This can be attributed to a lack of ICT expertise (Egbu and Botherill, 2002). Oladapo (2006), states that a hindrance to the adoption of ICT (and hence implementing modern information management) by Nigerian professionals is the inefficient power supply, and high costs of computer software.

An important part of the design stage is the design briefing phase which is the most important step in the design process. This is where client requirements for the project are defined, and major commitment of resources is made. However, this process is very difficult due to the complexities in identifying and conveying clients' actual needs and requirements to the design team, and the immense magnitude of information that needs to be considered (Shen *et al*; 2004).This problem can be reduced by adopting modern methods of information management that can adequately handle the large volume of information generated at this stage.

On receiving the client's brief, the members of the design team are responsible for producing design information and disseminating it among the various project participants. Most of the information disseminated by the design team is based on traditional means of communication such as face – to – face meetings and the exchange of paper documents in the form of technical drawings, specifications and site instructions.

While the traditional methods of communication may seem adequate, they pose a grave danger to the objective of achieving project success and client satisfaction, due to the fact that they are the sole reason why the industry has suffered from difficult- to- access, out – of – date and incomplete information (Shoesmith,1995).

1.3 NEED FOR THE STUDY

Kini (2000) observed that in the 21st century, construction companies will have to make changes in their information systems to be successful. For a construction firm to possess a competitive advantage, it must possess advanced technology. The factors that form a basis for international competition in construction have moved from managerial to technological issues (Mitropolous and Tatum, 2000).

A recurrent theme in most construction projects is the presence of several professionals working together in short time frame to develop a facility. These professionals can include architects, builders/structural engineers and quantity surveyors. This mix of professionals requires that communication is established amongst themselves, often with one group relying on the information produced by another group of professionals in the same team, to execute their work. As stated earlier, various members of the design team can be geographically dispersed, as is inevitable in the face of advancing globalization, which can lead to project members residing on different continents (Madigan, 1993). A global construction environment requires that the project (design) team have efficient and effective communication infrastructure that will yield successful collaboration among themselves. Effective communication systems that possess the ability to collapse distance constraints are therefore necessary.

According to Doherty, (1997) as computer application software daily become smarter and more powerful, many traditional methods aimed at providing decision support are rapidly becoming un-competitive. While it is possible to carry out many tasks without utilizing computer applications, the stage has been reached where the non-utilization of these tools in a particular project, constitutes a hindrance to the project. Rapid response team work is restricted, and it would be an unwise decision to ignore the computer applications that aid in work. However, while using computer tools does not remove the professional skill of the operator, their full potential (i.e. the tool) can only be realized by additional skill acquired by experience in using them.

Implementing information technology in the construction industry can lead to increased productivity. It significantly lowers the time required for data processing and communicating information, and also facilitates the designing of complex structures which in the past was almost impossible (Walker and Hampson, 2003).

According to Rivard *et al;* (2004), information plays the following vital roles in all construction projects:

i. The specification of the resultant product, or design information.
ii. The initiation and control of all facilities necessary for constructing the facility, management information.

Oladapo, (2006) opined that the design consultants (Engineers, quantity surveyors and architects), in their capacity as professional advisers to the client are largely responsible for the production and dissemination of both design and management information among various project participants.

The uncertain nature of construction projects demands that capable consultants are hired to realize the client's interests in a project (Ng and Chow, 2004). According to Oladapo, (2006), a common competency required by design consultants is the ability to manage and communicate project documents and information. He further stated that a main factor that influenced increased productivity in the construction industry is effective management of information. The information could be in the form of information exchange between project participants, and information accumulated, coded and then stored in databases belonging to firms (Mohammed and Stewart, 2003).

Interestingly, quantity surveyors are required to possess basic competency in data, information and information technology (RICS, 1998). For engineers, the availability of computer facilities serves as a pointer to their level of technical capability (Ng and Chow, 2004). While regarding architects, their performance is graded according to how effectively they communicate design information to contractors. (Oyedele and Tham, 2005). Consultants and project participants by necessity integrate their information systems together in order to improve information flow and aid effective decision making.(Li *et al*; 2000). By utilizing available ICT facilities, integration can be achieved in the construction industry (Mohammed and Stewart, 2003).

While reports abound of ICT being utilized in construction industries of industrialized countries (Toole, 2003), they might not be applicable to a developing country. (Austin, 1990). This can be attributed to differences in culture, socio-economic conditions and regulatory environments (Seyal *et al*; 2000).

1.4 AIM AND OBJECTIVES

1.4.1 Aim

The aim of this study is to appraise the methods of cost-based information management currently being utilized by construction design teams in Nigeria, benchmarking them with international best practices.

1.4.2 Objectives

i. To articulate the methods of cost based information management which are utilized by construction design teams in Nigeria.
ii. To determine the challenges to the adoption of modern cost based information management practices by construction design teams.
iii. To assess the attitude of construction design teams towards information technology.
iv. To assess the adequacy of the current cost based information management practices of the Nigerian construction industry for sustained growth and international competition.

1.5 METHODOLOGY

This research employed a two pronged approach to achieve its aim and objectives. First of all, a literature review was carried out, which provides insight into the available methods of information management that can be adopted by design teams. It also served as a basis to establish comparisons between the various methods of information management that can be utilized by construction design teams.

The second approach involved the production and distribution of structured questionnaires to randomly selected members of construction design teams. The questionnaires were handed to 90 respondents, with an equal representation among architects, builders/structural engineers and quantity surveyors. The population size of 30 was adjudged to be sufficient because of the central limit theorem which according to Dawdy and Wearden (1985), states that "with very few exceptions, no matter what form the underlying populations distribution takes, as 'n' increases, the sampling distribution of averages approaches a normal distribution, thus the normal distribution can be used to approximate probabilities in cases of reasonably large samples(n $\geq$30) from non-normal distributions".

The areas investigated were:

i. The information management methods practiced by the design team.
ii. The efficacy of the information management methods practiced by the design team.
iii. The attitude of design team members towards IT.
iv. Hindrances to adopting modern methods of information management by the design team.

The questionnaire data were analyzed by employing suitable statistical methods of analysis which included getting percentage responses, and collating approximate means based on weightings attached to responses. This was to aid in arriving at valid conclusions and make reasonable interpretations about the collected data.

1.6 SCOPE AND LIMITATION

This work focused on the technology being employed in information management. It studied the design teams engaged in building works only, and not engineering projects. In addition, it was concerned with the pre-construction phase of the project, focusing on cost-based information only.

The respondents for this research were located in three areas: The F.C.T, Kaduna and Lagos. The reason for this was because of the large amount of construction activities taking place in these areas.

A limitation on the work was the subjective nature of the issues in the questionnaires and the sincerity of the respondents.

CHAPTER TWO

LITERATURE REVIEW

2.1 CONSTRUCTION PROCESS

Murali (2004), stated that the construction process begins with discussions between the architect and client on user requirements, and the initiation of the site planning process. This phase includes studying soil conditions, existing structures and also preparing detailed site drawings. He furthermore stated that the second stage entails preparing scheme drawings and the introduction of a liaison that is tasked with preparing approval drawings and getting all plans approved. In addition, he stated that the third stage was the most important, and entailed the preparation of final architectural drawings. The reason he cited for naming this stage the most important was that major changes/deviations were not possible after this stage. This stage also entails producing structural drawings based on architectural drawings. The fourth stage, which is construction, begins after the preparation of site drawings, and site clearance. He stated that the other stages are all related to construction, and are distinguished by the addition of different elements to the structure (such as floors, walls and window openings). According to him, the final stage entailed mechanical and electrical services being provided for the structure, including painting and decoration. The construction process has also been said to comprise the following stages:

i. Pre-Design; which entails seeking design proposals.
ii. Design; which entails selecting a design team that develops construction documents. The design also progresses through many stages before a final solution is agreed on.
iii. Bidding/Negotiation; where the client accepts bids (prices) from contractors and sub-contractors, suppliers and manufacturers. This stage might occur concurrently with plans still being made in the design stage. This stage also includes opening of bids, considering them and selecting a contractor to execute the project.
iv. Construction; where work is either underway, or scheduled to begin. The star of work is referred to as the start of site work to accommodate the building foundation.
v. Operation; which commences with a notice of completion, signifying the project has been formally completed and is ready for utilization (Anonymous, 2009a).

2.1.1 The Design Stage

At the commencement of a building project, the architect will determine the scope of work (program). This programming phase (which includes site analysis) will define key parameters and objectives. If the project entails constructing a house, the program would contain information that includes derived amenities, room square footage requirements, number of rooms and the budget earmarked for the project. Larger building projects would require more complex programs that highlight the functions and number of room types, the building systems e.g. electrical and mechanical, exterior design features that could be playgrounds. For very complex projects, a project would be split into separate buildings linked by a master program document.

The site analysis stage entails the architect researching applicable building and planning codes that relate to the project location. The site analysis will aid in determining the size and layout parameters for the building. The next stage is where schematic and developed designs are drawn up. The schematic design is carried out by the architect first sketching or modeling several design schemes. These preliminary sketches/models are subsequently transformed into schematic floor plans, elevations and 3-D images of the building design. Depending on the program and the site analysis, the architect then transforms the information into floor plan and site plan drawings that fulfills all the client's design criteria. The end of each phase is signified by a presentation to the client which is followed by their approval of the architect's design work. The early design phase requires a lot of client feedback, and is characterized by several changes to the initial schematic design, before one design is finally approved. The developed design phase involves the schematic design being refined to form a workable building. This feat is achieved by the architect assembling a consultant (design) team to design elements relevant to their profession. The output of the consultants will be incorporated into the architectural design by the architect. The output of the consultants will be incorporated into the architectural design by the architect. The constant inflow of information from the other consultants creates the challenge of keeping the building true to its original design intent, within the estimated construction budget (Linda, 2009). This stage ends with the architect typically presenting CAD drawings of floor plans, elevations, sections and site plans. In addition, the client may request 3-D computer renderings of the design in order to get a preview of the appearance of the completed building (Linda, 2009).

The final stage of the design process is where final or working drawings are prepared. This comes about after the client has approved the design and look of the building. The architect then focuses on the design and documentation of the project details. This stage can also be referred to as the contract documentation stage. The interflow of elements essential to a successful project is worked through between the architect and the rest of the consultant team. This stage also yields a set of drawings and specifications that are completed for builders' pricing and building permitting (Linda, 2009).

The R.I.B.A outline plan of work (R.I.B.A., 2007), states that the design stage of building projects is split into three parts. The first part/phase is known as the "concept" phase, and it involves implementing the design brief, and preparing additional data. It also entails preparing the concept design and preliminary cost plan. Another activity that occurs here is the review of the procurement route. The institute also stated that the next phase in construction design is the "Design Development" phase. The activities carried out here include developing the concept design to accommodate structural and building service systems, updating the outline specifications and cost plan. In addition, this stage sees the completion of the project brief and it ends with an application for detailed planning permission. The final phase of the design stage is the technical design phase, and it involves preparing technical designs and specifications that would be sufficient to co-ordinate elements of the project, and also information for statutory standards and construction safety (R.I.B.A, 2007).

It would be prudent to mention the roles played by the different members of the design team. Murray, *et al;* (2001), stated that it is the architect's responsibility to initiate and or perform activity at the preliminary design stage. The quantity surveyor and engineer/builder requires information from this stage to enable them execute their own tasks. Furthermore, the quantity surveyor is responsible for carrying out feasibility studies, and supplies information to the client, architect and engineer. The detailed design and costing stage requires that the architect, quantity surveyor and builder play active roles and supply information to the client (Murray, *et al;* 2001).

2.2 INFORMATION (DEFINITIONS & TYPES)

According to Bytheway (2003), information is data that has been transformed into a form meaningful and useful to human beings. Information can also be said to mean raw data that has been processed to become accurate and timely, specific and organized for a purpose, presented in such a way so as to deliver meaning and relevance which in turn leads to increased understanding and decreased uncertainty. Information possesses value only if it has the ability to affect behavior, decisions or outcome (Anonymous, 2009b).Information also means knowledge derived from study, instruction or experience; knowledge of specific events that has been gathered/received via communications, intelligence or news; a collection of data or facts; or data that has been processed, stored or transmitted (Anonymous, 2009c).

Construction projects generate enormous and complex sets of information. The effective management of these large amounts of information so as to insure its availability and accuracy is a crucial management task. Project design and control crucially depend upon accurate and timely information. However, this information must be utilized effectively, and properly organized (Hendrickson and Au, 2000). Evolving projects experience a change in the types and extent of information required. Nevertheless, these projects almost always require the following information:

i. Cash flow and procurement accounts.
ii. Intermediate analysis results during planning and design
iii. Design documents, including drawings and specifications.
iv. Construction schedules and cost estimates.
v. Quality control and assurance records
vi. Chronological files of project correspondence and memorandum.
vii. Construction field activity and construction logs.
viii. Legal contracts and regulatory documents.

Some of these information sets are important at only a particular stage. An example is the information for structural analysis, which is important during the design stage, but may be subsequently ignored. While this shift in importance is true, the information may be necessary at later stages in the project to perform re-analysis when considering desired changes. In view of this, archival information storage and retrieval becomes important (Hendrickson and Au, 2000).

2.3 COST, COST BASED INFORMATION AND COST PLANS

Cost can be said to mean the total money, time and resources associated with a purchase or an activity (Anonymous, 2009d). Cost can also mean an amount paid or requiring in payment for a purchase, or the expenditure of something, such as time or labour, that is necessary for the attainment of a goal (Anonymous, 2009e).For consumers, cost describes the price paid for goods and services. Producers look at cost from the angle of the relationship between the value of production inputs and the level of output. The term "total cost" refers to all the expenses incurred in reaching a particular output. Construction costs are those incurred by a contractor for labor, materials, equipment, financing, services, utilities, overheads and profits (Anonymous, 2009f). Construction costs are also the costs of all construction portions of the project, and they are generally based on the contract sum (Anonymous, 2009g).

The most popular method of carrying out cost estimates is by adopting a bill of quantities. This is a bidding document that is usually prepared by the quantity surveyor, and which contains an itemized list of materials, parts and labour (with their costs) that are required to construct, maintain or repair a specific structure (Anonymous, 2009h). It should be noted that including the costs of materials in the bill of quantities is to aid at arriving at the total construction cost so as to make the client aware of his financial responsibilities. If the estimate shows that project is outside the budget/financial capacity of the client, alternate design solutions are then considered, so as to select the design solution that falls within the client's budget.

According to the list of the most common types of information maintained during a construction project (stated earlier), the major item that would influence the cost of the project is the information found in the design documents, which form the basis of the construction schedules and cost estimate. A construction project is born after the client discusses with the architect (briefing). This will give the architect an idea of the budget for the project.

As several design solutions are proposed, their estimates will play a major role in determining if they are accepted or not. Several evolutions of design estimates take place before the bill of quantities is produced which is intended to give a final estimate that is as accurate as possible. These estimates reflect the progress of the design. At the commencement of the design stage, the estimate used is the "screening" or "order of magnitude" estimate. This estimate is usually made before the facility is designed and therefore relies on cost data of past projects.

The next estimate is the "preliminary" or "conceptual" estimate that is based on the conceptual design of the facility. The distinguishing factor here is that the basic technologies for the design is known. The "detailed" estimate is made when the scope of work is clearly known and the detailed design is in progress. This estimate has the benefit of being able to identify the essential features of the building. The next estimate to be prepared after the detailed estimate is based on the completed plans and specifications. This is the estimate obtained from the bill of quantities (Hendrickson and Au, 2000).The bill of quantities usually groups a project into its different elements and each element is priced, and then totaled so as to arrive at an estimated total cost for the project.

It goes without saying that the design solution that is developed is the one that falls within the client's budget (in most cases). The other members of the design team perform their duties based on the design produced by the architect. In this work, "cost-based design information" refers to the information contained in the design that takes the cost (client's budget) into account. A useful procedure to be adopted in order to stay within the client's budget involves producing the schematics and then pricing the proposed plans. This estimate should give the client useful insight into his financial commitments. The major method that is employed to keep costs within the budget is the use of the cost plan.

A cost plan is a detailed estimate that describes the anticipated building in sufficient detail that can then be referred to during the design process to refresh memories concerning the usage of materials and design standards, and also provide a means of understanding the cost impact of design changes as the design progresses (Squire, 2008). The cost plan is the baseline that regulates design development and it serves as a tool that enables projects to be delivered within budget.

The cost plan is essential to ensure that the project is delivered on time, within budget and to the expected quality. A cost plan determines the fiscal feasibility of a construction project. When the project owner sets a maximum cost, a cost plan will help determine if the project can be executed within the cost limit. If that is not possible, the project would then have to be reworked to reduce costs (Johnson, 2009). When each proposal is developed, cost checks are made against the cost plan. Each element in the design is checked against the cost plan to determine that the budget is not overrun. In the case of design exceeding budget, alternative design solutions are developed and then cost checked to determine if they fall within the budget. In the use of the cost plan, the acceptance of a design of various elements is based on the cost plan (designs are rejected if their cost exceeds the cost plan, Smith and Jagger, 2007).Therefore designing a structure in accordance with a cost plan can be termed "cost based design". According to Smith and Jagger (2007), the following elements affects cost of projects, and information related to them are found in documents created by the design team :

i. Substructure
ii. Superstructure
iii. Finishes

iv. Fittings and Furnishings
v. Services
vi. External Work
vii. Preliminaries
viii. Contingencies

The information that is utilized in designing the above elements, when regulated by a cost plan, can be termed “cost based information”.

When costs need to be reined in, the areas that are adjusted mainly depend on the client. Some clients consider the finishing important to them while others might deem the services to be important to them. Certain core costs do not change, e.g. electrical services. Adjusting square footage and revisiting product areas are the avenues by which to trim costs. Some information incorporated into the design that can yield lower costs are:

i. The use of materials that are typical and easy to supply. The avoidance of unnecessary or expensive features. An example of this is reducing the size and number of windows.
ii. Designing a building with a square or rectangular shape. These shapes or structures cost less to build because extra work and equipment does not have to be put in for curved walls, etc. Materials can be utilized more effectively with fewer angles and corners.

iii. Choosing a relatively standard size for the building. A building's size affects the cost. In addition, the proposed construction site affects the cost. A leveled site is best for construction so as to avoid the costs of filling or excessive site clearance (Anonymous, 2007i).

A cost plan also serves to structure financing for a project. The owner of the project will be informed of the time periods that finance installments would be needed. In addition, the cost plan will aid the client make informed decisions on the quality and cost of products that would maintain the budget, during the pre-construction phase (Anonymous, 2009j). A cost plan involves two features. First, there is an overall budget for the project that is based on the current project scope and design. The second feature is the allocation of costs over time, obtained by predicting when costs will be incurred and paid along the project schedule. Cost planning should be performed three times in the design stage. Once at the project's inception, once after the preliminary design and once after the final design (Johnson, 2009)

2.4 INFORMATION SYSTEMS

Turban, *et al*; (1999), stated that an information system collects, processes, stores, analyses and disseminates information for a specific purpose. An information system provides input (data and instructions), and output (reports and calculations).It processes the input and produces output that is sent to the user or to other systems. Furthermore an information system is also “Any written, electronic, or graphical method of communicating information. The basis of an information system is the sharing and processing of information and ideas. Computers and telecommunication technologies have become essential information system components” (Anonymous, 2009k).

2.4.1 Computer Based Information Systems

The addition of the term ‘computer’ to ‘information system’ means that the information system utilizes computer technology to perform most (if not all) of its intended tasks. The system can include a single personal computer and software, or might comprise several thousand computers (Turban, *et al;* 1999).

2.4.2 Formal and Informal Information Systems

A formal information system consists of agreed-upon procedures, standard input and output and fixed definitions. An informal information system can range from an office gossip network to a circle of friends corresponding via email (Turban, *et al*; 1999).

2.4.3 Differentiating between Computers and Information Systems

The main role of computers is to provide effective and efficient methods of processing data. They also form a key component of an information system. An information system goes beyond computers. To successfully utilize an information system, there must be an understanding of the business and the environment that is supported by the information system (Turban, *et al*; 1999). According to Kelly (2008), information systems require various components to function effectively. These components are: people, equipment (hardware and software), procedures and data. Turban, *et al;* (1999), stated that the components of an information system are:

i. **Hardware:** A set of devices that accepts data and information, processes and then displays them
ii. **Software:** A set of programs that enable the hardware process data
iii. **A database:** A collection of related files that store data
iv. **A network:** A connecting system that permits the sharing of resources by different computers
v. **Procedures:** The set of instructions that lay out how to combine the above listed components so as to process the information and generate the required output

vi. **People:** The individuals who work with the system or use its output

2.4.4 Types of Formal Information Systems

Information systems differ in their business needs. According to Kelly (2008), the major types of information systems are:

i. **Transaction Processing Systems:** These systems collect and store information about transactions. They also control some aspects of transactions. Transactions are events of interest to the organization.

ii. **Decision Support Systems:** These systems help strategic management staff arrive at decisions by providing information, models or analysis tools. They are used for analytical work and aid managers make simulations and decisions.

iii. **Management Information Systems:** They condense and convert data from transaction processing systems into information for performance monitoring and managing an organization. Transactions that are captured in a transaction processing system are analyzed and reported by a management information system (Kelly, 2008).

Robertson (2004) stated that the following types of information systems also exist:

i. Content Management Systems (CMS): The purpose of these systems is to enable the creation, management, distribution, publishing and discovery of corporate information. It is also referred to as web content management. They focus on online content targeted at corporate websites or intranets.

ii. Enterprise Content Management System (ECMS): The purpose of this system is a web content management system, which has additional capabilities that aid in managing a broader range of organizational information. This system consists of document management, records management and digital asset management.

iii. Document Management System (DMS): These systems assist organizations manage the creation and flow of documents via a provided centralized repository, and subjecting the workflow to take consideration of business and metadata. The focus of this system is primarily on the storage and retrieval of self-contained electronic resources, in their original format.

iv. Records Management System (RMS): Also known as “record keeping” systems, their purpose is to capture, maintain and provide access to records over time. These records can either be paper or electronic documents.

v. Digital Asset Management (DAM) System: The purpose of this system is to support storage, retrieval and reuse of digital objects in an organization. The difference between this system and the document and content management systems is that its focus is on multimedia resources that include images, video and audio.

vi. Brand Management System (BMS): These are specific applications based on the DAM category of products, and are utilized for the management of advertising and promotional materials.

vii. Library Management System (LMS): These systems aid in providing a solution for administering all of a library's technical functions, and the rendering of its services to the public. Functions include tracking library assets, managing lending and also aiding in daily activities.

viii. Digital Imaging System (DIS): The purpose of this system is to automate the creation of electronic versions of paper documents, and they provide input to records management systems. This system is the key for eliminating physical filing of information.

ix. Learning Management System (LMS): This system automates the administration of training and other learning. Its functions include registering students, managing training resources, recording results and course administration. These systems meet the needs of professional trainers and other educators.

x. Learning Content Management System (LCMS): This system is the result of combining the capabilities of a content management system and a learning management system. It therefore permits managing the content of training materials, and the administration of the course itself.

xi. Geographic Information System (GIS): These systems are computer based, and specially built for capture storage, retrieval, analysis and display of spatial (location-referenced) data.

Turban, *et al;* (1999), stated information systems can be classified in several ways, which can be:

i. By organization levels: Organizations are made up of components such as departments, teams and work units. In light of this, information systems can be built for headquarters, divisions, departments, operation units and even for individual employees. The main types of information systems that adopt the organization structure are: A) Department Information Systems that utilize application programs in a particular department. B) Enterprise Information Systems: This classification of information systems refers to the collection of all departmental applications. C) Inter Organizational Systems: Judging by its name, this information system connects several organizations. They are primarily used among business partners, and are the foundation for e-commerce.

ii. By functional areas: The major functional information systems are; A) The accounting information system. B) The finance information system. C) The manufacturing (operations/productions) information system. D) The marketing information system E) The human resources management information system. In each functional area, there exist routine and repetitive tasks that are essential for organizations operations.

iii. By support provided: An information system can support an employee in almost any functional area. The major types of information systems according to functions are: A) Transaction Processing Systems: Provide support for repetitive mission critical activities. B) Management Information Systems: Supports functional activities and managers. C) Decision Support Systems: Supports decision making by managers and analysts. E) Group Support Systems: Supports people walking in groups.

2.4.5 Cost Based Information Systems

In this work, cost based information systems are the information systems that store cost based information. While information systems process information in the same way (according to their classification), the information they process provides an insight into what they are called. E.g. the Microsoft Office Word software can be used to type records in a hospital. In this case, it can be classified as a “health information” management system. When the same software is used in an insurance firm to store insurance records, it can be classified as an “insurance information” management system. Likewise, when utilized in the construction industry to manage “cost based information”, it can then be referred to as a “cost based information” management system.

2.5 INFORMATION MANAGEMENT & ITS EFFICACY

“This is the means by which an organization maximizes the efficiency by which it plans, collects, organizes, uses, controls, stores, disseminates and disposes of its information ,and through which it ensures that the value of that information is identified and exploited to the maximum extent…” (Anonymous, 2009l).Yet another definition is “a method to use technology for collecting, processing and condensing information with a goal of efficient management” (Anonymous, 2009m). Information management is also the “application of management techniques to, collect information, communicate it within and outside the organization, and process it to enable managers to make quicker and better decisions” (Anonymous, 2009n).

Reliable data is very important to executing daily business activities. However, data stores are maintained independently of each other with no control access point. This now leads to a higher probability of data (and the subsequent information) being inconsistent or erroneous. Information stored this way is usually out of date because its management requires several iterations and processes that are usually error prone In construction projects, different members of the design team usually possess their "own" copies of specific information relating to the project. While this might be seen to be helpful, danger can arise when a particular detail changes, and this change is not synchronized with every existing copy belonging to all design team members.

Improved information management is necessary for businesses to be more efficient and deliver new services. The first thought that springs to mind when information management is mentioned is that new technology has to be embraced. This is not so because information management encompasses people, processes, technology and content (Robertson, 2005). Construction design teams consist of different people from different professions, each of which generates information that is integrated together for the success of the project. The various team members have to be managed to ensure that the information that each produces is in harmony, and contributes to the project objective.

Information management is effective when the following principles are followed:

i. Recognize and manage complexity: Organizations are complex environments in which to deliver concrete solutions (Robertson, 2005). The problem of generating design solutions is very complex. To overcome this complexity, organizations (design teams) , react in many ways which include focusing on deploying just one technology in isolation, purchasing a suite of applications fro a single vendor, hoping this will solve all information management problems and even rolling out rigid standardized solutions across the whole organization (design team) even though individual components (team members) possess different needs. Realistically, these approaches are inadequate because they attempt to convert complex needs into simple solutions. To be effective, new approaches to information management must be found that are able to recognize and manage complexity. In addition, successful information management is based on strong leadership which defines a clear direction, and plans multiple activities that address in parallel the many needs and issues (Robertson, 2005). The onus is now on the architect (design team leader) to actively root out diverse technology that would suit the function that each team member carries out. The team leader should also be wary of the fact that the success of a particular brand of technology in a past project, does not guarantee success in the present project. Technology and project requirements change over time (Robertson, 2005).

ii. Focus on adoption: An effective information management system is one which is actually “used” by staff (design team members). It is not effective if it only installed centrally. Most information management systems need the active participation of the individuals it was designed for. If a system is not utilized, the required information will not be captured in the system. This will now lead to uselessness of the information repository (Robertson, 2005).

iii. Deliver tangible benefits: Even though there is an improvement of “behind the scenes” management of information, there will be a problem in general adoption by the design team if no tangible benefits can be recognized. For tangible benefits to be measured, the concrete needs of the project that must be met must be identified. The successful resolving of these needs should now allow meaningful measurement of the information management system on the project (Robertson, 2005). If the objective of the project is to save time, an information management system that greatly reduces the project duration should be adopted.

iv. The presence of strong leadership: Successful information management is based on organizational and cultural change. Seeing the nature of these factors, they can only be implemented by the presence of strong leadership. The starting point in the leader’s task is to state a clear vision of the desired outcome of the information management strategy. This will serve to state how the design team will operate, rather than just describing how the information systems will work. The leader then has to put in effort to generate a sufficient sense of urgency to affect the deployment and adoption of new systems and processes. It should be noted that effective information management requires strong leadership. The adoption of new technology alone, will result in little impact, seeing there is an absence of coordination (Robertson, 2005). The onus here is on the team leader (architect) to be technology savvy, and have a clear picture of the result(s) the information system is to yield.

v. Extensive communication: Extensive communication from the design team is crucial for successful information management. The purpose of communication is to ensure that all project participants possess a clear understanding of the information and its benefits to them. The knowledge of potential benefits is a pre-requisite to achieve the desired level of adoption. With many activities happening at the same time, being carried out by different members of the design team, coordination becomes paramount. The members of the design team should devote time to work closely with each other, so as to ensure that activities and outcomes are aligned. While this might be very difficult to implement in a complex environment, design teams could consider establishing a "project-site" on the intranet on the outset, to provide a location for planning documents, news releases, and other updates (Robertson, 2005).

vi. Deliver a seamless user experience: Most users don't understand systems. When confronted with six different information systems, each containing a fraction of what they desire, they generally rely on a piece of paper or ask a colleague. To combat this, a user experience that hides the complexity of the different information systems being accessed from the end-user should be developed. This can be achieved by delivering a portal that gives access to all information and tools ensuring that all applications have a consistent look and feel, and providing a "single sign-on" to all applications (Robertson, 2005).

Implementing ICT solutions in a complex and ever-changing environment is not an easy task. The challenges inherent in information management projects mean that new approaches need to be taken if they are to succeed. The key is to ensure that the information management strategy will meet the needs of the members of the design team. When this is done, focus should then be placed on ensuring that the design team actually uses the deployed solutions (information systems).

2.6 NEED FOR INFORMATION MANAGEMENT IN THE NIGERIAN CONSTRUCTION INDUSTRY

According to Lofgren (2006), present day construction projects depend on reliable and updated information. In order to solve problems that arise on-site, and tackle critical construction issues, there is a need for quick access to necessary information. Most importantly, the design of construction projects requires rapid access to information and communication in real time (Wikforss and Lofgren, 2007). It has been stated that changes in design result in time and cost overruns. However by adopting the use of information management tools in the design process, it would be possible to evaluate design, and assess the impact of design decisions on project activities early in the design process (Halfawy and Froese, 2005). However, improving information and communication support for core activities occurring at construction sites, has become a strategic challenge for the construction industry, which aims to increase efficiency and productivity in the construction process (Samuelson, 2003).

Castle (2002) stated that the rapid growth of ICT has made a very great impact on business systems and processes. The worldwide acceptance and widespread integration of ICT has served as a catalyst to increase the dimensions of competition both among organizations globally, and professions locally. The ability of professionals in the construction industry to avail themselves of emerging opportunities resulting from the explosion of ICT will depend on the adoption new technologies. Still going along this line of thought, Marsh *et al*; (2000) opined that the application of ICT into practice will increase competitiveness and reduce costs. Also it can be seen as a means to increase competitive advantage (Ives *et al;* 1991, Earle 1993). His view is supported by Gunasekaran *et al;* (2001) who said that implementing ICT into a project will improve operational efficiency, improve quality, reduce project time and increase profit levels.

The computer is going to be a reliable tool in all spheres of human endeavor. Oyediran and Edusami, 2005, and Shash and Al-mir (1997), have stated that the computer/computing are relevant to the construction industry. A profound statement was issued by Li (1996) and Pollack-Johnson and Liberatore (1998), saying that the professions that have advanced in their practice are those that took advantage of the technological tools available. According to Betts *et al*; 1991, the construction industry needs to effectively embrace ICT in order to promote effectiveness and responsiveness to customers, clients and team members.

Duyshart *et al;* (2003), stated that construction organizations that are ICT mature and sophisticated in recognizing its benefits have better prospects for survival and prosperity in the latest information revolution than those that do not.

Due to the combination of increasingly complex building types, an increase in the number of outsourced project participants and global competition in the construction marketplace, there is a serious challenge in the area of project delivery within budget and planned timeframe. The absence of an effective use of ICT to facilitate information management among project teams will make it unlikely that major improvements to the delivery process will occur due to the continuous use of traditional processes to manage information (Duyshart, 1997).

2.6.1 Impact of Cost Based Information Management Tools on the Construction Industry

According to Masqood *et al;* (2004), the construction process demands a heavy exchange of data and information between project participants daily. The use of ICT in construction results in changes to organization processes, working methods, and culture (Ruiker *et al;* 2005). ICT tools help reduce data processing and communication time, and improve communication to aid effective decision making and coordination among project participants (Peasupap and Walker, 2005). They also enhance construction productivity (Liston *et al;* 2000).The enhanced productivity comes about because of the ability of internet based ICT tools to enable communication between local and remote users, facilitate exchange of files, commenting on changes and posting requests for information (De Lapp *et al;* 2004). According to Oladapo, (2006), the three areas that ICT provides the most impact to professional practices involved in the construction industry are: making jobs easier, facilitating decision making and saving operating costs. Rivard (2000) also stated that the use of computers has brought about a radical change in how documents and information are exchanged between people.

Andresen *et al*; (2002) stated that ICT provided benefits in efficiency, effectiveness and performance which have impacted several components in the construction industry. Regarding the component of business planning in the construction process, efficiency wise; ICT provides reduced planning times. For effectiveness, ICT provides increased sales, minimized business risks, strategic competitive advantage and maintaining competitive capacity. In regards to performance ICT provides the capacity for business growth, safeguards future flexibility, overcomes obsolences and increases the responsiveness of senior management to business problems. The component of marketing has the efficiency benefits of reduced marketing costs and the ability to handle a larger a larger volume of enquiries. Benefits in the area of efficacy in regards to marketing are improved company image, generation of new businesses and an increase in the market share.

Focusing on performance benefits, the impact of ICT are an improved strategic intelligence for new markets and improved public relations targeting and delivery. The component of information management has the following efficiency benefits: a reduction in communication costs and reductions in paperwork. The area of effectiveness yields the following benefits: an ease to establish international links, less information bottlenecks and a sustained market share. Performance benefits for this component include an ease of capturing meaningful information, more reliable and relevant data, and an improvement in filtering information.

The component of procurement, efficiency wise, enjoys reduced transaction times and costs, and an improvement in delivery schedules. Regarding effectiveness, the procurement component enjoys the benefits of maintained competitive capacity and a faster response to supplier quotations. From a performance view, it enjoys an improved external access to stock levels and price information and an increased effectiveness in identifying and assessing new suppliers. The finance component of the construction industry benefits from faster invoicing and reduced transaction costs in the area of efficiency .For effectiveness there is a minimizing of business risks and better cash flow control. For performance, there is an improvement in transaction methods, forecasting and control, and a greater integration with other functions. The component of client management enjoys a quicker response to client enquiries and also the ability to give a quicker response regarding current project progress, in the area of efficiency. For effectiveness, there is a faster service delivery and an improved focus on client requirements. The area of performance benefits from an improved information interchange with the clients, and a strategic competitive advantage.

The design component has efficiency benefits of reduced design lead times, reduced rework and an increase in information exchange. Effectiveness benefits are improved output quality, a reduction in technology risks and an increased speed of new design development. Performance benefits are an improved sharing of ideas among project teams and an improved integration. The construction component has reduced construction times and reduced waste as efficiency advantages, improved output quality and the ability to exchange data as effectiveness benefits. Its performance benefits are improved integration and improved project relationships with strategic partners. Operation and maintenance as a component has efficiency benefits of reduced operating costs and quicker access to operation and maintenance data. Its effectiveness benefits are improved quality of output on the ability to refer back to data. For performance benefits, there are the improved capture of design and construction decisions and improved life-cycle information management.

The final component of human resources has the efficiency benefits of reduced staff and training requirements, the effectiveness benefits of an improved record of staff skills and an improved ability to select the appropriate team members, and the performance benefits of a more effective assembly of project teams, improved human relations, regularizing working arrangements and more effective assembling of project teams.

2.6.2 Impact of Cost Based Information Management Tools on Construction Design Teams

Teamwork, as seen in the interaction between members of the design team is based on shared understanding. Maximum results are seen if the team members possess similar backgrounds and similar experience bases. However, this is not always the case for each project. Collaboration grows more important as a result of increased globalization trends and increasingly complex technology and products. This challenge is too much for a single individual, and can be adequately tackled via collaboration. By adopting cost based information management tools, processes can be accelerated, and traditional stages overlap. At a very early stage of the design process, individuals who traditionally carry out their tasks later on in the project can make now make substantive contributions that aids in reducing uncertainty.

The ‘wheel of dominance’ (Gray and Hughes, 2001), which showed the participants that dominated different stages of the design process could change. Cost based information management tools impacts on the definitions of work processes, roles and responsibility. However, the overlap between earlier and later planning stages can lead to the provision of constraints that increase the complexity of problem solving (Moum, 2005).

Network technologies that include email and the internet have resulted in radical changes in working methods among the project participants, due to the fact that they support the exchange of information that defies geographical and organizational borders. This information exchange is fast and easy, and has served to accelerate the design process even more than the CAD tools (Schwagerl, 2004). Nevertheless, the challenges that have arisen from collaborative design and communication are mainly due to the nature of the network technologies. These technologies are yet to offer the same social presence, depth of information or the ability to transfer tacit knowledge that is available via face-to-face collaboration or conversation (Duarte and Snyder, 2001).

The development of database technologies has tremendously supported the handling of huge amounts of documents within a building project. A pool of documents can be made accessible to different project participants at any time. The flipside to this is that this information has to be actively pursued, presenting a divergence from the traditional trend of passively "getting-the-plan-with-mail" which has resulted in a pull rather than a push of information (Berg Von Linde, 2003).

The modern technologies support the distribution speed of information that is a necessity for smooth project completion. The adverse effect of this is that much of the information can be considered (in some situations) a hindrance rather than help. This can lead to information overload which has led to more attention now being paid to the receiver of the information, so as to enable distribution of "only" information that is necessary and required for a particular task (Davenport and Beck, 2002).

2.6.3 Impact of Cost Based Information Management Tools on the Architect (Designer)

A successful building process rests on the pillar of a good design process. Information management tools in the form of advanced visualization tools and CAD have powerful potential for facilitating change and improvement (Moum, 2005).The four central aspects of the architectural design process are:

i. The generation of design solutions.
ii. Communication.
iii. Evaluating Design Solutions.

iv. Decision Making.

Decision making is very crucial in the design process for many reasons which include the fact that a decision hugely impacts the design process and the finished product. This can take the form of new requirements, additional development of design ideas or refusing suggested solutions. Decisions are made by different individuals in regards to different problems/situations. The architect's decisions concern which design solutions should be placed on paper. The client decides which proposed design solution should become the foundation of further development. Good decision making leans heavily on the ability of the designer/design team to generate solutions initially (Lawson, 2006).

One cost based information management tool that aids in producing design solutions is the CAD system. CAD systems that are employed in the design process support drafting and modeling rather than aid in analytical capabilities. These systems have not changed the modeling or drafting tasks (Kalay, 2004). Nevertheless, CAD systems have brought the possibility of being able to produce large numbers of drawings in short timeframes, and also the ability to create highly realistic professional representations of the design solutions. In addition, software exists that performs sketching better than traditional CAD programs. The question to be posed is 'cans CAD systems support generating design solutions?' The most important design skills that include intuition and visualization are almost impossible for computers to simulate (Moum, 2005).

There are parts in the process of generating design solutions, in which computers can provide tremendous support. The computer is capable of handling enormous amounts of parameters and combining them with alternative solutions in much shorter times than humans can. The only flaw to this is that the computer can only generate these solutions based on parameters recognized and programmed by humans (Moum, 2005). Information management tools can also impact the design process through the application of virtual reality (VR) scenarios to the design process. This aspect of ICT is under research, but its main thrust is to make it possible to navigate within and see objects and their relation to each other in a 3D space. The success of such processes would depend on how user-friendly, ICT is. However, the development of user-friendly interfaces for information management tools is a big challenge (Moum, 2005). For the moment, cost based information management tools can serve as partners that support and relieves the designer, but which cannot create designs without human interaction.

For building projects to be effectively planned and realized, there has to be successful communication on many levels. The sender (architect) of information (design solutions) has to encode the message in a symbolic language (drawing) which is then transmitted through a suitable medium to the receiver (e.g. client). To process the information, the client has to decode the message. Both parties encode and decode information based on their knowledge. The question in this scenario is if the computer can interpret sketches that often contain high degrees of uncertainty. For now, the answer is no. cost based information management tools can not yet impact the designer in this way (Moum, 2005).

Cost based information management tools have impacted design through the introduction of 3D product models. In this model, the main objects like the doors and windows are standardized (Moum, 2005). This standardization can however create stumbling blocks to the creative process. The design elements that are not included in the standard list of items can be very difficult to generate (Fekete, 2003). The entire design team can make contributions to or receive information from this model in parallel. All information concerning the project is gathered into this model and it eliminates fragmenting the illustrations of the project in the shape of plans and sections. This characteristic serves to reduce a major source of building site failures, which is inconsistency within the fragmented drawing and document material (Kiviniemi, 2004, Wikforss, 2003). From this model, "traditional" drawings can be generated, and information density controlled (Moum, 2005).

The architectural design process involves evaluation of several alternatives. A crucial question to be answered is how to arrive at a conclusion that one design is better than another. In addition, the designer needs to possess the skill to balance qualitative and quantitative aspects (Lawson, 2006). Cost based information management tools aid tremendously in evaluation. The capability to simulate and provide highly realistic visualizations, makes it possible to get an impression of the building project before it is completed. Unrecognized problems can be identified and resolved, and errors avoided at an early stage of the building project. These tools usually function with a subject that they evaluate, and a level of precision which is often not feasible in the early stages of design. This precision which comes "too early" in the design process can actually serve to hinder instead of promote creative design.

In addition, the development of 3D models to serve as simulation bases is expensive and cumbersome, and has resulted in the damaging side effect of simulating limited parts of the total design. This now presents a serious problem seeing that the design problem is multi-dimensional and interactive. The focus on some parts alone can result in a lack of integration, which automatically reduces project quality (Lawson, 2006). However, the possibility of importing 3D product models into simulation software reduces the effort required to build models, which in turn leads to total simulation and testing of the building (Kiviniemi, 2004).

Faster distribution of information, improved access to information and better communication tools accelerate the planning process which makes higher decision frequency possible (Gann,2000). The designer must be able to juggle multiple ideas at the same time, without forcing premature precision or decisions (Lawson, 2006). Employing cost based information management tools can lead to the danger of forcing decisions too early and generating artificial constraints (due to over-precision). Addressing this, Wikforss (2003) stated that it is very important to give enough time for maturing the planning and decision making process. He also stated that cost based information management tools, such as the 3D product model, must permit a step-by-step precision. It goes without saying that decisions are easily made in the absence of uncertainty. Adopting cost based information management tools makes it possible to store and capture previous project experiences. In addition, this information can be reused and tailored to suit present project needs.

2.6.4 Impact of Cost Based Information Management Tools on the Quantity Surveyor

According to Oyediran and Odusami (2005), Nigerian quantity surveyors demand cost based information management tools mainly for word processing, database and spreadsheet functions. The word processing functions serve to aid in correspondence (internal and external), technical reporting which extends to providing information about current projects, staff and equipment. In the area of spreadsheets, cost based information management tools aid in preparing programs of works, material schedules, estimating cash flow requirements, scheduling, job costing, and resource leveling. These tools fall under the category of communication based software, general purpose software, industry related software and quantity surveying software. The database serves as a repository for data and information which the quantity surveyor can use as referral when confronted with similar projects. The quantity surveyors also utilize CAD drawings as the primary source of information for measurement, preparing bills of quantities, estimating and presentations.

The quantity surveying software serves to speed up and enhance the accuracy of quantity surveying functions (Oladapo, 2006). However, while Nigerian quantity surveyors indicate high proficiency in spreadsheets, word processing, communication (email/internet) and presentation (Microsoft PowerPoint) packages, the proficiency level and level of usage in quantity surveying packages calls for concern. Most of these software are foreign in origin, and their cost is an important factor in their acquisition (Oyediran and Odusami, 2005). However , this fact was countered by Oladapo (2006), who stated that the rapid drop in prices of ICT software, coupled with its tremendous benefits, would make it possible for construction professionals to embrace the technology (and purchase necessary software).

2.6.5 Impact of Cost Based Information Management Tools on Builders

The common types of software used in construction comprise word processing, CAD, spreadsheet and internet software (Goh, 2005). These software aid administration, communication, marketing, desktop publishing, presentation and project management (Doherty, 1997, Arif and Karam, 2001). Builders mostly employ CAD to simplify the tasks of design, drawing and presentation (Rivard, 2000, Arif and Karam , 2001, De Lapp *et al;* 2004). Arguably, the most significant impact of cost based information management tools to builders is seen in the area of structural design. Walker and Hampson (2003) stated that with the advent of 3D modeling structural design software, it is possible to design complex structures that previously could not be handled. In addition, builders can use software to compare energy models with actual construction to discover any variations between actual and projected consumption (Houghton, 2009). Almost all aspects of structural design are aided by the provision of the following software:

i. Retaining wall software which quickly and easily designs retaining wall systems.

ii. Steel design software that designs steel beams, columns and single span beam columns.
iii. Concrete beam design software that designs flexural members (beams and slabs).
iv. Timber design software that analyses, designs and checks continuous beams or columns with optional cantilevers and handles almost any type of loading conditions.
v. Static pile analysis software that performs vertical and lateral soil structure interaction analysis for structures like fence posts and deep piles. This software can also analyze plastic behavior of soil, skin friction and lateral subgrade reaction that varies with depth.
vi. Masonry wall software that designs masonry bearing walls that are subject to axial and transverse loads.
vii. Concrete column design software that designs/checks concrete columns for axial tension, compression and biaxial moments. Spread footing design software that can aid in designing footings for very many columns in a very short time.
viii. Pile group analysis software that analyses a group of piles for loads in any direction. The piles may be located at different elevations.
ix. Frame analysis software that analyzes building frames.

x. Pile cap analysis software that analyzes pile arrangements and designs pile caps (includes designing cap thickness, steel requirements and rebar spacing).

xi. Wind analysis software that calculates wind pressures.

xii. Shear wall analysis software that analyzes buildings which are laterally supported by shear walls to determine the shears and moments in each shear wall.

xiii. Aluminum design software that designs/checks aluminum members for axial loads, biaxial bending and deflections (Anonymous, 2009o).

These software all help make the task of the builder easier, faster and more precise, which in turn leads to increased productivity.

CHAPTER THREE

3.1 RESEARCH METHODS

This study examined the methods of cost based information management that are currently employed by members of construction design teams in Nigeria, in order to benchmark the current methods with international best practices. The specific issues of interest were: attitude of design team members to ICT, hindrances to adopting modern methods of information management, preferences for various methods of information management, readiness of design team members to embrace modern methods of information management, and technological aptitude of design team leaders.

3.2 POPULATION

The population of this study was comprised of the following members of the construction design team:

i. Architects
ii. Builders and Engineers
iii. Quantity Surveyors

3.3 SAMPLE SIZE

From the central limit theorem which states that, "with very few exceptions, no matter what form the underlying populations distribution takes, as 'n' increases, the sampling distribution of averages approaches a normal distribution, thus the normal distribution can be used to approximate probabilities in cases of reasonably large samples($n \geq 30$) from non-normal distributions", (Dawdy and Wearden ,1985), a sample size of 40, was chosen for this research so as to have a buffer of 10 which would cater for unforeseen circumstances.

The questionnaires were distributed using the simple random sampling method, where every member of the population (design team), had equal opportunity of being selected.

From the returned questionnaires, 30 samples from each of the design professionals studied were analyzed to achieve the research objectives.

3.4 DATA COLLECTION

The survey was by means of well structured questionnaires, which contained the following sections:

i. Personal Details: This section collected data of a personal nature from the respondent, such as gender, name and age.
ii. Professional Details: The information supplied by the respondent in this section included the experience, frequency of using computerized cost-based information management tools, proficiency level in using computerized cost-based information

management tools and the frequency at which ICT training seminars were attended.

iii. Organizational Details: This section captured details about the respondent's organization. Some of these details were the frequency at which the organization engaged in international projects, electronic tendering and how often it carried out staff training on computerized cost-based information management tools.

iv. Operational Details: This section concerned itself with the details of project execution. It sought to supply information such as the frequency at which the design team member utilized a computer network during projects, the frequency of using the same ICT tools on different projects, the frequency of storing project data on a computer system and also the frequency of using project websites.

3.5 DATA ANALYSIS PROCEDURES

This work employed percentages and computed the approximate mean response for each category of respondent, based on the weightings attached to various responses for each question. In addition, the grand mean response (collective mean response of design team) was also computed in order to get an indication of the general trend that was followed by the design team concerning the question being asked.

The formula to obtain the percentages of a given response for each category of professional was:

$$\mathbf{(nRn/N \times 100)},$$

Where: **nRn** represented the number of respondents who selected an option,

N stood for the sample size of each category of design professional (30).

The formula for the approximate mean response for each category of professional studied was:

$$\mathbf{\Sigma((n \times Wr1)+(n \times Wr2)+(n \times Wrn)) / N.}$$

Where: **n** was the number of respondents from a particular category of design professional

Wr1 to **Wrn** represented the weightings attached to a particular response

N represented the sample size of the category of design professional being studied.

The grand mean response for the total design team was derived by:

$$\mathbf{((\Sigma(\Sigma((n \times Wr1)+(n \times Wr2)+(n \times Wrn)) / Nbe)+ (\Sigma((n \times Wr1)+(n \times Wr2)+(n \times Wrn)) / Narc)+ (\Sigma((n \times Wr1)+(n \times Wr2)+(n \times Wrn)) / Nqs))/Np))}$$

Where: **n** was the number of responses from a particular category of design professional

Wr1 to **Wrn** represented the weightings attached to a particular response,

Nbe represented the sample size of the category of builders and engineers

Narc represented the sample size of architects

Nqs represented the sample size of quantity surveyors.

Np represented the total categories of design professionals studied, i.e. 3.

CHAPTER FOUR

4.0 DATA PRESENTATION, ANALYSIS AND DISCUSSION OF RESULTS.

4.1 DATA PRESENTATION AND ANALYSIS

A total of 120 questionnaires were distributed, and 119 were returned. Out of this, 90 questionnaires were used for analysis, 30 for each of the three categories of professionals studied.

4.1.1 Methods of Document Storage

This section studies the various methods by which documents are stored by construction professionals. It seeks to show which method amongst soft copy, hard copy and a combination of both, is dominantly used to store documents. In addition it displays the frequency at which professionals use computerized tools for their tasks, and also the frequency at which hard copy documents are used by professionals.

Table 4.1 Method of Document Storage By The Professionals

Profession	Soft Copy Only	Combination of Hard and Soft copy	Hard Copy Only	Total
Builder/Engineers	1(3.33%)	23(76.67%)	6(20%)	30(100%)
Architects	1(3.33%)	28(93.33%)	1(3.33%)	30(100%)
Quantity Surveyors	0(0%)	25(83.33%)	5(16.67%)	30(100%)
Total/Grand Mean	2(2.22%)	76(84.44%)	12(13.33%)	90(100%)

Table 4.1 shows that with 84%, the majority of members of the design team store their documents via a combination of hard and soft copy.

Table 4.2 Computerized Tools Usage Among Design Professionals.

Profession	Weighting/Response Frequency 3	2	1	Total	Mean
Builders/Engineers	11	13	6	30	2.17
Architect	21	9	0	30	2.70
Quantity Surveyor	2	8	20	30	1.50
Total/Grand Mean	34	30	26	90	2.12

With a weighting as displayed above, table 4.2 shows that with an approximate mean of 2, builders, quantity surveyors and engineers frequently use computerized tools to perform their tasks. However, with an approximate mean of 3, architects very frequently use computerized information management tools. To get insight into the collective behavior of the design team, the approximate mean value of 2 indicates that computerized tools are frequently used by design professionals.

Table 4.3 Use of Hard Copy Documents During Projects

Profession	Weighting/Response Frequency 3	2	1	Total	Mean
Builders/Engineers	13	11	6	30	2.23
Architects	13	11	6	30	2.23
Quantity Surveyors	4	22	4	30	2.00
Total/Grand Mean	30	44	16	90	2.15

Table 4.3 indicates that with an approximate grand mean of 2, all the design professionals frequently use hard copies during projects.

Tables 4.1-4.3 have revealed that despite computerized information management tools being constantly utilized by members of the construction design team, the majority of the design team store their organizations' information using a combination of hard and soft copy, while the use of hard copies , are still the main method of disseminating project information to design team members during projects.

4.1.2 Challenges to Modern Cost Based Information Practices

In this section, the main thrust is collecting data that investigates the factors that may inhibit the adoption of computerized cost-based information management tools by the design team. Also, they are asked to suggest methods by which the ICT standards in the construction industry can be boosted.

Table 4.4 Hindrances to Use of Modern Cost Based Information Management Practices

Profession	Too Expensive	Unavailable	Too Complex	I Prefer manual execution	I am not hindered	Total
Builders / Engineers	3(10%)	0(0%)	0(0%)	0(0%)	27(90%)	30(100%)
Architects	5(16.67%)	10(33.33%)	0(0%)	1(3.33%)	14(46.67%)	30(100%)
Quantity Surveyors	1(3.33%)	1(3.33%)	2(6.67%)	3(30%)	23(76.67%)	30(100%)
Total	9(10%)	11(12.22%)	2(2.22%)	4(4.44%)	64(71.11%)	90(100%)

From Table 4.4, the value of 71%, indicates that the majority of design team members do not consider themselves hindered when it comes to adopting modern cost based information management tools.

Table 4.5 Methods of Boosting ICT Standards in the Nigerian Construction Industry

Profession	Create more awareness of new technology	Create user-friendly technology	Professional bodies should implement new technology	Create cheaper but effective technology	Concrete benefits to be derive from modern ICT tools should	Total
Builders / Engineers	15(50%)	3(10%)	10(33.33%)	0(0%)	2(6.67%)	30(100%)
Architects	14(46.67%)	0(0%)	13(43.33%)	0(0%)	3(10%)	30(100%)
Quantity Surveyors	12(40%)	8(26.67%)	7(23.33%)	1(3.33%)	2(6.67%)	30(100%)
Total	41(45.56%)	11(12.22%)	30(33.33%)	1(1.11%)	7(7.78%)	90(100%)

Table 4.5 shows that with a value of 45.56%, most of the members of design team, desire that more awareness of new technology should be promoted.

From tables 4.4 and 4.5, the findings were that although a majority of design team members believe that they are not hindered in adopting modern methods of cost based information management, hindrances exist in low level of awareness of these modern methods.

4.1.3 Attitude of Design Team Members towards Information Technology.

The title above sheds light on the data collected in this section. The questions asked here unearth the contribution of ICT tools to effective task performance, the frequency at which staff are trained on information management tools, the efficiency/effectiveness by which hard copy manages information/documents and the efficiency/effectiveness by which soft copy manages information/documents.

Table 4.6 Contribution of ICT Tools To Effective Task Performance.

	Weighting/Response Frequency							Total	Mean
Profession	**7**	**6**	**5**	**4**	**3**	**2**	**1**		
Builders / Engineers	1	3	11	0	1	10	4	30	3.57
Architects	1	2	2	8	2	13	2	30	3.17
Quantity Surveyors	1	3	1	2	2	20	1	30	2.83
Total/ Grand Mean	3	8	14	10	5	43	1	90	3.19

Table 4.6 shows that with an approximate mean of 4, builders regard the performance of ICT tools as above average when employed to aid them in their tasks. With an approximate mean of 3, the quantity surveyors and the architects regard the performance of these tools as good, when deployed to aid them in their tasks.

Also with an approximate grand mean of 3, the design professionals in Nigeria regard the performance of ICT tools as good.

Table 4.7 Frequency of Staff training on Information Management Tools

Profession	Weighting/Response Frequency 4	3	2	1	Total	Mean
Builders / Engineers	1	3	20	6	30	1.37
Architects	2	4	18	6	30	2.01
Quantity Surveyors	1	5	15	9	30	1.93
Total/Grand Mean	4	12	53	21	90	1.77

Table 4.7 indicates that with an approximate grand mean of 2, design professionals are seldom trained on the use of information management tools.

Table 4.8 Efficiency and Effectiveness of managing Information/Documents on Hard Copy

Profession	Weighting/Response Frequency 4	3	2	1	Total	Mean
Builders/ Engineers	7	7	4	12	30	2.30
Architects	20	7	0	3	30	3.47
Quantity Surveyors	24	3	2	1	30	3.67
Total /Grand Mean	51	17	6	16	90	3.15

Table 4.8 shows that builders, with an approximate mean rating of 2, do not consider hard copy storage of information as efficient and effective. The architects and quantity surveyors, each with an approximate mean of 4, rate hard copy to be very efficient and effective in managing their information/documents.

The approximate grand mean value of 3 indicates that the design professionals regard hard copy as an efficient and effective method of managing information and documents.

Table 4.9 Efficiency and Effectiveness of Managing Information/Documents on Soft Copy.

Profession	Weighting/Response Frequency				Total	Mean
	4	3	2	1		
Builders / Engineers	26	2	1	1	30	3.77
Architects	13	12	5	0	30	3.27
Quantity Surveyors	26	3	1	0	30	3.83
Total/Grand Mean	65	17	7	1	90	3.62

Table 4.9 depicts that with an approximate mean of 4, the builders and quantity surveyors rate soft copy to be very efficient and effective in managing their documents. With an approximate mean of 3, the architects were of the view that soft copy was efficient and effective, in managing their documents. An approximate grand mean of 4 indicates that design professionals rate soft copy as a very efficient method of managing their documents and information.

Table 4.10 Perceptions On How ICT Can Aid Professional Duties.

Profession	Saves time	Better efficiency	Better accuracy	Better Information storage and retrieval	Does not aid me	Total
Builders/ Engineers	7(23.33%)	14(46.66%)	7(23.33%)	2(6.67%)	0(0%)	30(100%)
Architects	8(26.67%)	11(36.67%)	8(26.67%)	3(10%)	0(0%)	30(100%)
Quantity Surveyors	9(30%)	17(56.67%)	1(3.33%)	2(6.67%)	1(3.33%)	30(100%)
Total	24(26.67%)	42(46.67%)	16(17.78%)	7(7.78%)	1(1.11%)	90(100%)

Table 4.10 yields the result that with 46.67%, a majority of the members of the design team believe ICT makes them more efficient in their respective tasks.

Table 4.11 Proficiency level in using computerized information management tools

	Weighting/Response Frequency					
Profession	4	3	2	1	Total	Mean
Builders/Engineers	4	11	15	0	30	2.63
Architects	7	23	0	0	30	3.23
Quantity Surveyors	3	8	18	1	30	2.43
Total	14	42	33	1	90	2.76

From table 4.11, it is seen that the builders and architects (each with an approximate mean of 3), indicate that they are proficient in using computerized information management tools. This differs from the mean response of the quantity surveyors, which with an approximate mean of 2, indicate average proficiency level in using computerized information management tools. On the basis of a collective result, the approximate grand mean of 3 indicates that design professionals are proficient in using computerized information management tools.

In conclusion, the collected data indicated that members of construction design teams are not averse to computerized information management tools. However, a discrepancy resulted in a majority of the design team members stating that two separate methods of managing information (hard/soft copy) were efficient and effective.

4.1.4 Efficacy of Cost Based Information Management Practices

As stated in the literature review, many principles determine the effectiveness of information management (Robertson, 2005). This section collects data on the following:

i. The Presence Of Strong Leadership
ii. Managing Complexity In Different Projects
iii. The Intensity Of Communication During Projects

a) Presence of Strong Leadership. (Tables 4.12-4.13)

The first factor examined here depicts the strength of the design team leader. Its objectives are to determine whether the team leader produces clear guidelines on processing project information, and whether the team leader intervenes on the choice of ICT tools used during a project.

Table 4.12 Following Clear Guidelines on Processing Project Information

Profession	Weighting/Response Frequency 4	3	2	1	Total	Mean
Builders/Engineers	2	5	8	15	30	1.80
Architects	0	11	7	12	30	1.97
Quantity surveyors	2	4	20	4	30	2.13
Total/Grand Mean	4	20	35	31	90	1.96

Table 4.12 shows that with an approximate grand mean of 2, each profession that makes up the design team, seldom follow clear guidelines on how project information is to be processed.

Table 4.13 Team Leader Intervention Regarding Choice of ICT Tools During Projects.

Profession	Weighting/Response Frequency 4	3	2	1	Total	Mean
Builders/Engineers	1	19	8	2	30	2.63
Architects	11	9	10	0	30	3.03
Quantity Surveyors	1	5	12	12	30	1.83
Total/Grand Mean	13	32	29	14	90	2.50

Table 4.13 indicates that with an approximate mean of 3, the builders and architects have frequent team-leader intervention regarding the choice of ICT tools they use during projects. This statistic differs from the quantity surveyors, who with an approximate mean of 2, seldom have team leader intervention. However, the approximate grand mean of

3 indicates that there is frequent team leader intervention in the choice of ICT tools used during projects.

b) Managing Complexity in Different Projects

The second factor examines the ability of the design team to utilize different systems of cost-based information management on different projects. This is based on the premise that each project is different and has different information management needs.

Table 4.14 Frequency of Using the Same ICT Tools on Different Projects.

	Weighting/Response Frequency				Total	Mean
Profession	**4**	**3**	**2**	**1**		
Builders/ Engineers	5	11	12	2	30	2.63
Architects	13	13	4	0	30	3.30
Quantity Surveyors	0	23	3	4	30	2.63
Total/Grand Mean	18	47	19	6	90	2.85

With an approximate grand mean of 3, table 4.14 indicates that the same ICT tools are utilized on different projects.

c) Intensity of Communication during Projects (Tables 4.15-4.16)

Communication is critical for project success. In this section, data is presented which examines if computer networks and project web-sites are utilized when executing a project.

Table 4.15 Rate of Using Computer Networks on Projects

	Weighting/Response Frequency					
Profession	**4**	**3**	**2**	**1**	**Total**	**Mean**
Builders/ Engineers	0	5	2	23	30	1.4
Architects	1	7	7	15	30	1.8
Quantity Surveyors	0	1	4	25	30	1.2
Total/Grand Mean	1	13	13	63	90	1.47

In Table 4.15, an approximate mean of 1 exists for the builders and quantity surveyors. This now indicates that they never use computer networks while executing projects. For the architects, an approximate mean value of 2 indicates that they seldom use computer networks on their projects. The approximate grand mean value of 1 clearly shows that design professionals never utilize computer networks on projects.

Table 4.16 Frequency of Utilizing Project Websites

	Weighting/Response				
	Frequency			Total	Mean
Profession	**3**	**2**	**1**		
Builders/Engineers	0	1	29	30	1.03
Architects	5	11	14	30	1.70
Quantity Surveyors	0	1	29	30	1.03
Total /Grand Mean	5	13	72	90	1.25

From table 4.16, an approximate mean value of 1, indicates that the builders and quantity surveyors have never used a project website. An approximate mean value of 2 for the architects indicates that they seldom utilize project websites. However on an overall basis, the approximate grand mean value of 1 reveals that the design professionals never utilize project websites.

4.1.5 Global Competitiveness of the Local Industry Practice

This is assessed by: status of the domestic industry ICT with respect to international ICT standards, frequency of electronic tendering and rate of engagement in international projects, and are presented in tables 4.17-4.19.

Table 4.17 Rating of domestic Industry ICT Standards

Profession	Weighting/Response Frequency 5	4	3	2	1	Total	Mean
Builders/Engineers	1	14	14	1	0	30	3.50
Architects	10	14	6	0	0	30	4.13
Quantity Surveyors	1	26	2	0	1	30	3.87
Total/Grand Mean	12	54	22	1	1	90	3.83

A close look at table 4.17 deduces that with a value of 4 as approximate grand mean, each of the professions of the design team, rate the ICT standards of the domestic industry to be poor, when compared alongside international industry standards.

Table 4.18 Frequency of Tendering By Electronic Means

Profession	Weighting/Response Frequency 3	2	1	Total	Mean
Builders/ Engineers	3	11	16	30	1.57
Architects	13	7	10	30	2.10
Quantity Surveyors	1	25	4	30	1.90
Total/Grand Mean	17	43	30	90	1.86

Table 4.18 indicates that the members of the design team seldom participate in e-tendering. This conclusion was made because of the approximate grand mean value of 2, for each profession.

Table 4.19 Rate of Domestic Industry Professionals Engagement in International Projects

	Weighting/Response Frequency					
Profession	**4**	**3**	**2**	**1**	**Total**	**Mean**
Builders/Engineers	0	0	6	24	30	1.20
Architects	1	5	12	12	30	1.83
Quantity Surveyors	0	0	16	14	30	1.53
Total/Grand Mean	1	5	34	50	90	1.52

Table 4.19 shows that with an approximate mean value of 1, builders never engage in international projects. An approximate value of 2 for architects and quantity surveyors indicates that these professions seldom engage in international projects. The approximate grand mean value of 2 indicates that design professionals seldom engage in international projects.

4.2 DISCUSSION OF RESULTS

4.2.1 Methods of Document Storage

From the results obtained, it is seen that the major method of storing documents by the design team is via a combination of hard and soft copy. In addition, computerized tools are frequently utilized by the design professionals. Whilst the adoption of modern methods of information management is commendable, these methods are not utilized to their maximum potential. The information management is mostly restricted to document storage and production, as witnessed in the absence of computer networks and project web-sites being used during projects. Egbu and Botherill (2002) alluded to this fact when they stated that more sophisticated information management methods capable of achieving seamless information flow amongst the various design professionals are not being adopted. Furthermore, the results point to the fact that design professionals frequently use hard copies when executing projects. This fact contradicts Goh (2005), who stated that the construction industry is shifting from traditional 'paper based' information management to 'digital' information management.

4.2.2 Challenges to Modern Cost Based Information Practices

Egbu and Botherill (2002), stated that the construction industry is slow in adopting the benefits of ICT due to a lack of expertise. However, Oladapo (2006), stated that a hindrance to the adoption of ICT (and hence implementing modern information management) by Nigerian professionals is the inefficient power supply, and high costs of computer software.

The facts presented by this research indicate that design professionals face no hindrance in adopting modern cost-based information management practices. Furthermore, the majority of design professionals studied state that they are proficient in utilizing computerized cost-based information management tools. Interestingly, the results of this research also reveal that most organizations that hire design professionals seldom train them on the use of ICT tools.

4.2.3 Attitude of Design Team Members towards Information Technology.

According to Betts *et al*; (1991), the construction industry needs to effectively embrace ICT in order to promote effectiveness and responsiveness to customers, clients and team members. This research showed that the design professionals rate ICT tools above average when deployed to aid them perform their tasks. A majority also stated that ICT tools make them more efficient in their duties. Additionally, most design professionals also rated soft copy as an efficient and effective means of managing information and documents.

4.2.4 Efficacy of Cost Based Information Management Practices: Leadership Strength

According to Oladapo, (2006), a common competency required by design consultants is the ability to manage and communicate project documents and information. He further stated that a main factor that influenced increased productivity in the construction industry is effective management of information. For effective information management, several principles have to be followed (Robertson, 2005). This work examined the principles of strong leadership, complexity management and intensive communication.

According to Oladapo, (2006), a common competency required by design consultants is the ability to manage and communicate project documents and information. He further stated that a main factor that influenced increased productivity in the construction industry is effective management of information. For architects (team leaders), performance is graded according to how effectively they communicate design information to contractors (Oyedele & Tham, 2005). In addition, successful information management is based on strong leadership which defines a clear direction, and plans multiple activities that address in parallel the many needs and issues (Robertson, 2005). This research showed that most design professionals seldom follow clear guidelines on how information is to be processed.

From this research, it is indicated that builders and architects are frequently directed on the choice of ICT tools to be used during projects, which is a sign of leadership strength. This is not the case for the quantity surveyors, who seldom have team leader intervention in regards to the choice of ICT tools they use during projects.

4.2.5 Efficacy of Cost Based Information Management Practices: Managing Complexity

The problem of generating design solutions is very complex. To overcome this complexity, organizations (design teams) , react in many ways which include focusing on deploying just one technology in isolation, purchasing a suite of applications from a single vendor, hoping this will solve all information management problems and even rolling out rigid standardized solutions across the whole organization (design team) even though individual components (team members) possess different needs. Realistically, these approaches are inadequate because they attempt to convert complex needs into simple solutions. To be effective, new approaches to information management must be found that are able to recognize and manage complexity (Robertson, 2005). The findings of this research showed that design professionals frequently use the same ICT tools on different projects. This fact highlights the inadequacy of the current information management practices of the design professionals to combat complexity.

4.2.6 Efficacy of Cost Based Information Management Practices: Intensive Communication

Consultants and project participants by necessity integrate their information systems together in order to improve information flow and aid effective decision making. (Li *et al*; 2000). By utilizing available ICT facilities, integration can be achieved in the construction industry (Mohammed and Stewart, 2003).

According to this research, communication and resource integration among design professionals during projects is still on a basic level. Evidence of this is seen in the fact that the respondent builders and quantity surveyors have never used a computer network on a project, while the builders have seldom used such a network. The fact that the same statistic of builders and quantity surveyors have never used a project web-site, only serves to show the low level of communication that goes on during project execution.

4.2.7 Global Competitiveness of the Local Industry Practice

Kini (2000) observed that in the 21st century, construction companies will have to make changes in their information systems to be successful. For a construction firm to possess a competitive advantage, it must possess advanced technology. The factors that form a basis for international competition in construction have moved from managerial to technological issues (Mitropolous and Tatum, 2000).

Building design is normally done by teams, comprising of individuals from different firms that are geographically dispersed. (Sanvido and Norton, 1994). This phenomenon is inevitable in the face of advancing globalization, which can lead to project members residing on different continents (Madigan, 1993). A global construction environment requires that the project (design) team have efficient and effective communication infrastructure that will yield successful collaboration among themselves.

This study examined the preparedness of the local construction industry for the challenges of globalization by investigating the ICT standards of the industry, frequency of tendering by electronic means and also investigating the rate at which domestic professionals engaged in international projects. The findings indicated that the ICT standards of the domestic industry is poor, electronic tendering is seldom carried out, and that at best, design professionals seldom participate in international projects. These facts do not signify adequate readiness on the part of the domestic industry to profit from globalization. However, these results tally with the view of Austin (1990), who stated that advances in technology being enjoyed in industrialized nations might not be applicable to a developing country. This can be attributed to differences in culture, socio-economic conditions and regulatory environments (Seyal *et al*; 2000).

CHAPTER FIVE

5.0 SUMMARY, CONCLUSION AND RECOMMENDATIONS

The following points outline the summary of the findings of this research, which sought to achieve the research objectives.

5.1 SUMMARY

i. It was discovered that the primary method of storing cost-based information by building design professionals, is via a combination of hard and soft copy. However, most of the information is converted into hard copy and used for information dissemination during projects. (Tables 4.1-4.3).

ii. Tables 4.4 and 4.5 yielded the results that a majority of the construction design team members believe they are not hindered in adopting computerized information management tools in their professions. However, they opined that the ICT standards in the industry can be improved, by promoting greater awareness of modern technology.

iii. From tables 4.6 - 4.11, it was deduced that the members of the construction design team are not opposed to adopting modern methods of cost-based information management. The team members also find ICT tools to be useful in aiding them execute their various tasks. However, concern is to be taken from the fact that construction organizations seldom train their staff on industry related technology. Also, the tables revealed that a majority of the design team rated the efficiency of traditional and modern methods of information management, to be very high. This result is interesting, because the two opinions are meant to be mutually exclusive.

iv. It can be inferred that the information management practices among the design professionals do not adhere to most of the principles of effective information management. In addition, most of the design professionals rate the industry's ICT level to be low, most professionals seldom, or do not participate in electronic tendering (which is a cost-effective means of bidding for international projects),and most team members seldom or never engage in international projects.

5.2 CONCLUSION

The facts obtained from this research indicate that the ICT standards of the industry are poor, and the cost-based information management practices to be ineffective. This situation prohibits domestic design professionals from enjoying and utilizing the benefits of ICT on project delivery and profiting from the proceeds realized from participating in construction activities being undertaken in the global construction marketplace.

5.3 RECOMMENDATIONS

For better utilization of modern cost-based information management tools and systems within the Nigerian construction industry, the following are recommended:

Further research should be carried out to develop more user-friendly technology for the building design professionals in general, and quantity surveyors in particular.

i. Further research should be carried out to provide a detailed method of supplying design team members with the knowledge of concrete benefits to be derived from embracing a particular technology/cost-based information system.

ii. Professional bodies supervising the various practices that constitute the design team should formulate more stringent policies that demand a hands-on competency requirement in the area of profession related software, before certificates of membership are awarded.

iii. Various firms should schedule regular training of their employees in the use of profession related software

iv. Professional bodies should encourage a shift from "paper based" information management and processes, towards "electronic" information management and processes. E.g, there should be an encouragement for the practice of "e-tendering" to be used more frequently for bids.

v. Professional bodies should encourage their members to cultivate the practice of building computer networks to enhance communication with other design team members during projects.

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APPENDIX

QUESTIONNAIRE FOR DESIGN TEAM

Dear respondent,

I am from the department of building, Ahmadu Bello University Zaria, and presently conducting a study on appraising information management practices of construction design team members.

I will appreciate it very much if you would kindly complete this questionnaire to enable me collect data for this research. I assure you that all information given would remain confidential.

Thank you very much.

Yours faithfully,

A.E. Leleji.

PERSONAL DETAILS

1.Name:____

2. Sex: Male ( ) Female ( )

3. Age: 21-25 ( ) 26-30 ( ) 30 and above ( )

4. Do you posses an email address: Yes ( ) No ( )

5. If yes, how often do you check/send emails? Once/twice a week ( ) Three time a week ( ) Above three times a week ( )

PROFESSIONAL DETAILS

6. What is your profession: Builder/Structural engineer ( ) Architect ( ) Quantity Surveyor ( )

7 For how long have you been in practice: 1-5 years ( ) 6-10 years ( ) 11-15 years ( ) 16 years and above ( )

8. How often do you utilize computerized cost-based information management tools in your profession? Very frequently ( ) Frequently ( ) Seldom ( ) Never ( )

9. Indicate your proficiency level in using computerized cost-based information management tools that aid your duties. Very proficient ( ) Proficient ( ) Average ( ) Not proficient ( )

10. What hinders (if at all) you/your colleagues in using computerized cost-based information management tools in carrying out your duties? Too expensive ( )

Unavailable ( ) Too complex ( )

I prefer manual execution ( ) I am not hindered ( )

11. Rate how efficient and effective it is to manage information/documents via computers, on soft copy:

Very efficient/effective ( ) Efficient/effective ( ) Not efficient/effective ( ) I can't decide ( )

12. Rate how efficient and effective it is to manage information/documents on hard copy: Very efficient/effective ( ) Efficient/effective ( ) Not efficient /effective ( ) Not efficient/effective but it is easy to use ( )

13. In what way do you think information and communication technology can aid your professional duties: Saves time ( ) Better efficiency ( ) Better accuracy ( ) Better information storage and retrieval ( ) Does not aid me ( )

14. How often do you attend training seminars on construction industry related ICT tools? Very frequently ( ) frequently ( ) Seldom ( ) Never ( ) I would if I saw a seminar being organized( )

15. How do you rate the level of ICT standards in the Nigerian construction industry as compared to the standards of more developed countries? Very Poor( ) Poor( ) Average( ) Equal( ) Better( )

16. In your opinion what do you think can be done to boost (if need be) the level of ICT standards in the Nigerian construction industry? (Tick all that apply) Create more awareness of new technology ( ) Create user-friendly technology ( ) Professional bodies in the industry should insist on implementing new technology( ) Create cheaper but effective technology( ) Concrete benefits to be derived from modern ICT tools should be known( )

17. Do you believe that utilizing modern ICT tools would give you/your firm a competitive advantage? Yes ( ) No ( ) I don't Know ( )

18. Do you believe that utilizing modern ICT tools has a link to

the growth /survival of your firm?

Yes ( ) No ( ) I don't Know ( )

ORGANIZATIONAL DETAILS

19. Name of Organization: ______________________________

20. Does your firm posses an email address? Yes ( ) No ( )

21. If yes, how often does your firm check/send emails?

    Once/twice a week ( ) Three times a week ( ) Above three times a week ( )

22. Does your firm possess a website: Yes ( ) No ( )

23. How often does your firm engage in electronic tendering?

    Very frequently ( ) Frequently ( ) Seldom ( ) Never ( )

24. How often does your firm execute international projects/?

    Very frequently ( ) Frequently ( ) Seldom ( ) Never ( )

25. What factors (if any) do you think hinder your organization from participating in international projects? (Tick all that apply) Lack of qualified personnel ( ) Lack of Finance ( ) Distance constraints ( ) Lack of competitive information technology infrastructure ( ) Lack of interest ( )

26. How often has the level of your organization's information and communication technology infrastructure hindered it from participating in a project?

    Very frequent ( ) Frequent ( ) Seldom ( ) Never ( ) I don't Know( )

27. What proficiency level does your organization demand of its employees as regards usage of profession related computerized information management tools?

Very proficient ( ) Proficient ( ) Average ( )

Not an Issue ( )

28. What method does your organization use to store its documents/information?

Soft copy only ( ) Combination of hard and soft copy ( )

Hard copy only ( )

29. As a member of a construction project design team, what method is used to store project information?

Soft copy only ( ) Hard copy only ( ) Combination of hard and soft copy ( )

30. How often do members of the design team (of which you are part) possess their own hard copies of project documents (e.g. Drawings, Specifications)

Very frequent ( ) Frequent ( ) Seldom ( ) Never ( )

31. How often does your organization train its staff on profession related computerized cost-based information management tools?

Very frequent ( ) Frequent ( ) Seldom ( ) Never ( )

OPERATIONAL DETAILS

32. In executing projects, how often have you utilized a

computer network (comprising multiple computers) that enables you and other design team members share resources and information ?

Very frequent ( ) Frequent ( ) Seldom ( ) Never ( )

33. In executing projects, how often have you followed a guideline that clearly states how project data and information are to be processed ? Very frequent ( ) Frequent ( ) Seldom ( )

Never ( ) 34. In executing projects, how often \have you kept a collection of files that concern the project data , on a computer

system ? Very frequent ( ) Frequent ( ) Seldom ( )

Never ( )

35. In your opinion, rate how modern ICT tools perform in aiding

you execute your tasks: Very Poor( ) Poor( ) Average ( ) Above Average( ) Good( ) Very Good( ) Excellent( )

36. How often do you use the same ICT tools on different

projects ? Very frequent ( ) Frequent ( ) Seldom ( )

Never ( )

37. How often do you/your design team leader (architect) insist on a particular ICT tool for various design team members to utilize when executing projects?

Very frequent ( ) Frequent ( ) Seldom ( ) Never ( )

38. In your opinion, do you believe that most team leaders (architects) do not regard ICT tools as necessary for project success?

Yes( ) No( )

39. How often do you/your team leader (architect) state the objective to be achieved by the ICT tools to be used on the project? Very frequent ( ) Frequent ( ) Seldom ( ) Never ( )

40. How often have you participated in a project in which there was a website that enabled design team members to access information, update information, communicate and receive instructions?

Very frequent ( ) Frequent ( ) Seldom ( ) Never ( )