DEVELOPMENT OF A FRAMEWORK FOR MINIMISING ERRORS IN CONSTRUCTION DOCUMENTS IN NIGERIA

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

ABSTRACT

Many of the causes of poor project performance which result in cost and time overruns, and poor quality can be traced to some types of errors during the design process. It is discovered that design errors add 5.9% of the contract value and rework, which is a corrective work, has been estimated to be as high as 20% of the design consultant's fee for a given project. These errors should be eliminated to allow sound project performance. The aim of this research is to develop a framework supported with guidelines for the minimisation of errors in construction documents in Nigeria. The study was carried out by means of literature survey, questionnaire survey and semi structured interviews. Literature survey was used to discover the various definitions of errors and the general types, causes and effects of errors in construction documents. Semi structured interviews were made use of, to elicit the definitions of document error from the respondents. Questionnaires were distributed to construction professionals in south western states and the federal capital territory of Nigeria to determine the types and causes of errors specific to Nigeria and also the effects of document errors on construction cost, time, quality and building occupants. Content analysis, relative importance index, kendall's coefficient of concordance, severity index, and percentages were used to analyse the data collected. The study showed the causes of errors in construction documents to be: non – availability of information, poor communication, inadequate project brief, poor salaries of professionals, non – identification of project risks, inadequate consultant professional education, inadequate consultant professional experience, inadequate project manager experience, time scheduled pressure, inadequate project planning, complexity of project, concurrent documentation, heavy work load of consultant, poor consultancy fees, inadequate document preparation time and inadequate document manager experience. The study also identified the various types of error in construction documents specific to Nigeria which are: unnecessary additions, non – conformance to client requirement, non – conformance to design code/ SMM, absence of specifications, dimensional error, miscalculation, scanty specification, wrong specification, omission of necessary item and incorrect details. Documentation error added 20.39% to the original contract sum and 11.07% to the original contract period and within seven years in Nigeria 411 people lost their lives as a result of building collapse initiated by documentation error. The developed construction documentation error minimisation framework was captioned by a flow chart.

DECLARATION

This thesis is presented as an original contribution based on Doctor of Philosophy research at the University of Salford, Manchester, United Kingdom and has not been previously submitted to meet requirements for an award at any higher educational institution under my name or that of any other individual. To the best of my knowledge and belief, the thesis contains no previously published or written work by another person except where due reference is made.

…… (Signed)

……. (Date)

DEDICATION

This thesis is dedicated first to God Almighty through Jesus Christ for making me a beneficiary of His mercies and grace. Then, to my beloved wife, my *Best*, Victoria Ayodele and our children: Tim, Lois and Dan for their love and encouragement.

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CHAPTER ONE

INTRODUCTION

1.0 Introduction

This chapter commences with the background to the study. It also introduces the research problem, statement of the problem, research justification, research aim and objectives, research scope and limitations, research methodology, research outcome, the structure of thesis and ends with the summary.

1.1 Background to the Study

For any construction project, the three performance parameters of cost, time and quality are very significant (Hackett et al, 2007; Brandon, 1995). Generally, these three parameters are attached to each type of contractual arrangement and have been recognised as established norms in the construction industry. Clients want to receive completed projects that are of high quality, within budget and on time. Construction professionals such as Architects, Engineers, Quantity Surveyors, and also Contractors have no option than to comply with the clients desires. The ability of the project team to meet these conflicting but basic requirements under the uncertain project environment is always a challenge. It is therefore required of the project team to show adequate care and expertise for the project economy of scale starting from the completion time, economy of expenditure and optimum quality of the finished product (Andravei, 2003). According to Stewart (1992) error is defined as 'an event or process that departs from commonly accepted competent professional practice'. Edmonson (2002) also defined error as 'the execution of a task that is either unnecessary or incorrectly carried out'. According to Reason (1990), errors relate to those occasions in which a planned sequence of mental or physical activities fail to achieve its intended outcome, and when these failures

cannot be attributed to the intervention of some chance agency. Furthermore, Busby (2001) defines errors as the occurrences which were unexpected, involve surprise and which could not be attributed entirely to chance or circumstance. Errors are unintended deviations from correct and acceptable practice that are avoidable (Love et al, 2008). While Reason (2006) sees design error as an error that relates to those occasions in which a planned activity fails to achieve it's intended outcome, and when these failures cannot be attributed to the intervention of some chance agency. Love & Smith (2003) defined design error 'as unintended deviations from correct and acceptable practice that are avoidable'. The definition of error considered within this research can therefore be summarised as something that causes deviation from correctness or standard, which makes the document not being able to achieve its intended purpose. Construction documents on the other hand are the drawings, design specifications, quality control reports, and others (Hajjar & AbouRizk, 2000). Furthermore, Murdoch & Hughes (1997) defined contract documents as the means by which designers' intentions are conveyed to the client, the statutory authorities, the quantity surveyor, the contractor and sub-contractors. Mohammed (2007) asserts that it is during the preparation of construction documents that most of the parameters that influence construction works are established. That is, if there are costs and time overruns on a project, some of the problems; that is, errors that will lead to these must have been erroneously included in the construction documents. Some researchers have revealed that most of the construction costs, to the level of 75% have been committed during the product design process (Weustink, et al, 2000). Having discussed background to this study, next section will focus on research problem.

1.2 Research Problem

Construction industry; be it building or other types of infrastructure goes through certain stages before construction is completed. The first of the stages is that of the designs and the bill of quantities. At the design stage, the project objectives relating to cost, time and quality

have to be properly taken care of. Mistakes, such as unnecessary additions or omissions during the design stages often lead to enlarged problems later (Williams, 2010). Many of the causes of poor project performance, that is, cost, time and quality, can be traced to some types of errors during the design process (Williams (2010). According to Mohammed (2007), it costs more to solve problems that emerge during construction process. This is because the design documents have to be re-visited and amended appropriately. Many of these errors unwanted by the design team members, unforeseen but avoidable, could throw construction work off-balance. To achieve the project objectives, errors must be eliminated from the designs during the design process. In the UK, Hibberd (1980) cited in Mohammed (2007), it is discovered that the major source of variation on construction sites is the lack of adequate design at design stage which occurred in 25% of projects. Some researchers in the UK (Langford, et al, 1986) found out that 72% of variations were caused by the design team – obviously through the designs they produced. In Saudi Arabian construction industry, Al-Ghafly (1995) discovered that most changes that cause time overruns during construction result from the poor design of the project. Al-Subaiey (1997), in his survey, discovered that there were many errors and omissions of specifications, which ordinarily resulted into claims by contractors during the construction process. According to the Construction Industry Institute (1986) cited in Mohammed (2007) a savings on the order of 2-6% of original estimate is achievable through adequate constructability reviews only. Supporting the above view is a discovery from a study by Stassiowski & Burstein (1994) that variation order cost, reduces from 7% to 3% of the project cost, by the use of a system called REDICHECK method for conducting design reviews.

In Nigeria, Alutu & Ayodele (2006) discovered that 92% of respondents accepted “changes as a result of error in design” as one of the reasons for cost overruns. While in Alutu & Ayodele (2008), 94% of the respondents agreed with “changes as a result of error in design” as one of the reasons for delivery time overruns in Nigeria. In the work of Burati, et al (1992) it was

discovered that design changes accounted for 67-90% of the total number of changes on the project and that the design deviations generally accounted for the greatest increase in total contract sum ranging from 0.4% to 20.6%. Researchers (Alabi, 2013; Williams, 2010; Akindoyeni, 2002; Bolaji, 2002; Dare, 2002; Fadamiro, 2002; and Ogunsemi, 2002 & Olusola, 2002) in Nigeria have indicated that poor quality work that had resulted to building collapse have one of its causes to be errors in designs; which are errors in architectural, structural, electrical and mechanical designs and the bill of quantities. Fadamiro (2002) gave a list of 20 building collapses in Nigeria (1974-2001), while Dare (2002) also listed 35 collapsed buildings and all these have resulted to loss of lives and properties. Building collapses occur almost on monthly basis in Nigeria. Ashworth & Hogg (2002) stated that the construction industry has a poor reputation that is due mainly to its perceived inability to meet the need of clients in achieving project completion dates, completing project within budget and providing a high quality product. This, they linked to the complexity and scope of many building projects which are full of risks. Some of such risks are errors on construction documents, which is the subject of this thesis. Consultants, namely Architects, Civil Engineers, Electrical Engineers, and Mechanical Engineers, and Quantity Surveyors have contributed a great deal to cost overrun of projects because of inadequate information by them (Mohammed, 2007). They have also contributed to errors in contract documentation (Kirby, 1988; Love, Mandal, et al, 2000) and poor quality of construction documents (Stassiowski & Burstein, 1994; Tilley, et al, 1999).

It is unfortunate that because of documentation error, the Nigerian construction industry has performed badly in terms of cost, time and quality, in other words cost overrun, time overrun and poor quality jobs are prevalent. For example a research in Nigerian tertiary institutions building projects, conducted by Alutu & Ayodele (2006), showed that only 4.3% out of 141 projects were completed within budget while 95.7% had cost overrun (please refer to Table 1.1). The problem of high construction cost in Nigeria has been a major concern to all

stakeholders in the Nigerian economic system. It is worrisome and indeed embarrassing when it is reported that construction cost in Nigeria are among the highest in the world. A report by Ajanlekoko (2001) cited in Alutu (2006) shows that an industrial building, office block and a 3-star hotel can be built in South Africa at $\$201/m^2$, $\$575/m^2$,and $\$37,855/m^2$ respectively, whereas in Nigeria, these projects will cost 50%, 150% and 130% more respectively. The situation is slightly better in Ghana where the projects will cost `6%, 98% and 37% more respectively. The problem of cost overrun in Nigeria has been a great dissatisfaction to the clients.

Table 1.1: Percentage of Projects completed within and above contract sum (Source: Alutu & Ayodele, 2006)

Number of projects	Percentage completed within tender sum	Percentage completed above tender sum
141	4.3% (6)	95.7% (135)

Table 1.2: Percentage of projects completed within and above agreed delivery periods (Source: Alutu & Ayodele, 2006)

Number of projects	Percentage completed within agreed period	Percentage completed after agreed period
141	3% (6)	95% (137)

Table 1.3: Comparative unit cost of building and civil engineering projects between Nigeria, Algeria and Kenya (Source: Ajanlekoko, 2001,cited in Alutu, 2006).

Project type	Nigeria N	Algeria N	Kenya N
Residential Building	$350/m^2$	$313/m^2$	$132/m^2$
Multi storey Office Block	$450m^2$	-	$207/m^2$
Single Carriage road (2 lanes)	294000/km	149252/km	105961/km

Dual Carriage road (4 lanes)	800,000 - 1200000/km	587015/km	278961/km

From Table 1.3, cost per metre square of residential building in Nigeria was 10.57% higher than in Algeria and 33.71% higher than in Kenya. In Nigeria to build a multi storey office block is 51.78% higher than in Kenya. To construct single carriage road (2 lanes) in Nigeria was 49.23% higher than in Algeria and 63.96% higher than in Kenya. The report also showed that a dual carriage road (4 lanes) in Nigeria is 41.3% higher than in Algeria and 72.1% higher than in Kenya. A recent report on the cost of construction related project across the globe revealed that the cost of constructing a kilometer of asphaltic road in Nigeria happens to be the highest in the world compared to what is obtainable in other nations of the world (NIQS, 2003). In Nigeria, and in a study of delivery periods of building projects in Nigerian tertiary institutions conducted by Alutu & Ayodele (2008) on 141 building projects, 3% of the projects studied were completed within the initially agreed period while 97% were completed after agreed delivery periods (please refer to Table 1.2). One of the major reasons stated for the elongated completion of project was the occurrences of errors in construction documents. Research problem has been discussed in this section next section will state the research problem.

1.3 Statement of the Research Problem

Walker (1994) worked on different factors that cause errors in construction documents in general, but not on the mechanism of such influence. Atkinson (1999) in his doctoral research extensively worked on the management of errors in construction projects in the UK. He examined the defects problem during the construction phase from the viewpoint of human error. Atkinson's qualitative research drew causes of error from available literatures and developed models. Stasiowski (1994) carried out investigations in the area of detecting errors

in construction documents and their effect on the project but did not work on the causes of such errors. Mohammed (2007) in his doctoral research extensively researched on the relationship between errors that occur in construction design documents in Saudi Arabia and their possible causes, which resulted in an exploratory system dynamics model to reduce the occurrence of errors in design documents.

The types of design errors (Atkinson, 1998; Love et al, 2011; Chapman, 1991), factors responsible for design errors (Palaneeswaran, et al, 2007; Shelton, 1999; Endsley, 1999, Barkow, 1995) and effects of design errors (Love et al, 2008, Oyewobi, et al, 2011; Mohammed, 2007) on construction projects have been studied by authors outside the Nigerian construction industry. The causes and qualitative effects of construction documentation errors by Dosumu & Adenuga (2013) were carried out in Lagos state of Nigeria. Dosumu & Iyagba (2013) compared the responses of consultants and contractors on causes of errors in construction documentation and also in Lagos state of Nigeria. Ebekozien, Uwadia &Usman (2015) examined the causes and qualitative effects of construction documentation errors were carried out in Edo state of Nigeria. This research work has the objectives to investigate on a larger area of Nigeria in seven states, the robust definition, types, causes, qualitative and quantitative effects of construction documentation error, in addition to mapping of causes to types of error, the frequencies of occurrences of types of error and developing a framework supported with guidelines for the minimisation of errors in construction documentation in Nigeria. Nigeria is a nation with thirty six states. The earlier studies in Nigeria (one state each in Southern Nigeria) may not be able to produce enough strength to curb documentation errors in Nigeria because of the small area of coverage. This work covers a good portion of the Southern and Northern Nigeria. This current work which takes care of many sides of documentation error and on a larger scale and area will produce overall better results. The effects of errors in construction documents are both numerous and devastating on construction projects. Some of the effects that are identified in literatures include design-induced rework

(Love, 2002; Love *et al.,* 2008), propagation of failure (Vrouwenvelder, *et al.,* 2009), structural collapse, financial loss, inconvenience, deterioration of buildings, personal injury and sickness, time delay, damaged equipment (Barkow, 1995), defects, wastages and inconveniences (Palaneeswaran, *et al.*, 2007), conflicts and ambiguities (Olatunji, 2011). Others are cost overrun (Mohammed, 2007), procurement systems problems (Rashid, *et al.*, 2006), incomplete designs, change order, rework, construction delay, etc (Alarcon & Mardones, 1998). As a result of the adverse effects of errors in construction documents, it is important to identify factors that are responsible for them so that the professionals involved in the preparation of the documents and other stakeholders can be aware of them and work against them. There is therefore, the need to develop an intervention strategy that will tackle the causes of errors in construction documents in Nigeria, so that the appearances of all types of error, qualitative and quantitative effects of errors in Nigeria can be greatly minimised. The intervention strategy is the development of framework that will minimise the documentation error, which this study seeks to achieve. Statement of the problem was discussed in this section next section will focus on justification for the research.

1.4 Research Justification

The effects of errors in construction documents have devastating effects on construction economy in Nigeria. This is because the presence of error in construction documents has strong links to cost overrun, time overrun and poor quality job (Williams, 2010). The potential of the construction industry in generating employment is enormous; it is estimated to be responsible for about 7% of global employment. Construction industry contributes about 10% to the world's GDP. The industry consumes about 40% of total energy consumed around the globe, thus making it one of the largest energy consuming sector in the world. Resource allocation in the construction sector amounts to 50% of the total resources utilised in the world (Qs Connect, 2014). An error in contract document is a considerable economic loss and

probably exceeds that of tragic failure (Rollings & Rollings, 1991). Researchers have indicated that a 10% improvement in construction activities will lead to a 2.5% in Gross Development Product GDP (Stockel & Quirke, 1992). In Nigeria, construction industry contributes about 4% to the Gross Development Product (Moneke, 2014). Minimising errors in construction document will minimise cost overrun and time overrun. When cost overrun is minimised there will be more money to invest and therefore the GDP will increase, thereby raising the conditions of living of the nation's populace. In this respect the attempt to minimise errors in construction documents is justified.

Rework involves re-doing a work that was incorrectly executed because of the earlier faulty documentation. Rework is the necessary activity that takes place, when the earlier design is incorrectly done. This is an endemic feature of the project procurement process and is one of the primary causes of cost and time overruns (Mohammed, 2007). The direct cost of rework in the construction industry is considerable and has been found to be 10-15% of the contract sum (Burati, et al, 1992; Construction Industry Development Agency 1995). Rework which is a corrective work has been estimated to be as high as 20% of the design consultant's fee for a given project (Gardiner, 1994). Josephson (1998) showed that design errors result to 4.4% of the contract sum. Barber et al, (2000) also discovered that design errors add 5.9% of the contract value. Rework takes a good time and elongates delivery period by 7.1% of the normal time (Josephson, 1998). Rework which results into cost and time overruns will greatly reduce if such errors are minimised. All these unnecessary extra cost and time can be avoided if construction documents' errors are minimised, which this research seeks to achieve.

Project cost arrived at by the Quantity Surveyor from cost calculations of the various designs and drawings became unrealistic because of the errors embedded in the designs. Observations have shown that the contingency sums included in the bills of quantities most times, cannot cater for cost escalation resulting from errors in documents (Adafin et al 2013). According to

Ayodele & Alabi (2011) unrealistic estimate many times, results into abandonment of building projects and this is very rampant in Nigeria. Reduction of errors emanating from construction documents ordinarily will result to realistic estimate all things being equal. When errors are minimised in construction documents, realistic estimate will emerge.

Construction clients want to obtain their quality project at the normal cost and time. Any increase as a result of errors in construction documents will alter their desire. Reduction of errors in construction documents will make them stay within the limits of cost and time, and may result into being able to make more investments in the future. Occurrence of errors in construction documents creates a poor impression of the consultants and possible loss of future business (Mohammed, 2007). Developing framework for the reduction of errors in construction documents will increase reputation of consultants, as they may likely be invited for future jobs. Contract claims on building projects always lead to cost overrun and at times disputes, often times these are unsatisfactory to the clients. If errors are reduced in construction documents, claims also may be reduced in the future. Defects in buildings, certain times, lead to collapse of such buildings. Farrington (1987) discovered in his study of nine projects that design errors accounted for 79.1% of the total cost of quality defects. Josephson (1998) revealed that 42% of the defects were caused by errors in Architects designs. Defects with respect to design error will be greatly minimised if design errors do not occur or rarely occur. Buildability refers to the possibility of construction of the element of work to make it fulfil the desired goal. Errors in designs can result into an element not buildable. When such element is not buildable, the aspect has to be re-designed. Redesigning add to more time and money to the project design and construction. When errors in designs are minimised, buildablility can also be made effective. Having discussed the justification for this study in this section next section will focus on research aim and objectives.

1.5 Research Aim and Objectives

Aim of the Research

The aim of this research is to develop a framework supported with guidelines for minimisation of errors in construction documents in Nigeria by exploring causes and effects of errors.

Research Objectives

The research aim will be achieved through the following objectives:

1) To document a robust definition of construction documentation error
2) To determine the common types of errors in construction documentation in Nigeria
3) To identify the causes of errors in construction documentation specific to Nigeria
4) To examine the quantitative and qualitative effects of construction documentation errors on construction projects and economy in Nigeria
5) To explore causes to the common types of error in construction documentations in Nigeria
6) To critically analyse the frequencies of occurrences of the common types of errors in construction documentation in Nigeria
7) To develop a framework supported with guidelines for minimization of errors in construction documents in Nigeria.

1.6 Research Scope and Limitation

The problems raised in this study i.e. errors in construction documents, is international in nature. This research work is limited to the Federal Republic of Nigeria because of the significant scale of errors in construction documents in Nigerian construction industry. As obtained in the other parts of the world, Nigerian construction industry can be divided into three, namely- building industry, civil engineering industry and heavy engineering industry.

The study is limited to building industry projects because of availability of data, limited time and fund for the study. This research concern is focused on building (construction) documents produced by Nigerian professionals; that include architectural drawings, specifications / schedules; structural drawings, specifications / schedules; electrical drawings, specifications / schedules; mechanical drawings, specifications / schedules and the bills of quantities / preambles to trades. This study will cover construction documents preparation from inception to feasibility, outline proposal, sketch design, detail design, and bill of quantities stages and also include the specifications and preambles to trades. In other words documentation from inception up to, just before the contract is signed, is examined in this study. The study will be limited to the six states of south western Nigeria (Ondo, Ekiti, Osun, Oyo, Ogun and Lagos states) and Federal Capital Territory (located in Northern Nigeria) because of the large volume of building construction work being executed there. The study area is limited to the areas mentioned because of limited time and fund for the study and because the areas are free from security breach.

1.7 Research Methodology

This research aims to develop a framework supported with guidelines for minimising the occurrences of errors in construction documents in Nigeria. The onion research model consisting of six layers was adopted for use in the methodology of this research. The six layers are: research philosophy, research approach, research strategy, research choice, research time and research techniques and procedures. On research philosophy; the subjectivism option of ontological stand point was utilised. Also the Interpretist option of epistemological stand point was made use of. The value-laden option of axiological stand point of research philosophy was adopted. Research approach adopted deductive reasoning, research strategy made use of survey method, research choice adopted the multiple method. Research time utilised cross- sectional horizon while research techniques adopted the use of

literature survey, interview and questionnaire. The research procedures adopted the use of statistics as – content analysis, relative importance index, severity index and percentages to analyse data because they were best suited for it. The literature is utilised to survey the definitions of error from different authors and determine the general causes, types and effects of errors in construction documents in Nigeria. The structured questionnaires were used to evaluate the common causes, types and effects of errors in construction documents in Nigeria. The questionnaires data were used to map the causes to types of error and to determine the percentage occurrence of each of the types of error. The questionnaires were distributed to architects, civil engineers, electrical engineers, mechanical engineers, quantity surveyors and contractors that had practised in the six states of south western Nigeria and Federal Capital Territory and have had at least seven years professional experience. The samplings of construction professionals were determined through purposive and random samplings. The questionnaire data collection for research objectives 2, 3 and 4 were first collected and analysed. Thereafter data collection for research objectives 5 and 6 were done. This is because they are based on the findings of research objectives 2, 3 and 4. Methodology for this research will be fully discussed in chapter four of this thesis.

1.8 Research Outcomes

The outcome of the study is the development of a framework with the support of guidelines that will help in minimising errors in construction documents in Nigeria. All the activities that led to achieving the research objectives were very useful in the development of the framework. The activities that led to achieving the research objectives and including the items on the framework are very important and will be discussed in this section. The framework is presented by a flowchart. The outcomes:

1) Exposed the common causes of errors in construction documents in Nigeria. Problems are easy to solve when the causes of the problems are known. Therefore exposing the

causes of documentation errors will help to remove the errors by working against the causes. The common causes errors in construction documents in Nigeria are: non – availability of information, poor communication, inadequate project brief, poor salaries of professionals, non – identification of project risks, inadequate consultant professional education, inadequate consultant professional experience, inadequate project manager experience, time scheduled pressure, inadequate project planning, complexity of project, concurrent documentation, heavy work load of consultant, poor consultancy fees, inadequate document preparation time and inadequate documentation manager experience. When these causes are worked against all types of errors that appear in construction documents disappear with all the attendant effects.

2) Exposed the common types of errors in construction documents in Nigeria. This will identify the errors that exist in construction documents by name. The names of common documentation errors in Nigeria are: unnecessary additions, non – conformance to client requirement, non – conformance to design code/SMM, absence of specifications, dimensional error, miscalculation, scanty specification, wrong specification, omission of necessary item and incorrect details. All these types of error will disappear in documents when the causes of errors are worked against.
3) Showed the qualitative and quantitative effects of documentation errors in Nigeria. Qualitative effects will create the awareness of the social and economic negative effects of documentation errors on building owners / occupants, which are: defects, building collapse, loss of human lives, financial wastage, material wastage, cost overruns, time overruns, abandonment of project, rework, dis-satisfaction to clients, bad reputation of consultants, loss of confidence in consultants and deterioration to buildings,. Quantitative effects will create the awareness of percentage increase in contract sum and also percentage increase in delivery period which have been discovered in this study to be 20.39% and 11.07% respectively. The knowledge of

qualitative and quantitative effects of documentation errors will instigate stakeholders to quickly get rid of errors in construction documents in Nigeria. It will also make stakeholders to always want to construct building projects with error free documentations. All these qualitative and quantitative effects will disappear when causes of error are worked against.

4) Showed the origins of documentation errors as Government, Client and Consultant. Having known the specific origins of causes of documentation errors, recommendations can directly be made to each of them to work against causes of errors. Causes of errors from (a) Government is poor consultancy fees, (b) Client are: inadequate education of consultants, inadequate experience of consultants, inadequate experience of project manager, inadequate experience of documentation manager, inadequate documentation time, inadequate construction time and inadequate project brief, and (c) Consultant are: concurrent documentation, heavy work load, non-identification of risks, non- availability of information, poor communication, project complexities, inadequate project planning and poor salary of professionals. Knowledge of the causes of document errors and their origins will make the origins ie government, clients and consultants act swiftly to stop causes of error that originate from them.

5) Mapped causes to types of documentation errors. This creates the awareness of the types of errors that are associated with certain causes of errors. One of the objectives of this research is the mapping of causes to types of document error. Being aware of the types of error will help stakeholders concentrate minimization efforts on certain causes that go with the type of error concerned. It also enables professionals to understand the types of errors that are eliminated by dealing with certain causes of error.

6. Assessed the frequencies of causes and types of errors. This has given the knowledge that some errors occur more than others in construction documentation in Nigeria. Having the knowledge of this will make the stakeholders concentrate their minimisation efforts on the types of error with very high frequency and then move on in descending order. The frequencies of types of error in this study are in descending order as follows; Scanty specification as a type of error occurs in 99.24% of projects executed within the last 10 years by respondents. Omission of necessary items occurs in 92.62% of past projects, non-conformance to design code / SMM in 85.31% of projects, incorrect details in 85.26% of projects; non- conformance to client's requirement in 82.53% of projects; miscalculation in 76.93% of projects; absence of specification in 67.79% of projects; dimensional error in 60.89% of projects; unnecessary additions in 55.69% of projects and wrong specifications in 53.91% of projects. In this practical sense, stakeholders will put more efforts, first on eliminating scanty specification, then omission of necessary items and so on.

6) Stated a robust definition of construction documentation error. The contents of the definition showed the kind of error referred to, in this research. It has also added to the definitions of design errors in literatures. The definition of error considered within this research can therefore be summarised as something that causes deviation from correctness or standard, which makes the document not being able to achieve its intended purpose with respect to any of cost, time and quality.
7) Explained the implementation of the documentation error minimization process. This section will help stakeholders to propose solutions for minimization of documentation errors, step by step and in good detail. This is referred to as guidelines.

   The framework developed in this study is different from error reduction technique of Mohammed (2007), this is because that study took place in Saudi Arabia and took into consideration the type of errors that appear most among other errors on a particular project construction documents. It is very different from Atkinson (1999), this is

because that study took place in UK and it examined the management of error during construction stage.

The framework developed in this study is also different from other design error reduction techniques known around the world such as: taguchi approach, redicheck method, red-green-yellow checking technique, design review management, value management, activity based, failure mode and developing a corporate memory.

Taguchi Approach is a method where designs pass through three steps of quality, namely, system design, parameter design and tolerance design. Through this method the occurrences of types of error are minimised (Bendell, 1998). Redicheck Method, has a methodology that involves setting up of design documentation reviewers charged with the responsibility of reviewing the already produced designs to point out types of errors for removal (Statiowski & Burstein, 1994). Red- Green- Yellow method creates a situation where designs are reviewed by key design members, after which the reviewed designs are sent to the team leader who will either approve or disapprove the earlier recommendations on review (Statiowski & Burstein, 1994). Development of corporate memory which needs to do with learning from mistakes on previous projects so that they will not re-occur in future projects (Stassiowski & Burstein, 1994). Design Review Management creates a situation where technical reviews, constructability and operability reviews take place. This method points out the types of errors to be removed (Kirby et al, 1988; CII, 1986). Value Management creates a situation for elimination of unnecessary items, thereby minimising design changes and design errors (Mc Gregor et al, 1997). Failure Mode and Effect Analysis is a situation where a team of professionals are charged with the responsibility to identify all possible failures that could occur (Ledbetter & Burati, 1989). Activity Costing creates a situation where professionals are charged to identify value- added

and non- value- added activities in an organisation. This is also to remove occurrences of errors in designs (Gunasekaran & Sarhdi, 1998).

All the error reduction techniques mentioned above handles removal of types of errors which is on the surface, while document error minimising framework developed from this research will remove the causes. Removing the causes means pre- empting the occurrences of all types of errors from the roots. This is based on Juran's philosophy of quality management that in solving quality problems deal with the problems from the roots (Stassiowski & Burstein, 1994). Research outcomes have been discussed in this section next section will discuss the structure of the thesis.

1.9 Structure of the Thesis

This thesis is divided into six chapters. A brief breakdown of the chapters and what the researcher seeks to address in each chapter are as follows:

Chapter One: This chapter commences with the background to the study. It also introduces the research problem, statement of the problem, research justification, research aim and objectives, research scope and limitations, research methodology, research outcomes, thesis structure and ends with the summary.

Chapter Two: This chapter commences with the definitions of errors from different authors. It progresses into discussions on general types of errors under erroneous, omission, non-conformance, process, coordination and other classifications from literature survey. The chapter explains the general causes of errors with respect to pre- contract, consultant, client and project character classifications. It ends with discussions on the general qualitative and quantitative effects of documentation errors on the economy, project, humans and social life.

Chapter Three: This chapter provides the definition and significance of conceptual framework. It also displays the conceptual framework for error reduction in the construction

industry as formulated by two previous doctoral theses. The chapter closes by stating the conceptual framework for the current research work.

Chapter Four: This chapter on research methodology centres on the onion research methodological model. The chapter begins with the types of research methodological models and continues with discussions on research philosophies, research approaches, research strategies, research choices, research time horizons and research procedures (data collection). The chapter continues with discussions on sampling, validation and reliability of instruments and administration of questionnaire. The chapter states the general information on the respondents, statistics for data analysis and validation of results.

Chapter Five: The chapter shows the presentation and the analysis of data. Data presentation in this chapter consists of analysis of the definitions of construction document error, types of error in construction document, causes of error in construction document, effects of error in construction document, effect of error in construction document on humans, mapping of causes to types of error, frequencies of occurrences of types of error and the development of guidelines that will support the framework for minimising errors in construction documents. This chapter also provides discussions on the types, causes and effects of error identified in the construction documents with respect to similarities and/or dissimilarities with findings of past authors and researchers. It provides explanations on the causes of document error with respect to the current situations that led to negative effects and the suggested situations as a way out of the problems.

Chapter Six: This chapter reflects on the aim and objectives of this study to see how they have been achieved. The documentation error minimisation framework supported with guidelines is also presented and recommendation follows. The chapter also discusses the contribution of the study to knowledge, application of the study and suggestions for future research. Having discussed the structure of this thesis, it necessary to summarise this chapter which next section seeks to do.

1.10 Summary

This chapter has provided a brief introduction and background of this research. The research problems, statement of the problem, research justification, research aim and objectives, research scope and limitations, research methodology and the research outcomes have also been provided. The chapter closes with the structure of the thesis and the summary. It is crucial for any research that extensive literature review need be conducted to ensure that a thorough understanding of the research area is obtained. Therefore, the following chapter will review the current literature related to this research.

CHAPTER TWO

LITERATURE REVIEW

2.0 Introduction

This chapter commences with the definitions of errors from different authors. It progresses into discussions on general types of errors under erroneous, omission, non- conformance, process, coordination and other classifications. The chapter explains the general causes of errors with respect to pre- contract, consultant, client and project character classifications. It ends with discussions on the general qualitative and quantitative effects of documentation errors on the economy, project, humans and social life.

2.1 Definition of Error

There is no such a thing as a perfect design in construction projects. Therefore professionals must expect some design faults and that those design problems will translate into construction problems (Acharya, et al, 2004). An error is a deviation from accuracy or correctness, while a mistake is an error caused by a fault: the fault being misjudgement, carelessness or forgetfulness (Acharya, et al, 2004). It can therefore be said that mistake is a sub-set of error. One of the objectives of this research is to document a robust definition for construction documentation error but before this is done it is necessary to survey the different definitions of design error in literatures. The definitions of design error from authors of different backgrounds are summarised in Table 2.1.

Table 2.1: Definitions of Construction Documents Error

S/N	Author	Definition
1	Bea (1994)	Error is defined as "a departure from acceptable or desirable practice on the part of a group of individuals that can result in unacceptable or undesirable quality".
2	Reason (1990)	The term error refers to occasions where a planned sequence of mental or physical activities does not achieve its intended purpose, especially when these failures cannot be linked to intervention of some chances.
3	Senders et al (1991)	Error is defined as something that has been done which was not intended by the originator, not desired by a set of rules or an external observer, or that leads the task or system outside its acceptable limit.
4	Busby (2001)	Errors are the occurrences which were not expected, which involve surprise and which could not be linked entirely to chance.
5	Stewart (1992)	Human error is an event or process that departs from commonly accepted competent professional practice.
6	Edmonson (2002)	Error is the execution of a task that is either unnecessary or incorrectly carried out.
7	Bullon (2015)	Error is a mistake, especially one that affects the result.
8	Hollnagel (1993) & Wood et al (1994)	Erroneous actions are actions that do not lead to expected end and or which emits unwanted outcomes or the results are undesirable.
9	Ayinuola & Olalusi (2004)	Error is an unacceptable difference between the expected and the observed performance.
10	Sowers (1993)	Error is a departure from acceptable or desirable practice on the part of an individual that can result in unacceptable or undesirable results.
11	Mohammed (2007)	Error is a non-desired condition and the non-fulfilment intended requirements (stated or implicit).

12	researchClue.com	Design error is a deviation from drawing or specification also including omissions and ambiguities.

From the above, it is obvious that each of the definitions in Table 2.1 reveals that:

(1) There is a standard to be followed in order to achieve a purpose.

(2) The standard is either discarded or not completely conformed with.

(3) The gap between (1) and (2) above is the error.

Having defined what constitute error in this section, next section will explore the different types of document errors.

2.2 Types of Construction Document Error

One of the objectives of this thesis is to identify types of documentation errors specific to Nigeria but before this is done it is very necessary to identify the different types of error through literature survey. Types of error according to Mohammed (2007) are classified into six categories (please refer to Table 2.2). They are: erroneous, omission, non-conformance, process, coordination and others will be discussed in detail with respect to the types of errors under each of them.

Table 2.2: Classification of the types of errors (source: Mohammed, 2007)

S/No	Classifications	Types of error
1.	Erroneous	- Designer error - Errors in bills of quantities - Error in specifications - Miscalculation
2.	Omission	- Additional views/detail needed - Missing or incorrect and notes on the

		drawings
3.	Non-Conformance	- Non- conformance of document to vendor data - Non- conformance of document to design calculations - Non- conformance of document to clients criteria - Non- conformance of document to code/SMM - Non- conformance of document to law (e.g. conformance to Nigeria products) - Non- conformance of document to building regulation
4.	Process	- CADD problems - Document does not conform to drafting standard - Dimensional errors - Errors in symbols and abbreviations
5.	Coordination	- Coordination problem between disciplines - Coordination problem within the same discipline
6.	Others	- Operability problem - Constructability problem

1. Erroneous**:** The types of error here are errors that occur when an aspect on design is based on wrong information. These include designer error, omission in bills of quantities, miscalculation and error in specifications.

a) Designer error

Nikkie Construction (2001) reported some examples of designer errors. Also, Kirby et al (1988) and Morgen, (1986) discovered that 56% of all contract modifications are made to design deficiencies. These types of errors are considered to be the most serious by Mohammed (2007) because they are related to the pure mistakes of the designer owing to the

lack of education, knowledge or experience. These errors are in form of missing items and missing consideration of some important items in the design. These errors may cause the documents not to be able to deliver the purpose of the project. Also, this type of error leads to claims for extension of time and compensation of costs as a result of the extra time required to correct the errors. Designer error as a type of error is common in documents produced in Lagos state of Nigeria (Dosumu & Adenuga, 2013).

b) Errors and omission in the bills of quantities

The practice of pricing the project in most contract procurements is dependent on the bills of quantities. Researchers have identified errors and omissions in the bills of quantities as a main source of variations in the construction projects (Choy & Sidnell, 1991). According to Dosumu & Adenuga (2013) omissions and ambiguities type of error are very common in construction documentation in Lagos state of Nigeria. However, the influence of this type of errors on the project depends on the procurement of the contract selected for the execution of the project. The main types of errors found under this heading according to Mohammed (2007) are: wrong description of items, missing items in the bills of quantities, wrong measurement, items included in the bills but not shown in the drawings and wrong unit of measurement. The emergence of these errors will ordinarily create very bad impression on the professionals and reduce their reputation.

c) Error in specification

Error in specification can be in the form of absence of specification, scanty specifications or wrong specifications. According to AIA (1994), the specifications present "written requirements for materials, equipment, construction system as well as standards for products, workmanship and the construction services required to produce the work''. Errors in this regard include missing items in the specification, items included in the drawings but not in the specification or vice versa, items that do not conform to the client's criteria, the list of incorrect applicable applications or inconsistency with industry practices. When these types of

errors are discovered during the construction stage claims will be raised for either cost or time extension, or both. Scott (1990) opines that the object of specification "is to communicate to someone on how something is to be done, so that specifier's intention is clearly understood without doubt or ambiguity in order that there will be no confusion in the mind of the person who is to perform specified tasks". Jagboro (1996) pointed out that specification breaks down the interrelated information shown on drawings into separate organised orderly units of work and generally describes the followings: type of quality of materials, equipment and fixtures, quality of workmanship, methods of fabrication, installation and erection, test and requirements of British Standard, codes of procedures and catalogue references for manufacturer's equipment. In a study on Nigerian environment on the utilisation of specifications please refer to Table 2.3.

Table 2.3: Extent of utilisation of specification (Source: Ayodele & Ayodele, 2011b)

S/N	Content of Specification	Severity Index
1	Type and quality of materials	42.0
2	Type and quality of workmanship	42.0
3	Methods of fabrication and erection	6.46
4	Test and requirement of BS and code of procedure	0
5	Catalogue references for manufacturers equipment	0

From Table 2.3, type and quality of materials, and type and quality of workmanship are reflected on construction documents to a level below average (42.0 for each of them). For these first two items, specification is partially or scantily utilised. Item number 3 is almost absent in designs. Items 4 and 5 are absent in construction documentations. These and the assertion of Olotuah (2009) that designs are not accompanied by specification, and Aqua Group (1990) that specification has frequently been abandoned, agree that absence of

specification is a type of error. Wrong specifications are also frequent on drawings; that may be because of the low educational qualifications of the designer, and inexperience of the consultants. Ayodele & Ayodele (2011b) discover and itemise effects of scanty and non-use of specifications as: emergence of the use of substandard materials and workmanship, which may result to building collapse; it may also lead to delay in project completion and cost overrun; and it may also result in project abandonment. According to Mohammed, (2007), this type of error represents 4% of the total number of errors in projects in Saudi construction industry.

d) Miscalculations

All the documents, designs and bills of quantities are set in order through calculations. According to Mohammed (2007) miscalculations have been in form of adding lengths together to make a whole, on drawings and also in the form of additions, subtractions, multiplication and division as it relates to figures in the bills of quantities. This error in form of arithmetic and pricing errors are very frequent in bills of quantities in Nigeria (Dosumu & Adenuga, 2013).

2. Omission

This type of error occurs when some information or aspects of design are missing. This refers to additional views or details needed and missing or incorrect notes on the drawings.

a)Additional views or details needed

Additional views or details needed are the third category of non-conformance in the shop drawings. The documents need more details to be clear and understandable due to the ambiguities in the current situation of the documents. This is because, the documents do not transfer the information to the contractors for construction purposes clearly enough as they should. This type of error might raise many queries during the tender stage. It may also attract claims for extension of time during the construction stage if the details are missing or the design is not clear (Stasiowski et al (1994).

b) Incorrect or missing notes

AIA (1994) states that notes are the texts on the drawings which convey the intent of the drawings and clearly describe the contents or set up the conditions for the applicability of the design in the drawings. Construction Project Information Committee, CPIC (2003) opines that written information on drawings often lead to poor coordination because it can be difficult to ensure that all affected drawings are changed. The error in this category include the following: when the information is not applicable to the drawings, when the information describes wrongly what it is meant to be or an additional note is needed to make the drawings understandable. This, in other words, is when texts on drawings are missing or the content is vague. This type of error might result to requests for time extension and cost claims by the contractor and is frequent in construction documentations in Lagos state of Nigeria (Dosumu & Adenuga 2013)

3. Non-conformance:

These types of error occur when there are aspects of design or documentation that do not conform to established rules. Non- conformance of document to vendor data, non-conformance of document to design calculations, non- conformance of document to clients criteria, non- conformance of document to code/SMM, non- conformance of document to law e.g. conformance to Nigerian products, non- conformance of document to building regulations.

a)Non-conformance of document to vendor data

Dissanayaka & Kumaraswany (1997) identify that the lack of involvement of key subcontractors in the partnering process had a negative effect on project performance. Every vendor has his own equipment, specification, material and requirements for his product to get the best performance. The errors may be due to incompatibility of equipment, out-of-date specification and inappropriate materials. This type of errors may delay the project and raise it's cost as a result of the variation orders. It is essential that the client has to

approve vendors at the early stage of the design. Early involvement of the vendors in the documentation process can help the designer to reduce such errors.

b) Non-conformance of document to design calculations

Every profession has some standard used for it's calculations. Failure to adhere to these calculations will result in violation of the codes and failure of the system used for that profession. This type of error is usually the results of lack of experience of the designer, carelessness or pressure of time. This type of error is not easily discovered during the process of documentation. However, it might be discovered, if the error is obvious or the design is very bad. If the error is discovered during the construction stage it will raise the contractor's variation; he may ask for an extension of time and make claim for the extra cost. The designer will be made to correct the error at his or her own expense (Mohammed 2007).

c) Non- conformity of document with client's criteria

Projects normally start with a statement of what the project is about; it's goals, it's scope, it's requirements, activities to be accommodated, and the development of the construction documents. The client sets the scope, quality and the budget of the project. The proposed project is given a detailed definition to understand what it is all about, the facilities and amenities required, the time the project is needed and the cost (AIA, 1994). Kirby et al (1988) and Morgen (1986) identify the major cause of contracts modifications as alterations based on request from the user. If the documentations fail to address the requirements stated above and the constraints set up by the clients in the brief, it will be considered as an error. Also, Love et al (1999) discover that errors in the design stages of the project are the result of lack of comprehension and wrong interpretation of client's requirements. Contractually, the designer is obliged to develop a design solution based on the approved project requirements and constraints. If the documentations fail to address the requirements of the client's brief, the client has the right to direct the designer to correct the error. As earlier observed, failure

to address the requirements of the client at the early stage of the documentation development process will result to a rise in the cost of change at a later stage.

d) Non-Conformity of document to Code/SMM.

Dosumu & Adenuga (2013) made this finding among others that non- conformance to design codes is one of the types of errors in Lagos state of Nigeria. According to AIA (1994), the building code is the primary regulatory measure for the design of buildings. This is because it provides the fundamental design parameters for a large number of design and construction details. Non-compliance with the building code in construction documents is an evidence of negligence on the part of the designer. Failure to conform to the code at the beginning of the project will result in design alteration later and will delay the project. This type of error can be discovered during the documents approval by the plan approving authority. If not, it will be discovered at the final checkup of the project after construction. If however, the violation of the building code is not discovered until the occupation of the project, it can cause injury to the building users and expose the designer to legal liability and possible revocation of their licenses. If the error is discovered during the construction stage, the delay and rise in cost could be enormous for the client, who may run after the designer for the payment of the changes caused by the errors.

e) Non-conformance of document to the law

This is the type of error that emanates from non-conformance to the law used for certain types of projects and clients. When such errors are discovered during the construction stages, it will cause a delay in the project and may add to costs for the client as a result of the increase in the price of local materials (Mohammed, 2007).

f) Non-conformance of document with building regulations

Every project is governed by regulations and design parameters. Regulations for development are established by persons concerned so as to protect public welfare and conserve environmental resources. AIA (1994) opines that it is important that designers

comply with regulations unless they obtain specific instruction allowing alternative solutions. Regulations here include: zoning requirements, planning regulations and environmental regulations. According to Walker (1994), in Australia, the most serious cases of lost time and lost cost resulted from changes to design documents arising from design errors and incompatibilities in design details with building relations. NEDO (1988) identifies incompatibilities in design and design details with building regulations as a source of errors in construction documents. The occurrence of this type of error could result to delay in project and may raise the cost, from variation order given during the construction stage.

4) Process

These are types of error that occur as a result of the process of preparation of documents. Types of error in this respect include: CADD problems, non- conformity of document to drafting standard, dimensional errors, errors in symbols and abbreviations.

a)CADD – related problem

This type of error is connected to the capability of computer aided design and drafting (CADD) software used and the setup of the CADD standards and procedures. They are mainly connected to coordination problems between files and updated background files of other disciplines; which generate errors in the construction documents. However, organisations such as AIA (1994) have recognised the importance of CADD in the process of producing the construction documents and have set up procedures for CADD implementation and usage; following such procedures will have a lot of influence on the productivity of the designer and reduce this type of error. This type of error may affect the completion time of the projects and lead to claims from the contractor. This is because more time might be needed to resolve problems and update drawings (Mohammed, 2007).

b) Non-conformity of document to drafting standards

According to AIA (1994), to facilitate the production of construction documents and to make it easy for other people to read and understand, most offices employ documentation standards. These standards may address subjects such as:

1) Drawing sheet sizes, layout, scale, sequence, and numbering
2) Line thickness and lettering sizes
3) References within the documents
4) Notes and abbreviations
5) Dimensioning.

Errors in these standards will confuse contractors and result to misunderstanding while costing the project. Audi et al (2003) define clarity as one of the attributes of documentation quality. This type of error may tarnish the image of a designer as clients or contractors may not like to work with them in the future.

c) Dimensional error

Dimensioning requires an understanding of the sequence of construction. This is because new assemblies can only be located with respect to assemblies already in place. Necessary dimensioning should be numerically portioned on the drawings. This is because the contractors are not expected to depend on scaling the drawings for dimensioning. The drawing should contain the minimum dimensioning consistent with this concept (Mohammed, 2007). This type of error may sometimes increase the completion time of the project because the contractor has to wait for clarification from the designer about conflicting or missing dimension and frequently occurs in construction documentations produced in Lagos of Nigeria (Dosumu & Adenuga, 2013).

d) Symbol and abbreviation errors

The use of many symbols and abbreviations originate out of the need to communicate a lot of information in a limited space. According to AIA (1994), good practice suggests that these be defined early in the documents and used consistently. Also, designations on the drawings

should be consistent with the ones used in the other parts of the construction documents such as schedule and specifications. This type of error will lead to misunderstanding and confusion about the documents which might lead to requests of extension of time resulting from time wasted while waiting for a response from the designer.

5. Coordination

These are errors that occur as a result of poor coordination during documentation. These include coordination problem between disciplines and coordination within the same discipline.

a) Interdisciplinary Coordination Problem

According to Mohammed (2007), this type of error occurs at the coordination problem between plans, elevations, sections and the detail drawings, between the elevations and the drawings or between the drawings and the specifications. This finding was supported by the implementation of a general interdisciplinary coordination review system which has minimmised construction costs on projects by as much as 7%, and by reducing the number of variation (Nigro, 1987). When the number of errors in the document increases, many queries will be raised during the tender stage and this will create a negative impression on the designer. On the other hand, if this type of error is not discovered during the documentation process, it will result to problems later at the construction stage. This will result into claims for extension of time and extra costs.

b) Discipline coordination problems

According to NEDO (1987), the design process is difficult to control when there are several disciplines to bring together, especially when each of them can affect the performance of others. Nigro (1984) says that above 50 percent of the errors and omissions in construction drawings, and specifications are caused by poor coordination between design disciplines. Poor design coordination may be as a result of inadequate attention given to detailed design, much as overlapping of design and construction can save time for the client, it may on the

other hand cause delays during the construction phase from problems associated with the design coordination and design detailing. In most cases, this type of error is discovered during the review process of the quality assurance of the documents. Under the traditional procurements, the contractor has the right to claim extension of time and compensation for extra cost for correction on the drawings, if errors are discovered during the construction stage. However, if the number of errors in the document is on the high side, it will create a bad impression of the designer during the tendering stage (Mohammed, 2007).

6. Others**:** refer to operability and constructability, problems.

a) Operability problem

Operability is the ease to which a project is operated and maintained (Kirby et al, 1988). When the decisions are not taken as shown in the construction documents, it may negatively affect quality, that is, client's satisfaction. This may increase the maintenance cost during the occupancy of project. It is considered an error since it defeats the purpose of the construction document. This type of error can be linked to error of the designer due to lack of knowledge or experience. The seriousness of this error lies in the difficulty of discovering the errors in the construction documents; this is because it can only be discovered by experienced personnel. The occurrence of this type of error is serious because it is not normally discovered during documentation but when the project is put to use. This error usually lives in the project for a long period of time after the design team has completed her work. The long-term effect can be destructive as it can tarnish the image of the design firm. In that case, the user of the project has to either live with the error or repair it at an expensive cost.

c) Constructability problem

This is rated as an error because it defeats the purpose of the construction document and is common in documents in Lagos state of Nigeria (Dosumu & Adenuga, 2013) According to Patrick et al (2006) and Hon et al (1989), constructability and buildability are similar; the two terms can be used interchangeably. However, Kirby et al (1988) defines constructability

as the compatibility of the design with the site, materials, methods, techniques, schedules and construction. Constructability is commonly known as the optimum use of knowledge and experience in construction in different project stages to achieve ultimate project goals (CII, 1986; CII Australia, 1996a; Arditi et al, 2002). Just as it is in the case of operability, the seriousness of this error is in the difficulty of discovering the error in the construction document as they will only be discovered by experienced personnel. This type of error can be attributed to the error of the designer due to the lack of construction knowledge and experience. Audi et al (2003) discover that the designers acknowledge that lack of construction knowledge had been a major problem that results to producing non-practical designs. Often, this problem is as a result of insufficient time allowed for in design. According to Fox et al (2002) and Patrick et al (2006) lack of understanding of building construction on the part of the designer and constructability has received inadequate attention. This has led to wastage and rework. If this type of error is discovered during the construction stage, it may result to costly variations and lead to cost and time overruns.

The types of documentation errors and their classifications have been discussed in this section. It is necessary to discuss on the causes of document error, therefore next section will be devoted to discussions on the causes of construction document errors and their classifications.

2.3 Causes of construction document error

Errors will always occur and reoccur if their causes are not discovered and nipped in the bud. In order to reduce the occurrence of errors, it is necessary to understand the factors that make them occur (Andi et al, 2003b). Juran's quality improvement technique warns against taking the shortcut of going from symptom to solution without first discovering the factors that make them occur (Stassiowski & Burstein, 1994). Cause of error can be defined as a proven reason

for the existence of errors. It has been reported by Whittington et al, (1992) that there are between 3 and 15 causes of a type of error.

According to Mohammed (2007) causes of errors are classified into four. The classifications are done with respect to the sources from which the causes arise. The classifications are:

1. Pre Contract stage
2. Consultant
3. Client
4. Project Characters

Table 2.4 shows the classifications of the causes of errors. Causes of errors are listed against the common sources from which they arise. The classification of document errors into Pre Contract stage, Consultant, Client and Project Characters as shown in Table 2.4, will be discussed in detail with respect to causes of errors attached to each of them.

Table 2.4: Classifications of Causes of errors (Source: Mohammed 2007)

S/N	Classifications	Causes of error
1.	Pre-Contract Stage	- Management organisational structure - Project Manager Experience - Changes to key project personnel - Group organization
2.	Consultant	- Documentation manager experience - Consultant professional education - Consultant experience - Consultant Fees - Documentation Time Documentation team efficiencies - Professionals salary - Number of consultant - Concurrent documentation activities - Amount of work with the consultant - Reputation of consultant - Availability of quality management

		- Effective of documentation team - Communication - Availability of information - Transfer of knowledge and experience between consultants
3.	Client	- Project brief - Type of client - Client experience - Construction time constraint - Planning of project - Identification of project risk - Attitude of clients - Client's point of contact
4.	Project Characters	- Uniqueness of project - Time schedule pressure - Project budgeted cost - Procurement - Complexities of project - Quality

1. Pre Contract Stage: This stage is the period after the inception to a point before the contract is signed. It is the documentation period. The sources of the causes of error include the management organisational structure of the firm handling the documentation, the project manager's experience, changes to key project personnel and group organisation. These are discussed in detail below.

a) Management organisational structure

According to Morris (1994), for organisational forms to achieve effective communication, they have to be appropriately responsive to client objectives, project and external environment characteristics, management style and the organisational cultures of people concerned with the project. It is important for organisation structures to bear in mind the level of risk accepted by the project team. However, this does not mean the number of people on a team, but

instead, getting the appropriate skills and attributes mix in individuals in a team so that it matches what is required of it. Walker (1989) identifies the complex nature of designing organisational structure with respect to interdependency and relationships between teams.

According to Walker (1990) factors shaping an organisation are as follows; company policy, client characteristics, the industrial relations, climate prevailing at the time of projects and available skills of the proposed team which may be affected by changing technology. The study further indicates that characteristics of the project may have a very little impact. Other structural factors such as team motivation, level of integration and company cultural influences may also contribute to the effectiveness of teams. However, many of these structural factors are not easy to measure and model. It should be noted that the implication of these findings is that it may not be wise to assume that models can be easily established to represent an ideal management structure. According to Walker & Hughes (1984), an organisation's structure is necessary to ensure the following:

1 Planning is undertaken to anticipate potential problems, forecast data to investigate plans of action to overcome potential problems and to support decision making.

2Planned courses of action are communicated to concerned parties to allow feedback on progress achieved against the one anticipated.

3. Coordinated action to be undertaken is identified and parties agree to take responsibility for carrying out those actions as communicated.

4. Actions undertaken are supervised to ensure that priorities and objectives are met.

Walker & Hughes (1984) opine that there are situations where a project organisation is established while lines of authority may be blurred, accountability for making and/or carrying out decisions may not be clear, and line of communication between parties to the process may also not be effective.

In the opinion of Thamhain & Wilemon (1996), self- directed teams are seen as a significant tool for orchestrating and eventually controlling complex projects. As a matter of fact, they are gradually taking over the traditional and more hierarchically structured project team. Nevertheless, they equally need a more sophisticated style of management; they depend majorly on group interaction, resource and power sharing, individual accountability, commitment, self-direction and control. These complex projects and their integration also rely, to a very large extent on member-generated performance norms and evaluations rather than hierarchical guidelines, policies and procedures. While this paradigm shift is the result of changing organisational complexities, capabilities, demands and cultures. It also needs radical shift from traditional management philosophy of an organisational structure, motivation leadership and project control. Therefore, traditional management tools, designed specifically for top-down control and centralised command and communications, are no longer sufficient for generating satisfactory results.

This implies that project control has seriously changed from its norms focus of satisfying schedule and budget constraints to a much wider and more balanced managerial approach that focuses on the effective search for solutions to complex problems.

According to Thamhain (1996), the reasons for under-using or rejecting controls can be divided into four as follows:

i. Lack of confidence that tools will produce benefits
ii. Anxieties are the potentially harmful side effects.
iii. Conflict among users over the method or result
iv. The method is too difficult and burdensome or interferes with the work process.

To solve these problems, the management must acknowledge the potential barriers towards project control tools. They must equally deal with them and develop a positive attitude among project team members toward these new tools. This is to avoid rejection before a fair

evaluation is made of their usability and value. Failure to do the above might lead to anxieties, misunderstandings, unpleasant experiences or other unfavourable perceptions.

b) Project Manager's Experience

The project manager's previous experience in handling projects of similar nature goes a long way in leading the project team to prevent errors that occurred in the previous projects. It will also help in the selection of the most effective project team members, selection of the proper procurement of handling the project and transferring the risk to the proper party of the project team (Mohammed, 2007).

d) Changes to key project personnel

It has been identified that humans have been a cause of, and biggest risk of project failure. This is because it is the personnel that undertake the project tasks to achieve the end result (CCTA, 1995). Personnel issues have gained recognition in recent years as being at the centre of effective project management. As a matter of fact, in many cases, project staff turnover, has forced management to abandon projects (Oglesby & Urban, 1986; Aggarwal & Rezaee, 1996). This probably accounts for reasons why industries outside construction have concentrated on the management of human resources. Management of human resources is a special area where the construction industry stake holders should focus.

A change of design personnel and the vacuum created when a member of staff departs is one of the major factors responsible for the number of errors that occurs during different stages of producing the construction documents (Mohammed, 2007). Chapman (1999) opines that this important issue has been over looked by the construction industry. As a matter of fact, changes in key project members influence the performance of the client and designer as well (Mohammed, 2007).

e) Group organisation

Group organisation is one of the factors responsible for the deficient analysis of solutions and wrong decisions during the development stage of the project (Frankenberger et al, 1998). According to the researchers, it is necessary for a close cooperation to exist between group members as the main principles will be well known to each member of the group.

2. Consultant: The consultants are the designers. These include the architect that designs the building project, structural engineer that designs the structural aspects of building, electrical engineer that designs the electrical aspect and the mechanical engineer that handles the plumbing, etc. aspects, and the quantity surveyor who designs the cost of the project. The sources of the causes of errors that relate to consultants include: documentation manager experience, consultant's professional education, consultant's experience, consultant fees, documentation team efficiencies, documentation time and professionals salary. Other sources of error are, number of consultants on the job, concurrent documentation, consultant workload, non-conformance to client's criteria, non-conformance to code/SMM, non-conformance to law and non-conformance to building regulations. These are discussed in details as follows.

a) Documentation management experience

Experience can be described as the knowledge or skill of a particular job that has been acquired through working on the job for a period of time (Mohammed, 2007).

Rounce (1998) suggests that a greater part of the design-related rework generated in projects is caused by managerial practices of architectural firms. Also, Sverlinger (1996) discovers that the most common causes of severe deviations during design were inadequate planning and resource allocation and deficient information and states that the solution for the major faults identified as causing failure in design quality lies in management of the design process. Also, Cole (1990) identifies that the most significant causes of design problem are poor briefing and communication, inadequacies in the technical expertise of designers and lack of

confidence in preplanning for design work. Design management experience is related to the experience of project team leader of each design discipline. Often times, his experience and knowledge will affect the number of errors generated in the contract document. This is because he is responsible for guiding other members of the team to complete the work.

b) Consultant's professional education

According to Dosumu & Iyagba (2013) in a study in Lagos state of Nigeria assert that the designer's level of education in terms of amount and quality influences the generation of errors. Proper education of the professional designer provides all the necessary knowledge about the process of the development of the documents. This includes how to solve the problems, how to communicate and cooperate with other disciplines (Mohammed, 2007).

c) Consultant's experience

Dosumu & Iyagba (2013) in a study in Lagos state of Nigeria discover that the level of experience of designers influence the causes of errors. According to AIA (1994), design experience for the type of the project being handled, influences the number of errors in the construction documents. Lyneis et al (2001) states that less experienced people commit more errors and work more slowly compared to more experienced people. However, Frankenberger et al (1998) differ in their findings that experience is almost of no relevance for deficient analysis and decisions. It is discovered that lack of experience can be balanced by other factors like the theoretical education, the motivation and the open mindedness of the designer. Many a times, consultation with colleagues in the design process compensates for lack of experience. Often, better designer education and experience support the in-built knowledge for the project. It equally enhances communication among the team members and then increases the number of problems solved.

d) Consultant's fees

In a study in Edo state of Nigeria by Ebekozien et al (2015) low professional fees is one of the causes of documentation error. Rigid fees for professional services and financial pressure are sometimes responsible for errors (Atkinson, 1996; Chadwich, 1986; Brow et al, 1988; Petroski, 1985). According to Abolnour (1994), where designers are commissioned on low fees, the quality of the service provided is likely to be low. This generally results into additional project costs to the owner. This is in line with an African adage that says your money is commensurate to the quality of your medicine. In line with the above, Bubshait et al (1998); AIA (1994) state that the expected profit from the project influences the occurrence of errors in the construction documents. Andi et al (2003a) equally discovers that designers regarded the client's tendency to shop around for low design fees as negative. According to him, a low design fee is an important factor that affects the quality of design documents. In other words, quality of documents is very much proportional to the design fees.

e)Documentation time

According to AIA (1994), a realistic time schedule for design is important for the number of errors generated in the construction documents. Andi et al (2003a) discovered that the designers regarded inadequate design time as the most significant factor that affect quality of design document. NEDO (1987) citing Building Research Establishment (BRE) studies of communication and control of quality on a wide variety of non-housing projects says that "projects with quality problems were often those which are behind in their programme while tight contract times did not necessarily militate against quality". In the opinion of Atkinson (1996), and on the other hand, there is the possibility that lack of time may not be a cause of error, but bad time management may be related to low error rates and that quality, cost and productivity are interrelated.

f) Documentation team efficiencies

The effectiveness of the design team is highly related to the extent to which individuals or groups are attracted to a team of the project and the desire to remain in it. In order words, it is linked to the ability of the project team to be able to work together. This is dependent on the ability to combine the net attraction and repulsion for each other. Definitely, there will be instances of attraction and repulsion because values, norms and attitudes differ. As a result, they are bound to be situations that will lead to either highly functional or dysfunctional teams (Mohammed, 2007). The degree of cohesiveness in a team may lead to coordinated or uncoordinated behaviour when individuals in a group make their goals to be in line with the goals of the project with respect to time, cost, quality, innovation and client satisfaction. It is likely that the behaviour will be functional. However, individuals or groups will definitely have sub-goals such as marketing, turnover, survival and training which they will follow. These may not be compatible with those of the project. The overall project effectiveness depends on the coordinated efforts of the individual and the group's ability to become customer focused and work together towards common goals within a system of project organisation (Love, 1993).

g) Professional's salary

Asad et al (2005) in their findings discover that professional employees are generally more motivated by essential rewards than skilled and unskilled operatives. On the other hand, according to Love et al (2000); Abdel-Hamid (1998) and Ogunlana (1993), low wages can serve as demotivators which may result to the occurrence of errors.

h) Number of consultants

Availability of sufficient staff with enough time to pay attention to the project and the project owner has a lot of influence on the number of errors that occurred in the documents (AIA

1994). Increase in the number of designers available for the project, will decrease the workload. Also, an increase in the workload will increase the pressure of time and then an increase in the pressure of time will lead to a decrease in the share of knowledge (Mohammed, 2007). However, an increase in the number of designers will increase the share of knowledge on one hand, while on the other hand an increase in the number of designers will reduce the pressure on the designers. Further still, an increase in the amount of designer pressure will decrease the share of knowledge. Also, an increase in the share of knowledge will increase the designer's experience which will lead to a decrease in the number of errors generated in the construction documents (Mohammed, 2007).

j) Concurrent documentation activities

According to Frankenberger et al (1998), designers are collaborating more and more in teams, crossing departments and even firm borders. Atkinson (1996) says concurrency is cited frequently by implication in the construction management literature as a cause of error. Fazio et al (1988) and Lyneis (2001) believe that the number of error increases due to the following reasons: increased schedule pressure, low design fees, and when the degree of parallelism between tasks executed by different designer rises. Unavoidably, accelerated drawings and specifications are often hurriedly prepared, creating chance for a greater error margin and omissions. That is to say, as tasks are executed concurrently, the number of interactions increases and the likelihood for errors occurring also increases (Williams et al, 1995). Nevertheless, other researchers have discovered that the concurrent design activities will lead to the reduction of errors and rework as more consideration and communication normally take place (Love et al, 1997). According to Mohammed (2007), an increase in the concurrent activities will decrease the communication and coordination because of the time pressure. This will in turn increase the number of correctly solved problems and that the solving of errors will reduce the number of errors found in construction documents.

k) Amount of work with the consultants

According to AIA (1994), the number of errors that occurred in construction documents is a function of the capability of the design office to handle the number of projects. The amount of work with the designer will influence the amount of resources required for the job. However, an increase in the project resources will eventually increase the production of documents. Also, an increase in the production of documents will increase the number of errors generated. While an increase in the volume of work with the designer will increase the design fees and then an increase in the design fees will lead to an increase in the production of documents. To crown it all, an increase the amount of work with the designer will increase in the number of errors generated in the documents (Mohammed, 2007).

l) Reputation of consultant

According to AIA (1994), constant aim towards improvement of product and services with the objective of becoming competitive and staying in business has influence on the number of errors generated in the documents. This is because, from investigations, high reputation of the designer will lead to an increase in the quality of work. Further still, an increase in the quality of work leads to a decrease in the number of errors created in the construction documents. Nevertheless, an increase in the reputation will lead to an increase in the design fee; an increase in the design fee i.e. cost of design, will lead to an increase in the amount of resources available for the project. Increase in the resources leads to increase in the quality of work. Also, an increase in the number of errors generated in the construction documents will decrease the reputation of the designer (Mohammed, 2007).

m) Availability of quality management

Tilley et al (1999) discover that the inadequate reviews, check and corrective control are the main sources of failure in design quality. On the other hand the use of checking and

inspection suffers from the following three limitations despite its advocacy. Firstly, according to Kaminetzky (1991), checking is intermittent and cannot be expected to detect all errors. Secondly, checkers often make the same errors as the originators, thus making the process ineffective (Jones & Nathan, 1990; Petroski, 1994). Thirdly, checking assumes that errors move upwards from work face. This means, errors are likely to arise from the checkers (Atkinson, 1999). In short, the availability of quality management will influence the number of errors created in the construction documents.

n) Effective documentation team

The need for an effective management during the design phase cannot be over emphasised. According to AIA (1994), the characteristics of effective design team are interactive and open discussions to all members of the team in the areas of:

1Mutual understanding of each other's role and skills

2 Appropriate combination of functional/technical, problem solving and interpersonal skills among the members.

3 A specific set of team goals in addition to individual and organisational goals.

4Realistic, ambitions and goals and those that are clear and important to all team members.

5 A specific set of team work products.

6 A sense of mutual accountability, individual members feeling and joint responsibility for the teams purpose, goals, approach and work products, and

7. Ability to measure progress against specific goals.

p) Communication

Ebekozien et al (2015) in their study in Edo state of Nigeria discovered that poor communication between consultant staff can influence the occurrence of documentation

errors. It has also been discovered by Dosumu & Adenuga (2013) that poor communication among consultants is a cause of documentation error in Lagos state of Nigeria. Rianne (1998) opined that working in a team requires the ability of the team members to effectively communicate and cooperate. The major objective of the design team is to share knowledge and information so as to procure a better design. The mutual focus among team members is shared understanding on relevant design topics and design activities. As a result, shared understanding is a significant condition for team design and team decision making, hence, the need for effective communication. Tilley et al (2000) discover that a faulty line of communication between participants in the design process is a major cause of failure in design quality.

q) Availability of information

According to Tilley et al (2000), inadequate information or failure to check necessary information is mainly responsible for failure in design quality. According to Frankenberger et al (1998) deficient analysis and wrong decisions, could be a result of non-availability of information. They further opined that the quality of the leadership and the group organisation are the main causes of non-availability of information. Lack of information has also been recorded as one of the causes of document error in Lagos state of Nigeria (Dosumu & Adenuga, 2013). In conclusion, an increase in knowledge will increase the proper analysis which will in turn lead to increase in the problem solved that will result into increase in the available information to the team members.

r) Transfer of knowledge and experience between consultants

Knowledge is the information and understanding which a person has about a subject. Sometimes, it could be shared by all human beings; it includes skill and experience. Skill is the knowledge, understanding, capability or technique that a person has, to be able do

something (Bullon, 2015). Experience and knowledge are gained through a period of working. A lack of the ability to transfer previous knowledge into a fresh assignment will lead to restarting the work from the first principle each time. This will lead to repeating the errors that had surfaced in the previous project. A designer must have the essential knowledge and information for specific task to be performed (Collins, 1987). Tilley et al (1997) discover that inability to obtain feedback and learn from mistakes is one of the reasons for failure in design quality.

3. Client: Refers to the building owner. The sources of the causes of error as it relates to client on construction documents can be linked to project brief, the type of client, client's experience, construction time constraint and client's point of contact. Others are project planning, identification of project risks and attitude of clients.

a) Project brief

A project brief is a document that shows the background and the requirements for a building project. It defines the project in terms of quantity, quality, cost and time. It forms the basis for design. The brief provides the descriptions of specifications in relation to functions, connection, area needs, technical systems, working environment, budget, architectural design etc. (Mohammed, 2007). According to Nina (2004), how the brief requirements are formulated and used for communication between the client and the contractor are very significant factors in the success of building project. The project brief is normally prepared by the project manager in consultation with the client. The purpose of the project brief is to ensure that the requirements of the client are updated with the current requirements and plans. According to AIA (1994), the brief may include the following:

1 Review of project requirements as developed by the client and the designer. This may be made to include project goals, quality, scope schedule, code and regulations, key design and construction standards, budget and other project information.

2.Review of the project work plan, critical tasks, responsibility, uncertainties and

potential problem areas.

3 Review of schedule and milestone dates.

4. Review of project policies which include relevant project responsibility and authorities,

client structure and relationships, approaches to identifying and resolving problems, team meetings and communications, project changes and reports and other key management issues. John et al (2001) opine that, the way a brief is developed can be influenced by the different factors that are related to the information required. These include the nature of the project, the type and size of the client and the skills of those involved in the process. Complex projects may pose problems for briefing because they require much more information they also involve many and different professionals. It is also the opinion of NEDO (1988) that clients need to be clear about the nature and the degree of help needed to develop a brief as different from design development where a brief evolves from conversation between the client and the professionals. This is because a number of specialists may be required to contribute their expertise.

b) Type of client (Private, Government or Corporate)

Sidwell (1982) affirms that public client who has the experience of commissioning buildings just as organisations, can experience more cost and time overruns compared with private clients. He illustrates this with bureaucratic procedures that are publicly funded, and to which some private clients are subjects. According to Kaka & Price (1991) and Walter (1994), public building projects take longer time of completion than the private ones of similar construction cost. This may be due to bureaucracy, in terms of accountability and rigid adherence to procedures for decision making, approval and control mechanisms. These disallow new approaches and slow down the pace of decision making process.

c) Client experience

Sometimes, inexperienced clients do have unrealistic expectations of consultants. They at times expect more than the law requires of architects and thereby got disappointed with anything less. An experienced and sophisticated client in terms of project management may choose to take the initiative and lead the construction process. The client may be a corporation, government, parastatal or company. In such situations, a project manager is usually appointed as client representative. The client often allows other team members such as the architect or project manager to take initiative. This may be as a result of lack of experience, resources or desire. Experience is not usually at the level of organisation but rather at individual level. In other words, when an organisation builds up experience, the knowledge and the expertise is made available to individuals in the organisation. The key influence of the client on the outcome of building project is mirrored by the client's skill (NEDO 1988).

d) Construction constraint time (start or finish)

The construction time constraint regardless of the actual time required to finish the project, puts a time pressure on the project team to complete the project. Such pressure does not allow for thoroughness as it reduces the time for coordination of activities. It increases the parallelisation of activities during the documentation, in that activities that are supposed to go, one after the other, will have to take place at the same time. This at the end leads to increase in the same time and also to, increase in the number of errors that occurs at the pre-contract stage (Mohammed, 2007). Time constraints do not necessarily lead to poor quality but unrealistic constraints do. Poor design coordination is the consequence of inadequate attention being given to detailed design. It could also be the result of being hasty in the execution of projects. Fast tracking designs leads to the following problems: lack of coordination due to design instability, unclear and or missing information due to lack of available finalised

documentation. At the end of the day, it will lead to unworkable design details. Though it can save time for the client at first, it will eventually lead to delay during the construction period (NEDO, 1987).

e) Client's point of contact

According to NEDO (1988), a well- managed connection between design and construction is very important to project success and the client's interaction with the design team. As a result, the owner's interests which should be represented by a single entity should be given enough authority to communicate directives and make judgments on behalf of the client. When the decision making process of any project is controlled by uncoordinated group, there will be confusion, decision reversal and untimely decision making. These will result into the occurrence of temporary delays on construction work and contract variations (Barnet, 1988, 1989 and Ireland, 1987).

f) Project planning

Ireland (1983) and Dosumu & Adenuga (2013) in their findings discover that increase in time of planning and control techniques by contractors prior to construction activities has great positive effect on construction performance. It is also significant in minimising construction time. This is because potential problems and constraints will be identified during design on time; this will enable adequate plans to be made to overcome them. Also, elements of buildability through generation of alternative design solutions will be incorporated. This will minimise errors that may prove costly to overcome during construction. Initial planning helps in identifying and quantifying the magnitude of potential challenges such as industrial relations opportunities, threat and construction method, related to the project. Planning and monitoring needs to be regularly updated by all project stake holders to reflect changes in circumstances. This will enable control. According to Bennett (1993), the distinctive strength of the Japanese building industry is it's ability to plan work on site into details and then put

the plan into effect, on every project. He further states that control is achieved by means of a consistent sequence of daily meetings on site, where at the start of each day, teams of sub-contractors are brought together to be briefed on the expected milestones for the day.

g) Project risk identification

The development of a contractual strategy is a paramount task for client. It requires a proper evaluation of the chances available for both the execution and management of the design and construction processes. The job of those involved in the project is normally affected by the decisions taken during the development of a contract strategy. They equally influence the control of the design, construction, commissioning and the coordination of the parties. In addition, they share risk and define policies for risk management. They also define the extent of control transferred to contractors (Hages et al, 1986). According to Berkeley et al (1991), risk should not be ignored, project risk should not be dealt with in a completely arbitrary way, project risk should be identified at the early project phase and no major project decisions should be made unless those risks having meaningful significance on the project manager's decisions are clearly understood. Practical project risk appraisal should be subject to review. Moreover, an assessment of the variable risk factors acting upon the project and their likely extent and level of interaction should be completed. More project effort should be devoted to risk management as a rigorous and continuous activity throughout the project life.

h) Client's attitude

One of the many messages delivered at 'The Big Debate', part of the Constructing Excellence Conference held at the DTI Conference Centre, London, on 22nd November, 2004 is that client attitudes will be the key in achieving the most effective and efficient construction industry in the world (Mohammed, 2007). A client that cooperates with the project team will help to reduce his distractive influence in the project. When a client is committed, he can play

an important role in assuming responsibility for initiating, directing and maintaining the progress of a project (Walker, 1994)

4. Project characters:-This refers to the characteristics or parameters of the project. The sources of the causes of error as linked to the characteristics or parameters of the project are uniqueness of project, time scheduled pressure, project budgeted cost and procurement. Others are project complexity and quality.

a) Uniqueness of the project

Bullon (2015) defines unique as something having rare quality or something not comparable or unequalled or unparalleled. Unique projects are rarely executed. Unique projects do not usually possess the advantage of reference to past experience. Ordinarily, the uniqueness of the project, which the consultants are not used to, may result to the occurrence of errors. According to Mohammed (2007) there is evidence that uniqueness of the project will result into a minimum number of errors if more care is taken by the consultants during the design stage of the project.

b) Time schedule pressure

According to Andi et al (2003a), the designers regard insufficient design time as the most important issue influencing design document quality. As stated earlier, when time schedule pressures are forced on projects, it influences the procurement selected for the execution of the project. Usually, when this happens, the construction documentation stage is the one mostly sacrificed as the project will have to start on the site without: complete documents, enough study of the documents, coordination, etc. That is to say that, time schedule pressure increases the pressure on the design team which reduced the number of documents produced. When the number of documents produced is increased, there will be an increase in the concurrent activities. An increase in the concurrent activities will reduce the communication

as well as the coordination. An increase in communication and coordination will result into an increase in the number of problems solved which will result to minimisation of errors in the construction documents. On the other hand, a reduction in communication and coordination will eventually lead to an increase in the number of errors in the construction documents.

c) Project budgeted cost

According to Rocemand, (1984), Rowland (1981) and Dosumu & Adenuga (2013) when the winning bid is below the estimate of the client, the errors rate increases. Charles et al (1990) making a comparison between contracts with award amounts different from the estimate, discovered that contracts with award amounts less than the estimate were more likely to have a cost overrun rate above 5%. This difference may amount to a lack of understanding between the owner and designer regarding the scope of work. Mohammed (2007) discovers that an increase in the project budget will lead to increase in the scope of work which will in turn lead to an increase in the number of documents produced. An increase in the number of documents produced will influence the selection of the project team that is capable of carrying out the job properly. This will increase the quality of work and then the number of problems solved. In other words, an increase in the project budget will increase the possibility of selecting a proper project team directly which will in turn increase the quality of work. Similarly, an increase in the project budget will influence the selection of procurement which best fits the project and will eventually lead to solving more problems.

d) Procurement

Brown & Beaton (1990) Opine that failures encountered with the procurement process can contribute up to 30% of a project cost being wasted as a result of problems of integration. Mohammed (2007) states further that procurement will influence the number of documents produced the percentage of completion for the documentation and the available time for the

production of the construction documents. Further still, an increase in the number of documents to be completed will increase the amount of communication and coordination. An increase in communication and coordination will lead to the reduction of errors in the construction documents.

e) Complexities of project

Rowland (1981) in his study shows that the project size has influence on the number of errors. Larger projects have higher stakes and so, will need more care to be exercised in the bidding and planning process; thus the cost overruns may be reduced. This is because projects with longer periods are generally more complex; the more complex, the more number of errors. That is to say that increase in the size of the project will increase the complexity of the project which will lead to increase in the attention of the team members. That will increase the quality of work.

f) Quality

According to AIA (1994), the existence of a proper quality system amounts to the nature of a project will minimise the number of errors generated in the construction documents and it will reduce the time spent caused by the consultant's mistakes. Increase in attention will lead to increase in the discovery of errors. Increase in the discovery of errors will lead to an increase in the coordination which will increase the process of the document review. In other words, the discovery of more errors will lead to the correction of these errors. More discoveries of these errors will lead to an increase in the reduction of errors which will finally lead to good quality work.

This section discussed in detail the causes of error in construction documents under the broad categories of pre contract stage, consultant, clients and project characters. It is necessary to

know the effects of documentation error on projects, clients, building occupants / site workers in quantitative and qualitative phases, which next section seeks to discuss.

2.4 Effects of Construction Documentation Error

Effect is the result or outcome of a cause (Bullon, 2005). Causes produce effects. There can be no effect without a cause. Therefore there can be no quantitative and qualitative effects of document error without the causes. The occurrences of causes give rise to appearances of the effects. The effects of documentation error can be measured quantitatively and qualitatively and are respectively discussed in sub sections 2.4.1 and 2.4.2 below.

2.4.1 Quantitative Effects

Quantitative effects are effects reported in figures or numbers. Hammarlund, et al, (1990) investigated the sources of errors in a building project and found that the source of the error is the project itself. In another study, Josephson & Hammarlund (1999) discovered that, on the average, 32% of the defect costs originates from the client and the designers, 45% is related to site management, the workers and the subcontractors and about 20% originates from materials or machines. Moreover, the Building Research Establishment (1981) found that 50% of errors in buildings had their origin in the design stage and 40% in the construction stage. The research carried out in Australia reveals that ninety-two percent (92%) of the variation in their construction industries were attributable to errors in construction documents and the clients shared 16%, design team shared 60%, documentation shared 1.2% and quantity surveying shared 4% (Choy & Sidwell, 1991). Diekman & Nelson (1995) also noted that the largest proportion of change orders and modifications originated from the owners or their representatives (consultants/designers) and these account for 46% of claims in federally funded projects.

In another study, Stassiowski & Burstein (1994) found that most design firms spend 25-50% of design man-hours redesigning details that have already been designed on other projects and correcting errors found during design reviews. Moreover, the occurrence of errors at the design stage is not limited to construction industry alone. The withdrawal of many cars from the market in order to change some systems in the cars (National Highway Traffic Safety Administration, 2000) was due to design errors. The study conducted by Burati *et al.* (1992) on nine fast-track industrial construction projects show that while construction deviations average 16% of the total number of deviations, design deviations averaged 78% of the total number of deviations. The effect of error is very wide. Koskela (1992) opines that it sometimes seems that the waste caused by design error is larger than the design itself. In a research carried out in Kuwait, Kertam & Kertam (2000) reported that design error is one of the most significant risks to project delays. In the same view, studies in Japan by Sawada, (2000) in the USA by Kangari (1995) and in Hong Kong by Ahmed (2000), unanimously noted that, defective design is considered a critical risk. In the same vein Stassiowski & Burstein (1994) discovered that most design firms spend 25 – 50% of design man hours, redoing work that had been done before. In another survey conducted by Nikkei construction involving 79 Japanese Contractors, the result showed that 44% of the respondents experienced a good number of design document problems, common effects of such design error are in the area of constructability, conflicts in structured designs, inadequate temporary work designs, improper construction methods and information in different site conditions (Anon 2000). Josephson (1998) in their study of defects and defects cost in construction industry of Swedeen; out of the 2879 defects discovered, correction of defects carries 4.4% of the building cost. This is higher than the profit margin of Sweden construction industry. 22000 hours was used to correct the errors and about 7.1% of the total hours of working during the period. The researcher also discovered that design and management took the lion share of the cause of defects. The study also revealed that 645 defects were committed by design, which

added 26% to the cost, 42% of the defects were caused by Architects, 20% by structural Engineers, 7 – 8% by mechanical and Electrical Engineers. Also according to Josephson (1998), the most common type of defect was lack of coordination which resulted in conflicting drawings, 28% of the design defect cost, unstable design and faulty design caused 18% and 13% of design defect costs respectively. Incomplete drawings also had 10% of the design defects cost. In a study of nine projects, Farrington (1987) found that design errors accounted for 19.7% of the total number of deviations that occurred. Farrington also revealed that design errors accounted for 79.1% of the total cost of quality deviations that surfaced in the projects studied. In another development in engineering projects, review processes contributed 68% to rework, with 78% of the total attributed to design errors (Robinson-Fayek, 2003). In civil engineering projects, Barber et al (2000) found out that design error accounted for 50% of design defects cost. Love and Li (2000) has also reported that cost of design errors is lower in building projects and is put at 14% of rework costs. It has also been discovered that design errors in contract documentation accounts for 5% increase in project cost (Cusack, 1992). Lopez & Love (2012) surveyed 139 projects in Australia and total cost of design errors calculated from the sum of direct and indirect design errors are reported in the form of mean and standard deviation: M$\frac{1}{4}$ 14.2% and SD $\frac{1}{4}$ 17.47%. This also shows a serious negative effect of error on contract sum. Lopez &Love (2012) also revealed that total cost of design errors were found to considerably vary among construction and engineering projects, with report that design error cost falls within 1% of the contract sum. Others reported that such design error cost is not below 90% of the contract sum. This may be because the respondents may be uncertain about the actual design error incurred in the projects. A major Australian contractor was reported to have incurred 5% extra as rework cost done to design errors (Burroughs, 1993). Gardiner (1994) estimates that the cost of rectifying design errors could be as high as 20% of their fee for a given project. Diekmann & Nelson (1985) discovered that design errors as a result of vagueness from drawings and specifications can be as high as 40%.

Rework resulting from design error has been costly to the client and has been occasioned by project communication, contract documentation and design time management among others (Love et al, 2009). Wills & Wills (1996) discovered the cost of rectifying errors in engineering project to be 3.3%. Nylen (1996) studied quality failures in four railway projects and revealed that the cost of making good defects is 10% of contract value. Hammarlund et al (1990) noted the defects to be 5.9% of contract value in a community service building. In another study, Josephson & Hammarlund (1999) examined seven building projects and revealed defects range from 2.3% to 9.3%. Cnudde (1990) found that non-conformance cost is between 10% and 20% of total contract sum. Rework as a result of design error has become a serious problem in construction and engineering projects that if not curbed may result into huge economic ruin (Rogge et al, 2001; Josephson et al, 2002; Robinson–Fayok et al, 2004; Hwang et al, 2008; Love et al, 2000; Paleneeswaran et al, 2008). Client's dissatisfaction with the construction industry over its inability to deliver project at scheduled cost and time is very much on (Agbenyo 2014, Agbenyo & Aruleba 2014). A major factor that contributes to cost and time overruns is rework (Love, 2002). Burati et al (1992) reported quality deviation for engineering projects to be 12.4% of pr0ject cost, with 79% of these being connected to design changes and error. Abdul- Rahaman (1997) determined quality failures to be 2.5%for water treatment plant contract cost and 5% for highway project cost. In a study of design and documentation quality and its impact on the construction process, the construction industry of Australia was surveyed by Tilley, et al (1999) and it was reported that when design and documentation quality is considered to be very poor, an average of just over 11% was added to both the project cost and delivery period. When the design quality is average, an allowance of about 2.5% is added to both project cost and delivery period. Even when the quality of design is excellent, an average of 1% is still added to take care of any contingency of error.

The discussions on quantitative effects of documentation error on projects so far have centred on percentage increase in construction cost and time as a result of the occurrences of errors.

The next sub section will discuss qualitative effects of documentation errors which centre on other negative impacts on projects, contractors, consultants and building occupants.

2.4.2 Qualitative Effects

Qualitative effects are the effects reported in descriptions. Project performance in Nigeria with respect to cost, time and quality has been very poor because of the low quality of documentation. Low quality documentation is occasioned by the presence of errors in the documents concerned. This section will discuss qualitative effects of documentation errors which centres on other negative impacts on projects, contractors, consultants, site workers and building occupants.

Al–Dubaisi (2000) carried out a survey in Saudi Arabia and reported the qualitative effects of change orders in which occurrence of error were about 50% of the causes. Please refer to Tables: 2.5 & 2.6.

Table 2.5 below shows the view of the contractors on the qualitative effects of documentation errors on construction. According to Al–Dubaisi (2000) in Table 2.5, the 5 top effects are summarised as:

- Delay in completion schedule
- Increase in cost
- Increase in contractor’s overhead
- Decrease in productivity of workers and
- Additional revenue for Contractors.

The top 5 effects are those listed effects that have Prevalence Index to be above 55.00. These 5 top effects can be classified into 2 according to what they have in common, for example:

1) Cost overrun, which includes increase in cost (more cost to the client), increase in contractor's overhead (more cost to the client), and additional revenue for contractors (more cost to the client).

2) Time overrun, which includes delay in completion schedule (more time on construction) and decrease in productivity of workers (more time on construction).

Table 2.5: Prevalence Indexes of Effects: Contractor View (Source: Al- Dubaisi, 2000)

S/N	Effect of change order	Minimum	Maximum	Standard Deviation	Prevalence Index (PI)
1	Delay in completion schedule	25	100	23.19	72.06
2	Increase in project cost	25	100	20.78	69.12
3	Increase in contractor's overhead	0	100	24.48	60.29
4	Additional revenue for contractor	25	100	21.83	57.81
5	Demolition and re-work	25	100	24.63	57.35
6	Delay of material and tools	25	75	10.72	51.47
7	Delay of material and tools	25	75	10.72	51.47

8	Work on hold in other areas	0	100	24.16	51.47
9	Delays in payment to contractor	0	75	27.62	42.65
10	Dispute between owner and contractor	0	100	26.60	39.71
11	Decrease in quality of work	0	75	20.67	26.47

Cost overrun and time overrun are two major effects of error in construction documents as deduced from discussions on contractors view above and Table 2.5.These are in consonance with indications from several authors (Hammarlund et al, 1990; Josephson et al, 1999; Burati et al, 1992 and Barber et al, 2000)

Table 2.6 below shows the view of the consultants on the qualitative effects of documentation errors on construction. Al – Dubaisi (2000) (refer to Table 2.6) summarised the Consultants point of view with the first 5 top effects as:

- Increase in project cost
- Delay in completion schedule
- Additional revenue for Contractors
- Dispute between contractors and owners, and
- Demolition and re – work

The top 5 effects are those listed effects that have Prevalence Index to be above 60.00. The 5 top effects as summarised by consultants in Table2.6 can be categorised into 2 according to what they have in common:

1) Cost overrun, which includes increase in project cost (more cost to the client), additional revenue for contractors (more cost to the client) and demolition and re – work (more cost to the client).

2) Time overrun, which includes delay in completion schedule (more time on construction), dispute between contractors and owners (more time for construction) and demolition and re – work (more time on construction).

Table 2.6: Prevalence Indexes of Effects – Consultants View (Source: Al- Dubaisi, 2000)

S/N	Effect of change order	Minimum	Maximum	Standard Deviation	Prevalence Index (PI)
1	Increase in project cost	50	100	17.81	85.29
2	Delay in completion schedule	25	100	21.44	77.94
3	Additional revenue for contractor	25	100	23.39	75
4	Dispute between owner and contractor	50	100	20.67	73.53
5	Demolition and re – work	25	100	19.99	63.23
6	Work on hold in other areas	25	75	15.16	58.82

7	Increase in contractor's overheads	25	75	18.19	54.41
8	Delay of material and tools	0	75	20.67	51.47
9	Decrease in productivity	0	100	31.21	51.47
10	Decrease in quality of work	0	75	26.17	42.65
11	Delays in payment to contractor	0	100	27.62	42.65

Cost overrun and time overrun are two major effects of error in construction documents as deduced in discussions on consultants view above and Table 2.6. These are in consonance with indications from several authors (Hammarlund et al, 1990; Josephson et al, 1999; Burati et al, 1992 and Barber et al, 2000)

Combining the two Tables 2.5 & 2.6, Al- Dubaisi, 2000 determined the qualitative effects of error to be delay in completion schedule, increase in cost, increase in contractor's overhead, decrease in productivity of workers, additional revenue for contractors, dispute between contractors and owners, and demolition and re – work.

Researchers have listed qualitative effects of documentation errors as construction cost overrun, construction time overrun, rework (both in design and construction), Loss of labour, materials and equipment, contract dispute, contract failure, arbitration, litigation, accidents, loss of life, total abandonment, poor quality of work done to hurry, delay in getting profit by clients (Ebekozein, et al, 2015)

Errors in construction documents have had serious effects on construction projects and these effects are mostly manifested at the construction and post-construction stages of projects. The major effects identified are design-induced rework (Love et al, 2008), propagation of failure (Vrouwenvelder, Holicky & Sykora, 2009), structural collapse, financial loss, inconvenience, deterioration of buildings, personal injury and sickness, time delay, damaged equipment (Barkow, 1995), defects, wastages and inconveniences (Palaneeswaran, et al, 2007), conflicts and ambiguities (Olatunji, 2001). Oyewobi, Ibironke, Ganiyu and Ola-Awo (2011) noted that reworks (usually caused by designers' errors) threaten design quality as a result of incomplete and inexplicit drawings. Another serious effect of errors in construction documents is project cost overrun (Mohammed, 2007), procurement systems (Rashid, Taib & Ahmad, 2006), incomplete designs, change order, rework, construction delay, etc (Alarcon & Mardones, 1998).

From the findings of Dosumu & Adenuga (2013), qualitative effects of errors in bills of quantities, drawings, specifications, schedules and form of contracts are listed as: abandonment of projects, delays, rework, dissatisfaction by owners, lack of confidence in consultants, reputation of consultants, frustration on stake holders, lack of concentration on other projects, discourages investment and designers profit.

From the findings of different authors above and apart from cost and time overruns, other effects: i) on projects are demolition and rework, abandonment, poor quality, dissatisfaction of projects to clients and lack of concentration on other projects, ii) on contractors are increase in contractor's overhead, loss of labour, materials and equipment, disputes, arbitration, litigation and delay in getting profits, iii) on consultants are lack of confidence in consultants, bad reputation of consultant, poor design, incomplete design, frustration and work done in hurry, iv) and on building occupants is structural / building collapse, injury and sickness.

This chapter has been able to discuss on definitions of error from different authors, types of document errors, causes of document errors and effects of document errors. The discussions below are the general views of the researcher on this chapter.

2.5 Discussion

This chapter reviewed some relevant literatures on design errors. Bea (1994) defined error as a departure from acceptable or desirable practice on the part of a group of individuals that can result in unacceptable or undesirable quality. Error has been defined as the execution of a task that is either or incorrectly carried out (Edmonton, 2002). According to Bullon (2015) error is a mistake, especially one that affects the result. Definitions of design error by different authors showed that (i) there is a standard to be followed in order to achieve a purpose (ii) the standard is either discarded or not completely conformed with, (iii) the gap between (i) and (ii) above is the error. The definitions from literatures were that of design error and not made in relation to the project parameters of cost, time and quality. Design errors referred to, by these authors are errors in architectural and engineering designs, not including the bills of quantities. While error referred to in this study is documentation error which include errors in architectural, engineering designs and bill of quantities and is defined as something that causes deviation or departure from correctness or standard or accepted professional practice or principle, in drawings and bills of quantities which make it impossible for the client to achieve the desired project goal with respect to any of cost, time and quality.

The types of error mentioned by different by authors are the names of errors that show appearances on design/construction documents. Mohammed (2007) classified design errors into six according to the sources from which they arise and they are erroneous, omission, non-conformance, process, coordination and others. Three of the types of errors classified as ‘erroneous’ should not be, going by their definitions and descriptions. For example ‘designer error’ is described as missing items and missing considerations of some important items by

Mohammed (2007), it should therefore be classified under ‘omission’. Another type of error is ‘errors and omissions in bills of quantities’ and is described as missing items in the bills of quantities, missing items in the designs but included in the bills of quantities (Mohammed, 2007) which qualifies it to be classified under ‘omission’ and not under ‘erroneous’ as has been done. Error and omission in bills of quantities is further described as wrong description of items, wrong measurement and wrong unit of measurement which makes it to be classified under ‘non- conformance’ and not under ‘erroneous’. Another type of error classified under erroneous is ‘error in specification’. This type of error has been described by Mohammed (2007) to include missing items in the specification and items included in the drawings but not in the specification, which makes it to be grouped under ‘omission’ and not under ‘erroneous’ as it has been done. It is also described as items that do not conform to client criteria which groups it under ‘non- conformance’.

Causes of documentation errors are those things that make errors to appear on construction documents. According to Mohammed (2007) causes of errors have been classified into four, namely, pre-contract stage, consultant/designer, client and project characters. The causes were classified according to the sources from which they arise. ‘Consultant/designer fees’ which has been classified under ‘consultant/designer’ ought to be classified under ‘government’, this is because ‘consultant/designer fees’ are not determined by ‘consultants’ but by ‘government’ especially in Nigeria. Another cause of error is ‘planning of project’ which was grouped under ‘client’ should have been under ‘contractor’ because it is handled by contractor through his agents and not the client. This is according to Ireland (1983) that project planning is done by contractors prior to taking possession of a site.

This section also discussed the quantitative and qualitative effects of document errors on building owners. Quantitative effects of documentation error show negative effects on cost, time and quality. Discussions on qualitative effects of error show delay in completion schedule, increase in cost, increase in contractor’s overhead, decrease in productivity of

workers, additional revenue for contractors, dispute between contractors and owners, and demolition and re – work. Qualitative effects of errors by Al – Dubaisi (2000) only showed findings on effects on contractors and clients and showed no effect on building occupants and consultants. The findings of Dosumu & Adenuga (2013) on qualitative effects of errors in construction documents which are listed as abandonment of projects, delays, rework, dissatisfaction by owners, lack of confidence in consultants, reputation of consultants, frustration on stake holders, lack of concentration on other projects, discourages investment and designers profit, only showed effects on projects, consultants and clients and no mention was made on effects on building occupants. In Nigeria, cost and time overruns and majority of other qualitative effects are borne by the clients.

2.6 Summary

This chapter commenced with the definitions of errors from different authors. It progressed into discussions on general types of errors under erroneous, omission, non- conformance, process, coordination and other classifications. The chapter also explained the general causes of errors with respect to pre- contract, consultant, client and project character classifications. It ended with discussions on the general qualitative and quantitative effects of documentation errors on the building owners. Literature review has been extensively done in this chapter, there is the need to explain the details the development of conceptual framework for this study, which the next chapter seeks to do.

CHAPTER THREE

CONCEPTUAL FRAMEWORK

3.0 Introduction

This chapter delves into the definitions and significance of conceptual framework. It also discussed the previous studies on error reduction in the construction industry as put forward by Mohammed (2007) and Atkinson (1999) and pointed out the similarities and dissimilarities between each of them and this current study. The conceptual framework available for one of them is displayed. The chapter shows the development of conceptual framework for this current study in which case the key factors in the study were stated and discussed. The key factors in the study according to literature survey are causes of documentation error, types of documentation error and qualitative and quantitative effects of documentation errors. For each of these key factors what constitute it is brought out. For example the causes of documentation errors are listed. Types of documentation errors are listed and the qualitative and quantitative effects of documentation errors are listed. The chapter displayed the conceptual framework for this study and closed with explanation on the linkages among the key factors.

3.1 Definition and Significance of conceptual framework

Conceptual framework is a diagram of proposed causal linkages among a set of concepts believed to be related to a particular problem (Earp & Ennett, 1991). It can also be defined as a presentation that explains either graphically or textually, the main things to be examined, the key factors, concepts or variables and the presumed relationship among them (Miles & Huberman, 1994). Two things are clear from these definitions: establishment of key factors or main things through which a process goes from beginning to end of a study, in an attempt to

solve a problem and setting out the variables and the relationship between them. Conceptual framework is a kind of pre-planning that provides the structure and content for the whole study based on literature and personal experience (Vaughan, 2008). A conceptual framework is utilised in research to bring out possible courses of action or to put forward a preferred approach to a system analysis project. The framework is constructed from a set of concepts linked to a planned or existing system of methods, behaviours, functions, relationships and objects (Botha, 1989). The conceptual framework of a research project also explains how results are to be achieved including causal relationship and basic assumptions. According to Mayer & Greenwood (1980) cited in Ojo (2012), the conceptual framework furnishes a supportive framework for the model based on the empirical evidence from previous research and value assumptions underlying the proposed solutions. The framework is essential due to the fact that human nature has greater control on research. Therefore, it is used to decide unfairness and unawareness inherent in human. The framework guides what is observed and ensures that appropriate and inappropriate delimitations are made (Ojo, 2012).

Having defined and explained the significance of conceptual framework in this section, next section will discuss two previous similar error reduction studies.

3.2. Previous Similar Studies on Error Reduction in the Construction Industry.

The doctoral theses of Mohammed (2007) and that of Atkinson (1999) shall be considered in this section.

A) Mohammed (2007):

Mohammed (2007) developed an exploratory system dynamics model to investigate the relationship between errors that occur in construction documents in Saudi Arabia and their possible causes". This current study develops a framework supported with guidelines to

minimise occurrences of errors in construction documents in Nigeria. They are similar because both researched into the causes of documentation error, they are different because Mohammed (2007) made use of exploratory system dynamics to analyse data and study area is in Saudi Arabia construction industry while this study uses relative importance index to analyse data and study area is in Nigerian construction industry. Mohammed (2007) did not explore quantitative and qualitative effects of error, mapping of causes to types of error and frequencies of occurrences of types of error, which this study seeks to undertake in order to boost the thesis. Mohammed (2007) did not do any conceptual framework to make readers visualise, at the beginning of the study, the key factors to be examined and their linkages. What Mohammed (2007) did were the steps taken to achieve the aim, which were:

1. From the literature review, gather the initial insight into issues related to construction documents and error.

2. Study 5 case projects to investigate and understand the characteristics of construction document procedures in Saudi Arabia and identify initial list of errors occurring in Saudi industry.

3. Administer 36 questionnaires to understand procedures followed in Saudi construction industry and to obtain information on actual errors that occur in practice in the construction documents in Saudi industry.

4. Administer 10 interviews to understand the construction documents procedures of the Saudi industry.

The researcher (Mohammed, 2007) only highlighted the collection of general causes of error through literature survey and utilised case study, questionnaire and interview to determine causes of error specific to Saudi Arabia. Mohammed (2007) did not show any conceptual framework which this study seeks to do in this section.

Furthermore, the PhD thesis of Mohammed (2007) had the aim of reducing the occurrence of errors in construction documents by developing a theoretical model to capture the dynamics of processes that define the relationship between factors causing errors in construction documents. To achieve this aim, the types of error and causes of error in construction documents in Saudi Arabia were determined. This was done through literature search, case study of projects questionnaire and interviews. The research justified a mixed mode research approach and the use of System Dynamics as the modelling tool. The PhD work of Mohammed (2007) is different from this research because this research aims to develop a framework supported with guidelines for the minimisation of errors in construction documents in Nigeria. This is to be achieved by the determination of the causes, types and effects of error specific to construction documents in Nigeria, through the use of literature search and questionnaire. Data collected through questionnaire will be analysed by relative importance index.

This sub section has discussed the similarities and dissimilarities between Mohammed (2007) and this current study next sub section will discuss Atkinson (1999) similarities and dissimilarities with this current study.

B) Atkinson (1999):

Atkinson (1999) studied the management of error in construction projects in United Kingdom in the PhD work.

The researcher (Atkinson, 1999) had the aim of the development of an improved model which emphasised the importance of both project and general management of errors. The study of errors and defects were made during the construction phase of projects, that is, at the contract stage of the construction process in the UK construction scope. It is similar to this work because this work intends to develop a framework for reduction of errors and their associated effects on construction and the stakeholders. They are different because this current study

examines error at the documentation stage, that is, pre- contract period of the construction process in Nigerian construction industry. They are different also because the study areas are not the same. For collection of data Atkinson (1999) utilised literature survey, statistical method, interview method and observation method and analysed data by chi square, percentages, pie chart and bar chart. This current study uses literature survey, interview and questionnaire to collect data and analysed the collected by content analysis, relative importance index, severity index and percentages. Atkinson (1999) did not explore quantitative and qualitative effects of error, mapping of causes to types of error and frequencies of occurrences of types of error, which this study seeks to undertake in order to boost the thesis.

Furthermore, the PhD thesis of Atkinson (1999) examined the defects problem from the view of human errors. The study reviewed human error literature from a variety of industries and perspectives, and synthesised a model of error causation covering organisations in a construction project context. The model was then progressively tested in four studies of a general preliminary survey and three detailed studies of house-building. In conclusion the research supported the view that errors leading to failure in complex socio-technical systems often exhibit systems characteristics and involve the whole managerial structure. The research proposed an improved model which emphasised the importance of both project and general management of errors. The PhD work of Atkinson (1999) is different from this research because this research aims at developing framework with associated guidelines for the minimisation of errors in construction documents in Nigeria. This is to be achieved by the determination of the causes, types and effects of errors in construction documents in Nigeria, through the use of literature search and questionnaire. Data collected through questionnaires will be analysed by relative importance index.

Atkinson (1999) did a framework which was named Map of Research, that is, key factors that will help to shape the research in order to achieve the aim. Refer to Figure 3.1.

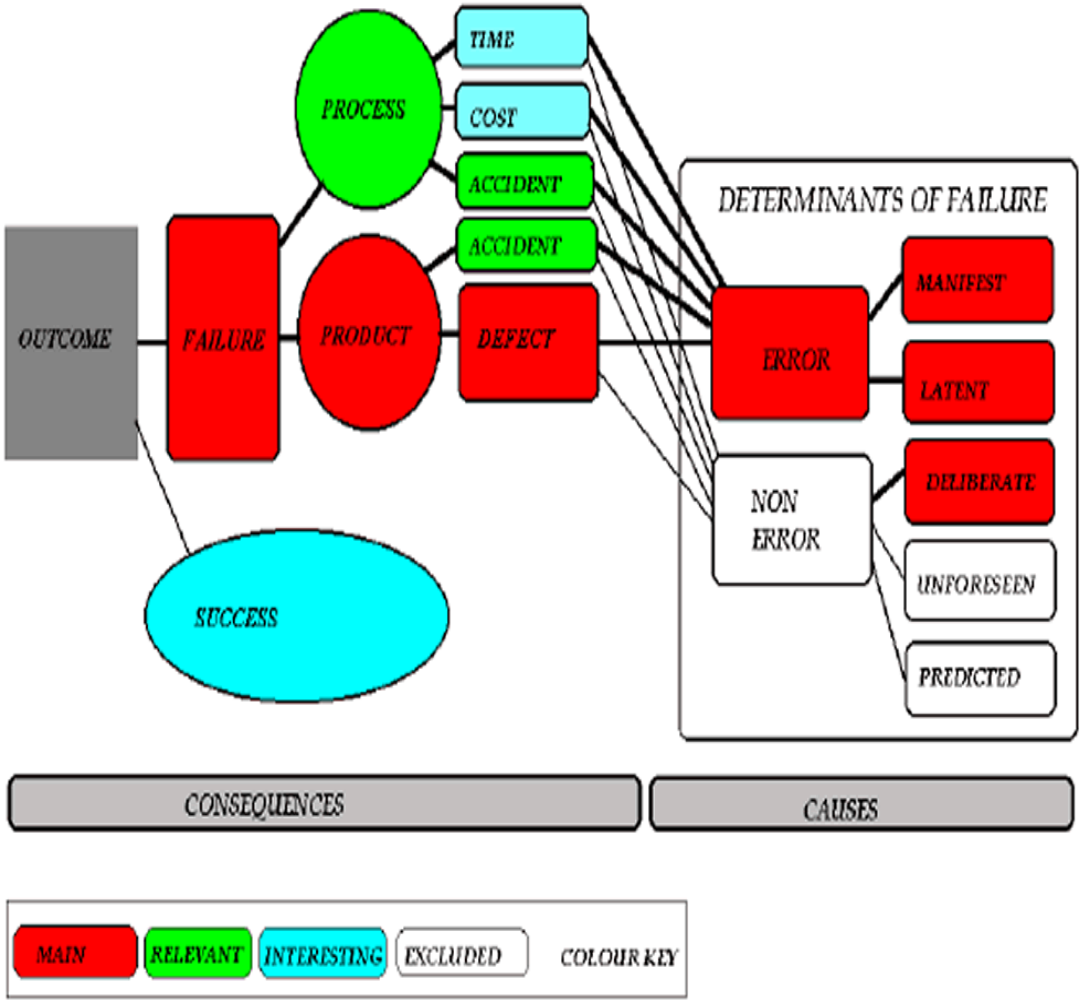

Figure 3.1: Map of research (Source: Atkinson, 1999)

The key factors and the main things in Atkinson (1999) are as shown in the map of research displayed in Figure 3.1. To explain the Figure 3.1: The boundary of error, non-error and their outcome and hence the scope of the research are illustrated in graphical form. The central problem during the research is defect. Defects imply shortfall in terms of the product of a business rather than shortfall in process of production. A wide range of failure includes the

latter which is evident as business failure related to cost and time performance. A shortfall in form of accidents caused by either product or process is unfortunate are usually avoidable, side effects of activities. They complete the map of the consequences of actions. A map of causes of failures can be drawn. It will be demonstrated that these are overwhelmingly human in origin. However some failures are either unforeseen or predicted as normal wear and tear. These classes of actions are called 'non- error' are frauds which whilst in human origin are by definition not errors. The map is completed by dividing errors into two classes: manifest and latent. It is in this area that the map is concentrated. The figure in red the path of primary interest centering on the error basis of defects, but using investigative logic, the research draws in apparently tangential areas of study to provide insights or corroborate findings on the primary path. Human error related to accidents is particularly active area of general research interest in this area marked green in the figure proved relevant. Business failure in terms of poor time and cost performance was also of interest and is marked blue. Also marked in blue is the converse of failure, success. Conformation of many findings uncovered in this study of error is found in success literature related to general management, project management, quality assurance and safety.

Having explained Mohammed (2007) that has no conceptual framework and Atkinson (1999) with a map of research (conceptual framework), next section will be devoted to discussion on development of conceptual framework for this research.

3.3 Development of conceptual framework for this current research

As found from literatures this section will isolate key factors that are involved, to go through the study successfully and then explain the presumed relationship between them. The conceptual framework, which is particularly useful for streamlining the researcher's understanding and holistic thinking for this research, is as illustrated in the following Figure 3.2. From the literature review, it can be deducted that in order for document error

minimization framework to be developed, the key factors should be taken care off. These concepts and key factors extracted from the literature review form the basis of the conceptual framework which directs the investigations to be made at the data collection stage. Although the conceptual framework has illustrated the concepts similar to portraying the relationship between independent-mediating-dependent variables, it should be noted that this research is exploratory in nature, which was indicated by the research objectives in Chapter 1 of this thesis. Furthermore, the aim of this research is to develop a framework for minimization of documentation errors in Nigeria which requires in-depth exploration of concepts, barriers, and challenges that indicates theory building rather than theory testing within the research context. Therefore, this conceptual framework serves only as visualization of concepts for further exploring in the real world the concepts identified in the conceptual world, which in this context are the error literatures.

The key factors in this study are the causes of documentation error, types of documentation error and quantitative and qualitative effects of documentation error as are discovered from literatures. Causes of documentation errors when acted upon by minimisation processes will minimise the appearances of types of documentation error and quantitative and qualitative effects of documentation error. Each of these is explained hereunder together with the relationship between them.

1. Causes of documentation error - It is asserted that to solve a problem the causes of the problem must be discovered (Andi & Takayuki 2003a). It is necessary to first determine the causes of documentation error. Juran's quality improvement methodology warns against taking shortcut from symptom to solution without finding out and removing the causes (Stassiowski & Burstein, 1994). The steps taken to remove causes of error are therefore the guidelines. To solve the problem of occurrences of errors on construction documentation in this study, the causes must be discovered and then removed. The causes errors in construction documents discovered in literature survey are: changes to key personnel, documentation team

inefficiencies, inadequate number of consultants, reputation of consultants, attitude of clients, non – availability of information, poor communication, inadequate project brief, poor salaries of professionals, non – identification of project risks, inadequate consultant professional education, inadequate consultant professional experience, inadequate project manager experience, time scheduled pressure, inadequate project planning, complexity of project, concurrent documentation, heavy work load of consultant, poor consultancy fees, inadequate document preparation time and inadequate documentation manager experience. Qualitative research approach is adopted for this particular study because opinions from professionals are needed (through questionnaire) to determine the causes of documentation errors. These causes of errors are removed to pave way for error free documentation.

2. Types of documentation error – The determination of common types of documentation error expose the names of errors that appear in the documents. The names of documentation errors as discovered from literature survey are: non- conformance to vendor data, non-conformance of document to law, CADD problems, errors in symbols and abbreviations, inadequate coordination within disciplines, inadequate coordination between disciplines, unnecessary additions, non – conformance to client requirement, non – conformance to design code/SMM, absence of specifications, dimensional error, miscalculation, scanty specification, wrong specification, omission of necessary item and incorrect details.

The removal of causes of errors leads to the disappearance of types of errors.

3. Effects of documentation errors – The determination of quantitative and qualitative effects of documentation error show the background/reason for the strong need for documentation error minimization framework. Effects of documentation error show the negative consequences of the errors on project procurement, building owners, consultants, building occupants / site workers. According to literatures qualitative effects will create the awareness of the social and economic negative effects of documentation errors on building owners /

occupants, which are: defects, building collapse, loss of human lives, financial wastage, material wastage, cost overruns, time overruns, abandonment of project, rework, dis-satisfaction to clients, bad reputation of consultants, loss of confidence in consultants and deterioration to buildings. Also according to literature survey quantitative effects show percentage increase in contract sum and also percentage increase in delivery period for examples: Josephson (1998) in their study of defects and defects cost in construction industry of Swedeen; out of the 2879 defects discovered, correction of defects carries 4.4% of the building cost. This is higher than the profit margin of Sweden construction industry. 22000 hours was used to correct the errors and about 7.1% of the total hours of working during the period. The researcher also discovered that design and management took the lion share of the cause of defects. The study also revealed that 645 defects were committed by design, which added 26% to the cost, 42% of the defects were caused by Architects, 20% by structural Engineers, 7 – 8% by mechanical and Electrical Engineers. Also according to Josephson (1998), the most common type of defect was lack of coordination which resulted in conflicting drawings, 28% of the design defect cost, unstable design and faulty design caused 18% and 13% of design defect costs respectively. Incomplete drawings also had 10% of the design defects cost. In a study of nine projects, Farrington (1987) found that design errors accounted for 19.7% of the total number of deviations that occurred. Farrington also revealed that design errors accounted for 79.1% of the total cost of quality deviations that surfaced in the projects studied. In another development in engineering projects, review processes contributed 68% to rework, with 78% of the total attributed to design errors (Robinson-Fayek, 2003). In civil engineering projects, Barber et al (2000) found out that design error accounted for 50% of design defects cost. Love & Li (2000) has also reported that cost of design errors is lower in building projects and is put at 14% of rework costs. It has also been discovered that design errors in contract documentation accounts for 5% increase in project cost (Cusack, 1992).

The removal of causes of errors leads to the disappearance of quantitative and qualitative effects of documentation error on the aforementioned stakeholders.

In conclusion, the relationship between them is that when causes of errors in documents are minimised, all the types of documentation error and effects of documentation error are also minimised, thus, giving way for document with minimised error to exist.

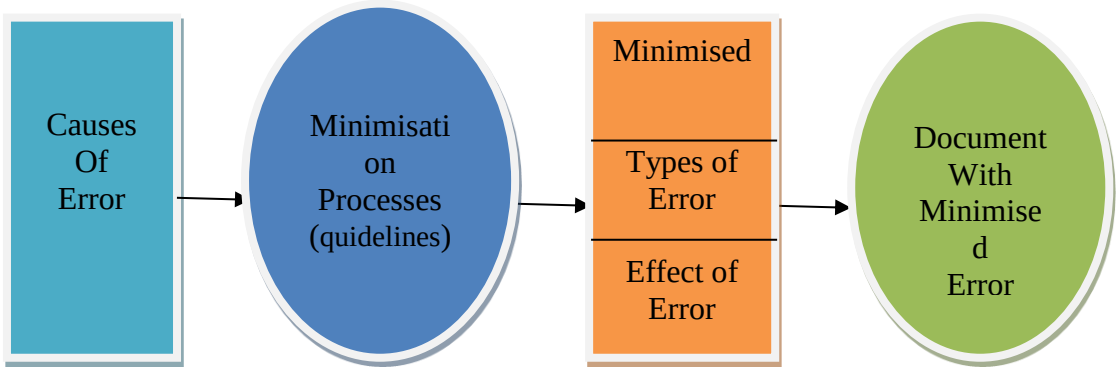

Figure 3.2: Conceptual Framework

3.4 Summary

This chapter delved into the definitions and significance of conceptual framework. It also discussed the previous studies on error reduction in the construction industry as carried out by Mohammed (2007) and Atkinson (1999). The chapter explained the details the development of conceptual framework for this study. In developing the conceptual framework the key factors to be considered in the study are highlighted, explained and linked. The conceptual framework was then displayed.

Having discussed the details of the development of conceptual framework for this study, there is the need to explain the research methodology for the study which centres on the onion research methodological model. This will show the step by step procedures on which the research will be based and shall be discussed in the next chapter.

CHAPTER FOUR

RESEARCH METHODOLOGY

4.0 Introduction

This chapter on research methodology centres on the onion research methodological model. The chapter begins with the types of research methodological models and continues with discussions on research philosophies, research approaches, research strategies, research choices, research time horizons and research procedures (data collection). The chapter continues with discussions on sampling, validation and reliability of instruments and administration of questionnaire. The chapter states the general information on the respondents, statistics for data analysis and validation of results. The chapter also presents the analysis of data, validation of research results through kendall's coefficient of concordance. Data presentation is also done here which consists of analysis of the definitions of construction document error, types of error in construction document, causes of error in construction document, effects of error in construction document, mapping of causes of error to types of error, frequencies of occurrences of types of error and causes of error and the development of framework with associated guidelines for minimising errors in construction documents. The chapter shows the revised conceptual framework for this work.

4.1 Research Methodological Models

Research methodology is a process of solving research problems scientifically. It is the study of the various steps that are generally adopted by a researcher in solving his research problem and also stating the logic or reason behind them. The scope of research methodology is wider than that of research methods. Research methodology includes research methods and the reason or logic behind the adoption for use of such methods. In research methodology,

explanations are given for the choice of adopted research methods. Research method explains the means of data collection, means of data analysis and means of validation of research results (Kothari, 2004).

Methodology is a subset of any research effort. This is because it provides the common platform that can be related to by researchers at different times and anywhere. To determine the methodology for this work, research layers of knowledge that relate to the research must be explored through philosophical review. The exploration of philosophical assumptions through view of known paradigms will help the researcher in choosing the research strategies to carry out the research (Abdul-Nifa, 2013).

Kagioglou et al (2000) and Saunders et al (2009) have outlined the significance of distinguishing the different research activities into distinct stages, which provide the sense of sequence and serve as guidelines for the researcher to manage the research, in ensuring the research is executed as planned. It is therefore important that the exploration of a research philosophy is systematically conducted through the adaptation of a research process model.

There are two methodological models that are widely used in executing research methodology, they are:

1) The Nested model as put forward by Kagioglou et al (2000) as represented by Figure 4.4 below and

2) The Onion model as put forward by Saunders et al (2009) as represented by Figure 4.2 below.

It is noted that the Nested model diagram looks like the aerial view of the nest of a bird, while the Onion model diagram looks like the cross- sectional view of onion used in the kitchen.

The Nested model consists of three layers; (please refer to Fig 4.1) they are stated below as:

i) Research Philosophies

ii) Research Approaches

iii) Research Techniques

Figure 4.1: Research model: nested methodology research model (Source: Kagioglou et al, 2000)

The Onion model has six layers as follows; please refer to Fig 4.2:

i) Research Philosophies

ii) Research Approaches

iii) Research Strategies

iv) Research Choices

v) Research Time Horizons

vi) Research Techniques and Procedures

The Onion model as put forward by Saunders et al (2009) will be adopted for use in carrying out the methodology of this research for the following reasons:

1) Onion model (propounded in year 2009) is an improvement on Nested model (propounded in year 2000).

2) Onion model has six layers that take care of the research methodology, systematically and in full, while Nested model consists of three layers that take care of a portion of research methodology.

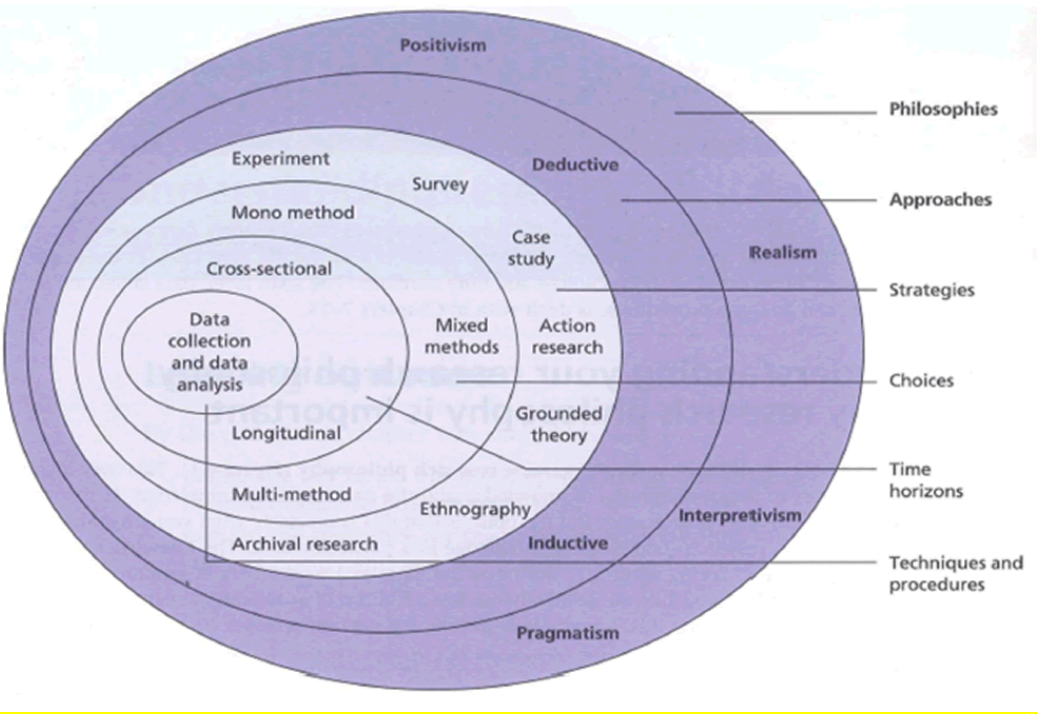

Figure 4.2: Research model: Onion methodology research model (Source: Saunders et al, 2009)

The research onion model provides a single and simple comprehensive framework for research process that allows the researchers to review each layer systematically. Research onion as formulated by Saunders et al (2009) is a framework which helps the researcher to discover issues or reasons surrounding the selection of research methods. According to Saunders et al (2009) research onion, has six layers namely, philosophies, approaches, strategies, choices, time horizons, techniques and procedures.

To operate on the research onion approach is to peel away the different layers of the onion to arrive at the centre. To reach the centre, one is required to follow a step by step method. The first step, research philosophy refers to the formation of knowledge and the character of the knowledge which is developed. It also refers to our opinion and views and the manner in understanding of the world. This greatly impacts and influences the research strategy which refers to the plan or method to be adopted for research. Three important elements of research philosophy are ontology, epistemology and axiology. Research approach which is the second layer refers to a process of creating new knowledge or a method of enhancing the

understanding of a subject. The four main approaches are quantitative, qualitative, pragmatic and participatory approach. Research strategy, the third layer, refers to a plan of action that directs the way in which research should go on. Research choice, the forth, layer refers to the defence of why somebody has chosen to research a particular subject or the manner in which a person chooses to research it. Research time horizon, which is the fifth layer, determines whether the research work will run through short time or long time. Research techniques and procedures, the sixth and last layer, refers to the collection and analysis of data. (Saunders et al, 2009). Each of these layers are discussed in succeeding sections

This section discussed the research methodological models and also explained the reasons for the choice of research onion methodology. The different layers on onion model were briefly discussed. Next sub- sections 4.3 to 4.8 will discuss in details the onion layers and the justifications for adoption of one of the options in each of the layers.

4.2 Research Philosophies

Researchers will always make assumption in relation to their research work. Research philosophy depends on the researchers thinking and assumption about the progress of knowledge which later affects the way the research is carried out (Saunders et al, 2009).

Keraminitage (2009) has outlined the characteristics of research philosophy as: ontological, epistemological and axiological assumptions. These are interrelated and are discussed in the following three sub sections.

4.2.1 Ontological Philosophy

Ontology is concerned with the nature of reality. It comprises all the questions that a researcher raises about the way that the world operates and the commitment held to particular views (Abdul-Nifa, 2013). Ontological Philosophy is a branch of metaphysics that addresses the nature and essential characteristics of beings that exist (Hatch & Cunliffe, 2006). Bryman

& Bell (2007) and Sutrisna (2009) identified two options of ontology; these are objectivism and subjectivism. Hatch & Cunliffe (2006) relate the position of objectivism to the question of whether reality exists independently of those who live in it. It can be said to be a state of being objective. It is a doctrine that holds that all reality is objective and exists outside of the mind. It is not subjected to the dictates of the mind but experiment. Objectivism relates to material object. It is not influenced by emotions or prejudices. It is based on observed facts.

Subjectivism, an ontological position asserts that social phenomena and their meanings are continually accomplished by social actors (Abdul-Nifa, 2013). Hatch & Cunliffe (2006) said that the questions that comes to mind concerning subjectivism is whether reality exists through the experience of it. It can be said to be a doctrine of being subjective, that is, forming opinions based on a person's feelings or intuition or reasoning, coming more from within the observer than from observation of the external environment. Subjectivism is a thing resulting from or pertaining to personal mind sets or experience arising from perspective mental conditions within the brain.

Sexton (2007) and Aouad (2009) also explicate another classification of ontological positions as realism and idealism. Aouad (2009) defined realism as a common external reality with a predetermined nature and structure, while idealism is defined as unknown reality perceived in different ways by individuals. There are therefore two different ontological positions: objectivism (realism) and subjectivism (idealism) (Abdul-Nifa, 2013).

Justification for adopting Subjectivism option of ontological philosophy

This study is not pure science where experiments are carried out in the laboratory, therefore

objectivism is not adopted. Subjectivism is adopted because this study is a social science in the fashion of construction economics. In this study the respondents are required to complete the questionnaire based on their experiences. Their responses to semi structured interview are

also based on the experiences acquired from their professional practices. This option is justified because the responses are required from the respondents based on their opinions, coming from their feelings, intuition and mind sets arising from their perspective mental conditions within their brain, which this option stands for. Specific to this research in adopting the subjectivism option of ontological philosophy, questionnaires were distributed to selected architects, civil engineers, electrical engineers, mechanical engineers, quantity surveyors and contractors in the six south western states in Nigeria and the federal capital territory. The questionnaires contain general types of documentation errors, general causes of documentation errors, general qualitative effects of documentation errors (obtained through literature survey), mapping of causes to types of documentation errors and the frequencies of occurrences of types of documentation errors. The questionnaires are well structured with options A to E as probable answers. The professionals respond to these questionnaires to determine the types of documentation error, causes of documentation error, qualitative effect of documentation errors, mapping of causes to types of documentation error and frequencies of occurrences of types of documentation errors specific to Nigeria. The professionals' responses are based on knowledge gained from their professional practices that have been stored in their brain as their opinion and mind set. Semi structured interviews are also administered to the selected professionals to state the definitions of documentation error to achieve objective 1 of this study. In this case no option was given as answers in which case the professionals respond based on their previous knowledge. The professionals' responses are also based on what has been stored in their brain gained from their practice experiences. The data collected were analysed by relative importance index, severity index and content analysis.

Having discussed ontology as an option of research philosophy with justification for the adopted variant in this sub- section, next sub- section contains the discussion of epistemological option of research philosophy.

4.2.2 Epistemological Philosophy

Epistemology concerns what constitutes acceptable knowledge in a field of study (Saunders et al, 2009). The major issue in epistemology is to know whether the social science can be studied in similar manner as the natural science which is based on principles and procedures. Epistemology is the branch of philosophy that deals with the theory and study of knowledge, asking questions such as – What is knowledge? How is knowledge acquired? What do people know? How do we know what we know? Epistemology tends to replace metaphysics as the most important aspect of philosophy (Saunders et al, 2009). Sutrisna (2009) brought out two contrasting positions of epistemology as positivism and interpretivism. According to Saunder et al (2009), positivism views reality as it is represented by objects that are considered to be real. Positivism is a doctrine that states that the only authentic knowledge is scientific knowledge and that such knowledge can only come from positive affirmation of theories through strict scientific method. Positivism embraces practical spirit, experiments, sense of reality and concreteness. It has been identified that positivist research equates to deductive approach and is referred to as quantitative research (Abdul-Nifa, 2013).

Abdul-Nifa, (2013) asserts that interpretism includes the researchers who are of the view that the subject matter of social sciences is basically different from that of natural sciences. Bryman & Bell (2007) also stated that interpretivists are of the opinion that the study of the social science requires a different logic of research procedure, one that reflects the distinctiveness of humans against the natural science. Interpretivism is a doctrine that holds that knowledge is not based set of given data, conventions or physical facts but on what practitionals obtain from their professional practices and experiences. Interpretivism is anti-positivism and according to Manty (2009) interpretivism epistemological position needs to do with qualitative and inductive types of research.

Justification for adopting Interpretivism option of epistemological philosophy

This study is not pure science where experiments are carried out in the laboratory, therefore positivism is not adopted. Interpretivism is adopted because this study is a social science in the fashion of construction economics, where respondents are to complete the questionnaires and respond to the semi structured interview based on their professional experiences from their practices. Specific to this research in adopting the interpretivism option of epistemological philosophy, questionnaires were distributed to selected architects, civil engineers, electrical engineers, mechanical engineers, quantity surveyors and contractors in the six south western states in Nigeria and the federal capital territory. The questionnaires contain general types of documentation errors, general causes of documentation errors, general qualitative effects of documentation errors (obtained through literature survey), mapping of causes to types of documentation errors and the frequencies of occurrences of types of documentation errors. The questionnaires are well structured with options A to E as probable answers. The professionals responded to these questionnaires to determine the types of documentation error, causes of documentation error, qualitative effect of documentation errors, mapping of causes to types of documentation error and frequencies of occurrences of types of documentation errors specific to Nigeria. The professionals' responses are based on knowledge gained from their professional practices that have been stored in their brain as their opinion and mind set. Semi structured interviews are also administered to the selected professionals to state the definitions of documentation error. In this case no option was given as answers in which case the professionals responded based on previous knowledge gained from their practices. The data collected were analysed by relative importance index, severity index and content analysis.

Having discussed epistemology as an option of research philosophy with justification for the adopted variant in this sub- section, next sub- section is the discussion of axiological option of research philosophy.

4.2.3 Axiological Philosophy

Axiology is a branch of philosophy deals with the study of the origin, nature, function, types and interrelations of value and value theory. Axiology studies judgement about value (Abdul-Nifa, 2013). Saunders et al (2000) observed that researchers exhibit axiological skill by being able to articulate their values as a basis for making judgement about the research they are conducting and how they go about it. Sexton (2007) opines that the axiological assumptions about the nature of value which can be determined as value- free that is unbiased or value-laden which is biased. According to Abdul- Nifa (2013) the two axiological positions identified are value- free linked to quantitative research and value- laden linked to qualitative research. Value is that quality in an object that satisfies the desire of the subject. In the theory of axiology presented here, value is defined as that quality of an object that satisfies the desire of the subject. Subject in this case refers to the respondents, while objects are the questions in the questionnaire presented to the respondents for their responses. That is, when an object has a certain quality that satisfies the desire or wish of the subject and which is recognized as such by the subject, then that special quality of the object can be called value. In other words, value is something that belongs to an object; yet, unless it is recognized as valuable by the subject, it does not become actual value. For example, even though there is a flower, unless someone (the subject) perceives the beauty of that flower, the actual value (beauty) of the flower does not manifest. In this way, in order for value to become real there is a need for a process in which a subject must recognize the quality of an object and must appraise that quality as valuable. Determining concrete value means determining the quantity and quality of value. The quantity of value refers to the quantitative appraisal of value, such as “very beautiful,” or “not so beautiful.” There are also qualitative differences in value. For example, in beauty

there are various grades, such as graceful beauty, awesome beauty, solemn beauty and so on. These are qualitative differences in value (Saunders, et al, 2012). In this study the respondents will rate the degree of their satisfaction with the questions in the questionnaire - as their responses. Sexton (2007) opines that the axiological assumptions are about the nature of value and the foundation of value judgements, which can be determined as value-free that is, unbiased or value-laden which is biased. Axiology depends crucially on opinions of value and sometimes seen to lay the foundational basis for philosophical fields (Nawi, 2012 and Tobi, 2011). Further still, based on the aim of this research the respondents will rate the degree of their satisfaction with the questions in the questionnaire- as their responses.

Value- free is linked to pure science or quantitative research where experiment is the order of the day. In value- free option, experiments dictate answers to questions unlike value- laden where answers are dictated by the mind and experiences of the professionals.

Justification for adopting value laden option of axiological philosophy

This study is not a quantitative research and since value- free is linked to quantitative research, value- free option is not adopted in this study. Quantitative research is one in which the results are recorded in figures while qualitative research is one in which results are reported in descriptions. This study employs the qualitative research linked to value- laden option of axiological philosophy then value- laden option is adopted in the study. Value laden is also adopted for use in this study because it stands for objects where value is concentrated, therefore have to be responded to, by the subjects. Their responses will indicate their degree of satisfaction with the objects qualities. This is the case in this study where respondents will respond to the qualitative questionnaire, indicating their degree of agreement with the questions posed. As it pertains to this research in adopting the value laden option of axiological philosophy, structured questionnaires containing questions and each question has five probable answers rated (A) standing for strongly disagree (B) standing for disagree (C) standing for no opinion (D) standing for agree and (E) for strongly agree. These options are

the values that the professionals will choose from. The professionals will respond to any of the options they think will be appropriate to the question asked. The questionnaires were distributed to selected architects, civil engineers, electrical engineers, mechanical engineers, quantity surveyors and contractors in the six south western states in Nigeria and the federal capital territory. The questionnaires contain general types of documentation errors, general causes of documentation errors, general qualitative effects of documentation errors (obtained from literature survey), mapping of causes to types of documentation errors and the frequencies of occurrences of types of documentation errors. The professionals respond to these questionnaires to determine the types of documentation error, causes of documentation error, qualitative effect of documentation errors, mapping of causes to types of documentation error and frequencies of occurrences of types of documentation errors specific to Nigeria. The professionals' responses to the answer options are based on knowledge gained from their professional practices that have been stored in their brain as their opinion and mind set. The data collected were analysed by relative importance index and severity index.

This section has outlined the characteristics of research philosophy as ontological, epistemological and axiological assumptions and the justifications for adoption of one of variants for use in this study. Next section will discuss the research approach and the justification for the use of one of it's options.

4.3 Research Approach

Research approach refers to a process of creating new knowledge or a method of enhancing the understanding of a subject. Sutrisna (2009), on theory generation, states that it is useful to know the two different ways of undertaking the reasoning of the research; inductive and deductive methods.

Inductive Reasoning is the process of deriving general principles from specific instances. This process involves movement from specific instances to general principles (Saunders et al, 2009) Inductive reasoning has a link to qualitative research methods (Bryman & Bell, 2007).

Deductive Reasoning is the process of deriving specific inferences from general principles. This process involves movement from general principles to specific instances (Hyde, 2000; Grix, 2010). Bryman & Bell (2007) have linked deductive reasoning to quantitative research methods.

Justification for the choice of Inductive reasoning as research approach

Deductive reasoning is linked to quantitative research (Bryman & Bell, 2007) and since quantitative research is not in use in this study, deductive reasoning is not adopted. This study employs qualitative research which has been linked to inductive reasoning (Bryman & Bell, 2007), therefore inductive reasoning is adopted. This study also adopts the use of inductive reasoning because the study aims at developing a framework with associated guidelines for minimization of construction documentation errors in Nigeria, in which we need to move from specific instances to general principles/guidelines. Specific instances are the common causes of construction documentation error in Nigeria which will help to develop general guidelines for minimization of construction documentation error. The professionals will respond to any of the options they think will be appropriate to the questions asked. The questionnaires were distributed to selected architects, civil engineers, electrical engineers, mechanical engineers, quantity surveyors and contractors in south western states in Nigeria and the federal capital territory. The questionnaires contain general types of documentation errors, general causes of documentation errors, general qualitative effects of documentation errors (obtained through literature survey), mapping of causes to types of documentation errors and the frequencies of occurrences of types of documentation errors. The questionnaires contain probable answers with options A to E. The professionals responded to

these questionnaires to determine the types of documentation error, causes of documentation error, qualitative effects of documentation errors, mapping of causes to types of document error and frequencies of occurrences of types of documentation errors specific to Nigeria. Semi structured interviews are also administered to the selected professionals to state the definitions of documentation error. In this case no option was given as answers in which case the professionals respond based on their previous knowledge. The data collected were analysed by relative importance index and severity index.

This section discussed the research approach and the justification for adopting one of the two different ways by which this can be achieved. Next section will discuss research strategy and justification for adoption of one of the two methods, for use in this study.

4.4 Research Strategy

Research strategy or research design basically provides the researcher with a road map or a plan of action that translates the research aim into achievable results (Bryman & Bell, 2007; Saunders et al, 2009; Sexton & Barrett, 2003; Sexton, 2003; Yin, 2009).

Bryman & Bell (2007) define research strategy as a general orientation to the conduct of business research; which can be classified as quantitative or qualitative in nature. Research design is also defined as a framework for the collection and analysis of data which reflect the decisions made on a range of dimensions of the research process (Bryman & Bell, 2007).

Saunders et al (2009) list seven types of research strategies as: experiment, survey, case study, action research, grounded theory, ethnography and archival research.

To determine the type(s) of research strategy to be adopted in this research, each of the strategies are hereby discussed:

1) Experimental Research – is a controlled investigation where certain variables are manipulated while certain variables are kept constant. The control group which is the standard

while experimental group will be compared in order to assess the role of the variable factor on the experimental group (Mohammed, 2007; Kothari, 2004; Saunders et al, 2009).

2) Survey research – is a field of investigation where large samples are needed from respondents who are to respond to various questions especially in questionnaire form, from their professional and social experiences. Surveys are concerned with describing, recording, analyzing and interpreting conditions that exist or existed. This is used in descriptive research studies and is appropriate for use in social and behavioural sciences (Sarantakos, 2005; Robson, 2007; Yin, 2009). Techniques used in survey studies according to Saunders et al (2009) are observation, measurement, construction, questionnaire, interview and literature.

3) Action research – According to Saunders et al (2009) one of the variants of action research relates to the involvement of practitioners in the research and, in particular, a collaborative democratic partnership between practitioners and researchers. Eden & Huxham (1996) argue that the findings of action research result from 'involvement with members of an organization over a matter which is of genuine concern to them'. Therefore, the researcher is part of the organisation within which the research and the change process are taking place (Coghlan & Brannick 2005) rather than more typical research or consultancy where, for example, employees are subjects or objects of study. It is related to ethnographic research, but instead of observing activity only, the researcher participates in the activity itself and may influence the manner by which it is carried out. In this study, the researcher is not part of the study and does not participate in giving data i e the researcher is not a respondent.

4) Ethnography – is a type of research which focuses on the manner in which people interact and collaborate in observable and regular ways. It is aimed at understanding behaviour from the perspective of the participants to capture social reality through fieldwork in natural settings (Osuala, 2001). It generally places more emphasis on semi structured interview than documentary data (Mohammed 2007). According to Gill & Johnson (1991) and Fellows & Liu (1997) ethnography approach is mainly observational as it observes human actions and

established principles and is founded in social sciences as it studies the relationships between different people or class of people. Ethnographic decision models are qualitative in analysis oriented to understand why a person makes a decision in a determined circumstance (Bernard, 1999). It can be used to analyse one-time decision such as adopting a particular technology and also recurring decision such as recycling behaviour or staffing policies (Bernard, 1999). Replication is impossible given the once-only nature of the data (Osuala, 2001). In ethnographic research, observation is mainly used.

5) Grounded Theory – is an application of ethnographic research that is becoming more common. It is not possible to define ethnography as a single method of collecting information since it usually entails the varying application of many techniques so as to elucidate the subjective basis of the behaviour of people. It attempts to understand the culture of the situation and so interpret it in such a way that its members do without conducting experiments or interviews in artificial environments (Mason, 1996). Grounded theory which is an application of ethnographic research also relies on mainly on observation for data collection. In grounded theory, data collection starts without the formation of an initial theoretical framework. Theory is developed from data generated by a series of observations. These data lead to the generation of predictions which are then tested in further observations that may confirm, or otherwise, the predictions Saunders et al (2009)

6) Historical / Archival research – is the area of investigation which deals with the collection of information on past events and situations using objective tools. The main sources of historical research are oral evidence, physical evidence, artefacts, pictures, autobiographies, record, letters, minutes of meeting, memoirs & witness accounts (Savantakos, 2005; Robson, 2007; Yin, 2009).

7) Case study research – is a form of qualitative analysis where a careful and complete observation of an individual or a situation or an institution is done, efforts are made to study

each and every aspect of the concerning unit in minute details and then from case data generalisations and inferences are drawn (Kothari, 2004). Case study is a method of studying in- depth rather than in- breadth. The case study places more emphasis on the full analysis of a limited number of events or conditions and their interrelations. The case study is an intensive investigation of the particular unit under consideration. The object of the case study method is to locate factors that account for the behaviour patterns of the given unit as an integrated totality (Mohammed, 2007). Case study can only collect limited data from single projects through observation, which is not in line with the current study.

Justification for adopting survey method as research strategy

Experimental research which is suitable for the pure science is not suitable for this current research because this study is a social science in the fashion of construction economics. In this study, the researcher is not part of the study and does not participate in giving data i e the researcher is not a respondent which action research stands for. Action research is not therefore adopted in this study. In ethnographic research, observation is mainly used, which is not required in this study. Ethnographic research therefore not adopted for the study. This current study does not require observation as a method of data collection and therefore grounded theory is not adopted. The current study does not deal with historical / archival matters and therefore historical or archival research is therefore not adopted in this study. Case study can only collect limited data from single projects through observation, which is not in line with the current study. Therefore, case study cannot be adopted for this study. This study is in social science / construction economics and is about collection of large quantity of data from professionals who are to respond to questions from their experiences. Specific to this research in adopting the survey method of research strategy, questionnaires were distributed to selected architects, civil engineers, electrical engineers, mechanical engineers, quantity surveyors and contractors in the six south western states in Nigeria and the federal capital territory. The questionnaires contain general types of documentation errors, general

causes of documentation errors, general qualitative effects of documentation errors (obtained from literature survey), mapping of causes to types of documentation errors and the frequencies of occurrences of types of documentation errors. The questionnaires are well structured with options as probable answers. The professionals respond to these questionnaires to determine the types of documentation error, causes of documentation error, qualitative effect of documentation errors, mapping of causes to types of documentation error and frequencies of occurrences of types of documentation errors specific to Nigeria. The professionals' responses are based on knowledge gained from their professional practices that have been stored in their brain as their opinion. Semi structured interviews are also administered to the selected professionals to state the definitions of documentation error. In this case no option was given as answers in which case the professionals respond based on their previous knowledge. Only the survey method satisfies all the conditions of carrying out this research and is therefore adopted for the study. The data collected were analysed by relative importance index and severity index.

Having discussed research strategy, its various types and justification for the use of one of them, the next section will discuss the research choices and justification for the use of one of the options.

4.5 Research Choice

According to Saunders et al (2009) the way in which qualitative and quantitative data collection techniques are combined for use in research is referred to as research choice. Research choice can be made from: mono method, multiple methods and mixed method.

Mono method refers to the use of single data collection technique and corresponding analysis procedures (Tashakkori & Teddlie, 2003). When two or more data collection techniques and analysis procedures are used, it is referred to as multiple methods (Curran & Blackburn, 2001). Mixed method is in use when qualitative and quantitative data collection techniques

and analysis procedures are adopted for use either parallel which is at the same time, or in sequential order that is one after the other (Tashakkori & Teddlie, 2003). Quantitative research methods were originally developed in the natural sciences to study natural phenomena. Qualitative research methods were developed in the social sciences to enable researchers to study social and cultural phenomena (Tashakkori & Teddlie, 2003). Neither of these methods is intrinsically better than the other; the suitability of which needs to be decided by the context, purpose and nature of the research study in question. Sometimes one can be alternative to the other depending on the kind of study. Qualitative research is socialistic; it attempts to study the everyday life of different groups of people and communities in their natural setting (Tashakkori & Teddlie, 2003). According to Myers (2009), qualitative research is designed to help researchers understand people, and the social and cultural contexts within which they live. Such studies allowed the complexities and differences of worlds-under-study to be explored and represented (Philip, 1998). Qualitative data sources include observation and participant observation (fieldwork), interviews and questionnaires, documents and texts, and the researcher's impressions and reactions (Myers, 2009). Data is derived from direct observation of behaviours, from interviews, from written opinions, or from public documents (Sprinthall, Schmutte, & Surois, 1991). Written descriptions of people, events, opinions, attitudes and environments, or combinations of these can also be sources of data. An obvious basic distinction between qualitative and quantitative research is the form of data collection, analysis and presentation. While quantitative research presents statistical results represented by numerical or statistical data, qualitative research presents data as descriptive narration with words and attempts to understand phenomena in "natural settings". This means that qualitative researchers study things in their natural settings, attempting to make sense of, or to interpret, phenomena in terms of the meanings people bring to them." (Denzin & Lincoln, 2000) Quantitative research makes use of surveys and experiments to gather data that is revised and tabulated in numbers, which allows the data

to be characterised by the use of statistical analysis (Hittleman & Simon, 1997). Quantitative researchers measure variables on a sample of subjects and express the relationship between variables using effect statistics such as correlations, relative frequencies, or differences between means; their focus is to a large extent on the testing of theory. However, all quantitative research requires a hypothesis before research can begin.

Justification for the use of multiple method of research choice

Mono method refers to the use of single data collection technique and corresponding analysis procedures. This study requires the use of three methods of data collection therefore mono method cannot be adopted. Mixed method is in use when qualitative and quantitative data collection techniques and analysis procedures are adopted for use. This is not the case in this research therefore mixed method is not adopted in this work. Multiple methods occur when two or more data collection techniques and analysis procedures are used. This study employs the use of three data collection techniques namely literature survey, semi- structured interview and questionnaire survey, therefore multiple method of research choice is adopted. Pertaining to this research in adopting the multiple method of research choice, literature survey was used to gather the general types, causes and qualitative effects of documentation error around the world, questionnaires were distributed to selected architects, civil engineers, electrical engineers, mechanical engineers, quantity surveyors and contractors in south western states in Nigeria and the federal capital territory. The questionnaires contain general types of documentation errors, general causes of documentation errors, general qualitative effects of documentation errors (obtained from literature survey), mapping of causes to types of documentation errors and the frequencies of occurrences of types of documentation errors. The questionnaires are well structured with options as probable answers. The professionals respond to these questionnaires to determine the types of documentation error, causes of documentation error, qualitative effect of documentation errors, mapping of causes to types of documentation error and frequencies of occurrences of types of documentation errors specific

to Nigeria. The professionals' responses are based on knowledge gained from their professional practices that have been stored in their brain as their opinion. Semi structured interviews are also administered to the selected professionals to state the definitions of documentation error. In this case no option was given as answers in which case the professionals respond based on their previous knowledge. The data collected were analysed by relative importance index and severity index and content analysis.

Having explained research choice and justification for use of one of it's variants, next sub-section will discuss research time horizons and justification for adopting one of it's variants.

4.6 Research Time Horizons

According to Sunders et al (2009) research time horizon are of the following two types:

1) Cross-sectional: this is a short time study of a particular phenomenon often caused by time and fund constraints. It is common with survey strategy (Easterby-Smith *et al*. 2008; Robson 2002).

2) Longitudinal: has to do with a long time study of a particular phenomenon.

The main strength of longitudinal research is the capacity that it has to study change and development. Adams & Schvaneveldt (1991) point out that in observing people or events over time, the researcher is able to exercise a measure of control over variables being studied, provided they are not affected by the research process itself.

Justification for the use of cross- sectional time horizon

Longitudinal time requires collection of data which would span through many years. For example in the study of growth of economic development of a country, data need to be collected for four to five or more years so that annual changes can be compared. The first year of this PhD work is to prepare and present the Interim Assessment report to the University. The second year is for field work, that is, collection of data, prepare and present the Internal Evaluation report to the University. The third and fourth years are to prepare the write up and

present the PhD thesis to the University. Although this PhD work is normally for four years, but data collection will be for a short time, that is, for one year especially in the second year. This is why the current study cannot adopt the longitudinal horizon. This study adopted the short time horizon because the collection will be for not more than one year and it is on the data collected that the whole study is based. Data collection for and to achieve objectives 2, 3 and 4 through questionnaire was done between April and September 2013. These data were analysed by relative importance index and this led to obtaining, i) the types of document errors specific to Nigeria, ii) the causes of document errors specific to Nigeria and iii) the qualitative and quantitative effects of errors specific to Nigeria. To achieve research objectives 5 and 6, results obtained for objectives 2 and 3 were placed in another set of questionnaire between January and May 2014. The data collected were analysed by severity index and percentages, i) to determine the causes of types of document error and ii) to determine the frequencies of occurrences of types of error specific to Nigeria. Data collection to achieve objective 1 through semi structured interview was carried out January and March 2014.The data collected were analysed through content analysis and it led to documenting a robust definition for construction document error. Therefore considering the aim of this research, that is, to develop framework with support of guidelines that minimises error in construction document, cross sectional time (short time) is most appropriate for the study.

4.7 Research Techniques (Data Collection Methods)

The research techniques which this section will discuss in detail, is dictated by the already determined research strategy which is survey studies. According to Saunders et al (2009) research techniques utilised in survey studies are:

1) Observation
2) Measurement
3) Construction

4) Questionnaire survey

5) Interviews

6) Literature survey.

Each of these listed techniques is discussed below.

1) Observation – is the act of noting and recording some events or the record of such noting. The act of observation becomes a scientific tool and the method of data collection for the researcher when it serves a formulated research purpose is systematically planned and recorded and is subjected to checks and controls on validity and reliability (Kothari 2004). Observation cannot be used in this study because data are collected from professional experiences of the respondents.

2) Measurement – measurement in this case is technical, and is a process of mapping aspects of a domain unto other aspects of a range according to some rules of correspondence. In measuring a devise is made in form of a scale in the range (in terms of set theory: range may refer to some set) and then transform or map the properties of objects from domain on to this scale (Kothari 2004). Measurement technique cannot be used in this study because data are collected from professional experiences of the respondents which are impossible through this technique.

3) Construction – this involves the use of artifacts and is a step by step plan for a computational procedure that possibly begins with an input value and yields an output value in a finite number of steps. It is also a kind of calculation with Arabic numerals and algorithm (Akogun, 2000). Construction technique cannot be used in this study because data are collected from professional experiences of the respondents which are not possible through this technique.

4) Literature survey is the documentation of a comprehensive review of the published and unpublished work from secondary sources of data in the areas of specific interest to the

researcher (Sekaran, 2003). A literature review is also intended to prevent the researcher from repeating the same issues that have been noted by previous researchers as well as making the researcher's knowledge up-to-date within the same research area (Kulatunga, 2008). Bryman & Bell (2007) highlighted the importance of literature review in developing an argument about the importance of a research and where it leads. A competent literature review should extend beyond mere reproduction of theories and opinions of previous scholars it equally interprets previous theories and uses these ideas to support a particular viewpoint or argument. The literature review conducted in this research is meant to capture the gap in knowledge for errors in construction documents in Nigerian and gain secondary data for this research. Therefore, the literature survey was conducted on definitions of error, causes of error types of error and effects of error on construction documents.

5) Questionnaire Survey is one of the most effective ways to involve a large number of participants in the process in order to achieve better result (Kothari, 2004). Questionnaire has been defined as a pre-formulated written set of questions to which respondent record their answers, usually within rather closely defined alternatives (Sekaran, 2003). A questionnaire consists of a number of questions printed or typed in a definite order on a form or set of forms. They can be administered personally, mailed to the respondents or can be distributed electronically (Kothari, 2004). Questionnaire may be used as the only data collection method, sometimes, it may be better to link them with other methods in a multiple method research design (Saunders et al, 2009). This research extensively makes use of questionnaires to collect qualitative and quantitative data. The use of questionnaire also enables the researcher to obtain information from larger group of respondents within a short time, and at a low cost. The purpose of the questionnaire in this research is to assist the researcher in obtaining the opinion of the practitioners, that is, professionals in the construction industry of Nigeria about the types, causes and effects of errors on construction documents. The questionnaires were constructed using a variety of question forms (Wilson & McClean 1994) to ensure that data

and the type of the format required for analysis (McCormack & Hill 1997) were elicited from respondents. Questionnaire was used to elicit information from respondents to determine the types, causes and effects of documentation errors specific to Nigeria. It was also used to elicit data to map causes to types of documentation errors and determine the frequencies of occurrences of types and causes of errors in Nigeria.

6) Semi –structured interview - as previously determined, this research employs a multiple methodology research design, where qualitative method will be used to collect data. The qualitative method applied in this research is in the form of semi-structured interviews.

Bryman & Bell (2007) categorises qualitative interviewing into two main types which are; unstructured and semi-structured interviews. Unstructured interviews provide the platform for the interviewee to respond freely, with the interviewer asking a single question and responding only to points deemed worthy to be followed up. According to Saunders et al (2009), unstructured interviews have also been named informant interview due to the fact that it is the interviewee's perception which guides the conduct of the interview. In semi structured interviews the researcher will have a list of items and questions to be covered, although these may vary from interview to interview. This means that one may omit some questions in particular interviews, given a specific organisational context that is encountered in relation to the research topic. The order of questions may also be varied depending on the flow of the conversation. On the other hand, additional questions may be required to explore research question and objectives given the nature Sunders et al (2009). The semi-structured interview refers to a context in which the interviewer has a series of questions that are in the general form of an interview schedule but is able to vary the sequence of the questions (Bryman & Bell, 2007). This type of interview are widely used in qualitative research as it gives the respondents the opportunity to relate to the research matter in their own opinion, which in return may bring forth enriched information for the researcher. The richness and vividness of

the interview data enables the researcher to see and understand what is reflected rather more abstractly in other kinds of data (Gillham, 2000). Yin (2011) notes three main characteristics of semi-structured interview which sets it apart from the structured interview:

1. The relationship between the researcher and the participant is not strictly scripted;

2. The researcher does not try to adopt any uniform behaviour for every interview;

3. The more important questions in the interview will be open-ended rather than close- ended questions. In this research, semi-structured interviews are selected as one of the techniques of qualitative data collection due to the needs of this research in gathering information from the practitioners in Nigeria. The interview sections were conducted with the aid of an interview guide (as attached in the appendix) which provides a 'loose' format of questioning that enables the researcher, not only to ask the standard set of questions, but also adjust the sequence of the questions and follow up on specific issues mentioned by the participants, which were not necessarily included in the interview guide. The interview sections were conducted face-to-face, allowing close contact between the researcher and participants during the data collection process. The semi-structured interview was used for research objective1 which is to document a robust definition for document error.

Justification for the use of Literature survey, semi-structured interview and questionnaire survey for data collection

Observation which is the act of noting and recording some events cannot be used in this study because data in this study are collected from professional experiences of the respondents.

Measurement which is technical is a process of mapping aspects of a domain unto other aspects of a range according to some rules of correspondence. Measurement technique cannot be used in this study because data from this study are collected from professional experiences of the respondents which are impossible through this technique.

Construction which involves the use of artifacts and is a step by step plan for a computational procedure cannot be used in this study because data are collected from professional experiences of the respondents which are not possible through this technique.

Literature survey is the documentation of a comprehensive review of the published and unpublished work from secondary sources of data in the areas of specific interest to the researcher. Literature survey has been used largely in this research to discover the general causes of documentation error, general types of documentation error and general qualitative effects of documentation error which form the basis of the questionnaire used in this study.

Questionnaire which has been defined as a pre-formulated written set of questions to which respondent record their answers, usually within rather closely defined alternatives and is used to collect large amount of data has been adopted in this study. Pertaining to this research in adopting the questionnaire method of research technique, questionnaires were distributed to selected architects, civil engineers, electrical engineers, mechanical engineers, quantity surveyors and contractors in south western states in Nigeria and the federal capital territory. The questionnaires contain general types of documentation errors, general causes of documentation errors, general qualitative effects of documentation errors (obtained from literature survey), mapping of causes to types of documentation errors and the frequencies of occurrences of types of documentation errors. The questionnaires are well structured with options as probable answers. The professionals respond to these questionnaires to determine the types of documentation error, causes of documentation error, qualitative effect of documentation errors, mapping of causes to types of documentation error and frequencies of occurrences of types of documentation errors specific to Nigeria. The professionals' responses are based on knowledge gained from their professional practices that have been stored in their brain as their opinion and mind set. The semi-structured interview refers to a context in which the interviewer has a series of questions that are in the general form of an interview schedule but is able to vary the sequence of the questions are also administered to the selected

professionals to state the definitions of documentation error. In this case no option was given as answers in which case the professionals respond based on their previous knowledge. The data collected were analysed by relative importance index and severity index. Data collected from the interview were analysed by content analysis.

Having explained each of the first, five and a half layers of onion methodology model and the justifications for the use of each of the options in each of them in sections 4.3 to 4.8, next sections will discuss some preliminaries to data collection under the headings of target population, sampling techniques, reliability of instruments and validity of instruments. The second half of the sixth onion methodology layer (research techniques and procedure- which is data analysis) will be discussed in chapter 5 of this thesis.

4.8 Target Population

The target population for this study consists of the professionals namely architects, civil engineers, electrical engineers, mechanical engineers and quantity surveyors and contractors that are practicing in south west states of Nigeria and the Federal Capital Territory. All the participants have the data ability to respond to the definitions of error, types and causes of error, effects of error, mapping of causes to types of error and the frequencies of occurrences of types of error. The quantity surveyors, contractors and architects have better data ability to respond to effects of error on cost and time- this is because they deal more with cost and time schedule of building projects.

This section has defined target population for this study next section will explain the sampling techniques.

4.9 Samples and Sampling Techniques

It was not practically possible to look at every object in the situation being investigated. This is the reason for sampling. Asika, (2000) follows the saying that "You don't have to eat the whole ox to know that the meat is tough". That is the essential idea of sampling to gain information about the whole by examining only a part. The participants were sampled through purposive or judgmental or deliberate sampling method; where the participants must have practised for at least 5 years on the job. Purposive sampling was combined with random sampling which has provided the means of enabling data collected from representatives of the population that have put reasonable number of years into professional practice. Data collected from this process were representative of the population and were reliable.

Having explained the sampling method utilised in this section, it is necessary to discuss the reliability and validity of instruments in the next two sections (refer to 4.11 & 4.12)

4.10 Reliability of Instruments

According to Schreier (2012) reliability is a criterion that is typically used in evaluating the quality of an instrument. In research, reliability of an instrument is concerned with its consistency in producing accurate results (Asika, 2000). Schreier (2012) proposes two methods of reliable test for qualitative method of data collection:

1. Comparisons across persons - that is, where two or more coders use the same coding frame to analyse the same units of coding, and they do so independently of each other. The coding frame is considered reliable if the results apply across different coders.

2. Comparisons across points in time – that is, where one coder uses the same coding frame to analyse the same units of coding after a certain period of time. The coding frame is considered reliable if the results remain stable over time.

Justification for adopting *Comparisons across points in time* in reliability of instrument

The author made use of the comparison of result of coding frame across points in time to fulfil the qualitative reliability issue. The instrument, that is, questionnaire is administered in Edo State outside the states of the South West Nigeria to architects, civil engineers, electrical engineers, mechanical engineers, quantity surveyors and contractors. The questionnaire consists of questions which when responded to by the respondents to achieve objectives 2, 3 and 4 which respectively determine the types of document error, causes of document error and effects of document error specific to Nigeria. The questionnaire is well structured consisting of five options (A) strongly disagree, (B) agree, (C) no opinion, (D) agree, (E) strongly agree from which the respondents will choose one. The administration of questionnaire was repeated for the second data collection. This needs to do with achieving objectives 5 and 6 which respectively determine the causes to types of error and the frequencies of occurrences of types of document errors specific to Nigeria. The responses collected were analysed by relative importance index, severity index and percentages. The results are stored. The way the respondents responded to the questionnaire revealed the weaknesses of the instrument as regards the language used in constructing the instrument, ambiguity and cultural acceptability of the instrument. In the manner advised by Nworgu (2006) after the instruments were corrected and made to be free of weaknesses, it was for the second time re-administered on the same set of pilot respondents. The second set of responses were also scored and compared with the initial test scores. In spite of the corrections on the structure and grammar of the second instruments, the two sets were found to be highly reliable having been tested with correlational coefficient statistic, the result of which yielded 0.89.

Reliability of questionnaire used in the study has been discussed in this section including justification for the use of one of the methods adopted for use, next section will explain the validity of instrument, it's variants and the justification for the use of one of the variants in the study.

4.11 Validity of Instrument

Validity is defined as the degree at which a measuring instrument measures what it is designed for (Asika, 2000). If correctly designed, it measures what it is supposed to measure. If it is faulty, then it may have measured something which may not be what it is supposed to measure (Asika, 2000). A research instrument is also said to be valid if it enables a researcher elicit the correct responses from the sample subjects (Abdul-Nifa, 2013). Cresswell (2009) stresses the point that qualitative validity signifies procedures that the researcher had undergone to test the accuracy of findings.

In addressing the validity for an instrument, various methods exist, which includes: content validity, construct validity and criterion validity (Asika, 2000; Saunders et al, 2009; Creswell & Plano Clark, 2011).

i. Content Validity

Content validity is established through the judgement of the external experts whether the items or questions are representative of the construct investigated (Creswell & Plano Clark 2011; Asika, 2000).

ii. Construct Validity

Construct validity is an attempt to measure how adequately an instrument measures the actual meaning of a construct. A construct is a concept that has been deliberately adopted for a special scientific purpose. An instrument is designed to measure data and test hypothesis based on the construct (Asika, 2000).

iii. Criterion Validity

Criterion validity measures the predictive ability of an instrument in relation to other past and currently validated instrument (Asika, 2000).

This research made use of the content validity.

Justification for adopting content validity in validation of instrument

The requirement of this study demands that content of the questionnaire be standardised which content validity stands for, therefore construct and criterion methods were not made use of. Content validity is established through the judgment of the external experts whether the items or questions are representative of the things investigated (Creswell & Plano Clark, 2011). The first set of questionnaire consists of questions which were responded to by the respondents and achieved objectives 2, 3 and 4 which respectively determined the types of document error, causes of document error and effects of document error specific to Nigeria. The second set of questionnaire needs to do with achieving objectives 5 and 6 which respectively determined the causes to types of error and the frequencies of occurrences of types of document errors specific to Nigeria. The questionnaires were well structured consisting of five options (A) strongly disagree, (B) agree, (C) no opinion, (D) agree, (E) strongly agree from which the respondents will choose one. The factors of errors placed as questions in the questionnaire were found in literatures. To ensure that the questionnaire instrument generated in this research measures what it is supposed to, the questionnaires have been reviewed by a panel comprising of 5 experts from various segments in the Nigerian construction industry prior to the data collection stage, to evaluate the content validity of the instrument. Experts were asked specifically to review each of the items according to (1) how the item represented the enabling factors in content, and (2) whether they think the Likert scale assigned was applicable to each item in meaning. The questionnaires were also given to my supervisors – local advisor and University of Salford based supervisor for their comments and criticisms. According to Dong (2011), a common way to evaluate content validity is to analyse the content of a test and to compare it with a statement of what the content should be. During the content validation process, the reviewers were given a fact sheet in which contain the objectives of this research stated in chapter 1 and were asked if the items in the questionnaire reflected what are supposed to be achieved. The comments and concerns raised

by this panel of experts during this review process have been acknowledged and incorporated to improve the questionnaire instrument for use in data collection stage. Apart from that, the review process have also resulted in the Likert scale applied being varied according to the meaning of each item; whether the item implied action or opinion of the respondent's organization.

This section explained the validity of instrument, it's variants and the justification for the use of one of it's variants in the study. Next sections will discuss the practical implementation of research technique (data collection) which theory has been discussed in section 4.8.

The next sections (sections 4.12 – 4.14) include the explanations on how data for this study were practically collected. It will be discussed under administration of questionnaires, matching of data collection methods with research objectives, sequence of data collection, periods for data collection and the various associated tables.

4.12a Administration of Questionnaire

Questionnaires were distributed to sampled architects, civil engineers, mechanical engineers, electrical engineers, quantity surveyors and contractors in the six south western states of Nigeria and the federal capital territory. The list of architects, civil engineers, mechanical engineers, electrical engineers, quantity surveyors and contractors were obtained from their respective state chapters' professional bodies, that is, Nigerian Institute of Architects (NIA) whose regulatory body is Architects Registration Council of Nigeria (ARCON); Nigerian Society of Engineers (NSE) whose regulatory body is Council for Regulation of Engineering in Nigeria, (COREN) and the Nigerian Institute of Quantity Surveyors (NIQS) whose regulatory body is Quantity Surveyors Registration Board of Nigeria (QSRBN) and then the Federation of Building and Civil Engineering Contractors of Nigeria (FBCEN).

Having discussed the administration of the questionnaires it is necessary to bring out the method of data collection for each of the objectives.

4.12b Data collection and Research Objectives

This sub section discusses the association of data collection with research objectives. Table 4.2 below matches the research objectives with the methods of data collection. For Research Objective 1 which talks of documenting a robust definition for document error, literature survey and semi structured interview were used to collect data. For Research Objective 2 which is to determine the types of document error common in Nigeria, literature survey and questionnaire survey were utilised. Research Objective 3 which is to identify the causes of document error specific to Nigeria, literature survey and questionnaire survey were used to collect data. For Research Objective 4 which is to examine the effects of document error on projects specific to Nigeria, literature survey and questionnaire survey were made use of to collect data. Research Objective 5 which is to explore causes to types of document error specific to Nigeria, questionnaire survey was utilised to collect data. For Research Objective 6 which is to critically analyse the frequencies of occurrences of types of document errors in Nigeria, questionnaire survey was used to collect data. For Research Objective 7 which is to develop a framework supported with guidelines for minimisation of errors in construction documentation in Nigeria, the combination of literature survey and questionnaire survey were made use of.

Table 4.2: Research objectives and methodology of data collection

		Methods of data collection		
S/N	Research Objectives	Questionnaire Survey	Literature Survey	Semi - structured interview.
1	Document a robust definitions for construction documentation error		√	√
2	Determine the types of error common in construction documents in Nigeria	√ Qualitative	√	

		(structured Q)		
3	Identify the causes of errors in construction documents specific to Nigeria.	√ Qualitative (structured Q)	√	
4	Examine the qualitative and quantitative effects of errors in construction documents on cost, time and humans	√ Qualitative (structured Q)	√	
5	Explore the causes to types of errors in construction documents in Nigeria	√ Qualitative (structured Q)		
6	Critically analyse the frequencies of occurrences of the types of error in construction documents in Nigeria	√ (structured Q)		
7	Develop framework supported with guidelines for minimisation of errors in construction documents in Nigeria	√ Qualitative (structured Q)	√	

Having related research objectives to method of data collection in the table above (refer to Table 4.2), next section will discuss the sequence of data collection.

4.13 Sequence of Data Collection and analysis

This section discusses the order of arrangements in which this work was carried out with respect to data collection and analysis. Refer to Figure 4.3 on the sequence of data collection and analysis for this work. It is in the order of:

i. Literature survey which was used to collect data in order to achieve:

Research objective 1, general definitions of document error, represented by ‘Defn’ in the flow chart diagram;

Research objective 2, general types of document error, represented by ‘Types’ in the flow chart diagram;

Research objective 3 general causes of error, represented by ‘Causes’ in the flow chart diagram;

Research objective 4, general qualitative effects of document error, represented by ‘Effects’ in the flow chart diagram;

ii. Questionnaire survey which was used to collect data to achieve:

Research objective 2, specific types of document error in Nigeria, represented by ‘Types’ in the flow chart diagram and the data collected were analysed by relative importance index.

Research objective 3, specific causes of document error in Nigeria, represented by ‘Causes’ in the flow chart diagram and the data collected were analysed by relative importance index.

Research objective 4, specific qualitative and quantitative effects of document error in Nigeria, represented by ‘Effects’ in the flow chart diagram and data collected were analysed by severity index and percentages.

Research objective 5, specific causes of types of document error in Nigeria, represented by ‘Mapping’ in the flow chart diagram and data collected were analysed by severity index.

Research objective 6, frequencies of occurrences of types of document error in Nigeria, represented by ‘Frequencies’ in the flow chart diagram and data collected were analysed by percentages

iii Semi Structured Interview was used to collect data to achieve research objective 1, robust definition of document error, represented by 'Defn' in the flow chart diagram and data collected were analysed by content analysis.

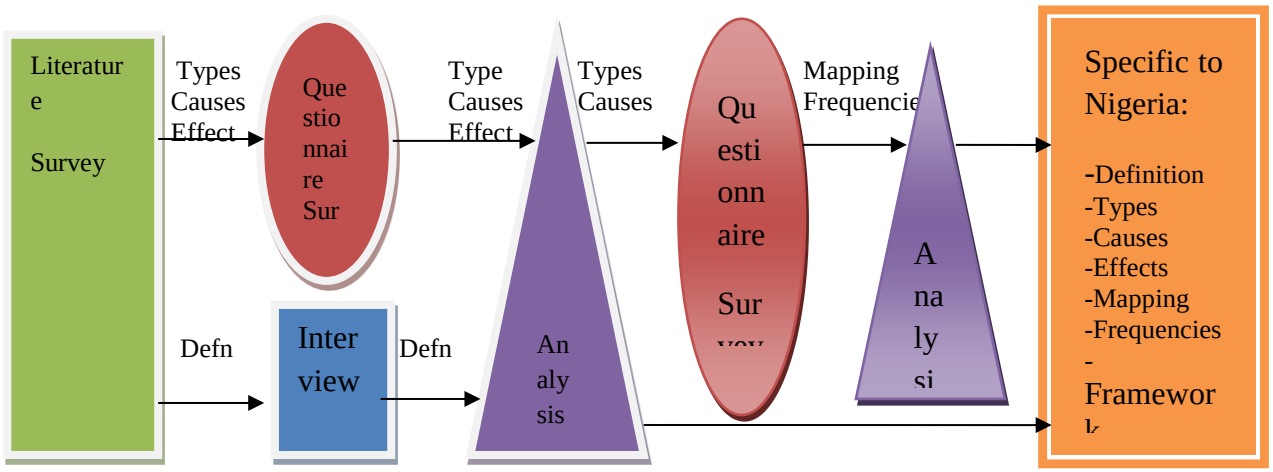

Figure 4.3: Flow Chart for sequence of data collection

From Figure 4.3: literature survey was first utilised to collect data while questionnaire survey and semi structured interview were simultaneously utilised.

For Research Objectives 5 & 6, the questionnaires were administered after analysing data and getting results for Research Objectives 2 & 3. This was because results for Research Objectives 2 & 3 were needed for the questionnaire for achieving Research Objectives 5 & 6.

This section has explained the sequence of data collection for this study next section will explain the periods for data collection.

4.14 Periods for data collection

Questionnaire data for research objectives 1, 2, 3 and 4 represented by Tables 4.3, 4.4, 4.5 and 4.6 were collected between April and September 2013. It was discovered that more data needed to be collected based on the already collected data of research objectives 2 and 3. It was not possible to collect data to achieve research objectives 5 and 6 until data for research

objectives 2 and 3 were ready and analysed. Therefore, data for research objectives 5 and 6 represented by Tables 4.7a and 4.7b were collected between January and May 2014.

Having explained the administration of questionnaire, sequence of data collection and periods for data collection, next section will discuss and display the tables that show practical administration of questionnaires.

Table 4.3 shows the responses of professionals to semi structured interview on definitions of construction document error. The semi structured interview took place between April and September 2013. Twenty professionals each were contacted in each of the six states in south western Nigeria and the Federal Capital Territory. Responses through interview received from professionals in Ondo state is 11 representing 55% of those contacted; Ekiti state is 9 representing 45%; Osun state is 8 representing 40%; Oyo state is 10 representing 50%; Ogun state is 8 representing 40%; Lagos state 11 representing 55% and the Federal Capital Territory is 11 representing 55%. In all 140 professionals were contacted but only 68 had time for the interview representing 48.6% of the number of those contacted. Many of the professionals who did not respond were those who did not have interest to talk concerning the question of what the definition of document error is.

Table 4.3: Responses to semi structured interview on definition of document error.

SN	States	Number of respondents contacted	Number of respondents who responded	Percentage of respondents who responded
1	Ondo	20	11	55
2	Ekiti	20	9	45
3	Osun	20	8	40
4	Oyo	20	10	50
5	Ogun	20	8	40

6	Lagos	20	11	55
7	FCT	20	11	55
	Total	140	68	48.6

The practical distribution and retrieving of questionnaire is shown in Table 4.4. This shows the collection of data for objectives 2, 3 and 4 done between April and September 2014. Table 4.4 shows the distribution of questionnaire in the six states of South Western Nigeria and the Federal Capital Territory with respect to the professionals engaged in the study. The number of questionnaire distributed was 680 and the number of questionnaires retrieved was 417 representing 61.3% of the total number distributed. According to Table 4.4 the questionnaires were distributed to architects, civil engineers, electrical engineers, mechanical engineers, quantity surveyors and contractors in Ondo state, Ekiti state, Osun state, Oyo state, Ogun state, Lagos state and the Federal Capital Territory. These professionals responded to research objectives 2, 3 & 4, that is, types, causes and effects of documentation errors. Table 4.4 is summarised in Table 4.5.

Table 4.4: Administration of Questionnaires on types, causes and effects of document error

S/N	States	Architect	Civil Engineer	Electrical Engineer	Mechanical Engineer	Quantity Surveyor	Contractor
1	ONDO Distributed 80 Retrieved 62	20 16	10 8	10 6	10 7	20 17	10 8
2	EKITI Distributed 80 Retrieved 53	20 13	10 7	10 6	10 6	20 14	10 7

3.	OSUN Distributed 80 Retrieved 51	20 13	10 7	10 5	10 5	20 13	10 8
4.	OYO Distributed 80 Retrieved 52	20 13	10 8	10 5	10 5	20 16	10 15
5.	OGUN Distributed 80 Retrieved 43	20 10	10 5	10 5	10 5	20 13	10 5
6	LAGOS Distributed 160 Retrieved 89	40 21	20 11	20 10	20 10	40 25	20 12
7.	FCT Distributed 120 Retrieved 67	30 14	15 9	15 8	15 8	30 18	15 10
TOTAL	Distributed 680 Retrieved 417 61.30%	170 100 58.2%	85 54 63.5%	85 44 57.8%	85 45 52.9%	170 116 67.6%	85 53 62.4%

With the discussions and table on administration of questionnaires to the respondents it is necessary to summarise the table for easy understanding. Table 4.5 below is the summary of

Table 4.4 and it shows the percentages of retrieved questionnaire per group of participants. 170 questionnaires were distributed to architects and 100 of them were retrieved representing 58.2% of the number distributed, while 85 copies of questionnaire were distributed to civil engineers and 55 were retrieved representing 63.5%. Electrical engineers received 85 copies of the questionnaire and 45 were retrieved which is 57.8% of the copies distributed while mechanical engineers received 85 copies and 46 were retrieved representing 52.9%. 170 copies of questionnaire were distributed to quantity surveyors and 116 were retrieved representing 66.7%, while the contractors received 85 questionnaire and 55 copies were retrieved representing 62.4% of the number distributed.

Table 4.5: Percentages of retrieved questionnaire with respect to participants on types and causes of document errors

S/No	Group of participants	Number of questionnaires administered	Percentage of questionnaires retrieved
1.	Architect	170 100	58.2
2.	Civil Engineer	85 55	63.5
3.	Electrical Engineer	85 45	57.8
4.	Mechanical Engineer	85 46	52.9
5.	Quantity Surveyor	170 116	67.6
	Contractor	85 55	62.4
	Total	680 417	61.3

Table 4.5 shows the summary of percentages of questionnaires distributed and retrieved from architects, civil engineers, electrical engineers, mechanical engineers, quantity surveyors and the contractors.

Having discussed the summary of administration of questionnaire in Table 4.5, next discussion will be on administration of questionnaire on the collection of data on the response of participants to effects of errors on cost and time.

Table 4.6 is also drawn from Table 4.4 and it shows that only three groups of professionals (architect, quantity surveyor and contractor) who possess the data ability were able to respond to questions in the questionnaire on effects of documentation error on cost and time. According to Table 4.6, out of the 417 retrieved questionnaires 198 completed questionnaires were those of many of the architects, quantity surveyors and contractors which represents 47.5% of the total questionnaire retrieved from respondents.

Table 4.6: Response of participants to effects of errors on cost and time

Number of participants	Response from participants	Percentage response from participants
417	198	47.5

Having shown the discussions on response of participants to effects of errors on cost and time, it is necessary to discuss and show table for percentages of retrieved questionnaire on mapping of causes to types of error.

Table 4.7a shows the summary of administration of questionnaire from January to May 2014, which is on the collection of data for research objective 5 that is mapping of causes to types of error. It shows the percentages of questionnaires retrieved from architects, civil engineers, electrical engineers, mechanical engineers, quantity surveyors and contractors. These participants have the data ability to respond to mapping of causes to types of error. From Table 4.7a: 120 questionnaires were distributed to architects and 78 were retrieved representing 65% of the questionnaires distributed, while civil engineers received 80 questionnaires and 50 were retrieved representing 62.5% of questionnaire distributed. 60 questionnaires were distributed to electrical engineers and 23 were retrieved representing

38.3% of questionnaire distributed to them, while 60 questionnaires were distributed to mechanical engineers and 24 were retrieved representing 40% of the questionnaire distributed. Quantity surveyors received 120 questionnaires and 85 were retrieved from them representing 70.8% of the questionnaire distributed, while 80 copies of questionnaire were distributed to contractors and 46 were retrieved which is 57.5% of the number of questionnaire distributed to them

Table 4.7a: Percentages of retrieved questionnaires from participants on mapping of causes to types of error.

S/N	Participants & Number of Questionnaires distributed	Number of Questionnaire Retrieved	Percentage of Questionnaire Retrieved
1	Architect 120	78	65
2	Civil Engineer 80	50	62.5
3	Electrical Engineer 60	23	38.3
4	Mechanical Engineer 60	24	40
5	Quantity Surveyor 120	85	70.8
6	Contractor 80	46	57.5
	Total 520	306	58.8

Having shown the discussions on response of participants on percentages of retrieved questionnaire to participants on mapping of causes to types of error, it is next to discuss and show table for percentages of retrieved questionnaire with respect to participants on frequencies of occurrences of types of document errors.

Table 4.7b shows the summary of administration of questionnaire from January to May 2014, which is on the collection of data for research objective 6, that is, frequencies of occurrences of types of error. It shows the percentages of questionnaires retrieved from quantity surveyors, architects civil engineers, electrical engineers, mechanical engineers and contractors. These participants have the data ability to respond to mapping of causes of types of error. From

Table 4.7b: 120 questionnaires were distributed to architects and 78 were retrieved representing 65% of the questionnaires distributed, while civil engineers received 80 questionnaires and 50 were retrieved representing 62.5% of questionnaire distributed. 60 questionnaires were distributed to electrical engineers and 23 were retrieved representing 38.3% of questionnaire distributed to them, while 60 questionnaires were distributed to mechanical engineers and 24 were retrieved representing 40% of the questionnaire distributed. Quantity surveyors received 120 questionnaires and 85 were retrieved from them representing 70.8% of the questionnaire distributed, while 80 copies of questionnaire were distributed to contractors and 46 were retrieved which is 57.5% of the number of questionnaire distributed to them

Table 4.7b: Percentages of retrieved questionnaire with respect to participants on frequencies occurrences of types and causes of errors on construction documents

S/N	Participants & Number of Questionnaires distributed	Number of Questionnaire Retrieved	Percentage of Questionnaire Retrieved
1	Architect 120	78	65
2	Civil Engineer 80	50	62.5
3	Electrical Engineer 60	23	38.3
4	Mechanical Engineer 60	24	40
5	Quantity Surveyor 120	85	70.8
6	Contractor 80	46	57.5
	Total 520	306	58.8

Having discussed the issues on practical implementation of the data collection in sections 4.12, 4.13 and 4.14, next section will discuss research techniques (statistics for data analysis) which is the first half of the sixth layer of the onion methodology model. The second half of sixth layer of the onion methodology model which is the research procedure (presentation of data analysis) will be discussed in chapter 5 of this thesis.

4.15 Research techniques for data analysis

The statistical tools used for the analysis are stated below with respect to the objectives of the study:

Objective 1: Document a robust definition for construction document error.

Analysis tool: Content Analysis

Objective 2: Determine the types of errors in construction documents,

Statistical tool: Relative Importance Index.

Objective 3: Identify the causes of errors in construction documents,

Statistical tool: Relative Importance Index.

Objective 4: Examine the qualitative and quantitative effects of errors in construction documents.

Statistical tool: Severity Index.

Objective 5: Explore the causes of error to types of errors and vice versa,

Statistical tool: Severity Index.

Objective 6: Critically analyse the frequency of occurrences of the types and causes of errors in construction documents.

Statistical tool: Severity Index & Percentages.

Objective 7: Develop a framework with support of guidelines to minimise the occurrence of errors in the construction documents in Nigeria.

Tool: Flow Chart

Having stated the statistical tools used for the analysis with respect to the research objectives, next section will define the statistics used in the study.

4.16 Definitions of Statistics Used: Content Analysis, Severity Index and Relative Importance Index

1) Content Analysis is a research tool used to determine the presence of certain words or concepts within texts or set of texts. It is used to quantify and analyse the presence of meanings and relationships of such words and concepts, then make inferences about messages within. It is a technique for systematically describing written, oral or visual communication. In this way the set of information are broken down into categories and then summarised (Weber, 1990; Mc Brooen, 1992). Content analysis is a means of analysing the contents of interview administered to participants and bringing out the similarities and end with a summary.

2) Severity Index –is a method of stratification of data into five groups in an attempt to indicate the weak and strong groups (Asika, 2000). During the research respondents were allowed to rate their opinions on a set of questions on a category of five levels and through analysis, indicate the weaker, weak, neutral, strong, and stronger categories.

3) Relative Importance Index- refers to the contribution a variable makes to the prediction of a criterion variable by itself and in combination with other predictor variables (Johnson & LeBreton, 2004). This definition refers only to the relative contribution of a variable to total predictable variance and makes no assumptions about either the statistical significance or practical significance associated with a particular predictor. Information concerning the contribution of a variable to predictable variance is helpful when considering the practical utility of a variable, but aspects of the particular situation must also be considered to fully gauge practical importance (Cortina & Landis, 2009). In certain circumstances, a variable may explain only a small proportion of predictable variance and yet be very meaningful (Martell et al,1996), whereas in other situations, a variable may account for a larger percentage of the variance but may provide little practical utility (Cortina & Landis, 2009).

Relative importance weights are a useful supplement to multiple regression because they provide information not readily available from the indices typically produced from a multiple regression analysis (Tonidandel & LeBreton, 2011) When one is mainly concerned with how much scores on the criterion variable would change based on a unit increase in a predictor while holding the other predictors constant, then regression coefficients are well suited to address such a question (Tonidandel & LeBreton, 2011) The relative importance index analysis in this study made use of the SPSS.

This section defined the various statistics made use of in this study next section will examine the statistics for validation of research results.

4.17 Statistics for Validation of Research Results

Validation is the process of building confidence in usefulness (Pedersen, et al, 2000; Seepersad et al, 2006) It is a means to prove that the research results to be obtained reflect the true situation and therefore reliable, dependable and can be utilised.

The followings explain what are to be done in this validation exercise:

1. Validation Process:

The Validation process involves:

(i) The presentation of research results to group(s) of experts through electronic or meeting medium.

(ii) The experts rating of their agreement with each of the research results (strongly agree, agree, undecided, disagree or strongly disagree).

(iii) Selection of Experts:

Experts in this study refer to the architect, civil engineer, mechanical engineer, electrical engineer and the quantity surveyor.

The selection of experts for the purpose of this validation of results is by purposive and random samplings.

(a) Purposive Selection

The experts must possess:

i. BSc or HND-PGD plus MSc or PhD

ii. Professional registration awarded by the relevant professional and regulatory bodies.

iii. At least 15 years professional practice experience.

(b) Random Selection:

From the experts who have been selected by purposive sampling; the required number of experts will be picked randomly for the validation exercise (refer to Table 4.9)

Table 4.8: Selection of experts for validation exercise

Experts	Number
Architect	2
Civil Engineer	2
Mechanical Engineer	2
Electrical Engineer	2
Quantity Surveyor	2

2 Questionnaire for Validation of Research Results:

Each of the seven research results will be stated in a tabular form for the experts to rate, with respect to their agreement with them (please refer to Table 4.10)

Table 4.9: Experts Rating for Research Result 1

Experts	Research Results	Ratings				
		SD (1)	**D (2)**	**U (3)**	**A(4)**	**SA(5)**
1	Definition of error					
2	Definition of error					
3	Definition of error					
4	Definition of error					
5	Definition of error					
6	Definition of error					
7	Definition of error					
8	Definition of error					
9	Definition of error					
10	Definition of error					

The table above is repeated for each of the research results 2 to 7.

3 Analysis of Agreements of Experts:

The analysis of agreement of the experts rating of research result was done by Kendall's Coefficient of Concordance. Kendall's Coefficient of Concordance is a measure of agreement among several judges or experts who are assessing a given set of objectives (Legendre, 2005 & Kendall, 1948). It estimates or calculates or evaluates the agreement between three or more rankers or judges or experts as they rank a number of objects or data (Trosset, 2005; Legendre 2000 & Legendre 2010) SPSS was used to arrive at Kendall's Coefficient of Concordance in this study. The experts in this study are 2No Architects, 2No Civil Engineers, 2No Electrical Engineers, 2No Mechanical Engineers and 2No Quantity Surveyors. The experts who are the construction professionals formed a team of judges. The seven research results were presented to each of the team members. Each of the professionals rated each of the seven research results on a scale of 1 to 5. Scale 1 stand for strongly

disagree, 2 stand for disagree, 3 for undecided, 4 for agree while 5 is for strongly agree. To determine whether a research result is valid, the professionals need to agree with result. The agreement of the professionals on each of the seven research results were determined by Kendalls coefficient of concordance.

This section examined the statistics for validation of research results next section will discuss presentation of data.

4.18 Summary

This chapter on research methodology centred on the onion research methodological model. The chapter commenced with the types of research methodological models and continued with discussions on research philosophies, research approaches, research strategies, research choices, research time horizons and research procedures (data collection issues). The chapter continued with discussions on sampling, validation and reliability of instruments and administration of questionnaire. The chapter stated the statistics for data analysis and validation of results. The chapter also presented the research techniques (statistics for analysis of data), validation of research results and summary. Having discussed in detail the onion research methodological model on how the research was carried out and validation of the research results and the revision of conceptual framework next chapter will show analysis of data and discuss the research results one after the other.

CHAPTER FIVE

DATA ANALYSIS, RESULTS AND DISCUSSION

5.0 Introduction

The chapter shows presentation and analysis of data relating to this study. This chapter also provides discussions on the types, causes and effects of document error identified in the construction documents with respect to similarities and/or dissimilarities with findings of past authors and researchers. It provides explanations on the causes of documentation error with respect to the current situations that led to negative effects and the suggested situations as ways out of the problems. Having stated what this chapter contains in this section, next sections will present and analyse data, discuss the types, causes and effects of document error.

5.1 Data Presentation

This section presents the analysis of data on general information on respondents and then proceeds to presentation and analysis of data to achieve the research objectives.

Table 5.1 shows the general information on respondents for this study. Out of the 417 respondents 34% are professionally qualified, 4% possess MSc, 39% possess BSc/HND + PGD while 23% has only the HND. None of the respondents has less than 5 years of experience, those with 5-10 years of experience are 41%; 11-20 years of experience 35%; 21-30 years of experience 20%; above 30 years of experience 4%. In this study projects with contract sum of less than N50m were18%; N51-100m, 30%; N101-250m, 26.3%; N251-500m, 18%; N501m-N1b, 7% and above N1b, 0.7%. On duration of projects examined, none was less than one year, 1-3 years were 12%; 3-5 years 49%; above 5 years 39%. On the type of buildings where the respondents practiced, 4% were religious buildings; 13% were

commercial buildings; 12% residential; 15% industrial and 56% educational. Of the professionals that were respondents, 24% were architects; 13% civil engineers; 11% electrical engineers; 11% mechanical engineers; 28% quantity surveyors and 13% were building contractors. The professionals worked with 64% public clients;16% private clients and 20% corporate clients.

Table 5.1: General information on respondents

Respondents Qualifications	Number	Percentage
Professional Qualifications	142	34
MSc	18	4
BSc / HND + PGD	159	39
HND	98	23
Total	417	100
Respondents Experience		
Less than 5 years	0	0
5 – 10 years	171	41
11 – 20 years	144	35
21 – 30 years	85	20
Above 30 years	17	4
Total	417	100
Project Contract Sum		
Below N50m	73	18
N50m – N100m	123	30
N101m – N250m	111	26.3
N251m – N500m	76	18
N501m – N1bn	31	7

Above N1bn	3	0.7
Total	417	100
Project Duration		
Less than 1 year	0	0
1 – 3 years	48	12
3 – 5 years	207	49
Above 5 years	162	39
Total	417	100
Type of Building Project		
Religious	17	4
Commercial	54	13
Residential	49	12
Industrial	65	15
Educational	232	56
Total	417	100
Profession of Professionals		
Architecture	100	24
Civil Engineering	55	13
Electrical Engineering	45	11
Mechanical Engineering	46	11
Quantity Surveying	116	28
Building / Contracting	55	13
Total	417	100
Client		
Public sector	266	64

Private sector	69	16
Corporation	82	20
Total	417	100

Table 5.1 in section 5.1 exposed general information on the respondents with respect to respondents' qualifications, respondents experience, project contract sum, project duration, type of building projects, profession of the professionals and type of clients involved on the building projects. All these combined to outline the size of projects and the respondents involved in the study. Next is to present and analyse data with respect to the objectives of the study.

Data will be presented for each of the research objectives in this section. In chapter one of this study, seven objectives were set out. It was equally mentioned that this work will attempt to proffer answers to satisfy the following research objectives:

1. To document a robust definition of construction documentation error
2. To determine the common types of errors in construction documentation in Nigeria
3. To identify the common causes of errors in construction documentation in Nigeria
4. To examine the quantitative and qualitative effects of construction documentation errors on construction projects and economy in Nigeria
5. To explore causes to the common types of error in construction documentations in Nigeria
6. To critically analyse the frequencies of occurrences of the common types and causes of errors in construction documentation in Nigeria
7. To develop framework supported with guidelines for minimizing construction documentation errors in Nigeria.

The presentation of data is made to tally with the objectives of this study one after the other.

5.2.1 Robust Definition of Construction Document Error

Research Objective 1: is to document a robust definition for construction documentation error. The study was carried out through literature search and semi-structured interview as shown in Tables 5.2 and 5.3 below respectively. Please refer to Table 5.2 which shows the definitions from different authors through literature survey. According to Bea (1994) error is defined as departure from acceptable or desirable practice on the part of an individual or group of people that can result into unacceptable or undesirable quality. Reason (1990) refers to error as occasion where a planned sequence of mental or physical activities does not achieve it's intended purpose especially when these failures cannot be linked to intervention of some chances. Senders et al (1991) define error as something that has been done which was not intended by the originator, not desired by a set of rules or an external observer or that leads the task outside it's acceptable limit. Busby (2001) defines error as the occurrences which are not expected which involve surprise and which could not be linked entirely to chance. According to Stewart (1992) error is defined as an event or process that departs from commonly accepted competent practice. Other definitions of error are shown on Table 5.1. From the eleven authors it is clear that error is something that is missing or omitted from documents which makes the document imperfect and unacceptable.

Table 5.2: Definitions of Construction Document Error from literature survey

S/N	Author	Definition
1	Bea (1994)	Error is defined as 'departure from acceptable or desirable practice on the part of a group of individuals that can result in unacceptable or undesirable quality''.
2	Reason (1990)	The term error refers to occasions where a planned sequence of mental or physical activities does not achieve its intended purpose, especially when these failures cannot be linked to intervention of some chances.

3	Senders et al (1991)	Error is defined as something that has been done which was not intended by the originator, not desired by a set of rules or an external observer, or that leads the task or system outside its acceptable limit.
4	Busby (2001)	Errors are the occurrences which were not expected, which involve surprise and which could not be linked entirely to chance.
5	Stewart (1992)	Human error is an event or process that departs from commonly accepted competent professional practice.
6	Edmonson (2002)	Error is the execution of a task that is either unnecessary or incorrectly carried out.
7	Bullon (2015)	Error is a mistake, especially one that affects the result.
8	Hollnagel (1993) & Wood et al (1994)	Erroneous actions are actions that do not lead to expected end and or which emits unwanted outcomes or the results are undesirable.
9	Ayinuola & Olalusi (2004)	Error is an unacceptable difference between expected and the observed performance.
10	Sowers (1993)	Error is a departure from acceptable or desirable practice on the part of an individual that can result in unacceptable or undesirable results.
11	Mohammed (2007)	Error is a non-desired condition and the non-fulfilment intended requirements (stated or implicit).

From Table 5.2, it is revealed that error is the happening that aborts the realisation of the intended scenario. Table 5.2 shows the definitions of error from various authors recorded in various literatures, it is necessary to show the various definitions of error collected through semi structured interview, which Table 5.3 stands for.

Table 5.3 represents the data collected on definitions of construction documentation error through semi structured interview. From Table 5.3: Participant 1 defines error as a mistake committed on construction documents thereby making it imperfect. According to Participant 2, error means not doing things in the right way thereby not achieving the goal. Participant 3

defines error as undesirable items in drawings resulting to low quality. Participant 4 refer to error as what reduces quality in construction documents and the final job. According to Participant 5 error is a thing done unprofessionally on documents and making it imperfect to fulfil the goal. Participant 6 defines error as a thing done wrongly on construction documents resulting to imperfection, cost and time overruns. According to Participant 7 error refers to missing items in construction documents that can lead to claims and time overrun. Definitions from the remaining participants, that is, Participants 8 to 68 are on Table 5.3.

Table 5.3: Definitions of Construction Documents Error from semi structured interview

S/N	Author	Definition
1	Participant 1	Error is a mistake committed in construction documents thereby making it imperfect.
2	Participant 2	Error means not doing things in the right way thereby not achieving the goal.
3	Participant 3	Error refers to undesirable item in drawings resulting to low quality.
4	Participant 4	Error is what reduces quality in construction documents and the final job.
5	Participant 5	Error is a thing done unprofessionally on documents and making it imperfect to fulfil the goal.
6	Participant 6	Error refers to a thing done wrongly on construction documents resulting to imperfection, cost and time overruns.
7	Participant 7	Error refers to missing items in construction documents that can lead to claims and time overrun.
8	Participant 8	Error means wrong things done on designs and not making it to achieve the target.
9	Participant 9	Error is the thing that is opposed to quality in construction documents.
10	Participant 10	Error is the unprofessional job done on drawings and specifications which lowers the quality in the final output.
11	Participant 11	Error means departure from acceptable practice in

		construction documents resulting more money and time expended in construction work.
12	Participant 12	Error is the thing done on documents that is not according to principles of practice.
13	Participant 13	Error is the incorrect things that appear in construction documents resulting to low quality.
14	Participant 14	Error means incorrect specification on drawing resulting in more time spent in completing the job.
15	Participant 15	Error is untidy work done in designs.
16	Participant 16	Error is the non-quality work in documents
17	Participant 17	Error is non-compliance with the rules of design which to low quality.
18	Participant 18	Error means non-conformance with documentation codes.
19	Participant 19	Error is non-compliance with accepted principles of construction documentation.
20	Participant 20	Error refers to non-conformance with professional principles of design documentation.
21	Participant 21	Error means inclusion of unwanted items on documentation.
22	Participant 22	Error means exclusion of necessary items in construction documentation which may result to building collapse.
23	Participant 23	Error is failure to achieve quality on construction documentation.
24	Participant 24	Errors are omissions in documents that result to, not achieving project goals.
25	Participant 25	Errors are inclusions on designs that result to building collapse
26	Participant 26	Errors are unnecessary omissions on drawings that result to building collapse.
27	Participant 27	Errors are omissions in documents that make the documents incomplete and result to extended time and increased cost of construction,
28	Participant 28	Errors are wrong descriptions that lead to misinterpretation of the drawings and make the job

		unworkable.
29	Participant 29	Errors are missing descriptions on documents that leads to inadequate achievements of the building owner's goals
30	Participant 30	Errors are wrong things on designs that results to client not achieving his objectives.
31	Participant 31	Inadequate information on building documents that result into goals not being achieved.
32	Participant 32	Errors are scanty descriptions and items on documents that leaves gap during construction.
33	Participant 33	Errors are inadequate description of items in drawings which renders the job imperfect.
34	Participant 34	Errors are mistakes in drawings and bill of quantities that produces imperfect job.
35	Participant 35	Errors are what make the document achieve less than the set goals.
36	Participant 36	Error means inclusion of unwanted items on documentation.
37	Participant 37	Error refers to a thing done wrongly on construction documents resulting to imperfection and cost and time overruns.
38	Participant 38	Error means exclusion of necessary items in construction documentation which may result to building collapse.
39	Participant 39	Errors are scanty descriptions and items on documents that leaves gap during construction.
40	Participant 40	Error is a mistake committed in construction documents thereby making it imperfect.
41	Participant 41	Error refers to undesirable item in drawings resulting to low quality, and cost and time overruns.
42	Participant42	Errors refer to omissions in documents that result to, not achieving project goals.
43	Participant 43	Errors are what make the document achieve less than the set target.
44	Participant 44	Error refers inclusion of unwanted items on documentation that increase the cost at the end.

45	Participant 45	Error means not doing things in the right way thereby not achieving the quality goal.
46	Participant 46	Error is a mistake committed in construction documents thereby making it imperfect.
47	Participant 47	Error refers to non-compliance with accepted principles of construction documentation that increases the cost and period of construction.
48	Participant 48	Errors are inadequate description of items in drawings which renders the job imperfect.
49	Participant 49	Error is what reduces quality in construction documents and the final job.
50	Participant 50	Error means wrong things on designs and not making it to achieve the target.
51	Participant 51	Error is the thing that is opposed to quality in construction documents that also increases the cost and time
52	Participant 52	Error is the unprofessional job done on drawings and specifications which lowers the quality in the final output.
53	Participant 53	Error means incorrect specification on drawing resulting in more time spent in completing the job.
54	Participant 54	Errors are what make the document achieve less than the set target.
55	Participant 55	Errors are unnecessary omissions on drawings that result to building collapse.
56	Participant 56	Inadequate information on building drawings that result into goals not being achieved.
57	Participant 57	Errors are omissions in documents that make the documents incomplete and result to extended time and increased cost of construction,
58	Participant 58	Errors are wrong descriptions that lead to misinterpretation of the documents and make the job unworkable.
59	Participant 59	Error is what makes document imperfect that results in imperfect job.
60	Participant 60	Error refers to missing information on documents that

		produces imperfect job.
61	Participant 61	Error means inadequate documentation that produces less than what the goal requires.
62	Participant 62	Error is inadequacy in documents that result in imperfect job.
63	Participant 63	Error is incomplete documentation that does not achieve the goal.
64	Participant 64	Error refers to incomplete information on drawings that makes the client not to achieve his goal.
65	Participant 65	Errors are mistakes made on documents that lead to non-fulfilment of purpose.
66	Participant 66	Error refers to wrong information in documents that lead to wrong job being done.
67	Participant 67	Error refers to scanty information in documents that result to achieving less than the target.
68	Participant 68	Error is what makes the drawing to fall below standard resulting to non-fulfilment of purpose.

From definitions of document error collected from the Participants 1 to 68, it can be said that error creates gap between the actual scenario and the intended which results into desired goal not being achieved.

From the above, it is obvious that each of the definitions in Tables 5.2 and 5.3 above reveals that:

(1) There is a standard to be followed in order to achieve a purpose.

(2) The standard is either discarded or not completely conformed with.

(3) The gap between (1) and (2) above is the error.

Error refers to the gap in construction documents that make the documents unable to achieve sound required project performance.

From the definitions stated in Tables 5.2 & 5.3 above, construction document error is defined as something that causes deviation or departure from correctness or standard or accepted professional practice or principle, in drawings and bills of quantities which make it impossible for the client to achieve the desired project goal with respect to any of cost, time and quality.

This sub-section analysed data to arrive at a robust definition of construction documentation error, next sub-section will analyse data to determine the types of construction document error.

5.2.2 Types of Error on Construction Documents

1) Research Objective 2, is to determine the common types of error in construction documents in Nigeria. The research was carried out through administration of questionnaire to construction professionals. Below is the answer as deduced from the data collected and analysed by Relative Importance Index (RII).

Analysis of the types of error in construction documents

Table 5.4a in the appendix is the analysis of data by relative importance index to determine the common types of documentation errors, while Table 5.4b below shows the ranking of the common types of documentation errors specific to Nigeria. Table 5.3b identifies the types of errors in construction documents in Nigeria as: unnecessary additions, non – conformance to client requirement, non – conformance to design code/ SMM, absence of specifications, dimensional error, miscalculation, scanty specification, wrong specification, omission of necessary item and incorrect details.

Table 5.4b: Types of documentation error: Summary and ranking.

S/N	Types of construction document error	RII	Ranking
1	Unnecessary additions	0.90	1st
2	Non – conformance to client requirement	0.89	2nd
3	Non – conformance to design code/ SMM	0.89	3rd

4	Absence of specifications	0.89	4th
5	Dimensional error	0.87	5th
6	Miscalculation	0.87	6th
7	Scanty specification	0.86	7th
8	Wrong specification	0.85	8th
9	Omission of necessary item	0.80	9th
10	Incorrect details	0.80	10th

The findings of this study on types of construction document error specific to Nigeria are similar to the discoveries of Dosumu & Adenuga (2013) but not the same. From the findings of Dosumu & Adenuga (2013), the 25 types of errors in bills of quantities, drawings, specifications, schedules and form of contracts are merged and summarised into 14, and are listed as: design error, poor coordination, inaccuracy details, dimensional error, missing information, symbols and abbreviation error, approximation error, measurement error, omission and ambiguity, random error, arithmetic error, pricing error, document not conforming to building code / regulations and buildability. The research results of this thesis are placed side by side with the findings of Dosumu & Adenuga (2013) as shown in Table 5.5. It was discovered that six of the types of errors as discovered by Dosumu & Adenuga (2013) agree with six types of error as determined by this research. The rest eight types as discovered by Dosumu & Adenuga (2013) do not agree with the remaining four types as determined by this work. The dissonance may be because of the small coverage area (only one state in Nigeria) of the work of Dosumu & Adenuga (2013) and the larger coverage area (seven states in Nigeria) of this research work. Table 5.5 shows the meeting points when the results of this research are compared with the findings of Dosunmu & Adenuga (2013) on the types of documentation error. The remaining types of documentation error from this PhD work that do not agree with findings of Dosumu & Adenuga (2013) are: unnecessary additions, wrong specifications, miscalculation and non- conformance to clients' requirements. The rest findings of Dosumu & Adenuga (2013) that are not in consonance with

results from this work are design error, poor coordination, symbols and abbreviation error, approximation error, random error, arithmetic error, pricing error and buildability.

Table 5.5: Meeting points of types of error determined in this research and findings on types of error of Dosumu & Adenuga (2013)

Types of Documentation Error		
Research Results		Dosumu & Adenuga (2013)
1	Omission of necessary items	Omissions & ambiguity
2	Non-conformance to design codes	Document not conforming to design codes & measurement error
3	Incorrect details	Inaccurate details
4	Absence of specifications	Missing information
5	Scanty specifications	Missing information
6	Dimensional error	Dimensional error

In this sub-section data were analysed in other to identify and discuss the common types of construction documentation errors in Nigeria. Next sub-section will be devoted to analysis of data to identify the causes in construction document errors specific to Nigeria.

5.2.3 Causes of Error on Construction Documents

Research Objective 3: is to identify the common causes of error in construction documents in Nigeria. The research was carried out through administration of questionnaire to construction professionals while the data collected was analysed by Relative Importance Index, RII.

Table 5.6a in the appendix shows the analysis of data by relative importance index in order to identify common causes of documentation errors in Nigeria. Table 5.6b below shows the summary and ranking of the common causes of documentation errors. Table 5.6b identifies causes of errors in construction documents in Nigeria as: non – availability of information, poor communication, inadequate project brief, poor salaries of professionals, non –

identification of project risks, inadequate consultant professional education, inadequate consultant professional experience, inadequate project manager experience, time scheduled pressure, inadequate project planning, complexity of project, concurrent documentation, heavy work load of consultant, poor consultancy fees, inadequate document preparation time and inadequate document manager experience.

Table 5.6b: Causes of documentation error: Summary and ranking.

S/N	Causes of construction document error	RII	Ranking
1	Non – availability of information	0.97	1st
2	Poor communication	0.96	2nd
3	Inadequate project brief	0.92	3rd
4	Poor salaries of professional	0.92	4th
5	Non – identification of project risks	0.91	5th
6	Inadequate consultant professional education	0.90	6th
7	Inadequate consultant professional experience	0.89	7th
8	Inadequate project manager experience	0.89	8th
9	Time scheduled pressure	0.89	9th
10	Inadequate project planning	0.86	10th
11	Complexity of project	0.86	11th
12	Concurrent documentation	0.85	12th
13	Heavy work load of consultant	0.85	13th
14	Poor consultancy fees	0.80	14th
15	Inadequate document preparation time	0.80	15th
16	Inadequate document manager experience	0.80	16th

The findings of this study on causes of construction document error specific to Nigeria are similar to the discoveries of Dosumu & Adenuga (2013) but not the same. From the findings of Dosumu & Adenuga (2013), the 21 causes of errors in bills of quantities, drawings,

specifications, schedules and form of contracts were merged and summarised into 14, and are listed as: lack of adequate documentation, poor communication, negligence of professionals, missing information, incomplete drawings, insufficient planning, design error, changes to specifications, designers experience, poor cost control, lack of adequate computation, professional experience, incorrect drawings and long period between time of bidding and award. The research results of this thesis are placed side by side with the findings of Dosumu & Adenuga (2013) as shown in Table 5.7. It was discovered that seven of the causes of errors as discovered by Dosumu & Adenuga (2013) agree with seven causes of error as determined by this research. The rest seven causes as discovered by Dosumu & Adenuga (2013) do not agree with the remaining nine causes as determined by this work. The disagreement may be because of the small coverage area (only one state in Nigeria) of the work of Dosumu & Adenuga (2013) and the larger coverage area (seven states in Nigeria) of this research work. Table 4.16 shows the meeting points when the results of this research are compared with the findings of Dosunmu & Adenuga (2013) on the causes of documentation error. The remaining causes of documentation error from this PhD work that do not agree with findings of Dosumu & Adenuga (2013) are poor salary of professionals, poor consultancy fee inadequate project brief, inadequate documentation time, inadequate experience of document manager, non-identification of risks, inadequate construction time, concurrent documentation, project complexities. The rest of the causes of error in Dosumu & Adenuga (2013) that do not agree with findings of this work on causes of error are: negligence of professionals, incomplete drawings, design error, changes to specifications, designers experience, poor cost control, lack of adequate computation, incorrect drawings and long period between time of bidding and award.

Table 5.7: Meeting points of causes of error determined in this research on findings on causes of error of Dosumu & Adenuga (2013)

Causes of Documentation Error		
Research Results		Findings of Dosunmu & Adenuga (2013)
1	Non availability of information	Missing information
2	Poor communication	Poor communication
3	Inadequate documentation	Lack of adequate documentation
4	Inadequate consultant education	Designer's inadequate education
5	Inadequate consultant's experience	Professional's inexperience
6	Absence of project planning	Insufficient planning
7	Heavy workload of consultant	Negligence of professionals

The findings of this study on causes of construction document error specific to Nigeria are similar to the discoveries of Ebekozein, et al, (2015) but not the same. From the findings of Ebekozein, et al, (2015) causes of documentation error from the consultant point of view are unclear document, inadequate document, inadequate site investigation, hurry to meet up, poor design management, inadequate feasibility studies, poor communication, lack of design coordination to eliminate conflicts, lack of constructability reviews on designs, conflicts between drawings from different disciplines, fees paid not adequate, slow responses. With respect to Table 5.8 it was discovered that five of the causes of errors as discovered by Ebekozein, et al, (2015) agree with seven causes of error as determined by this research. The rest eight causes as discovered by Ebekozein, et al, (2015) do not agree with the remaining eight causes as determined by this work. The disagreement may be because of the small coverage area (Edo state - only one state in Nigeria) of the work of Ebekozein, et al,(2015) and the larger coverage area (seven states in Nigeria) of this research work.

Table: 5.8 Comparison of causes of error determined in this research with findings of Ebekozein, Uwaida & Usman (2015)

Causes of Documentation Error		
Research Results		Findings of Ebekozein, Uwaida & Usman (2015)
1	Non availability of information	Inadequate site investigation
2	Poor communication	Poor communication
3	Inadequate documentation prep time / Time scheduled pressure	Hurry to meet up
4	Inadequate consultant education/experience	Incompetent design consultant
5	Poor consultancy fees	Fees paid not adequate

Table 5.8 shows the intercepting points when the results of this research are compared with the findings of Ebekozein, Uwaida & Usman (2015) on the causes of documentation error.

The remaining causes of documentation error from this PhD work that do not agree with findings of Ebekozein, Uwaida & Usman (2015) are poor salary of professionals, inadequate project brief, inadequate experience of document manager, non- identification of risks, heavy workload, inadequate experience of project manager, concurrent documentation, project complexities.

The findings of this study on causes of construction document error specific to Nigeria are similar to the discoveries of Dosumu & Iyagba (2013) but not the same. From the findings of Dosumu & Iyagba (2013), the causes of documentation error are listed as: designer experience, erratic decision making, lack of design reviews value engineering and constructability, lack of coordination between disciplines, lack of planning and inspection of

project, design management experience, lack of awareness of changes in standards, communication, unclear and ambigious requirements for design specifications and availability of information. The research results of this thesis are placed side by side with the findings of Dosumu & Iyagba (2013) as shown in Table 5.9. It was discovered that five of the causes of errors as discovered by Dosumu & Iyagba (2013) agree with six causes of error as determined by this research. The rest five causes as discovered by Dosumu & Iyagba (2013) do not agree with the remaining nine causes as determined by this work. The disagreement may be because of the small coverage area (Lagos state - only one state in Nigeria) of the work of Dosumu & Iyagba (2013) and the larger coverage area (seven states in Nigeria) of this research work.

Table: 5.9 Comparison of causes of error determined in this research with findings of Dosumu & Iyagba (2013)

Causes of Documentation Error		
Research Results		Findings of Dosunmu & Iyagba (2013)
1	Non availability of information	Non availability of information
2	Poor communication	Poor communication
3	Inadequate project planning	Lack of planning and inspection
4	Inadequate consultant's experience	Designer's inexperience
5	Inadequate project manager / documentation manager experience.	Design manager experience

Table 5.9 shows the intercepting points when the results of this research are compared with the findings of Dosunmu & Iyagba (2013) on the causes of documentation error.

The remaining causes of documentation error from this PhD work that do not agree with findings of Dosumu & Iyagba (2013) are poor salary of professionals, poor consultancy fee

inadequate project brief, inadequate documentation time, non- identification of risks, inadequate construction time, concurrent documentation, heavy workload, time scheduled pressure and project complexities.

In this sub-section data were analysed in other to identify the causes of construction document errors specific to Nigeria and with discussions. Next sub-section will be devoted to analysis of data to examine the quantitative and qualitative effects of documentation errors on construction projects.

5.2.4 The Effects of Errors on Construction Documents

Research Objective 4: is to examine the quantitative and qualitative effects of documentation errors on construction projects and economy in Nigeria.

The research was carried out through administration of questionnaire to construction professionals. Below are the answers as deduced from the data collected and analysed by percentage and mean, for cost, refer to Table 5.10; for time, Table 5.11, and for building occupants, refer to Tables 5.12 and 5.13 below:

5.2.4.1: Quantitative effects of error in construction documents on cost.

This sub section discusses the quantitative effect of documentation error on construction cost. Below on Table 5.10 is the answer as deduced from the data collected and analysed by percentage and mean for cost.

From Table 5.10, the effects of errors in construction document as it relates to project cost performance are stated as:

Percentage of error cost during project execution =5.67% of contract sum, that is, percentage of contract sum utilised to rectify documentation errors during project execution.

Percentage of error cost after project execution =14.72% of contract sum, that is, percentage of contract sum utilised to rectify documentation errors when the particular element has been executed.

Total percentage effect of error cost = 20.39% of contract sum.

Table 5.10: Total Error Cost

Project	**ECDPE**	**ECAPE**	**Percentage Total**
198	1122.5 Mean=5.67	2915 Mean=14.72	4037.5 Mean=20.39

Legend:

ECDPE = Error Cost During Project Execution (for design- induced errors).

ECAPE = Error Cost After Project Execution (for design- induced errors)

This finding translates to the fact that construction document error raises construction cost by 20.39%. That is, if there is no error in construction documents there will be a saving of 20.39% of the construction cost. This finding to a similar to a study outside Nigerian environment on the quantitative effect of document error where researchers noted that deviations on the project accounted for an average of 12.4% of the total costs, design deviations carries an average of 78% of the total number of deviations, 79% of the total deviation costs, and 9.5% of the total project cost. They concluded that the deviation costs of the design change as a result of error amounted to about 54.2% of the total deviation costs (Burati et al, 1992). This finding is also similar to a study outside Nigerian environment on the quantitative effect of design error where research undertaken by the Construction Industry Institute (1987) and National Research Council (1994) reveals that design error and omission rate is in the range of 2-3% of construction cost and is deemed to be an acceptable threshold

level. Having discussed the quantitative effect of document error on construction time next is the discussion of document error on construction time.

5.2.4.2 Quantitative effects of error in construction document on time.

This sub section discusses the quantitative effect of documentation error on construction time. Below on Table 5.11 is the answer as deduced from the data collected and analysed by percentage and mean, for construction time.

From Table 5.11, the quantitative effects of errors in construction documents as it relates to project time performance are stated as:

Percentage of error time during project execution =3.17 % of the contract period, that is, percentage of time period taken to rectify documentation errors during project execution.

Percentage of error time after project execution = 7.90 % of the contract period, that is, percentage time period taken to rectify documentation errors after that portion of the project has been executed.

Total percentage effect of error time = 11.07% of the contract period.

Table 5.11: Total Error Time

Projects	**ETDPE**	**ETAPE**	**Percentage Total**
198	Total=627.5 Mean=3.17	Total=1565 Mean=7.90	2192.5 Mean=11.07

Legend

ETDPE = Error Time During Project Execution (for design- induced errors).

ETAPE = Error Time After Project Execution (for design- induced errors).

This finding translates to the fact that construction documentation error raises construction time / period by 11.09%. That is, if there is no error in construction documents there will be a saving of 11.07% of the construction period. This finding is similar to a study outside Nigerian environment on the quantitative effect of document error, on the investigation of source of quality failures in a building project where researchers discovered that the cost of

making good the errors to be 6% of the construction cost and time taken to correct the defects was estimated to be 11% of the total working hours (Hammarlund et al, 1990).

5.2.4.3: Quantitative effects of errors in construction document on building occupants

This sub section discusses the quantitative effects of documentation error on building occupants. Data were collected through literature survey as shown on Tables 5.12 and 5.13. Below is the answer as deduced from the data collected from literature survey and analysed by summation, for building occupants and site workers who lost their lives as a result of building collapse induced by document errors.

Table 5.12 below shows some selected reported incidents of building collapses in Nigeria from 1974 to 2001 in Nigeria. It reveals the type of building, location of the building, date of collapse, causes of collapse and remark. From Table 5.11 and with respect to serial number 8, in 1990, the building collapsed because of absence of structural design (the error) and 50 people died; serial number 10 in 1987, the building collapsed because of absence of structural design (the error) and 17 building occupants died; serial number 11 in 1986, the building collapsed because of absence of structural design (the error) and 2 building occupants died and serial number 19 in 1980, the building collapsed because of faulty structural design (the error) and 6 people lost their lives.

Table 5.12: Some Selected Reported Incidents of Building Failures/Collapses in Nigeria from1974 to 2001 (Source: Fadamiro, 2012).

S/N	Type of building structure	Location of building	Failure/ collapse date	Suspected causes	Remarks
1	2-Storey Mosque	21, Buhari St. Mushin, Lagos	April 18, 2001	Former bungalow converted to storey. Overloading	7 Persons reported dead
2	Luxury Flats	Ajah, Lagos	April, 2000	Faulty	2 persons reported

		(Eleganza)		Supervision	dead
3	2-Storey	Dawodu St. Iju Ishaga, Lagos	Oct. 16, 1999	Rain Storm	20 people died
4	3-storey Res. Building	Salisu St. Iju Ishaga, Lagos	Aug. 18,1999	Rain Storm	35 people died
5	Multi-Storey Building	Ojuelegba, Lagos	April 28, 1999	Use of Poor quality materials	35 people died
6	2-Storey Residential Building	Road 3, Plot 10 Funbi Fagun St. Abeokuta, Ogun State	Nov. 1998	Use of poor Quality Building Materials	No death recorded
7	Uncompleted 2-Storey Building	Premises of St. Thomas's Ang. Church Isinkan, Akure	Sept. 1998	Failure of Structural Design	2 person reported dead and many injured
8	School Building	Diobu, Port Harcourt	April, 1990	No Structural Design	Over 50 people reported dead
9	Commercial Building	Ikorodu Road, Lagos	Sept. 29, 1987	Rain Storm	4 died and 15 injured
10	Residential Building	Idusagbe Lane, Idumota, Lagos	May 9, 1987	No Structural Design	17 dead, 12 injured
11	2-Storey Building under Construction	Agege, Lagos	May, 1986	No Structural Design	2 dead including owner

12	Mosque Building	Osogbo Osun State	February, 1986	Structural Failure	No death recorded
13	High Court Building	Isiala,, Imo State	July 18, 1985	Collapse Ceiling	No casuality
14	Residential	Victoria Island, Lagos		Excessive loading	13 people reported dead
15	Residential	Ojuelegba, Lagos	May 18, 1985	Rain Storm	No casualty
16	Uncompleted 4-Storey Building	Iponri, Lagos	May 20, 1985	Structural Failure	13 reported dead
17	Residential	Adeniji Adele Lagos	February, 1985	Excessive loading	2 dead including owner
18	Residential	Allen Avenue Lagos	January, 1985	Excessive loading	No casualty recorded
19	3 Residential Buildings	Barnawa Housing Estate, Kaduna	July, 1980	Faulty Structural Design	6 people dead, 184 units pulled down
20	Multi-Storey Building	Mokola, Ibadan	October, 1974	Structural Failure	27 people reported dead

The total number of lives lost as a result of documentation error on Table 5.12 within these four years (50+ 17+ 2+ 6= 75) is 75 as analysed above.

Table 5.13 shows some selected reported incidents of building collapses in Nigeria from 2007 to 2011. It reveals the type of building, location of the building, date of collapse, causes of collapse and remark. Refer to Table 5.13: Serial number 9 in July 2007, a four storey building under construction collapsed in Utako district in Abuja due to faulty design (the error) and

100 construction workers died. On serial number 12, in March 2009, a four storey building in Lagos state, because of faulty design (the error), the building collapsed and 11 building occupants died. On serial number 23 at Ebute Metta in Lagos state, in June 2009, a three storey building collapsed because of disregard for building regulation (the error), 5 building occupants lost their lives. On serial number 26 at Asokoro Abuja in July 2009, a three storey under construction, collapsed due to faulty design (the error) and 1 building occupant died. In serial number 28, at Ilora in Oyo state, in August 2009, a church building collapsed because of faulty design (the error) and 4 building occupants lost their lives. It is observed that in years 2007 and 2009, 121 building occupants / site workers lost their lives as a result of documentation error. Table 5.13 below shows Reported cases of building collapse in Nigeria from 2007-2011

Table 5.13: Reported cases of building collapse in Nigeria from 2007-2011(Source: Akinjogbin & Balogun 2013)

	Building location	Building type	Date of incident	Suspected cause(s) of building collapse	No. of lives lost
1.	Fajuri road, Ile-Ife, Osun State	A Storey Building	March, 2007	Rainstorm/Flooding/Nature	3
2.	118 Ojulegba road, Surulere Lagos	2 Storey building	May, 2007	-	-
3.	LasuIba Road, opposite Rosellas, Lagos	2 Storey building	May, 2007	-	-
4.	48,adams Str. Lagos	3 Storey building	May, 2007	-	-
5.	38,	3 Storey	May, 2007	-	-

	Idumagba Avenue, Lagos	building			
6.	32B egertton Lane, Oke Arin Lagos	4 Storey buiding	June, 2007	-	-
7.	71, Agoro Str. Lagos	3 Storey building	June, 2007	-	-
8.	8, Ashka Str. Abulenla Ebute Meta Lagos	2 Storey	June, 2007	-	-
9.	Utako District Abuja	4 Storeybuilding u/c	July, 2007	Faculty Design	100
10.	Odi Olowo Osogbo, Osun State	3 Storey building	Sept.,2007	Faculty Design	-
11.	Ogbomoso, Oyo State	Teaching Hospital Multy Storey building	Feb. 2009	-	-
12.	Lagos State	4 Storey building	March, 2009	Faculty Design	11
13.	Idi Araba Mushin Lagos	3 Storey	March, 2009	-	15
14.	Ipaja Alimosho LG Lagos State	Residential building	April, 2009	-	2
15.	Asaba, Delta State	2 Storey	April	-	1
16.	Ilesha Osun State	Residential building u/c	March, 2009	Poor materials	1

17.	Lagos State	4 Storey building	March, 2009	Faculty Design	11
18.	Idi Araba Mushin Lagos	3 Storey building	March, 2009	-	15
19.	Ipaja Alimosho LG Lagos State	Residential building	April, 2009	-	2
20.	Halleluyah Osun State	Residential building u/c	April, 2009	-	-
21.	Asaba, Delta State	2 Storey building u/c	April, 2009	-	1
22.	Enugu State	3 Storey building u/c	May, 2009	-	-
23.	EbuteMeta, Lagos	3 Storey building u/c	June, 2009	Disregard for building regulation	5
24.	Ile-Ife, Osun State	Residential building u/c	June, 2009	-	-
25.	Iddo terminal of Nigeria Railway	2 Storey Plaza u/c	June, 2009	Salinity old age	18
26.	Aya Asokoro Abuja	3 Storey u/c	July, 2009	Faculty Design	1
27.	Kano State	5 Storey u/c	July, 2009	Poor materials	-
28.	Ilora, Oyo State	Church building	August, 2009	Faculty Design	4
29.	Elerin Street, Ede, Osun State	A Storey building	August, 2009	Salinity old age	-
30.	Oshodi, Lagos State	2 Storey market plaza	April, 2010	Substandard building materials	4
31.	Victoria	Uncompleted Storey	June, 2010	Substandard building	1

	Island, Lagos	building		materials, non compliance with approved building plan and weak structure	
32.	Garki, Abuja	5 Storey building	August, 2010	Addition of two floors to existing three floors	1
33.	Victoria Island, Lagos	4 Storey building	September 2010	Structural defects/overloading	3
34.	Karu, Nasarawa State	2 Storey building under construction	June,, 2011	-	4
35.	Mogaji street, Lagos Island	3 storey building	July, 2011	-	15
36.	Naka road, Makurdi	Church building	August, 2011	Rainstorm	2
37.	Adeniji Adele, Lagos	3 storey building	August, 2011	Structural failure	-

The total number of lives lost as a result of building collapse caused by documentation error within these two years on the five incidents (100+ 11+ 5+ 1+ 4) is 121.

In another development, a six storey building belonging to the Synagogue Church of All Nations located at Ikotun - Egbe in Lagos State Nigeria collapsed on Friday 12th September, 2014 leaving 115 building occupants dead. The building was originally designed and approved as a five- storey building complex; but it was later turned to six-storey building (Punch Newspaper, September 15, 2014). The addition of the sixth storey by the owner with

no architectural and structural drawings and without approval from planning authority is an error. It is an error because a five-storey building foundation cannot carry six-storey.

Table 5.14 below shows losses of lives of building occupants as a result of building collapse occasioned by documentation error. It is a summary of lives lost as a result of documentation error as revealed in Tables 5.12, 5.13 and Punch Newspaper, September 15, 2014, all already discussed in section 5.1.4.3 under quantitative effects of errors in construction document on building occupants/ site workers.

Table 5.14: Summary of loss of lives as a result of building collapse occasioned by documentation error

S/N	Year of building collapse	Loss of lives of building occupants
1	1980	6
2	1986	2
3	1987	17
4	1990	50
5	2007	100
6	2009	5
7	2009	11
8	2009	1
9	2009	4
10	2014	115
Total		411

Table 5.14 is a summary of data collected with respect to sub section 5.1.4.3 on quantitative effects of errors in construction document on building occupants. It is shown that 411 building occupants /site workers lives were lost in 7 years (10 incidents) as a result of construction documentation error.

The three sub sections above have discussed quantitative effects of error on cost, time and building occupants, next sub section will discuss the qualitative effects of documentation errors on projects.

5.2.4.4: Qualitative effects of documentation error on projects

To determine the qualitative effects of documentation error on projects, data collected were analysed by severity index and then ranked. Table 5.15 contains items on effects, severity index analysis and the ranking. Items with severity index value of above 0.70 on the table were reckoned with while those below 0.7 show negligible effect. From this study, (refer to Table 5.15) qualitative effects of documentation error are discovered to be: defects, building collapse, loss of human lives, financial wastage, material wastage, design-induced rework, cost overruns, time overruns, abandonment of project, dissatisfaction to clients, bad reputation of consultants, loss of confidence in consultants and imperfect project.

Table 5.15: Qualitative Effects of Documentation Error on Projects

	Effects	A	B	C	D	E	SI	Ranking
1	Defects	5	6	18	86	191	0.90	1st
2	Building Collapse	6	8	15	82	191	0.89	2nd
3	Loss of lives of the occupants	6	9	14	2	189	0.88	3rd
4	Financial loss	14	11	14	80	187	0.87	4th
5	Material loss	13	10	16	80	187	0.87	5th
6	Cost overrun	16	14	18	78	179	0.84	6th
7	Time overrun	20	12	16	78	179	0.84	7th
8	Project abandonment	14	33	13	75	171	0.80	8th
9	Rework	22	18	24	72	170	0.79	9th
10	Non satisfaction of clients	20	20	29	69	168	0.77	10th
11	Bad consultant reputation	23	23	25	67	168	0.76	11th
12	Loss of confidence in consultants	14	16	51	60	165	0.73	12th

13	Imperfect project	22	25	35	62	162	0.73	13th
14	Deterioration of buildings	48	57	60	20	121	0.46	14th
15	Inconveniences	66	46	56	15	123	0.45	15th

The result of this study on qualitative effects of document error is similar to, but not the same with the findings of Dosumu & Adenuga (2013). The findings from Dosumu & Adenuga (2013) stated the qualitative effects of errors in bills of quantities, drawings, specifications, schedules and form of contracts as: abandonment of projects, delays, rework, dissatisfaction by owners, lack of confidence in consultants, reputation of consultants, frustration on stake holders, lack of concentration on other projects, discourages investment and designers profit. When the two results are placed side by side it is discovered that six of the results of this work are the same with six of the findings of Dosumu & Adenuga (2013). Refer to Table 5.16. The remaining four findings of Dosumu & Adenuga (2013) are different from seven of the results of this work on qualitative effects of document error.

Table 5.16 Comparison of qualitative effects of document error determined in this research with findings of Dosumu & Adenuga (2013

Qualitative Effects of Error		
Research Result		Findings of Dosumu & Adenuga (2013)
1	Abandonment of project	Abandonment of project
2	Time overrun	Delays
3	Rework	Remark
4	Non satisfaction of clients	Dissatisfaction to clients
5	Loss of confidence in consultants	Lack of confidence in professionals
6	Bad reputation of consultants	Bad reputation of professionals

The result from this PhD work on qualitative effects of document error that are not in consonance with Dosumu & Adenuga (2013) are defects, building collapse, loss of lives, financial loss, material loss, cost overrun and imperfect project. The dissonance on the part of some of the findings may be because the small area of study of Dosumu & Adenuga (2013) of only one state in Nigeria as compared with seven states in Nigeria that this study covered.

From the results of this research on qualitative effects of document error, clients will bear the heavy burdens of defects, financial wastage, material wastage, rework, abandonment of project, dissatisfaction and imperfect project. Consultants will be negatively affected by bad reputation and loss of confidence in them. Building occupants and site workers will be affected by building collapse that may lead to loss of their lives.

Having discussed the quantitative and qualitative effects of document errors on humans and building projects, the next sub-section will explore mapping of causes to types of error.

5.2.5: Mapping of the Causes to Types of Error

Research Objective 5: is to explore the causes to the specific types of construction document errors in Nigeria.

The research was carried out through administration of questionnaires to construction professionals. Below is the answer as deduced from the data collected and analysed by severity index. From the analysis of data in this study, causes of the ten types of documentation error specific to Nigeria are summarised in Table 5.17.

Refer to Table 5.17: Unnecessary addition, as a type of error is caused by inadequate project manager experience, inadequate consultant education, inadequate consultant experience and concurrent documentation. Non- conformance to client's requirements is caused by inadequate project brief, non- availability of information, inadequate documentation manager experience, poor communication, inadequate consultant education and inadequate consultant experience. Non- conformance to design code / SMM is caused by inadequate documentation

manager experience, heavy workload, inadequate consultant education and inadequate consultant experience. Absence of specification as a type of error is caused by inadequate project manager experience, poor consultant fees, inadequate project brief, poor salary of professionals, inadequate documentation manager experience, inadequate consultant education, inadequate consultant experience, poor communication, non- availability of information, inadequate project planning and time scheduled pressure. Dimensional error is caused by inadequate project manager experience, inadequate documentation manager experience, inadequate consultant experience, inadequate consultant education, inadequate documentation time, heavy workload of consultant, concurrent documentation and complexities in shape. Miscalculation a type of error is caused by inadequate documentation time, inadequate consultant education, inadequate consultant experience, concurrent documentation, poor consultancy fees, poor salary of professionals, poor documentation, non-availability of information, time scheduled pressure and project shape complexities. Scanty specification is caused by poor communication, non- availability of information, inadequate project brief, inadequate documentation manager experience, inadequate consultant education, inadequate consultant experience, poor salary of professionals, poor consultancy fees, inadequate documentation preparation time and inadequate project planning. Wrong specification is caused by inadequate project manager experience, poor consultancy fees, poor salary of professionals, inadequate documentation experience, inadequate project brief, inadequate consultant education, poor communication, non- availability of information, inadequate consultant experience and time scheduled pressure. Omission of necessary item is caused by inadequate project brief, inadequate documentation manager experience, inadequate consultant education, inadequate consultant experience, poor consultancy fees, poor salary of professionals, inadequate documentation preparation time, heavy workload, concurrent documentation, poor communication, non-availability of information, project shape complexities, non- identification of risks and time scheduled pressure. Incorrect detail

is caused by inadequate project brief, inadequate documentation manager experience, inadequate consultant education, inadequate consultant experience, inadequate documentation time, heavy workload, poor communication, non-availability of information and non-identification of risks.

Table 5.17: Mapping Causes of Error to Types of Error

S/N	Types of error	Causes of the types of error
1	Unnecessary additions (over-design)	Inadequate Project Manager exp Inadequate Consultant education Inadequate Consultant experience Concurrent documentation
2	Non-Conformance to clients requirements	Inadequate Project brief Non-availability of information Inadequate Doc Mgr experience Poor Communication Inadequate Consultant education Inadequate Consultant experience
3	Non-conformance to design code/SMM	Inadequate Documentation Mgr exp Heavy Workload of consultants Inadequate Consultant education Inadequate Consultant experience
4	Absence of Specification	Inadequate Project Manager Exp Poor Consultant fees Inadequate Project brief Poor Salary of Professionals Inadequate Doc Mgr experience Inadequate Consultant Education Inadequate Consultant experience Poor Communication Non-availability of Information Inadequate Planning the Pro Time schedule pressure
5	Dimensional error	Inadequate Pro Mgr experience Inadequate Doc Mgr experience Inadequate Consultant Edu Inadequate Consultant Exp Inadequate Doc Time Heavy Workload of Consultant Concurrent Documentation Complexities in shape.
6	Miscalculations	Inadequate Documentation time Inadequate Consultant Education Heavy Workload of consultant

		Consultant Experience Concurrent Documentation Poor Consultant fees Poor Communication Poor Salary of Professionals Non-availability of Information Size and Complexities Time schedule pressure
7	Scanty Specification	Poor Communication Non-availability of information Inadequate Project brief Inadequate doc manager experience Inadequate Consultant Prof exp Inadequate Consultant experience Poor Consultant fees Inadequate doc preparation time Poor Salary of Professionals Inadequate Planning of project Time schedule pressure
8	Wrong Specification	Inadequate Project Manager exp Poor Consultant fees Inadequate Doc experience Inadequate Project brief Inadequate Consultant Prof Exp Poor Communication Inadequate Consultant experience Poor Salary of Professionals Time Schedule Pressure Non-availability of Information
9	Omission of necessary items	Inadequate Project brief Inadequate Doc Mgr experience Consultant Professional Edu Inadequate Consultant experience Poor Consultant fees Inadequate Doc Prep time Poor Salary of Professionals Heavy Workload of consultants Concurrent documentation Poor Communication Non- availability of information Size and complexities Non-identification of risks Time schedule pressure
10	Incorrect detail	Inadequate Project brief Inadequate DocMgr experience Inadequate Consultant Edu Inadequate Consultant experience Inadequate Documentation time Heavy Workload of consultant

		Poor Communication Non-availability of Information Non-identification of risks

Table 5.17 shows the mapping of causes to types of error, that is, causes of the ten types of errors are shown. The significance of Table 5.17 lies in Table 5.18 where types to causes of error are listed, number of causes listed and ranked. Table5.18 which is deduced from Table 5.17 is where types of error are mapped to their causes, that is, a list of causes of error and the types of errors that are associated with each of the causes. Table 5.18 also shows the ranking of the causes of the types of error which enables the stakeholders to be aware of causes that are very significant and the insignificant ones. From Table 5.18 Inadequate consultant education and inadequate consultant experience are ranked 1st because they are common to all the ten types of error which implies that taking care of these causes of error will to an extent reduce the occurrences of all the ten types of errors. Inadequate documentation time is ranked 3rd because it is common to seven out of ten types of errors which implies that taking care of this type of error will to an extent reduce the occurrences of seven types of error. Poor communication, Non availability of information and Poor consultancy fees are ranked 4th because they are common to six types of error which implies that removing these causes of error will reduce the appearances of six types of error. Inadequate project brief, Poor salary of professionals engaged and Heavy workload of consultants are ranked 7th because they are common to five types of error which implies removing these causes will minimise to an extent the appearances of the five types of errors concerned. Inadequate project manager experience, Inadequate documentation manager and Time scheduled pressure are ranked 10th because they are common to four types of error with implication that removing these causes will reduce to an extent the occurrences of four types of error. Concurrent documentation, Complexity of project and Inadequate project planning are ranked 13th because they are common to three types of error with implication that removing them will minimise appearances of the three types of errors. Non- identification of project risks is ranked 16th

because it is related to two types of errors with implication that removing it will to an extent reduce the two types of errors.

Table 5.18: Mapping of Types of Error to their Causes

S/N	Causes	Types of Errors
1	Inadequate Consultant Education	Dimensional error, incorrect detail, omission of necessary items, absence of specification, wrong specification, scanty specification and non-conformance to clients requirement, miscalculation, unnecessary addition and no – conformance to design code/SMM.
2	Inadequate Consultant Experience	Dimensional error, incorrect detail, omission of necessary items, absence of specification, wrong specification, scanty specification and non-conformance to clients requirement, miscalculation, unnecessary addition and no – conformance to design code/SMM.
3	Inadequate Doc Time	Dimensional error, incorrect detail omission of necessary items, absence of specification, wrong specification, scanty specification and non-conformance to clients requirement
4	Poor Communication	Incorrect details, omission of necessary items, absence of specification, wrong specification, wrong specification non-conformance to clients, requirements
5	Non-availability of Information	Incorrect detail, omission of necessary items, absence of specification wrong specification, scanty specification non-conformance to clients requirements
6	Poor Consultant Fees	Omission of necessary items, absence of specification, scanty specification, absence of specification, miscalculation. Non – conformance to SMM.
7	Inadequate	Incorrect detail, omission of necessary items, absence of

	Project Brief	specification, scanty specification wrong specification
8	Poor Salary of Professionals engaged	Omission of necessary item, miscalculation, absence of specification, scanty specification, non- conformance to SMM.
9	Heavy Workload of Consultant	Dimensional error, incorrect detail omission of necessary items, miscalculation, non-conformance to clients requirements
10	Inadequate Project Manager exp	Dimensional error, absence of specification, wrong specification, unnecessary additions
11	Inadequate Doc Mgr Experience	Dimensional error, omission of necessary items, miscalculation, scanty specification
12	Time Scheduled Pressure	Omission of necessary items, wrong specification, scanty specification absence of specification.
13	Concurrent Documentation	Dimensional error, omission of necessary items, miscalculation
14	Complexity of project	Dimensional error, omission of necessary items, miscalculation
15	Inadequate Project Planning	Absence of specification, scanty. Specification, omission of necessary items
16	Non-identificati	Incorrect details, omission of necessary items

	on of Project risks	

The implication of the analysis above is to enable the stakeholders to be aware of the significant causes of error so that they can commence the operation of minimisation efforts from them.

Having explored mapping of causes to types of error, the next sub-section will critically analyse the frequencies of occurrences of the types of errors in construction documents.

5.2.6 Frequencies of occurrences of types of error.

Research Objective 6: is to critically analyse the frequencies of occurrences of the types of errors in construction documents in Nigeria.

The research was carried out through administration of questionnaire to construction professionals. Below is the answer as deduced from the data collected and analysed by severity index and percentage. Table 5.19 shows the common types of documentation error with the percentages of their occurrences in past projects stated against each of them. Refer to Table 5.19: Scanty specification as a type of error occurs in 99.24% of projects executed within the last 10 years by respondents. Omission of necessary items occurs in 92.62% of past projects, non- conformance to design code / SMM in 85.31% of projects, incorrect details in 85.26% of projects; non- conformance to client's requirement in 82.53% of projects; miscalculation in 76.93% of projects; absence of specification in 67.79% of projects; dimensional error in 60.89% of projects; unnecessary additions in 55.69% of projects and wrong specifications in 53.91% of projects.

Table 5.19: Frequencies of occurrences of types of error

S/N	Types of construction document error	Percentage of occurrence
1	Scanty specification	99.24
2	Omission of necessary item	92.62
3	Non – conformance to design code/ SMM	85.31
4	Incorrect details	85.26
5	Non – conformance to client requirement	82.53
6	Miscalculation	76.93
7	Absence of specifications	67.79
8	Dimensional error	60.89
9	Unnecessary additions	55.69
10	Wrong specification	53.91

This study shows that scanty specification as a type of error occurred in all the projects engaged in by the respondents (99.24%). Miscalculation as a type of error occurred in about three quarter of the total number of projects undertaken by the respondents (76.93%). Wrong specification occurred in a little above half of the total number of projects undertaken by the respondents (53.91%). The findings from this section will expose the type of errors that have high frequencies thereby enabling the stakeholders to put more effort to eliminate them fast. It will also send signals to the designers to put extra effort in curbing the types of errors that have high ranking frequencies of occurrences first, during documentation.

A similar study was carried out in Saudi Arabian construction industry by Mohammed (2007), where questionnaire results indicated the percentage that a type of error represents out of the total number of errors in the projects surveyed. For errors in specifications, questionnaire

results indicated that this error represents 4% of the total number of errors in the projects surveyed; for omission of necessary items it is 6%; for non- conformance to design code/SMM it is 3%; for non- conformance to client's requirement it is 3%; for miscalculation it is 3%; for dimensional error it is 4%; and for unnecessary addition it is 6%.

Findings from Mohammed (2007) showed the percentage / size an error represents in the total number errors in project documentation, this will move the stake holders to vehemently work against large sized errors first. The findings from this study show the frequencies of occurrences of types of error in the projects studied while that of Mohammed (2007) show the percentage an error represents out of the total number of errors in particular project documentation. These two findings are not in the same direction.

Having critically analyzed the frequencies of occurrences of the types of errors in construction documents in this sub section, next sub-section will develop framework supported with guidelines for minimization of errors in construction documents in Nigeria.

5.2.7 Development of Construction Document Error Minimisation Framework.

Research Objective 7: is to develop framework supported with guidelines for minimization of errors in construction documents in Nigeria.

This is achieved with the result for objective 3 on the causes of documentation errors specific to Nigeria. The causes are stated against their origins. Refer to Figure 4.4. The origin of poor consultancy fees in Nigeria is the Government because it is the government that decides and gazettes the fees due to consultants engaged in construction works. In Nigeria it is the client that decides consultants, documentation manager and project manager to employ for his job. It is also the client that decides the documentation time, construction time and gives the brief. Therefore all issues relating to education of consultant, experience of consultant, experience of project manager, experience of documentation manager, documentation time, construction time and project brief have their origins from the client. It is the consultant that handles

documentation, workload, risks, information, communication, complexities, project planning and salary of professionals. Therefore all issues that relate to concurrent documentation, heavy workload, non- identification of risks, non- availability of information, poor communication, project complexities, inadequate project planning and poor salary of professionals have their origins from consultants. The categorisation of causes of documentation errors into their origins in this section has some of the categorisations in consonance while some are in dissonance with Dosumu & Iyagba (2013). Dosumu & Iyagba (2013) categorised communication and availability of information under designer which are in tandem with findings of this study. Dosumu & Iyagba (2013) also categorised designer experience under designer, planning of project under client and designer management experience under designer which this study disagrees with. This dissonance may be because of the small area of study of Dosumu & Iyagba (2013) of only one state in Nigeria but this research study area is in seven states of Nigeria.

The causes of documentation error in this study based on their origins are summarized in the chart as presented in Figure 5.1 below:

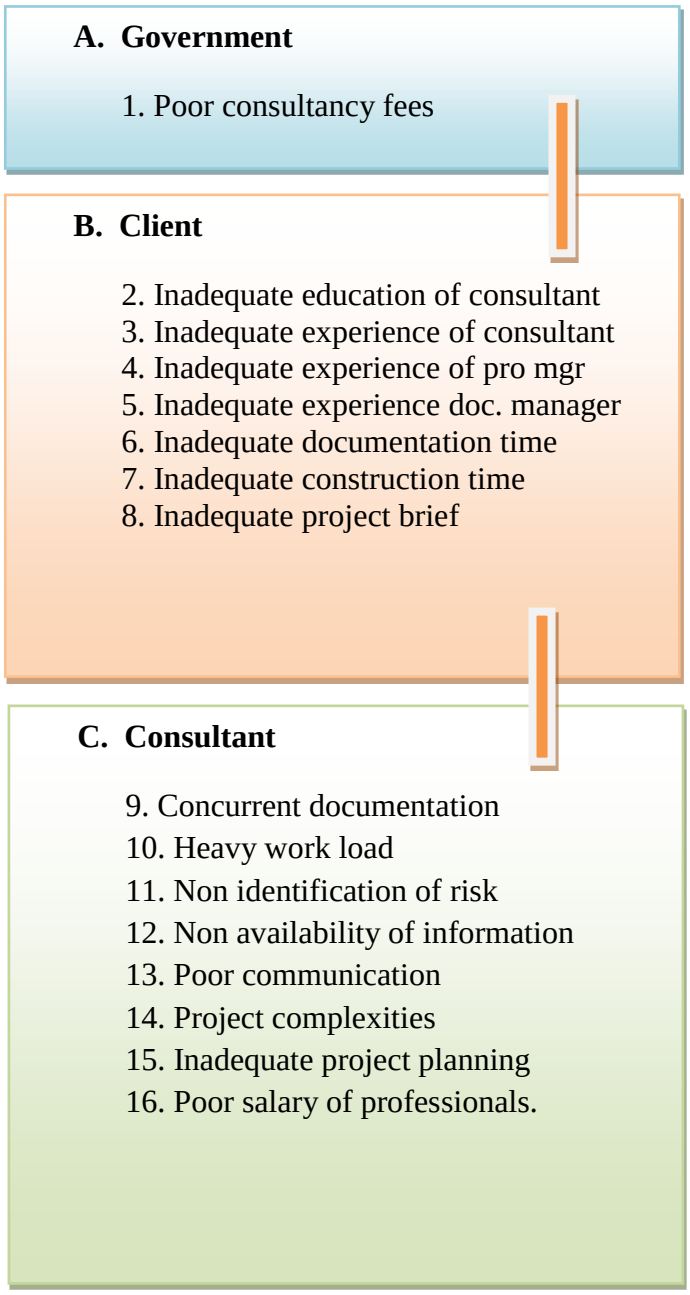

Figure 5.1: Chart of the origin of causes of error (basis of the guidelines)

The guidelines are the things to be done to undo all the items listed 1-16 by government, client and consultant respectively. All these will be explained into detail in chapter six.

Having developed the basis of the robust guidelines for minimization of errors in construction documents in Nigeria, next sub-section will discuss validation of research results, one after the other.

5.3 Validation of Research Results

The validation of the seven results of this research was enabled by the use of Kendall's coefficient of concordance to analyse the expert ratings. Each of the ten experts rated each of the seven results separately.

Research result 1: Construction document error is defined as something that causes deviation or departure from correctness or standard or accepted professional practice or principle, in drawings and bills of quantities which make it impossible for the client to achieve the desired project goal with respect to any of: cost, time and quality.

Ho – experts did not agree.

H1 – experts agree.

Kendall's W = 0.936 Asymp sig = 0.000

since Asymp sig < 0.05

then, Ho is rejected and H1 is accepted.

There is therefore concordance that is agreement between experts opinion on research result 1.

Research result 2: The type of errors in construction documents are: omission of necessary items which is details needed, unnecessary additions that is over design, non-conformance to design code/SMM, incorrect details, absence of specifications, wrong specifications, scanty specifications, miscalculations, dimensional errors and non-conformance to clients' requirements.

Ho – experts did not agree.

H1 – experts agree.

Kendall's W = 0.964

Asymp sig = 0.000

since Asymp sig < 0.05

then, Ho is rejected and H1 is accepted.

There is therefore concordance (agreement) between experts opinion on research result 2.

Research result 3: The causes of errors in construction documents are non-availability of information, poor communication, inadequate project brief, poor salary of professionals, inadequate documentation time, inadequate consultant's education, poor consultancy fees and inadequate experience of documentation manager. Others are inadequate experience of project manager, non-identification of project risks, inadequate construction time, concurrent documentation, heavy workload of the consultants, inadequate experience of consultant, project complexities, and inadequate project planning.

Ho – experts did not agree.

H1 – experts agree.

Kendall's W = 0.936 Asymp sig = 0.000

since Asymp sig < 0.05

then, Ho is rejected and H1 is accepted.

There is therefore concordance that is agreement between experts opinion on research result 3.

Research result 4: The discovery from the study is that documentation error cost is 20.39% of contract sum, documentation error time is 11.07% of contract period in Nigeria and within 7 years, 411 building occupant's lives were lost. Qualitative effects of errors are defects, building collapse, loss of human lives, financial wastage, material wastage, design-induced rework, cost overruns, time overruns, abandonment of project, dissatisfaction to clients, bad reputation of consultants, loss of confidence in consultants and imperfect project.

Ho – experts did not agree.

H1 – experts agree.

Kendall's W = 0.964

Asymp sig = 0.000

since Asymp sig < 0.05

then, Ho is rejected and H1 is accepted.

There is therefore concordance (agreement) between experts opinion on research result 4.

Research result 5: Please refer to Table 5.17 for mapping of causes to types of errors and types to causes of error.

Ho – experts did not agree.

H1 – experts agree.

Kendall's W = 0.940

Asymp sig = 0.000

since Asymp sig < 0.05

then, Ho is rejected and H1 is accepted.

There is therefore concordance (agreement) between experts opinion on research result 5.

Research result 6: Please refer to Tables 5.18 & 5.19 for frequencies of occurrences of: types of error and causes of error.

Ho – experts did not agree.

H1 – experts agree.

Kendall's W = 0.964

symp sig = 0.000

since Asymp sig < 0.05

then, Ho is rejected and H1 is accepted.

There is therefore concordance (agreement) between expert's opinions on research result 6.

Research result 7: Please refer to Figure 5.1 for the guidelines to minimise errors in construction documents.

Ho – experts did not agree.

H1 – experts agree.

Kendall's W = 0.982 Asymp sig = 0.000

since Asymp sig < 0.05

then, Ho is rejected and H1 is accepted.

There is therefore concordance (agreement) between experts opinion on research result 7.

The expert opinions/ratings showed concordance with all the research results, therefore the results are valid.

Having discussed validation of the research results by Kendall's coefficient of concordance, one after the other, next section will make a revision of the conceptual framework.

5.3 Revised Conceptual Framework

The conceptual framework for this work was established in chapter 3 of this thesis, please refer to Figure 3.2. The conceptual framework displayed in Figure 3 of chapter 3 of this thesis has been revised with the following explanations. In the course of carrying out this research it was discovered that more factors needed to be determined to boost the thesis. These other key factors are the exploration of the causes of the types of document error and the critical analysis of the frequencies of occurrences of types of errors on construction documents specific to Nigeria. These necessitated the administration of the second set of questionnaire. From the analysis of questionnaires retrieved, the followings summarise the findings:

Refer to Table 5.17 and 5.18. The importance of Table 5.17 lies in Table 5.18 which shows the ranking of the causes of the types of error which enable the stakeholders to be aware of causes that are very significant and the insignificant ones. For example from Table 5.18 in sub-section 5.2.8, Inadequate consultant education and inadequate consultant experience are ranked 1st because they are common to all the ten types of error which implies that taking care of these causes of error will to an extent reduce the occurrences of all the ten types of errors. Inadequate documentation time is ranked 3rd because it is common to seven out of ten types of errors which implies that taking care of this type of error will to an extent reduce the occurrences of seven types of error. Poor communication, Non availability of information and

Poor consultancy fees are ranked 4th because they are common to six types of error which implies that removing these causes of error will reduce the appearances of six types of error. Inadequate project brief, Poor salary of professionals engaged and Heavy workload of consultants are ranked 7th because they are common to five types of error which implies removing these causes will minimise to an extent the appearances of the five types of errors concerned. Inadequate project manager experience, Inadequate documentation manager and Time scheduled pressure are ranked 10th because they are common to four types of error with implication that removing these causes will reduce to an extent the occurrences of four types of error. Concurrent documentation, Complexity of project and Inadequate project planning are ranked 13th because they are common to three types of error with implication that removing them will minimise appearances of the three types of errors. Non- identification of project risks is ranked 16th because it is related to two types of errors with implication that removing it will to an extent reduce the two types of errors. With this information in mind, stake holders will start to work against the causes of error that rank highest down to lower ones.

Refer to Table 5.19. The findings on frequencies of occurrences of types of error shown on Table 5.19 show that scanty specification as a type of error occurred in all the projects engaged in by the respondents (99.24%). Miscalculation as a type of error occurred in about three quarter of the total number of projects undertaken by the respondents (76.93%). Wrong specification occurred in a little above half of the total number of projects undertaken by the respondents (53.91%). The findings from this section will expose the type of errors that have high frequencies thereby enabling the stakeholders to put more effort to eliminate them fast. It will also send signals to the designers to put extra effort in curbing the types of errors that have high ranking frequencies of occurrences first, during documentation.

Combining the two key factors explained above, the stake holders especially the client will focus minimisation efforts on eliminating inadequate education and inadequate experience of the consultants. The adequately educated and adequately experienced consultants employed by the client will commence the elimination of scanty specifications, miscalculations, wrong specifications and etc according to descending order of frequencies of occurrences of types of errors, refer to Figure 5.2. In accordance with the new developments explained above especially in Tables 5.17, 5.18 and 5.19, the initial conceptual framework has been revised as shown in Figure 5.2.

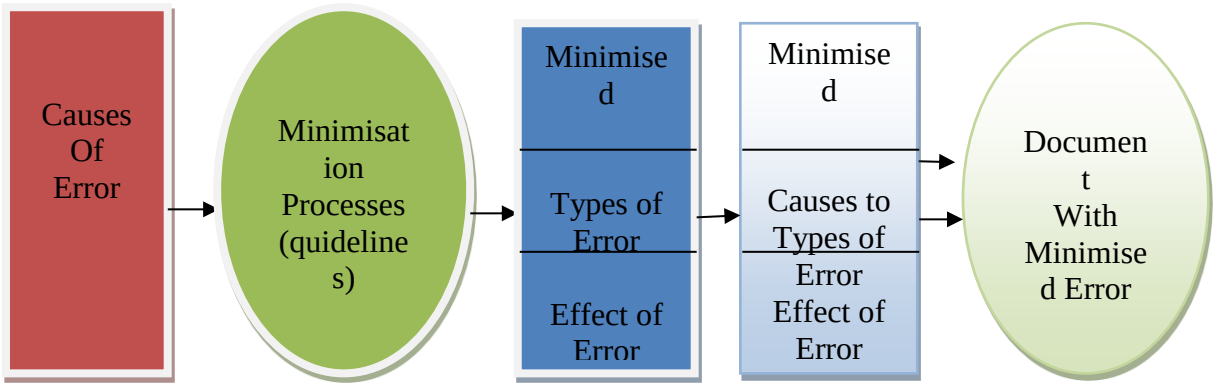

Figure 5.2: Revised Conceptual Framework.

This section discussed the revised conceptual framework next section will be devoted to discussions on each type of error.

5.4 Types of errors in construction documents in Nigeria

Results from data analysis on types of documentation error showed that the following names of errors are specific to Nigeria, namely unnecessary additions, non – conformance to client requirement, non – conformance to design code/ SMM, absence of specifications, dimensional error, miscalculation, scanty specification, wrong specification, omission of necessary item and incorrect details. The following discussions center on the listed types of error that occur in construction documents in Nigeria.

5.4.1 Unnecessary Additions (Over-Design)

Analysis from the questionnaire shows that the respondents agreed that unnecessary additions are a major type of error in construction documents in Nigeria. Over-design amounts to addition of unnecessary items in the construction documents. Sometimes, some civil engineers over-design the structures because of inexperience and fear of structural collapse. Over design in itself is a form of error and has caused building collapses in Nigeria. This type of error is found in 55.69% of projects executed by the respondents. It is caused by inadequate experience of project manager, inadequate education of consultant, inadequate experience of consultant and concurrent documentation.

5.4.2 Non Conformance to Client's Requirements

The respondents recognise non-conformance to client's requirement as one of the types of error that is common in construction documents in Nigeria. The client sets the scope, the designer especially architect often miss out on this because architect may design to scope and quality but not to the budget. The quantity surveyor (QS), who is supposed to cost plan the designs are not brought in early enough, they are later brought in to prepare the bill of quantities. By the definition of AIA (1994) the prospective project is designed at least sufficiently well to understand what is being undertaken, what facilities and amenities are required when the project is needed, and it's cost. By this definition, if the construction documents fail to address such requirements and constraints proposed by the client in the brief, this will be considered as an error. Love, et al (1999) discovered that errors at the design stages are the result of lack of understanding and incorrect interpretation of client's requirements. This type of error is found in 82.5% of projects undertaken by the respondents in Nigeria. This is caused by inadequate project brief, non-availability of necessary information, inadequate communication, inadequate experience of documentation manager, inadequate professional education of consultant and inadequate experience of consultant.

5.4.3 Non-conformance to Design Code/SMM

Respondents agree that non-conformance to design code/SMM is one of the types of errors on construction documents in Nigeria. The QS measures quantities from drawings in order to prepare bills of quantities in accordance to the Standard Method of Measurement (SMM). The last SMM that was used in Nigeria was the SMM 7 prepared by the Royal Institution of Chartered Surveyors, (RICS) London. There was a change to the use of SMM 1 Nigerian edition, prepared by the Nigerian Institute of Quantity Surveyors (NIQS) in 1988. Later NIQS introduced BESSM – Building and Engineering Standard Method of Measurement. The second edition of SMM 1 was robustly packaged as BESMM 2 and was published in 2002, BESMM 3 was published in 2008 and BESMM 4 was in 2015. Within twenty seven years the SMM / BESMM has been re-written four times. Currently BESMM 4 is in circulation and there is move that another kind of Standard Method of Measurement will soon be published. So the old and young quantity surveyors are in a way confused as to the use of the right standard method of measurement. Many old quantity surveyors are still using SMM 1, Nigerian edition, few old and younger ones are using BESMM. In effect many quantity surveyors in Nigeria do not conform to the current method of measurement – BESMM 4. This type of error is very common in Nigeria as attested to by Dosumu & Adenuga (2013) that omissions and ambiquities have significant occurrence. This type of error is found in 85.31% of projects undertaken by the respondents in Nigeria. Also, this error type is caused by inexperienced documentation manager, consultant's inadequate education and inadequate experience of consultant.

5.4.4 Absence of Specifications / Schedules

From the study, absence of specification / schedules is another common type of error in the construction documents in Nigeria. Scott (1990) opines that the purpose of specification is to communicate to someone how something is to be done so that specifier's intention is clearly understood without doubt or ambiguity so that there will be no confusion in the mind of the

person who is to perform specified tasks. The assertion of Olotuah (2009) that designs are not accompanied by specification, and the opinion of Aqua Group (1990) that specification has frequently been abandoned agree with the finding of this research that absence of specification is a type of error. The occurrence of this error is in line with the result of a study in Lagos state of Nigeria by Dosumu & Adenuga (2013) that missing information is a common error. This error type is revealed in 67.79% of projects already executed by respondents. Also from this study absence of specification / schedules in construction documents is caused by inadequate project manager experience, inadequate project brief, low education of documentation manager, inadequate education of consultant, inadequate experience of consultant, poor communication, non-availability of information, inadequate planning of the project and time pressure.

5.4.5 Dimensional Error

Respondents attested that dimensional error is one of the common types of errors in construction documents in Nigeria. This type of error occurs in the documents as a result of wrong dimensioning, missing dimensions, incomplete dimension, and unclear dimension. Dimension requires an understanding of the sequence of construction, for new assemblies can only be located relative to assemblies in place. When dimensional error occurs, the contractor relies on scaling of drawings, which is not supposed to be so. A lot of time is wasted for this type of error to be rectified as the contractor has to make clarifications from the architect or engineers. Most dimensional errors could easily be prevented, if proper guidelines for dimensioning are followed. These errors include that the dimensions do not add up to make a whole, conflict of dimension between drawings, details and schedules. Reference can be made to AIA dimensioning guidelines (AIA, 1994) for the set of standard for dimensioning drawings. This finding is in consonance with the discovery by Dosumu & Adenuga (2013) that dimensional error is common in architectural drawings in Nigeria. This error type is found in 60.89% of the projects undertaken by the respondents. This is caused by

inexperienced project manager, low professional education of the consultant, inexperienced consultant, heavy workload of consultant, concurrent documentation, short time available for documentation and complexities of projects.

5.4.6 Miscalculation

From the study, it is found that in Nigeria, miscalculation is one of the major types of error that occur in construction documents. Ordinarily all the documents, designs and bills of quantities, are set in order through calculations. It is discovered from experience that miscalculations do occur at the level of adding lengths together to make a whole on drawings. It also takes place at the level of addition, subtraction, multiplication and division as it relates to figures in the bills of quantities. These are found to be very frequent in construction documents and so can be said to be a common type of error in Nigeria. This is supported by Dosumu & Adenuga (2013) in a study carried out in Lagos state of Nigeria, when it was discovered that arithmetic errors, a form of miscalculation are very common in Nigerian bills of quantities. This error type occurred in 76.93% of previously executed projects of the respondents in this study. According to respondents in this study miscalculations are caused by inadequate time for documentation, inadequate education of consultant, inadequate consultant experience, heavy workload of consultant, concurrent documentation, time scheduled pressure and project complexities.

5.4.7 Scanty Specifications / Schedules

Also from the research, scanty specification / schedules is one of the types of error in construction documents in Nigeria. AIA (1994) defines specification as the requirement for materials, equipment, construction system as well as standard for product, workmanship and the construction services required to produce work. This finding is in agreement with Ayodele & Ayodele (2011) who discovered scanty specifications in construction drawings and stated the effects as: emergence of the use of substandard materials and workmanship, which may result to building collapse; it may also lead to delay in project completion as well as cause

cost overrun. Sometimes, it may result in project abandonment. This type of error is discovered in 99.24% of project already executed by the respondents. From this study it is equally discovered that it is caused by lack of communication, non-availability of information, inadequate documentation manager experience, inadequate consultant experience, lack of project planning, inadequate time for documentation, and construction time scheduled pressure.

5.4.8 Wrong Specifications / Schedules

Also, it is discovered that the wrong specification is a major type of error in construction documents in Nigeria. Jagboro (1996) pointed out that specification breaks down the interrelated information shown on drawings into separate organised orderly unit of work. Also, it generally describes the following: type of quality of materials, equipment and fixtures, quality of workmanship, methods of fabrication, installation and erection, test and requirements of British standard and codes of procedures, and catalogue references for manufacturer's equipment. Wrong specifications are frequent on drawings; this may be as a result of the inadequate educational qualifications of the designer, and inexperience of the consultant. This type of error occurred in 53.91% of projects already executed by the respondents in this study. It is caused by inadequate documentation manager experience, lack of communication, low experience of the consultant, lack of information.

5.4.9 Omission of Necessary Items

Respondents assert that omission of necessary items is one of the common types of error on construction documents in Nigeria. Omission of necessary items occur when necessary items such as the call outs that describe different aspects in the drawings or details is either wrong or missing or do not give clear description. Vague statement is an example of this type of error. If someone mentions timber or blocks without giving further details, the essential information about the type, size or method of fixing will be unknown. This error can result to doing a wrong thing. Rework, cost overrun, time overrun are possible outcomes of this kind

of error. These can be categorised into two: the inevitable ones e.g. sub-structural items that are measured provisional and evitable ones e.g. omission of necessary items through mistake. In agreement with this finding, is the discovery of Dosumu & Adenuga, (2013) that omissions of necessary items and ambiguity occur in the bills of quantities in Nigeria. This also leads to extension of cost and time. This type of error is discovered in 92.62% of projects executed by the respondent in this study. It is caused by inadequate project brief, inexperienced documentation manger, poor consultancy fees, poor salary of professionals engaged, inadequate education of consultant, inadequate experience of consultant, heavy workload of consultant, concurrent documentation, inadequate communication, lack of information, design complexities, non-identification of risk and time pressure.

5.4.10 Incorrect Details

Questionnaire data revealed that respondents agreed that incorrect detail is another type of error. The details are the sketched on drawings and the notes appear in text form on drawings; all these illuminate the intent clearly, describe the contents or set up the conditions for the applicability of design in the drawings (AIA, 1994). When details or notes are not correct, the intent of the drawings will be wrongly interpreted. This might lead to the execution of an unwanted task. The Construction Project Information Committee (CPIC, 2003) recognised that written information on drawings is often the cause of poor coordination because it can be difficult to ensure that all affected drawings are changed when revisions are being made. Annotations should therefore be put on drawings only for good reasons. This type of error can result to time and or cost overrun. Rework may also arise from this error. Dosumu & Adenuga (2013) discovered inaccurate details as a type of error that is very common in building designs in Nigeria and is line with this finding.

This error surfaced in 85.26% of projects executed by the respondents in Nigeria. It is caused by inadequate project brief, inexperienced documentation manager, inadequate education of consultant, inexperienced consultant, inadequate time for documentation, heavy workload of

consultant, poor communication, non-availability of adequate information, and non-identification of project risks.

Having discussed in detail the types of documentation error in Nigeria, next section is devoted to discussion on causes of documentation error in Nigeria.

5.5 Causes of Error in construction documents in Nigeria.

The results from the analysis of data on the causes of documentation error showed the following as being specific to Nigeria, they are, non – availability of information, poor communication, inadequate project brief, poor salaries of professionals, non – identification of project risks, inadequate consultant professional education, inadequate consultant professional experience, inadequate project manager experience, time scheduled pressure, inadequate project planning, complexity of project, concurrent documentation, heavy work load of consultant, poor consultancy fees, inadequate document preparation time and inadequate document manager experience. The causes of errors in construction documents in Nigeria as listed are discussed below:

5.5.1 Non-availability of Information

Non-availability of adequate information has been recognised by respondents as a cause of error in construction documents in Nigeria. A major problem of lack of information on ground conditions which includes lack of soil test on the ground where the building is to be constructed is a source of error. This has not always enabled the architect and civil engineers to produce adequate project designs in Nigeria. Also, this in turn has not always enabled the quantity surveyors to produce adequate cost through bills of quantities. This finding is in consonance with Ayodele & Ayodele (2011b), that contract bills are limited in effectiveness, because the bills are not well thought out and do not contain all the necessary information. It is in agreement with Dosumu & Adenuga (2013) that lack of necessary information is one of the causes of errors in building drawings and schedules. It is also in line with Ayodele &

Ayodele (2011c), where it was discovered that contract drawings are also limited in effectiveness because they are not well thought-out and do not contain all the necessary information. This has appeared in 97.74% of projects that the respondents had executed. This cause of error leads to some types of error such as incorrect detail, omission of necessary items, absence of specification, wrong specification, scanty specification, and non-conformance to client's requirements.

5.5.2 Poor Communication

From the data, poor communication has been identified as a major cause of error in construction documents in Nigeria. Inadequate or poor communication occurred in 87.07% of the number of past projects fully executed by the respondents. Lack of detailed formal communication which includes unclear documents, conflicting specialist documents such as architectural, engineering, subcontractor drawings, also, inclusion of irrelevant instruction/materials are very common in Nigeria. In line with this finding are the interviews in the UK by Atkinson, (1999) with 40 managers in the house building industry which revealed that most common cause of defects out of 220 causes relayed by the managers was poor formal communication which is 61/220, followed by errors related to site worker that is 47/220, time pressure is 19/220 while checking is 17/220. According to Atkinson (1999) when the level of informal communication is high, the level of reported cases of defects will be low ($p = 0.057$) and vice versa; also when the quality of formal communication is high, the level of reported defects will be low ($p = 0.827$) and vice versa. This finding is also in agreement with Suther (1998) who discovered from the designer's response that lack of communication and coordination accounted for one of the major contributing factors to design errors. It was found that a faulty line of communication between participants in the design process is a significant cause of failure in design quality (Tilley et al (2000). Josephson, (1996) emphasised that when measured by cost, design-caused errors are in the biggest category. From design-caused errors, those originating from lack of coordination between

disciplines are in the largest category. This finding is also in consonance with the discovery of Dosumu & Adenuga (2013) in a study in Lagos state of Nigeria, that poor communication is one of the causes of bills of quantities error. This cause of error, according to this study has also contributed to the existence of some types of error such as incorrect detail, omission of necessary items, absence of specification, wrong specification, scanty specification and non-conformance to client's requirement.

5.5.3 Inadequate Project Brief

Inadequate project brief from client has been discovered from the data collected as one of the causes of error in construction documents in Nigeria. This cause of error appeared in 68.77% of projects that has been executed by the respondents. The finding that project brief is one of the causes of errors in construction documents in Nigeria is in agreement with the discovery of Ayodele & Ayodele (2008) who found out that quantity surveyors and civil engineers in projects were not given project brief by clients in Nigeria. Brief were only given to the architects. This has led to the absence of approximate estimates and cost plans for such projects which later led to the emergence of outrageous designs, and cost and time overruns. It has also contributed in a good measure to the existence of some types of error such as incorrect detail, omission of necessary items, absence of specification, scanty specifications, and wrong specifications.

5.5.4 Poor Salary of Professionals Engaged by Consultants

This study discovered poor salary paid to professionals employed by consultants as one of the causes of errors on construction documents. This cause occurred in 70.5% of projects executed by the respondents, and it is one of the causes of some types of error such as omission of necessary items, miscalculation, absence of specification, scanty specifications and non-conformance to design code/SMM. This finding agrees with observation of Love et al (2000), Abdel–Hamid (1998) and Ogunlana (1993) that low wages can serve as de-motivators which may equally contribute to the occurrence of errors.

5.5.5 Non-identification of Project Risks

Non-identification of project risks has been identified by respondents as one of the causes of error in Nigerian construction documents. Decisions are concerned with variables which are normally classified as risks or uncertainties. Risks are unknown therefore the probability of occurrence cannot be assessed by statistical means (Chapman & Ward 1997). It is possible however, for a decision maker to assign a subjective probability to an uncertainty (Del Cano & Dela Cruz, 2002 cited in Greedy, 2006). Allocation of risk for parts of the design, construction and management of projects is defined in contractual arrangement.

This cause of error occurred in 58% in past projects that the respondents got involved. It has also contributed to the existence of some error types such as incorrect details and omission of necessary items.

5.5.6 Inadequate Consultant's Professional Education

From the study, inadequate professional education of consultants has been identified as one of the causes of error. In Nigeria, construction professionals must attain a minimum educational and professional qualification before they are allowed to practice. For example a quantity surveyor must possess BSc or HND/ PGD plus MNIQS and become registered as a Quantity Surveyor (RQS) through the regulatory body. The same goes for architects and engineers, but the fact is that as soon as the academic qualification is obtained, they begin to practice without getting registered. Many people who do not even possess requisite academic qualification get engaged in quackery. Among others, inadequate professional education of the consultant, has led to the existence of some types of error such as: dimensional error, incorrect detail, omission of necessary items, miscalculations, absence of specification, wrong specifications, scanty specifications, unnecessary additions, non-conformance to client's requirement, and non-conformance to design code/SMM. The academic and professional qualifications of the consultants have influences on the generation of errors in construction documents. Appropriate educational qualifications will help the professionals in doing what they are

supposed to do on the documents to minimise errors. This finding is in consonance with Atkinson (1999) who found out that qualification of the managers and the consultants are very significant; when the consultant is qualified, the level of reported cases of defects is low when the consultant is unqualified the level of reported cases of defects is high. This result is also in line with a study in Lagos state of Nigeria by Dosumu & Adenuga (2013) that designer's inadequate education is one of the causes of documentation error. The more highly qualified academically and professionally a consultant is, the more know-how he possesses which will result to very low occurrence of errors. If a consultant is marginally qualified, the work he does may contain many errors. This cause of error occurred in 76.49% of already executed projects of the respondents.

5.5.7 Inadequate Consultant's Professional Experience

One of the outcomes of the research also reveals that inadequate consultant professional experience is one of the causes of error in construction documents in Nigeria. In Nigeria, as soon as a quantity surveyor is registered by the Quantity Surveyors Registration Board of Nigeria QSRBN, he is immediately licensed to practice. However, to be very much professionally experienced, he still needs to partner with senior registered quantity surveyors to gain more professional experience. The occurrence of errors in construction documents will continue until this so. Inadequate consultant professional experience has contributed to the emergence of all types of errors in construction documents in Nigeria. These are dimensional error, incorrect detail, omission of necessary items, miscalculations, absence of specification, wrong specification, scanty specifications, unnecessary additions, non-conformance to client's requirements, and non-conformance to design code/SMM. The knowledge and skill already gained by respective consultants in past projects influences the occurrence of errors on the construction documents they produce. This finding is in line with Lyneis, et al (2001) who are of the opinion that less experienced people make more errors and work more slowly than more experienced people. This finding is in agreement with

Atkinson (1999) who in a study discovered that experienced managers record low occurrence of errors in their documents, while inexperienced managers record high occurrence of errors on their jobs. It is also in consonance with the discovery of Dosumu & Adenuga (2013) in Lagos state of Nigeria, that professional inexperience is one of the causes of construction documentation error. These opinions and discoveries are at variance with the assertion of Frankenburger et al (1998) who stated that experience has no relevance for deficient analysis and decisions. The reason was because a lack of experience can be balanced by other factors e.g. theoretical education, open mindedness or motivation of the consultant. Very often the consultation of colleagues in the documentation process compensates for a lack of experience. This cause of error, according to the projects studied, occurred in 86.67% of them.

5.5.8 Inadequate Project Manager Experience

The experience of a project manager influences the occurrence of error. Findings from the study reveal that inadequate project manager experience is one of the causes of error on construction documents in Nigeria. The project manager's experience in executing projects will go a long way to determine the occurrence of errors in construction documents. This finding agrees with Atkinson (1999) who reveals that, when the experience of a project manager is categorised as "experienced", the level of reported cases of defects will be low, but when it is categorised "inexperienced", the level of reported cases of defects will be high (with $p = 0.019$). Suther (1998) has this similar finding in a study where it was discovered through the designer's response, that a project manager's non-understanding of the project scope is one of the major causes of design errors. This finding also agrees with Al-Dubaisi (2000) that lack of coordination between the contractor and consultant, which ordinarily should be handled by the project manager, is one of the causes of change orders in construction projects in Saudi Arabia. This cause of error is responsible among others for the occurrence of the following types of error: dimensional error, absence of specification, wrong

specification and unnecessary additions. Also, this occurred in 54.32% of project already executed by the respondents.

5.5.9 Time Scheduled Pressure

Pressure of time for a project completion has been discovered to be a cause of error in construction documents in Nigeria. Clients in Nigeria have been known to always be in a hurry to procure their projects. This has always shortened documentation time and also made the consultants to hurriedly produce their documents. This time pressure has at many times resulted to emergence of errors. An increase in the number of documents produced within a certain period of time leads to an increase in the time schedule pressure; it also increases the concurrent activities. On the other hand, an increase in the time schedule pressure reduces the design time available for documentation. In the same vein, an increase in concurrent activities will reduce the communication as well as the coordination. Also, an increase in communication and coordination will reduce the number of problems solved which will reduce the number of errors in the construction documents (Mohammed, 2007). This cause of error occurred in 51.58% of past projects executed by the respondents who participated in this study and has contributed to the existence of some types of error such as omission of necessary items, wrong specification, absence of specification and scanty specification.

5.5.10 Inadequate Project Planning

This study also found that inadequate planning of project is another cause of error in Nigerian construction documents. It discovered that clients in Nigeria do not bother about project planning and this has adversely affected effective project execution. To plan means to think carefully about something you want to do, and decide how and when you will do it (Bullon, 2005). At times in the Nigerian environment, proper project planning is not taken seriously. Poor planning cause insufficient oversight and design changes later in the construction process (Suther, 1998). Agbenyo (2014) has revealed that improper pre contract planning including improper documentation as the major cause of construction delay in Nigerian

construction industry. It further reveals that late completion of project and escalation of authorised contract costs, will be the major effects of delay in construction. Elamah et al (2014) concluded in their research report that the major factor affecting cost, time and quality are planning deficiencies including documentation among others. Rowland (1981) concluded that construction performance was positively influenced by increased planning prior to taking possession of a site and commencing construction activities. He also noted that increased use of time planning and control techniques by contractors also proved significant in reducing construction time. This finding is also in line with Dosumu & Adenuga (2013) in a study in Lagos state of Nigeria that inadequate planning is one of the causes of errors in drawings and specifications. In Nigeria inadequate planning of project occurred in 32.95% of projects that had been executed by the respondents in this study and this has contributed to existence of some types of errors such as absence of specification, scanty specification and omission of necessary items.

5.5.11 Size and Complexities of projects

In this study, complexities in the shape and size of building projects have been spotted as a cause of error in Nigerian construction documents. Architects in Nigeria sometimes, boost their ego by producing very complex designs which they themselves are not able to fully dimension properly. This also causes other consultants who depend on their drawings, to run into error. A building is complex when it has complicated parts that are difficult to understand. Rowland (1981) has shown that project size influences the number of errors. Because stakes are higher on larger projects, more care must be shown in the building and planning processes; thus, the cost overrun may be reduced. This cause of error occurred in 45.92% of projects fully executed by the respondents and has also been responsible among others, for the existence of some error types such as dimensional error, omission of necessary items and miscalculation.

5.5.12 Concurrent Documentation

Also in this study, respondents distinguished concurrent documentation as a cause of error in construction documents in Nigeria. The idea of developing products of higher quality and at lower cost and time had led to parallel execution of jobs instead of executing the jobs in sequence. The designs therefore are collaborating more and more in teams, crossing both departments and company borders (Frankenburger, et al 1998). Concurrency has been cited in construction management literature as a cause of errors (Atkinson, 1996). The number of errors is deemed to increase as schedule pressure increases, and when the degree of parallelism between tasks carried out by different designers increases. This type of error occurred in 42.69% of already executed projects of the respondents in Nigeria. According to this survey, concurrent documentation contributes to the existence of some types of error such as dimensional error, omission of necessary items and miscalculation.

5.5.13 Heavy workload of Consultants

Further still, heavy workload of consultants has been indicated by the respondents as one of the causes of error in construction documents in Nigeria. This cause of error occurred in 62.66% of projects previously executed by the respondents. Many times in the Nigerian environment there is concentration of construction documentation job in the hands of few professionals for some reasons: the reputation, the experience, the effectiveness etc. of the professionals concerned. Many times too, this has been harmful because the professionals did the work under pressure so as to complete the job at the time specified by the clients. AIA (1994) has stated that the capacity of the design office to handle the number of projects will influence the number of errors generated in the construction documents. If the workload on the consultant is heavy more errors will show on the documents. One of the ways to reduce errors in documents is either for the consultants to increase their professional resources or lighten the workload. In Nigeria, according to this study, heavy workload of consultants among others is responsible for the existence of some error types such as: dimensional error, incorrect detail, omission of necessary items, miscalculation and non-conformance to design code/SMM.

5.5.14 Poor Consultancy Fees

Data collected from the respondents show that poor consultancy fee is one of the causes of error in construction documents in Nigeria. What obtains on the Nigerian environment is that consultancy fee is fixed by the Federal Government for each of the professionals: architect, civil engineer, electrical engineer, mechanical engineer and the quantity surveyor, and all such scale of fees is binding on all government contracts. The professionals enjoy full payment of the fees when it is a Federal Government contract. When it comes to state government, parastatals and etc, such fixed fees are illegally negotiated downwards as ridiculously low as less than 50% of the fees. Such low fees are usually a discouragement to the professionals who may result to doing haphazard job resulting to imperfect job full of errors. From the study, a poor consultancy fee is found to have contributed to the existence of some types of errors such as omission of necessary items, absence of specification, wrong specification, scanty specification and miscalculation. Atkinson, (1999); Chadwick (1986) and Petroski (1994) have lend their voices that poor fees for professional services has led to error where designers are selected based on low design fees. Then the level and quality of such services provided is likely to be limited and generally translated into additional project costs to the owner (Abolnour, 1994). Poor consultancy fee resulted into error in 87.48% of the projects executed by the respondents.

5.5.15 Inadequate Documentation Time

Data retrieved from the respondents in this study show that inadequate documentation time is one of the causes of error in construction documents in Nigeria. The nature of projects varies from simple to complex; so also the designs and other documentation for the projects concerned. AIA (1994) has the opinion that a realistic time schedule for the documentations is related to the number of errors generated. Andi, et al (2003b) discovered that the designers regarded insufficient design time as the most important issue influencing design document quality. This cause of error occurred in 72.15% of the previously executed projects of the

respondents. Inadequate documentation time is one of the factors responsible for some types of error such as: dimensional error, incorrect detail, omission of necessary items, absence of specification, wrong specification, scanty specification, non-conformance to client's requirement, and non-conformance to design code/SMM.

5.5.16 Inadequate Documentation Manager's Experience

This research reveals that inadequate experience of the documentation manager is a cause of error. This refers to the experience of the leader of each of the professionals namely architect, civil engineer, electrical engineer, mechanical engineer and quantity surveyor engaged in the development of designs and bills of quantities. Experience is the knowledge or skill that has been gained from doing a particular job or activity (Bullon, 2005). Experience is also defined as the knowledge or skill of a particular job that has been gained because of working on the job for a long time (Mohammed 2007). Rounce (1998) has suggested that much of the design related re-work generated in projects is attributable to poor managerial practices in architectural firms. Among other causes, this cause of error is responsible for the existence of the following types of error: dimensional error, omission of necessary items, miscalculations, scanty specification. It is also pronounced in 52.85% of project executed by the respondents who participated in this study.

Having shown discussions on the various common causes of documentation errors in Nigeria, next section will expose discussions on quantitative and qualitative effects of documentation error.

5.6 Quantitative effects of errors in construction documents with respect to construction cost and time.

These shall be discussed below as follows:

5.6.1 Quantitative effects of error in construction documents with respect to cost and time.

Results from this study reveals (refer to Table 5.10) that cost due to errors in construction documents is 20.39% of contract sum, and (refer to Table 5.11) time due to errors in construction documents is 11.07% of contract period in Nigeria. This agrees with what is obtained from other parts of the globe as discovered by different researchers. In a related study Josephson & Hammarlund (1999) in their analysis pointed out that an average of 32% of defect costs have their origin in the early phases i.e. in relation to the client and the design. Approximately 45% of the cost of error originated on the site i.e. in relation to management, workers and the sub-contractors, and about 20% of the defect cost originated in materials or machines. The effect of error is very wide. Koskela (1992) opines that it sometimes seems that the waste caused by design error is larger than the design itself. In a research carried out in Kuwait, Kertam & Kertam (2000) reported that design error is one of the most significant risks to project delays. In the same view, studies in Japan by Sawada, (2000) in the USA by Kangari (1995) and in Hong Kong by Ahmed (2000), unanimously noted that, defective design is considered a critical risk. Also researchers noted that deviations on the project accounted for an average of 12.4% of the total costs, and design deviations is average of 78% of the total number of deviations, 79% of the total deviation costs, and 9.5% of the total project cost. They concluded that the deviation costs of the design change as a result of error amounted to about 54.2% of the total deviation costs (Burati et al 1992). In the same vein Stassiowski (1994) discovered that most design firms spend 25 – 50% of design man hours, redoing work that had been done before. In another survey conducted by Nikkei construction involving 79 Japanese Contractors, results showed that 44% of the respondents experienced a good number of design document problems, common effects of such design error are in the area of constructability, conflicts in structured designs, inadequate temporary work designs, improper construction methods and information in different site conditions (Anon 2000).

5.6.2 Quantitative effects of documentation error on building occupants / site workers.

Results from analysis of data showed that 411 building occupants / site workers lost their lives in 7 years (in 10 incidents) as a result of building collapse occasioned by documentation errors (please refer to Table 5.14)

The loss of lives as a result of construction document error is not limited to Nigeria alone. Table 5.20 shows reported and selected cases of occurrences and causes of building collapse in three nations of the world, namely Singapore, Thailand and Malaysia between 1986 and 2009. The table also shows the type of building, date of building collapse, location of the building collapse, causes of collapse and remarks.

From Table 5.20, in Singapore, the Hotel New World, located on Serangoon road, collapsed in 1986 because of inadequate structural design (the cause of error) and left 33 people dead. Also in Thailand, the six storeys Royal Plaza hotel building located in Nakhon Ratchasima collapsed in 1993 and 137 people lost their lives because of illegal conversion of the structure and faulty design (the cause of error). In 1999, in Singapore, a multipurpose hall located at Compasvale primary school collapsed and left 7 people dead because of faulty design (the cause of error). In the year 2009, in Malaysia, a multipurpose hall collapsed because of faulty design but there was no casualty (Alabi, 2013).

The loss of 411 building occupants lives in7 years in Nigeria is very significant (refer to Table 5.14). Nigeria must have lost people who would have contributed to the nation's economic development, sound re-definition of political ideology, sound local, state or national leadership, etc.

Table 5.20 Reported Cases of Occurrences and Causes of Building Collapse in three nations of the world from 1968 -2010 (Source: Alabi, 2013).

SN	Year	Country	Location	Type of building	Causes of building collapse	Casualties.
1	1986	Singapore	Serangoon Road	Hotel New World	Inadequate structural design	33 people

						dead
2	1993	Thailand	Nakhon Ratchasima	Six storey Royal Plaza hotel building	Illegal conversion and faulty design	137 people dead
3	1999	Singapore	Campassyale primary school	Multipurpose hall	Faulty design	7 people dead
4	2009	Malaysia	Kuala Terenganu	Sultan Abidin stadium	Faulty design	No casualty.

Having discussed the quantitative effects of document errors on cost and time of construction of building projects and also on building occupants / site workers, next sub section will discuss qualitative effects of documentation errors on projects and economy

5.6.3 Qualitative Effects of Error in Construction Documents on projects and economy

Results from this of study qualitative effects of documentation error are: defects, building collapse, loss of human lives, financial wastage, material wastage, design-induced rework, cost overruns, time overruns, abandonment of project, imperfect project, dissatisfaction to clients, bad reputation of consultants, and loss of confidence in consultants. These findings agree with discoveries of the various authors (Love, 2002; Love *et al.*, 2008; Vrouwenvelder, *et al.*, 2009; Barkow, 1995; Palaneeswaran, *et al.*, 2007; Olatunji, 2011; Mohammed, 2007; Rashid, *et al.*, 2006; Alarcon & Mardones, 1998; Dosumu & Adenuga, 2013; Dosumu & Iyagba, 2013).

Lawal (2016) in a study expanded the woes of building collapse to include the followings

1. Loss of life, property and huge sum of capital. Where human live is lost, no compensation is sufficient as an exchange for the soul.

2. Loss of reputation and integrity leading to psychological trauma.

3. The integrity and values of industry professional are put to test.

4. Loss of new commissions and contracts. The professional competence of both the constructor and the team of consultants is called to question by the society.

5. Withdrawal of practicing licenses.

6. Loss of materials and capital investments: Components and materials are damaged beyond re-use. Capital investments are not recoverable, leading to bankruptcy and high economic implications to the nation's economy.

7. Important documents lost in a collapsed building may never be recovered.

8. Hangover of the collapsed building can constitute a threat to health and safety of the neighbours both at present and even generations after the reinstatement of the building.

9. Two scarce resources – time and money are wasted on the cost of clearing the debris from the site.

10. Loss of revenue which includes capital, profit and other sundry incomes.

11.Extra expense is incurred on investigations of the causes of the collapse. This may be carried out by various interest groups – governments, professional bodies, the procurer, etc.

12.If it was only injury suffered by the victims, it may lead to loss of limbs which in turns may lead to loss of employment opportunity and such a victim becomes a total dependant on others for life sustenance.

13.There is also the possibility of legal and professional fees for the redesign and execution of remedial work.

14.Possible litigation and extra cost on borrowed capital or loss of interest on capital used.

15.Depreciation in value of the property concerned.

16.Cost of making good the environment in compliance with the Environmental Impact Assessment.

This section showed discussions on the quantitative and qualitative effects of documentation error, next section explains the framework with support of guidelines that will minimise documentation error in Nigeria.

5.7. Explanation on the Construction Documents Error Minimisation Framework.

All the common causes of construction documentation error in Nigeria are listed. Solutions are proffered to remove the said causes. These solutions are referred to as the guidelines.

This section explains Figure 5.1 which forms the basis of the error minimising framework supported with guidelines stated in Figure 6.1. The various causes of errors in construction documents in Nigeria are discussed. When steps are taken to minimise all the causes of error thereby drastically reducing all the types of error, all the negative effects of the construction document errors of cost and time overruns, high frequency of building collapse and the huge loss of human lives are also drastically reduced.

The current situations on each of the causes of error and the required situations that will wipe out such causes of error are discussed below.

1 Non-Availability of Information

The current situation is that there is no knowledge of the nature of ground conditions or soil test before project documentation in Nigeria. The engineers do not carry this out and documentation is just based on what are visible on the surface of the soil. This occurs on most of the projects executed in Nigeria.

The required or suggested situation is that the civil engineers should carry out survey of ground conditions and soil tests before documentation. This will enable appropriate inclusions to be made on architectural and structural drawings and the bills of quantities

2 Poor Communication

The current situation in Nigeria is poor formal communication which includes unclear documents conflicting specialist documents and the inclusion of irrelevant materials. The required or suggested situation is that the consultants should engage in the production of clean

documents which are very clear to understand. Documentation should be void of irrelevancies.

3 Inadequate Project Brief

The current situation is that generally in Nigeria, clients give scanty brief, and even the scanty brief, most of time is given to only the architect. This is corroborated by Ayodele (2008) when it was discovered that the situation of project brief being given to architects alone creates gap when the quantity surveyor, who would have prepared the approximate estimate and cost plan of the proposed project is left out.

The required or suggested situation is that clients should give their comprehensive project brief to the consultants at the same time and also in writing. This will enable each of them to work towards the same goal, starting at the same time. The quantity surveyor will be able to perform his cost and economic functions right from the inception.

4 Poor Salary of Professionals Engaged by Consultants

The current situation is that the salary paid to professionals engaged by the consultants in Nigeria is ridiculously small. It is usually lower than what their counterparts in the civil / government service earn. The situation is worsened because they are not sure of their continuous employment. Their continuous employment depends on the number of jobs in the hand of the consultant. In the absence of job in the hands of the consultant, the engaged professional may be laid-off.

The required or suggested situation is that **a** situation should exist whereby the salary earned by professionals should be thrice of what they earn now. With this done they will concentrate on the job.

5 Non-Identification of Project Risks

The current situation is that in Nigeria generally, consultants do not seek to identify risks before the commencement of contract job. Clients, consultants and contractors view this as a waste of time. The required or suggested situation is that consultants are advised to identify

risk factors before the commencement of contract job, so as to determine ways to scuttle dangerous risks, before they subdue the project parameters of cost, time and quality,

6 Inadequate Education of Consultant

The current situation of consultant education in Nigeria is as stated below.

There are four categories in the current situation:

i. Those with BSc, or HND and PGD
ii. Those with BSc, or HND and PGD plus professional qualification e.g. MNIQS, MNIA, MNSE;
iii. Those with the above plus registration by the concerned registration board, eg QSRBN, ARCON, COREN.
iv. Those with qualifications other than required for the practice of the professions concerned e.g. quacks.
v. Those with lower qualification than the least above.

The required or suggested situation of a consultant should be that a consultant is expected to possess a BSc or HND/PGD plus professional diploma qualification awarded after 12 months course of instruction in an accredited institution, plus registration by the concerned regulatory bodies such as, QSRBN, ARCON or COREN.

The Nigerian Institute of Quantity Surveyors, NIQS, in conjunction with the Quantity Surveyors Registration Board of Nigeria, QSRBN, in 2016 established the Quantity Surveying Academy, where in future years candidates with BSc or HND and PGD can attend a 12 months professional programme in quantity surveying. After the 12 months programme, the successful candidate will be issued a certificate that will qualify them for direct registration by the regulating board, QSRBN.

7 Inadequate Experience of Consultant

Currently**,** the popular thing is that people start to practice after the professional qualification, even before being registered by the regulatory body.

However, the required or suggested situation should be that after obtaining professional diploma qualification awarded after 12 months course of instruction in an accredited Institution, candidates should practice with senior colleagues for at least 2 years before being licensed or registered to practice by the respective regulatory board or council. The consultant must also attend workshop or seminar organised by the respective professional or regulatory bodies at least once a year after being licenced / registered to practice, otherwise, such consultant should be de-registered.

8 Inadequate Experience of Project Manager

The current situation is that the experience of a consultant or professional to be commissioned as a project manager is not tied to any number of years. Any practicing consultant (Quantity Surveyor, Architect or Engineer) can be appointed as project manager. The required or suggested situation should be that a project manager should be a consultant that has practiced for at least 10 years and must have undergone a 12 months training on project management in an accredited institution, may be on part time.

9 Inadequate Time for Project Completion.

The current situation is that most of the time, Nigerian clients want their job executed within a short time. This also results in hurrying the consultants to document the proposed project. Hurrying, generally leads to mistakes / errors.

The required or suggested situation is that clients should give the consultants enough time to do their job well.

10 Inadequate Project Planning

The current situation is that Nigerian consultants do not do any project planning before commencement of project work on site.

The required or suggested situation is that project planning should be done before documentation is completed. This makes all the facts of construction open to the consultants.

11 Complexity of Project

The current situation is that many architects in Nigeria produce complex designs to boost their ego and impress the client. Apart from the fact that it leads to more money expended on the job, it also creates avenue for occurrence of errors through dimensioning and miscalculations.

The required or suggested situation is that architects should try as much as possible to make their designs not to be too complex and also dimension the drawings appropriately.

12 Concurrent Documentation

The current situation is that the concurrent documentation is embarked upon by the consultants to save time but in actual fact it is a cause of error.

The required or suggested situation is that concurrent documentation should be discouraged in Nigeria.

13 Heavy Workload of Consultants

The current situation is that **c**onsultants, because of low scale of fees, take as many commissions as possible, so that they can be in control of large sum of money. Having too many jobs at hand without corresponding increase in the number of professionals being engaged has created error situations in documentations. The required or suggested situation is that the number of commissions to be taken by any consultant should be dictated by the number of sound professionals in his employment and his own span of control.

14 Poor Consultancy Fees

The current situation is that Nigerian construction professionals are still using the scale of fees that was approved by the Federal Government of Nigeria in 1992. This scale of fees is out-dated and has become so poor that it can hardly put food on the table. The scale of fees is bad to the extent that it is only on Federal Government contracts, that the consultant is paid the 100% of the fees and at the time it (Federal Government) feels it can pay, not as at when due, as specified in the contract conditions. The other levels of government: state, parastatals and local governments, illegally negotiate the fee down to as low as below 40% many times. As a result of the poor fees, many consultants have also gone into contracting (operating as a

contractor) i.e. combining consulting with contracting. This makes them to pay little attention to the consultancy job.

In 2013, the Federal Government of Nigeria proposed that the consultancy payment should be in form of man-hour. The professionals responded to the proposal, just in 2016 a new man-hour professional scale of fees was released by government but it has not been tested enough to determine whether it is adequate. Required or suggested situation should be that a consultant should be paid an adequate amount that will alleviate the poor condition and make him to concentrate on consultancy job. The amount should not be less than thrice of what is earned currently. All levels of government: federal, state, local, parastatals and also companies should pay 100% of such fees, without any form of negotiation. Such an amount should be reviewed upwards every five years.

15 Inadequate Documentation Time

The current situation is that most clients in Nigeria are in a hurry to get their proposed project documentation done in a short time. This short documentation time is usually not convenient for the consultants; who in a bid not to lose the client's patronage, does the documentation hurriedly, thereby giving rise to errors. The required or suggested situation is that **c**lients should not be in a hurry about documentation. Consultants should be allowed a good time to prepare the construction documentation.

16 Inadequate Experience Documentation Manager

The current situation is that the documentation manager is usually the most senior of the professionals that the consultant employed or at times the consultant himself. The year of experience is not tied to any number of years.

The required or suggested situation is that whoever will be documentation manager in the discipline concerned should have undergone a professional training for 9 months in an accredited institution that will lead to obtaining a professional diploma. It may be on a part time basis.

5.7 Summary

The chapter presented data and also analysed them. It commenced with data analysis with respect to general information on the respondents. Data presentation also consisted of analysis of the definitions of construction document error, types of error in construction document, causes of error in construction document, effects of error in construction document, effect of error in construction document on humans, mapping of causes to types of error, frequencies of occurrences of types of error and causes of error and the development of guidelines for minimising errors in construction documents. The chapter discussed validation of the research results through Kendall's coefficient of concordance. The revised conceptual framework was displayed with the associated explanations. The chapter provided discussions on the types, causes and effects of document error identified in the construction documents with respect to similarities and/or dissimilarities with findings of past researchers. It also provided explanations on the causes of error with respect to the current situations that led to negative effects and the suggested situations as ways out of the problems. Having discussed the research results one after the other in this chapter next chapter will reflect on the objectives of study and see how they have been achieved and then make recommendations.

CHAPTER SIX

CONCLUSIONS AND RECOMMENDATIONS

6.0 Introduction

This chapter reflects on the aim and objectives of this study to see how they have been achieved. The documentation error minimisation guidelines will also be presented. Recommendations will follow. The chapter also discusses the contribution of the study to knowledge, application of the study and suggestions for future research.

6.1 Conclusions

i. The first objective that this study sets out to achieve is to document a robust definition for construction document error. From literature survey: Stewart (1992) defines error as event that departs from commonly accepted competent professional practice. Edmonson (2002) defines error as execution of a task that is incorrectly carried out. According to Bea (1994) error is defined as departure from acceptable or desirable practice on the part of a group of individuals that can result in undesirable or unacceptable quality. Bullon (2005) defines error as mistakes especially one that causes problems or affects the result. Ayinuola & Olalusi (2004) define error as unacceptable difference between expected and the observed performance. The study was carried out by means of semi-structured interview administered to construction professionals and data collected were analysed by content analysis. Few of the definitions of error collected by means of interview are as follows: According to Participant 5, error is a thing done unprofessionally on documents and making it imperfect to fulfil the goal. Participant 6 defines error as a thing done wrongly on construction documents resulting to imperfection, cost and time overruns. According to Participant 7 error refers to missing items in construction documents that can lead to claims and time overrun. Participant 10 defines

error as unprofessional job done on drawings and specification which lowers the quality in the final output. According to Participant 11, error means departure from acceptable practice in construction documents resulting to more money and time expended in construction works. Participant 13 defines error as the incorrect thing that appears in construction documents resulting to low quality. According to Participant 24, errors are omissions in construction documents that lead to project goals not being achieved. From the literature survey and data collected through semi structured interview, it is revealed that: (1) there is a standard to be followed in order to achieve a purpose (2) the standard has been either discarded or not completely conformed to, (3) the gap between (1) and (2), is the error. Error refers to the gap in construction documents that makes the documents unable to achieve sound required project performance. From the study and data analysis (refer to Tables 5.2 & 5.3) the following is the summarised definition of construction document error: Construction document error is defined as something that causes deviation or departure from correctness or standard or accepted professional practice, in drawings and bills of quantities which makes it impossible for the client to achieve the desired project goal with respect to any of cost, time and quality.

ii. The second objective that this study sets out to achieve is to identify the various types of error that occur on construction documents. From the literatures the following are the various types of construction document error: non- conformance to client's requirements, non-conformance to design code/SMM, non- conformance to design calculations, constructability problems, dimensional error, non- conformance to vendor data, non- conformance to local authorities, non- conformance to law, incorrect details computer related problems, non-conformance to drafting standards, unnecessary additions, omissions of necessary items, errors in symbols and abbreviations, miscalculations, absence of specifications, wrong specifications, scanty specifications, error in labelling, error in arrangement of items and error in pagination. This study was carried out by means of questionnaire administered to construction professionals, and analysed by relative importance index. From the data analysis

(refer to Table 5.3) the types of error that occur in construction documents are: unnecessary additions, non – conformance to client requirement, non – conformance to design code/ SMM, absence of specifications, dimensional error, miscalculation, scanty specification, wrong specification, omission of necessary item and incorrect details.

iii. The third objective is set to determine the causes of errors in construction documents. From literature survey the following are the various causes of error: ineffective management organisation structure, project manager inexperience, change of key project personnel, inefficient group organisation, poor documentation process, documentation manager inexperience, consultant poor education, consultant inexperience, poor consultancy fees, inadequate documentation preparation time, poor salary of professional, number of consultants, workload of consultants, reputation of consultants, procedure for producing documents, inefficient documentation team, concurrent documentation, poor quality management, ineffective consulting team, poor communication, non- availability of information, transfer of knowledge, poor project brief, type of client, client inexperience, construction time constraint, client point contact, poor project planning, non- identification of project risk, bad attitude of client, uniqueness of the project, time scheduled pressure, project budget cost, procurement method, complexity of project, poor quality, compatibility with consultant goal, subdivision of documentation into separate services for experts and planning authority approval. This current research was carried out by means of questionnaire administered to construction professionals, and analysed by relative importance index. Table 5.4 presented the causes of error on construction documents as; non – availability of information, poor communication, inadequate project brief, poor salaries of professionals, non – identification of project risks, inadequate consultant professional education, inadequate consultant professional experience, inadequate project manager experience, time scheduled pressure, inadequate project planning, complexity of project, concurrent documentation,

heavy work load of consultant, poor consultancy fees, inadequate document preparation time and inadequate document manager experience.

iv. Objective four relates to examining the quantitative and qualitative effects of errors in construction documents on projects, delivery cost, delivery time and building occupants.

As per the quantitative effects of documentation error on projects delivery cost and time: from literature survey the following are as found with several authors: Josephson & Hammarlund (1999) in their analysis pointed out that an average of 32% of defect costs have their origin in the early phases i.e. in relation to the client and the design. Approximately 45% of the cost of error originated on the site i.e. in relation to management, workers and the sub-contractors, and about 20% of the defect cost originated in materials or machines. In a research carried out in Kuwait, Kertam & Kertam (2000) reported that design error is one of the most significant risks to project delays. In the same view, studies in Japan by Sawada, (2000) in the USA by Kangari (1995) and in Hong Kong by Ahmed (2000), unanimously noted that, defective design is considered a critical risk. Also researchers noted that deviations on the project accounted for an average of 12.4% of the total costs, and design deviations is average of 78% of the total number of deviations, 79% of the total deviation costs, and 9.5% of the total project cost. They concluded that the deviation costs of the design change as a result of error amounted to about 54.2% of the total deviation costs (Burati et al 1992). The quantitative effect of documentation error on project cost and time specific to Nigeria was carried out by administering questionnaire to construction professionals. From data analysis, findings reveal (refer to Table 5.10) that cost due to errors in construction documents is 20.39% of contract sum, and (refer to Table 5.11) time due to errors in construction documents is 11.07% of contract period in Nigeria.

As per quantitative effects of documentation error on building occupants / site workers and from literature survey: in Singapore, the Hotel New World, located on Serangoon road, collapsed in 1986 because of inadequate structural design and left 33 people dead. Also in

Thailand, the six storeys Royal Plaza hotel building located in Nakhon Ratchasima collapsed in 1993 and 137 people lost their lives because of illegal conversion of the structure and faulty design. In 1999, in Singapore, a multipurpose hall located at Compasvale primary school collapsed and left 7 people dead because of faulty design. In the year 2009, in Malaysia, a multipurpose hall collapsed because of faulty design but there was no casualty (Alabi, 2013). For quantitative effects of documentation error on building occupants / site workers, specific to Nigeria data collection was done through the administration of questionnaires to construction professionals. From data analysis findings show that 411 building occupants / site workers lost their lives in Nigeria in 7 years (in 10 incidents) as a result of building collapse occasioned by documentation errors (please refer to Table 5.14)

As for qualitative effects of documentation error on project and stakeholders, literature survey reveal the impacts as: cost and time overruns, loss of labour, materials and equipment, contract dispute contract failure, arbitration, litigation, accidents, total abandonment, poor quality job and delay in getting profits by clients (Ebekozein et al, 2015). Literature survey also reveal impacts of documentation error as: abandonment of projects, delays, rework, dissatisfaction by clients, lack of confidence in consultants, frustration of stakeholders, low reputation of consultants office, lack of concentration on other jobs, discourages investments and designer;s low profit (Dosumu & Adenuga, 2013). Qualitative effect of documentation error specific to Nigeria was carried out by means of questionnaire administered to construction professionals. Analysis of data collected (refer to Table 5.15) reveal qualitative effects of documentation error as: defects, building collapse, loss of human lives, financial wastage, material wastage, design-induced rework, cost overruns, time overruns, abandonment of project, imperfect project, dissatisfaction to clients, bad reputation of consultants, and loss of confidence in consultants.

v. Objective five relates to determining the specific causes of errors that are responsible for the occurrence of types of errors. Findings from studies similar to this were not available in

literatures surveyed. Therefore to address the causes of types of documentation error specific to Nigeria, data were collected by means of questionnaire administered to construction professionals. Data collected were analysed by percentages and mean. Refer to Table 5.17. Findings show the followings: Unnecessary addition, as a type of error is caused by inadequate project manager experience, inadequate consultant education, inadequate consultant experience and concurrent documentation. Non- conformance to client's requirements is caused by inadequate project brief, non- availability of information, inadequate documentation manager experience, poor communication, inadequate consultant education and inadequate consultant experience. Non- conformance to design code / SMM is caused by inadequate documentation manager experience, heavy workload, inadequate consultant education and inadequate consultant experience. Absence of specification as a type of error is caused by inadequate project manager experience, poor consultant fees, inadequate project brief, poor salary of professionals, inadequate documentation manager experience, inadequate consultant education, inadequate consultant experience, poor communication, non-availability of information, inadequate project planning and time scheduled pressure. Dimensional error is caused by inadequate project manager experience, inadequate documentation manager experience, inadequate consultant experience, inadequate consultant education, inadequate documentation time, heavy workload of consultant, concurrent documentation and complexities in shape. Miscalculation a type of error is caused by inadequate documentation time, inadequate consultant education, inadequate consultant experience, concurrent documentation, poor consultancy fees, poor salary of professionals, poor documentation, non- availability of information, time scheduled pressure and project shape complexities. Scanty specification is caused by poor communication, non- availability of information, inadequate project brief, inadequate documentation manager experience, inadequate consultant education, inadequate consultant experience, poor salary of professionals, poor consultancy fees, inadequate documentation preparation time and

inadequate project planning. Wrong specification is caused by inadequate project manager experience, poor consultancy fees, poor salary of professionals, inadequate documentation experience, inadequate project brief, inadequate consultant education, poor communication, non- availability of information, inadequate consultant experience and time scheduled pressure. Omission of necessary item is caused by inadequate project brief, inadequate documentation manager experience, inadequate consultant education, inadequate consultant experience, poor consultancy fees, poor salary of professionals, inadequate documentation preparation time, heavy workload, concurrent documentation, poor communication, non-availability of information, project shape complexities, non= identification of risks and time scheduled pressure. Incorrect detail is caused by inadequate project brief, inadequate documentation manager experience, inadequate consultant education, inadequate consultant experience, inadequate documentation time, heavy workload, poor communication, non-availability of information and non- identification of risks.

vi. The sixth objective is to critically analyse the frequencies of occurrences of the type of documentation errors in projects construction documents in Nigeria. This was not available in literatures that were surveyed. To analyse the frequencies of occurrences of types of documentation error specific to Nigeria, data were collected by means of questionnaire administered to construction professionals. Data collected were analysed by severity index. Findings from this study as displayed in Table 5.19 show that: Scanty specification as a type of error occurs in 99.24% of projects executed within the last 10 years by respondents. Omission of necessary items occurs in 92.62% of past projects, non- conformance to design code / SMM in 85.31% of projects, incorrect details in 85.26% of projects; non- conformance to client's requirement in 82.53% of projects; miscalculation in 76.93% of projects; absence of specification in 67.79% of projects; dimensional error in 60.89% of projects; unnecessary additions in 55.69% of projects and wrong specifications in 53.91% of projects.

vii. Objective seven is set to develop framework with support of guidelines for the minimisation of errors on construction documents in Nigeria.

Findings from research objective 3 on causes of error and chart of the origin of causes of error in Figure 6.1 were used in design of the error minimisation framework as presented in Figure 6.2.

6.2 Development and implementation of Framework supported with guidelines for minimisation of errors in construction documents in Nigeria.

The development of documentation error minimisation framework with the support of guidelines is hereby discussed. The literary dictionary meaning of framework according to Bullon (2015) is the identification and categorisation of steps or processes that constitute mind set or complex task in order to render explicit the tacit and implicit. In order words a framework identifies and categorises the steps that constitute well explained solution(s) to a complex problem. The complex problem in focus is the minimisation of document errors in Nigeria. A problem gets solved when it's causes are identified and tackled. The identification of causes of document errors specific to Nigeria was achieved through administration questionnaires to construction professionals who responded based on the experiences from their practices. This research is qualitatively driven because the causes of document error specific to Nigeria on which the guidelines are based are identified through questionnaire administered to professionals who responded to the questionnaire based on experiences from their professional practices. The identified causes of document errors are then categorised into origins, that is, they are categorised into sources from which they arise. These origins are government, client and consultant. Therefore the development of documentation error minimisation framework will involve three parties, namely: Government, Client and Consultant. The guidelines are the steps or solutions that are proffered to eradicate or

minimise the occurrence of errors on documentations. According to Bullon (2015) with respect to framework, the causes of documentation error have been identified and then categorised into three with respect to the sources from which they arise. Guideline is defined as a rule or principle that provides direction to action. It can also be defined as plan or explanation that directs one in setting standard (Bullon, 2005). This approach of developing framework with support of guidelines is followed because this work involves framework to identify and categorise steps that lead to solving a complex task while guidelines explain the steps are the remedies to the causes of document error. Next are discussions on the potentials of the three parties in solving the problems of documentation error. Guidelines which are explanations of steps to be taken to minimise document errors are involved and are discussed below. Refer to Figure 6.1 for next discussions.

A. Government

It is the government that formulates the consultancy fees for the different construction professionals in Nigeria. In order to solve the problem of poor consultancy fees the Federal Government of Nigeria should produce a new consultancy scale of fees that will be adequate for consultants in other to make them to concentrate on their jobs. The government may instead of this, gazette a robust man–hour consultancy mode of remuneration.

B. Client

In order to solve the problems, that is, causes of document errors, the client should solve all the causes of errors that arise from it as follows:

- Engage consultants with adequate education and experience.
- Engage project manager and documentation manager with adequate experience on the job.
- Allow the consultants enough time to do the documentations and execute the projects.

- Make adequate project brief on the proposed project available to all the consultants at the same time.

C. Consultant

In order to solve the problems, that is, causes of document errors, the consultant should solve all the causes of errors that arise from it as follows:

- Discourage concurrent documentation.
- Not be involved in heavy workload unless they have adequate number of professionals who would work with them.
- Identify risks before the project execution commences.
- Should produce clean and clear documentation for thorough communication.
- Determine the nature of ground, and include this in the necessary documents, that is, architectural and structural drawings and bill of quantities.
- Produce well dimensioned documents
- Do project planning before documentation is completed.
- Pay the engaged professionals adequately, to make them concentrate on their jobs.

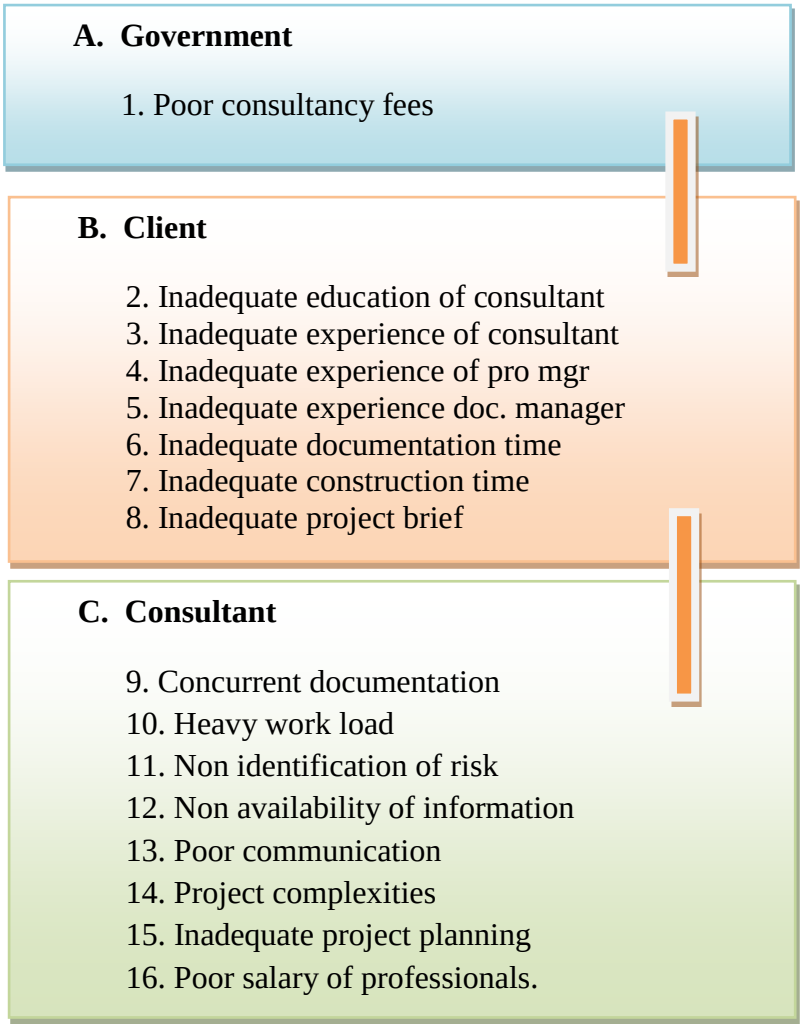

Figure 6.1: Chart of the origin of causes of error

From Figure 6.1:

In A: Government is the origin of the cause of documentation error number 1.

In B: Client is the origin of the causes of documentation error numbers 2 to 8.

In C: Consultant is the origin of the causes of documentation error numbers 9 to 16.

The Chart of the Origin of Causes of Error in Figure 6.1 formed the basis for the formulation of the error minimisation framework with the support of guidelines, as shown in Figure 6.2. The causes of documentation error summarised in A, B and C in Figure 6.1 are represented in Figure 6.2 as A (1), B (2-8) and C (9-16) as also the causes of construction document error.

As soon as they are tackled by acting on them as explained in the "Development and Implementation of framework with support of guidelines for minimisation of errors on construction documents in Nigeria" (please refer to section 6.2 above) all types of error in construction documents with the attendant quantitative and qualitative effects will disappear or be greatly minimised.

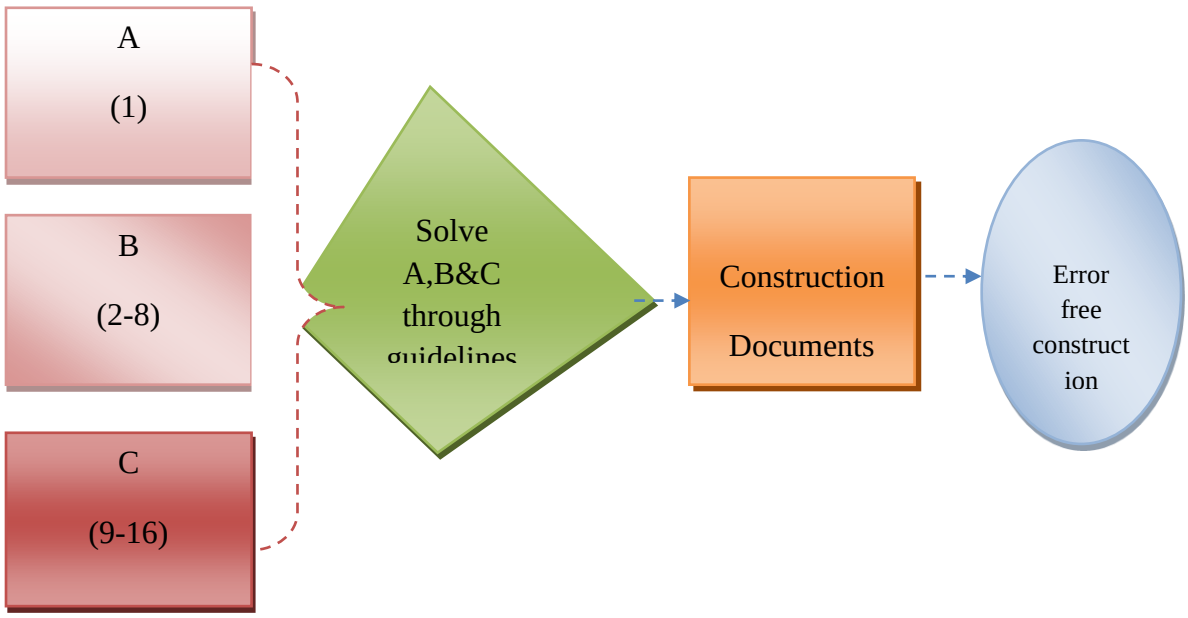

Figure 6.2: Flowchart for error minimisation Framework

Having discussed the development and implementation of framework supported with guidelines for minimisation of construction document errors in Nigeria in this section next section will discuss the recommendation of the error minimising framework.

6.3 Recommendation

From this study the causes of error in construction documents were discovered to be inadequate project manager experience, inadequate experience of documentation manager, inadequate education of consultant, inadequate consultant experience, poor consultancy fees, inadequate documentation preparation time, poor salary of professionals engaged, heavy workload of consultant, concurrent documentation, poor communication, non- availability of information, inadequate project brief, inadequate project planning, non- identification of project risks, time scheduled pressure and project complexities. All these error combine together to result in cost and time overruns. It is therefore recommended that the contents of the guidelines should be adhered to, so that there will be minimisation of occurrence errors in construction documents in Nigeria. This will result to savings of about 20.39% of contract sum, savings of about 11.07% of contract period and the reduction of loss of building occupants lives. All other qualitative effects will be minimised. This section discussed on recommendation of the result of this research to construction industry stakeholders in Nigeria next section will expose the contribution of the study to practice.

6.4 Contribution of the study to practice

To the best of my knowledge there are very few published papers on construction document error in Nigeria which have been referenced in this work but this is the pioneering PhD work on construction document error in Nigeria. This work has contributed to existing knowledge in many ways. First, the study has been able to give a robust definition of construction document error. Second, it has been able to assemble the different types of error that occur in construction documents in Nigeria. Third, the research work has exposed the various causes of error in construction documents. Fourth, the study has been able to state qualitative and quantitative effects of construction document errors on projects and economy. Fifth, the work

stated the various causes of each of the types of error that are common in construction documents in Nigeria. Sixth, the frequencies of occurrences of types of error in construction documents in Nigeria have been clearly stated. Lastly, the research work resulted in the development of framework for reduction of errors in construction documents in Nigeria. If the framework with support of guidelines are utilised, it will result to reduction of cost and time overruns by 20.39% and 11.07% respectively and also reduce the destruction of human lives and properties as a result of building collapse. Sound professional practice that will result into sound project performance will emerge when the developed framework is utilised. Having discussed the contribution of the study to practice, it is necessary to expose the contribution of the study to theory which next section seeks to do.

6.5 Contribution of the study to theory

This study better enhances the understanding in the production of construction documents. As a result it can be of some pedagogical value in the construction industry class. The whole of the study can be classified as a moderate contribution to the expanding interest in construction studies in the areas of the types, causes and effects of errors in construction documents and also mapping causes to types of error, the frequencies of occurrences of types of errors in construction documents; and finally the development of error reduction framework. University and Polytechnic teachers and students in the areas of quantity surveying, architecture, civil engineering, electrical engineering and mechanical engineering will benefit a great deal, from this study. Contribution of the study to theory has been discussed in this section, it is necessary to explain the limitation and scope of the study which is done in the next section

6.6 Limitation and Scope

This research work is carried out in Federal Republic of Nigeria because of the significant scale of errors in construction documents in Nigerian construction industry. As obtained in the other parts of the world, Nigerian construction industry can be divided into three, namely- building industry, civil engineering industry and heavy engineering industry. The study is limited to building industry projects because of easy availability of data, limited time and fund for the study. This research concern is focused on construction documents in the building industry produced by Nigerian professionals; that include architectural drawings, specifications / schedules, structural drawings, specifications / schedules electrical drawings, specifications / schedules, mechanical drawings, specifications / schedules and the bills of quantities and preambles to trades. This study will cover construction documents preparation from inception to feasibility, outline proposal, sketch design, detail design, and bill of quantities stages and also include the specifications and preambles to trades. In other words documentation from inception up to, just before the contract is signed, is examined in this study. The study will be limited to the six states of south western Nigeria (Ondo, Ekiti, Osun, Oyo, Ogun and Lagos states) and Federal Capital Territory (located in Northern Nigeria) because of the large volume of building construction work being executed there. The study area is limited to the areas mentioned above because of limited time and fund for the study and because the area is free from security breach. Having discussed the limitation and scope of the study, next section will make suggestions for future research.

6.7 Suggestions for Future Research

Future research efforts can study error on construction sites can be carried not only in Nigeria but also in other parts of the world, in an attempt to develop framework to minimise building collapse. This current research work can also be replicated in other parts of the world, in an attempt to develop framework to minimise the occurrences of errors in construction documents. Suggestions for future research has been taken care of in this section next section will provide a summary of chapter six.

6.8 Summary of Chapter Six

This chapter presented the objectives of the research and how each of them has been achieved. The developed framework supported with guidelines was presented. It also provided explanations on the implementation of the guidelines. Recommendations were also provided. The chapter discussed the contributions of the study to theory and practice, limitation and scope of research and also pointed to suggestions for future research. Having provided a summary of chapter six in this section next section will make a summary of the thesis.

6.9 Summary of the Thesis

The concern of this research work is the development of framework with support of guidelines for the minimisation of errors in construction documents in Nigeria. Many of the causes of weak project performance which result to cost and time overruns and poor quality can be traced to some types of errors at the documentation process. These errors should be eliminated so that sound project performance can emerge. The study was carried out by means of literature survey, questionnaire and semi structured interview. Literature survey and semi structured interview were used to discover the various definitions of errors and the general

types and causes of errors in construction documents. Questionnaires were distributed to construction professionals in south western states and federal capital territory of Nigeria to determine the types and causes of errors specific to Nigeria and also the effects of errors on cost, time and quality. Content Analysis, Relative Importance Index, Severity Index and Percentages were used to analyse the data collected. The error minimisation guidelines were captioned by flow chart. The study showed the causes of errors in construction documents to be inadequate experience of project manager, inadequate experience of documentation manager, inadequate experience consultant, inadequate consultant professional education, poor consultancy fees, poor salary of professionals engaged by the consultants, heavy workload of Consultants, concurrent documentation, poor communication, non-availability of information, inadequate project brief, inadequate project planning, non-identification of project risks, time scheduled pressure and project complexities. The study also identified the various types of error in construction documents in Nigeria to be: non-conformance to client's requirements, non-conformance to design codes/SMM, dimensional errors, incorrect detail, unnecessary additions, omission of necessary items, miscalculation and absence of specification. Documentation errors added 20.39% to the original contract sum and 11.07% to the original contract period and caused the loss of lives of 295 building occupants within 7years who would have contributed to the growth of the economy of the nation.

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APPENDIXES

Appendix 1: Questionnaire

School of Built Environment,

University of Salford,

Manchester,

U. K.

Dear Sir/Madam,

I am a PhD student of the University of Salford in United Kingdom, currently carrying out a research work titled "Guidelines for Minimising Errors in Construction Documents in Nigeria." Errors (in this research context) means – a deviation from correctness or standard on a document which makes it not being able to achieve its purpose, or, missing information which is required to achieve its intended purpose. The objectives of the research are to determine the types, causes and effects of errors on construction documents (i.e. architectural, structural, electrical and mechanical drawings and specifications and bills of quantities) and also develop a set of guidelines that will reduce the occurrence of such errors on construction documents.

Literatures have hitherto shown that huge amount of money, time and quality have been lost because of errors on construction documents. This study and the emerging set of guidelines will greatly reduce or eradicate such losses. Expected respondents/participants includes: Architects, Civil Engineers, Electrical Engineers, Mechanical Engineers, Quantity surveyors and Contractors. The identities of all respondents/participants will not be revealed throughout our research and future publications.

My request is that you kindly help me complete the questionnaire as it relates to your professional work experience. The information you supply will be collated and analysed along with other respondents/participants, and will constitute your valuable; immeasurable and positive contributions to the Nigerian Construction Industry.

I shall come back to collect the completed questionnaire at the end of the next two weeks. If you wish to receive the result of this research, kindly indicate this on the questionnaire in part C.

I sincerely appreciate your valuable time and other contributions to promote this research.

Thank you.

Yours faithfully,

AYODELE, Elijah Olusegun

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Part A

General Information on Respondent/Participant and the Firm/ Company/ Establishment/ Practice

1. Your Name/GSM No. …… (Optional)
2. Location of your Firm/Company/Establishment/Practice …….

(Town:)……..(State:)…….....

(Optional)

3. How old is your professional practice in your firm/company/establishment (Please tick as appropriate).

(a) 1-5 yrs **(b) 6-10yrs** **(c) 11-15yrs** **(d)16-20yrs** **(e) above 20yrs**

3. Number of projects handled up to date (Please tick as appropriate).

(a)none **(b) 1-5** **(c) 6-10** **(d)11-20** **(e) above 20**

4. Number of on-going projects (Please tick as appropriate).

(a)none **(b) 1-3** **(c) 4- 6** **(d) 7-10** **(e) above 10**

4 Your Academic and Professional qualifications(Please tick as appropriate)

Academic qualification	**Professional qualification**
HND	MNIA/Reg. Arc.
HND-PGD/BSc	MNSE/Reg. Engr.
MSc/MPhil	MNIQS/Reg. Q.S.

6. Your Profession/Firm (Please tick as appropriate)

(a). Architecture
(b). Civil Engineering
(c). Electrical Engineering
(d). Mechanical Engineering
(e). Quantity Surveying
(f). Building
(g). Consortium
(h). Contractor / Contracting

8. Types of project handled/on-going: (Please tick)

(a). Residential

(b). Offices

(c). Shopping Complex

(d). Educational

(e). Industrial

(e). Others – name

9. Nature of Contracts you have handled/on-going:

(a). Traditional

(b). Design & Built

(c). Construction Management

(d). Turnkey

(e). Others (please name) ……...

10. Your position in the Firm/Company/Establishment/Practice

(a). Principal partner

(b). Project Manager

(c). Partner

(d). Senior Partner

(e). Director

(f). Senior cadre in government establishment

(g) Others (Please state)

11. Which of the following describes the type of ownership of your Firm/Company/Establishment/Practice: (Please tick as appropriate)

(a). Public sector

(b). Private sector

(c). Partnership

(d). Corporation

(e). Others, please state …..

12) F*or designers only; please tick as appropriate*

i. Identify the stages of your design process

(a) Inception stage

(b) Outline design stage

(c) Sketch design stage

(d) Detail design stage

ii. Identify methods of design preparation

(a) Manual with computer typesetting

(b) Soft ware

(c) (a) and (b)

(d) Others, Please state

13.i Identify the stages in the Bill of Quantities preparation process. (Please tick as appropriate)

(a) Taking-off

(b) Working-up

(c) Abstracting

(d) Billing

(e) Direct billing

(f) Others – name

ii. Identify methods of bill preparation

(a) Manual with computer typesetting

(b) Soft ware

(c) (a) and (b)

(d) Others, Please state

14. **Composition of the Construction Documents Development Team.**

How many professionals/persons in the team?

(Tick as it is appropriate to you)

	(a) 1-3	**(b) 4-6**	**(c) 7-10**	**(d) Above 10**
Project Manager				
Architect				
Civil Engineer				
Electrical Engineer				
Mechanical Engineer				
Quantity Surveyor				
Contractor				

15. Experience of the Construction documents development team (for the most senior)

(i) Project Manager

(a)Less than 5 years, (b) 5 – 10 years (c) 11- 20 years (d) more than 20 years.

(ii) Architect

(a) Less than 5 years (b) 5 – 10 years (c) 11 – 20years (d)more than 20 years

(iii) Civil Engineer

(a) Less than 5 years (b) 5 – 10 years (c) 11 – 20years (d)more than 20 years

(iv) Electrical Engineer

(a) Less than 5 years (b) 5 – 10 years (c) 11 – 20years (d)more than 20 years

(v) Mechanical Engineer

(a) Less than 5 years (b) 5 – 10 years (c) 11 – 20years (d)more than 20 years

(vi) Quantity Surveyor

(a) Less than 5 years (b) 5 – 10 years (c) 11 – 20years (d)more than 20 years

(vii) Contractor

(a) Less than 5 years (b) 5 – 10 years (c) 11 – 20years (d)more than 20 years

PART B

SECTION 1

Information on types of errors in Construction documents in Nigeria

The following (items 1-21) are the various types of errors that may occur on Construction documents. Please assess the importance of each of them based on your experience on construction projects; using **1** for **not relevant**; **2** for **of little relevance**;**3** for **somewhat relevant**; **4** for **relevant**; **5** for **very relevant**. Please tick where appropriate.

	Types of errors in the construction documents	**1**	**2**	**3**	**4**	**5**
1	**Non-Conformance to Clients Requirements**					
	Architectural drawings and specifications					
	Structural drawings and specifications					
	Electrical drawings and specifications					
	Mechanical drawings and specifications					
	Bills of Quantities					
2	**Non-Conformance to design Code/SMM**					
	Architectural drawings and specifications					
	Structural drawings and specifications					
	Electrical drawings and specifications					

	Mechanical drawings and specifications					
	Bills of Quantities					
3	**Non-Conformance to design calculations**					
	Architectural drawings and specifications					
	Structural drawings and specifications					
	Electrical drawings and specifications					
	Mechanical drawings and specifications					
	Bills of Quantities					
4	**Constructability Problem**					
	Architectural drawings and specifications					
	Structural drawings and specifications					
	Electrical drawings and specifications					
	Mechanical drawings and specifications					
	Bills of Quantities					
5	**Dimensional error**					
	Architectural drawings and specifications					
	Structural drawings and specifications					
	Electrical drawings and specifications					
	Mechanical drawings and specifications					
	Bills of Quantities					
6	**Non-Conformance to vendor data**					
	Architectural drawings and specifications					
	Structural drawings and specifications					
	Electrical drawings and specifications					
	Mechanical drawings and specifications					
	Bills of Quantities					
7	**Non Conformance to Local Authorities**					

	Regulations					
	Architectural drawings and specifications					
	Structural drawings and specifications					
	Electrical drawings and specifications					
	Mechanical drawings and specifications					
	Bills of Quantities					
8	**Non Conformance to Law (Such as documents must specify Nigerian materials)**					
	Architectural drawings and specifications					
	Structural drawings and specifications					
	Electrical drawings and specifications					
	Mechanical drawings and specifications					
	Bills of Quantities					
9	**Incorrect details**					
	Architectural drawings and specifications					
	Structural drawings and specifications					
	Electrical drawings and specifications					
	Mechanical drawings and specifications					
	Bills of Quantities					
10	**CAD (Computer) related problem**					
	Architectural drawings and specifications					
	Structural drawings and specifications					
	Electrical drawings and specifications					
	Mechanical drawings and specifications					
	Bills of Quantities					
11	**Non-Conformance to drafting standards**					
	Architectural drawings and specifications					
	Structural drawings and specifications					

	Electrical drawings and specifications					
	Mechanical drawings and specifications					
	Bills of Quantities					
12	**Unnecessary additions(over design)**					
	Architectural drawings and specifications					
	Structural drawings and specifications					
	Electrical drawings and specifications					
	Mechanical drawings and specifications					
	Bills of Quantities					
13	**Omission of necessary items(details needed)**					
	Architectural drawings and specifications					
	Structural drawings and specifications					
	Electrical drawings and specifications					
	Mechanical drawings and specifications					
	Bills of Quantities					
14	**Errors in symbols and abbreviations**					
	Architectural drawings and specifications					
	Structural drawings and specifications					
	Electrical drawings and specifications					
	Mechanical drawings and specifications					
	Bills of Quantities					
15	**Miscalculations**					
	Architectural drawings and specifications					
	Structural drawings and specifications					
	Electrical drawings and specifications					
	Mechanical drawings and specifications					
	Bills of Quantities					

16	**Absence of specifications/preambles**					
	Architectural drawings and specifications					
	Structural drawings and specifications					
	Electrical drawings and specifications					
	Mechanical drawings and specifications					
	Bills of Quantities					
17	**Wrong specifications/Preambles**					
	Architectural drawings and specifications					
	Structural drawings and specifications					
	Electrical drawings and specifications					
	Mechanical drawings and specifications					
	Bills of Quantities					
18	**Scanty specifications/preambles**					
	Architectural drawings and specifications					
	Structural drawings and specifications					
	Electrical drawings and specifications					
	Mechanical drawings and specifications					
	Bills of Quantities					
19	**Error in labelling**					
	Architectural drawings and specifications					
	Structural drawings and specifications					
	Electrical drawings and specifications					
	Mechanical drawings and specifications					
	Bills of Quantities					
20	**Error in arrangement of items/elements**					
	Architectural drawings and specifications					
	Structural drawings and specifications					

	Electrical drawings and specifications					
	Mechanical drawings and specifications					
	Bills of Quantities					
21	**Error in Pagination**					
	Architectural drawings and specifications					
	Structural drawings and specifications					
	Electrical drawings and specifications					
	Mechanical drawings and specifications					
	Bills of Quantities					

PART B

Section 2

Information on the causes of errors on construction documents in Nigeria

The following are the causes of errors that may occur on construction documents. Please assess the importance of each factor, based on your experience on construction projects using **1** for **not relevant**, **2** for **of little relevance**, **3** for **somewhat relevant**, **4** for **relevant**, and **5** for **very relevant**. Please tick as appropriate.

	CAUSES OF ERRORS	**1**	**2**	**3**	**4**	**5**
1.00	**CONSULTANTS**					
1.01	**Management Organisational Structure**					
	Architectural drawings and specifications					
	Structural drawings and specifications					
	Electrical drawings and specifications					
	Mechanical drawings and specifications					
	Bills of Quantities					
1.02	**Project Manager experience**					
	Architectural drawings and specifications					
	Structural drawings and specifications					
	Electrical drawings and specifications					

	Mechanical drawings and specifications					
	Bills of Quantities					
1.03	**Change of key project personnel**					
	Architectural drawings and specifications					
	Structural drawings and specifications					
	Electrical drawings and specifications					
	Mechanical drawings and specifications					
	Bills of Quantities					
1.04	**Group organisation (in the area of close Cooperation)**					
	Architectural drawings and specifications					
	Structural drawings and specifications					
	Electrical drawings and specifications					
	Mechanical drawings and specifications					
	Bills of Quantities					
1.05	**Design/Documentation Process**					
	Architectural drawings and specifications					
	Structural drawings and specifications					
	Electrical drawings and specifications					
	Mechanical drawings and specifications					
	Bills of Quantities					
1.06	**Design/Documentation Management experience**					
	Architectural drawings and specifications					
	Structural drawings and specifications					
	Electrical drawings and specifications					
	Mechanical drawings and specifications					
	Bills of Quantities					

1.07	**Consultant Professional Education**					
	Architectural drawings and specifications					
	Structural drawings and specifications					
	Electrical drawings and specifications					
	Mechanical drawings and specifications					
	Bills of Quantities					
1.08	**Consultant Experience**					
	Architectural drawings and specifications					
	Structural drawings and specifications					
	Electrical drawings and specifications					
	Mechanical drawings and specifications					
	Bills of Quantities					
1.09	**Consultancy Fees**					
	Architectural drawings and specifications					
	Structural drawings andspecifications					
	Electrical drawings and specifications					
	Mechanical drawings and specifications					
	Bills of Quantities					
1.10	**Design/Documentation Preparation time**					
	Architectural drawings and specifications					
	Structural drawings andspecifications					
	Electrical drawings and specifications					
	Mechanical drawings and specifications					
	Bills of Quantities					
1.11	**Salary of Professionals Engaged by Consultants**					
	Architectural drawings and specifications					

	Structural drawings and specifications					
	Electrical drawings and specifications					
	Mechanical drawings and specifications					
	Bills of Quantities					
1.12	**Number of Consultants**					
	Architectural drawings and specifications					
	Structural drawings and specifications					
	Electrical drawings and specifications					
	Mechanical drawings and specifications					
	Bills of Quantities					
1.13	**Work load of the Consultants**					
	Architectural drawings and specifications					
	Structural drawings and specifications					
	Electrical drawings and specifications					
	Mechanical drawings and specifications					
	Bills of Quantities					
1.14	**Reputation of Consultants**					
	Architectural drawings and specifications					
	Structural drawings and specifications					
	Electrical drawings and specifications					
	Mechanical drawings and specifications					
	Bills of Quantities					
1.15	**Procedure for producing documents**					
	Architectural drawings and specifications					
	Structural drawings and specifications					
	Electrical drawings and specifications					
	Mechanical drawings and specifications					

	Bills of Quantities					
1.16	**Design/Documentation Team Efficiencies**					
	Architectural drawings and specifications					
	Structural drawings and specifications					
	Electrical drawings and specifications					
	Mechanical drawings and specifications					
	Bills of Quantities					
1.17	**Concurrent Design/Documentation**					
	Architectural drawings and specifications					
	Structural drawings and specifications					
	Electrical drawings and specifications					
	Mechanical drawings and specifications					
	Bills of Quantities					
1.18	**Availability of quality management**					
	Architectural drawings and specifications					
	Structural drawings and specifications					
	Electrical drawings and specifications					
	Mechanical drawings and specifications					
	Bills of Quantities					
1.19	**Effective Consulting Team**					
	Architectural drawings and specifications					
	Structural drawings and specifications					
	Electrical drawings and specifications					
	Mechanical drawings and specifications					
	Bills of Quantities					
1.20	**Communication**					

	Architectural drawings and specifications					
	Structural drawings and specifications					
	Electrical drawings and specifications					
	Mechanical drawings and specifications					
	Bills of Quantities					
1.21	**Availability of information**					
	Architectural drawings and specifications					
	Structural drawings and specifications					
	Electrical drawings and specifications					
	Mechanical drawings and specifications					
	Bills of Quantities					
1.22	**Transfer of knowledge and experience between consultants**					
	Architectural drawings and specifications					
	Structural drawings and specifications					
	Electrical drawings and specifications					
	Mechanical drawings and specifications					
	Bills of Quantities					
2.00	**CLIENTS**					
2.01	**Project brief**					
	Architectural drawings and specifications					
	Structural drawings and specifications					
	Electrical drawings and specifications					
	Mechanical drawings and specifications					
	Bills of Quantities					
2.02	**Type of Clients (public/private/corporate)**					
	Architectural drawings and specifications					

	Structural drawings and specifications					
	Electrical drawings and specifications					
	Mechanical drawings and specifications					
	Bills of Quantities					
2.03	**Client experience**					
	Architectural drawings and specifications					
	Structural drawings and specifications					
	Electrical drawings and specifications					
	Mechanical drawings and specifications					
	Bills of Quantities					
2.04	**Construction Time Constraint (Start/Finish)**					
	Architectural drawings and specifications					
	Structural drawings and specifications					
	Electrical drawings and specifications					
	Mechanical drawings and specifications					
	Bills of Quantities					
2.05	**Client Point of Contact (With Consultants)**					
	Architectural drawings and specifications					
	Structural drawings and specifications					
	Electrical drawings and specifications					
	Mechanical drawings and specifications					
	Bills of Quantities					
2.06	**Planning of the project**					
	Architectural drawings and specifications					
	Structural drawings and specifications					
	Electrical drawings and specifications					

	Mechanical drawings and specifications					
	Bills of Quantities					
2.07	**Identification of Project Risks**					
	Architectural drawings and specifications					
	Structural drawings and specifications					
	Electrical drawings and specifications					
	Mechanical drawings and specifications					
	Bills of Quantities					
2.08	**Attitude of Client**					
	Architectural drawings and specifications					
	Structural drawings and specifications					
	Electrical drawings and specifications					
	Mechanical drawings and specifications					
	Bills of Quantities					
3.00	**PROJECT CHARACTER**					
3.01	**Uniqueness of the Project**					
	Architectural drawings and specifications					
	Structural drawings and specifications					
	Electrical drawings and specifications					
	Mechanical drawings and specifications					
	Bills of Quantities					
3.02	**Time Schedule Pressure**					
	Architectural drawings and specifications					
	Structural drawings and specifications					
	Electrical drawings and specifications					
	Mechanical drawings and specifications					
	Bills of Quantities					

3.03	**Project Budget Cost**					
	Architectural drawings and specifications					
	Structural drawings and specifications					
	Electrical drawings and specifications					
	Mechanical drawings and specifications					
	Bills of Quantities					
3.04	**Procurement Methods**					
	Architectural drawings and specifications					
	Structural drawings and specifications					
	Electrical drawings and specifications					
	Mechanical drawings and specifications					
	Bills of Quantities					
3.05	**Size and Complexities**					
	Architectural drawings and specifications					
	Structural drawings and specifications					
	Electrical drawings and specifications					
	Mechanical drawings and specifications					
	Bills of Quantities					
3.06	**Quality**					
	Architectural drawings and specifications					
	Structural drawings and specifications					
	Electrical drawings and specifications					
	Mechanical drawings and specifications					
	Bills of Quantities					
3.07	**Compatibility with Consultant Goals**					
	Architectural drawings and specifications					
	Structural drawings and specifications					

	Electrical drawings and specifications					
	Mechanical drawings and specifications					
	Bills of Quantities					
3.08	**Subdivision of Documentation into separate services for Experts**					
	Architectural drawings and specifications					
	Structural drawings and specifications					
	Electrical drawings and specifications					
	Mechanical drawings and specifications					
	Bills of Quantities					
3.09	**Planning Authority Approval**					
	Architectural drawings and specifications					
	Structural drawings and specifications					
	Electrical drawings and specifications					
	Mechanical drawings and specifications					
	Bills of Quantities					

PART B Section 3

Information on effects of errors on construction documents in Nigeria

Please provide the following in respect of 1 or 2 or 3 **recently completed project(s)** in which you were involved. Please tick or fill as appropriate.

PROJECT 1

1. Name and location of project (optional) ……..

2. Types of project (Please tick)

   (a). Educational
   (b). Shopping Complex
   (c). Religious

(e). Industrial
(f). Others
(name)……
…

3. Type of client (Please tick)

   (a). Public Client
   (b). Corporate client
   (c). Private client

4. Procurement method (Please tick)

   (a) Open tendering

   (b) Selective tendering

   (c) Negotiated tendering

   (d) Others (Please state)

5. What is the percentage difference between the initial and final completion cost of the project (please tick on the correct option)

%	Zero	1-5	6-10	11-15	16-20	21-25	26-30	31-35	36-40	41-45	46-50
%	51-55	56-60	61-65	66-70	71-75	76-80	81-85	86-90	91-95	96-100	Above 100

6. What is the percentage difference between the initial and final completion periods of the project. (Please tick on the correct option).

%	Zero	1-5	6-10	11-15	16-20	21-25	26-30	31-35	36-40	41-45	46-50
%	51-55	56-60	61-65	66-70	71-75	76-80	81-85	86-90	91-95	96-100	Above 100

7. What percentage of the final completion cost was used to rectify the **executed work** when the errors were discovered **during** the project execution (Please tick on the correct option)?

%	Zero	1-5	6-10	11-15	16-20	21-25	26-30	31-35	36-40	41-45	46-50
%	51-55	56-60	61-65	66-70	71-75	76-80	81-85	86-90	91-95	96-100	Above 100

8. What **percentage of final completion period** was used to rectify the **executed work** when errors were discovered **during** project execution (Please tick on the correct option)?

%	Zero	1-5	6-10	11-15	16-20	21-25	26-30	31-35	36-40	41-45	46-50
%	51-55	56-60	61-65	66-70	71-75	76-80	81-85	86-90	91-95	96-100	Above 100

9. What percentage of final completion cost was used to rectify the **executed work** when errors were discovered **after** project execution(Please tick on the correct option)?

%	Zero	1-5	6-10	11-15	16-20	21-25	26-30	31-35	36-40	41-45	46-50
%	51-55	56-60	61-65	66-70	71-75	76-80	81-85	86-90	91-95	96-100	Above 100

10. What is the percentage of final completion period was used to rectify the **executed works,** when errors were discovered **after project execution**(Please tick on the correct option)?

%	Zero	1-5	6-10	11-15	16-20	21-25	26-30	31-35	36-40	41-45	46-50
%	51-55	56-60	61-65	66-70	71-75	76-80	81-85	86-90	91-95	96-100	Above 100

11. When were the errors discovered (Please tick)

    (a). Before project execution
    (b). During project execution
    (c). After project execution

12. What is the quality of work before rectification (Please tick)

    (a). Very poor
    (b). Poor
    (c). Average
    (d). Good
    (e). Very good.

13. Errors discovered after project execution (Please tick)

    (a) Rectified

(b) Not Rectified

14. Quality of work when errors were not rectified after project execution (Please tick)

(a). Very poor
(b). Poor
(c). Average

(d). Good

(e). Very good.

PART C

Section I

The following contains information on the Mapping of Causes of Error to Types of Error on Construction Documents in Nigeria. The following 1 – 10 are the types of errors on construction documents; I – 16 are causes of error on construction documents. Please attach or map the causes of error to types of error as shown in the table below. The mapping should be based on your experience on construction projects using A for not relevant; B for of little relevance; C for somewhat relevant; D for relevant and E for very relevant.

Please tick as appropriate

1.	Type: Non-Conformance to Client's Requirement	A	B	C	D	E
I	<u>Causes:</u> Project Manager Experience					
Ii	Documentation Mgr experience					
Iii	Consultant Professional experience					
Iv	Consultant Experience					
V	Consultant Fees					
Vi	Documentation Preparation time					
Vii	Salary of Professionals engaged					
Viii	Workload of Consultants					
Ix	Concurrent documentation					

X	Communication					
Xi	Availability of Information					
Xii	Project Brief					
Xiii	Planning of the Project					
Xiv	Identification of Project risk					
Xv	Time Schedule Pressure					
Xvi	Size and Complexities.					

The following types of error to be placed in the Table as in above: dimensional error, incorrect details, unnecessary additions (over-design), omission of necessary items, miscalculations, absence of specification, wrong specification, scanty specification, non-conformance to clients requirements, and non-conformance to design code/SMM.

Section 2

On how many projects you executed did the following types of error occur

Give the answer in percentage ranges.

1. Non-Conformance to Clients Requirements

Percentage	1-10	11-20	21-30	31-40	41-50	51-60	61-70	71-80	81-90	91-99	100

The following types of error to be placed and treated in the Table as in above:

2. Non-Conformance to design code/SMM, 3. Dimensional errors, 4. Incorrect details

5. Unnecessary additions, 6. Omission of necessary items, 7. Miscalculation, 8. Absence of specification, 9. Scanty specification, 10. Wrong specification

On how many projects you executed, did the following causes of error occur

Give the answer in percentages.

1. Project Manager Low Experience

Percentage	1-10	11-20	21-30	31-40	41-50	51-60	61-70	71-80	81-90	91-99	100

The following types of error to be placed and treated in the Table as in above:

2. Documentation Manager Low Experience, 3. Consultant Low Experience, 4. Inadequate Consultant Education, 5. Poor Consultancy Fees, 6. Inadequate Documentation Preparation Time, 7. Poor Salary of Professionals Engaged, 8. Heavy Workload of Consultants, 9. Concurrent Documentation, 10. Poor-communication, 11. Non-availability of Information, 12. Inadequate project brief, 13. Poor project planning, 14. Non-identification of project risk

15. Time Scheduled Pressure, 16. Project Complexities

Section 3

PART D

Result of Research

If you need the result of this research, please give your:

e-mail address:.. or, Postal address:.. or, Tel/GSM number

Appendix 2: Guide for Semi Structured Interview

Please state the definition of construction document error from your professional experience.

Appendix 3: Analysis of Types and Causes of Document Error

Table 5.4a: Analysis of the types of documentation error by RII

Types of error	N	Min	Max	Mean	Factor	RII
Non Conformance to Clients Requirement						
Architectural drawings and specifications	417	1	5	4.39	5.00	0.88
Structural drawings and specifications	417	1	5	4.40	5.00	0.88
Electrical drawings and specifications	417	1	5	4.39	5.00	0.88
Mechanical drawings and specifications	417	1	5	4.36	5.00	0.87
Bills of Quantities	417	1	5	4.43	5.00	0.89
Non Conformance to Design code/SMM						
Architectural drawings and specifications	417	1	5	4.47	5.00	0.89
Structural drawings and specifications	417	1	5	4.47	5.00	0.89
Electrical drawings and specifications	417	1	5	4.45	5.00	0.89
Mechanical drawings and specifications	417	1	5	4.46	5.00	0.89
Bills of Quantities	417	1	5	4.52	5.00	0.90
Non Conformance to Design Calculations						
Architectural drawings and specifications	417	1	5	2.55	5.00	0.51
Structural drawings and specifications	417	1	5	2.62	5.00	0.52
Electrical drawings and specifications	417	1	5	2.59	5.00	0.52

Mechanical drawings and specifications	417	1	5	2.53	5.00	0.51
Bills of Quantities	417	1	5	2.53	5.00	0.51
Constructability Problems						
Architectural drawings and specifications	417	1	5	2.56	5.00	0.51
Structural drawings and specifications	417	1	5	2.55	5.00	0.51
Electrical drawings and specifications	417	1	5	2.47	5.00	0.49
Mechanical drawings and specifications	417	1	5	2.48	5.00	0.50
Bills of Quantities	417	1	5	2.43	5.00	0.49
Dimensional Error						
Architectural drawings and specifications	417	1	5	2.39	5.00	0.87
Structural drawings and specifications	417	1	5	3.69	5.00	0.83
Electrical drawings and specifications	417	1	5	4.15	5.00	0.83
Mechanical drawings and specifications	417	1	5	4.30	5.00	0.86
Bills of Quantities	417	1	5	4.31	5.00	0.86
Non Conformance to Vendor Data						
Architectural drawings and specifications	417	1	5	2.41	5.00	0.48
Structural drawings and specifications	417	1	5	2.40	5.00	0.48
Electrical drawings and specifications	417	1	5	2.36	5.00	0.47
Mechanical drawings and specifications	417	1	5	2.46	5.00	0.49
Bills of Quantities	417	1	5	2.46	5.00	0.49
Non Conformance to Local Authorities Regulations						
Architectural drawings and specifications	417	1	5	2.53	5.00	0.51
Structural drawings and specifications	417	1	5	2.50	5.00	0.50

Electrical drawings and specifications	417	1	5	2.45	5.00	0.49
Mechanical drawings and specifications	417	1	5	2.44	5.00	0.49
Bills of Quantities	417	1	5	2.32	5.00	0.46
Non-Conformance to Law						
Architectural drawings and specifications	417	1	5	2.46	5.00	0.49
Structural drawings and specifications	417	1	5	2.47	5.00	0.49
Electrical drawings and specifications	417	1	5	2.46	5.00	0.49
Mechanical drawings and specifications	417	1	5	2.46	5.00	0.49
Bills of Quantities	417	1	5	2.37	5.00	0.47
Incorrect Details						
Architectural drawings and specifications	417	1	5	4.00	5.00	0.80
Structural drawings and specifications	417	1	5	4.00	5.00	0.80
Electrical drawings and specifications	417	1	5	4.00	5.00	0.80
Mechanical drawings and specifications	417	1	5	4.00	5.00	0.80
Bills of Quantities	417	1	5	4.46	5.00	0.89
CAD (Computer) Related Problem						
Architectural drawings and specifications	417	1	5	2.44	5.00	0.49
Structural drawings and specifications	417	1	5	2.42	5.00	0.48
Electrical drawings and specifications	417	1	5	2.28	5.00	0.46
Mechanical drawings and specifications	417	1	5	2.27	5.00	0.45
Bills of Quantities	417	1	5	2.33	5.00	0.47
Non-Conformance to Drafting Standards						
Architectural drawings and specifications	417	1	5	2.50	5.00	0.50

Structural drawings and specifications	417	1	5	2.48	5.00	0.50
Electrical drawings and specifications	417	1	5	2.45	5.00	0.49
Mechanical drawings and specifications	417	1	5	2.44	5.00	0.49
Bills of Quantities	417	1	5	2.38	5.00	0.48
Unnecessary Additions (over design)						
Architectural drawings and specifications	417	1	5	4.51	5.00	0.90
Structural drawings and specifications	417	1	5	4.53	5.00	0.91
Electrical drawings and specifications	417	1	5	4.49	5.00	0.90
Mechanical drawings and specifications	417	1	5	4.48	5.00	0.90
Bills of Quantities	417	1	5	4.48	5.00	0.90
Omissions of Necessary Items (Details Needed)						
Architectural drawings and specifications	417	1	5	4.61	5.00	0.92
Structural drawings and specifications	417	1	5	4.00	5.00	0.80
Electrical drawings and specifications	417	1	5	4.00	5.00	0.80
Mechanical drawings and specifications	417	1	5	4.00	5.00	0.80
Bills of Quantities	417	1	5	4.61	5.00	0.92
Errors in Symbols and Abbreviations						
Architectural drawings and specifications	417	1	5	2.13	5.00	0.43
Structural drawings and specifications	417	1	5	2.14	5.00	0.43
Electrical drawings and specifications	417	1	5	2.14	5.00	0.43
Mechanical drawings and specifications	417	1	5	2.26	5.00	0.45
Bills of Quantities	417	1	5	2.06	5.00	0.41
Miscalculations						

Architectural drawings and specifications	417	1	5	4.34	5.00	0.87
Structural drawings and specifications	417	1	5	4.40	5.00	0.88
Electrical drawings and specifications	417	1	5	4.36	5.00	0.87
Mechanical drawings and specifications	417	1	5	4.35	5.00	0.87
Bills of Quantities	417	1	5	4.34	5.00	0.87
Absence of Specifications/Preambles						
Architectural drawings and specifications	417	1	5	4.54	5.00	0.91
Structural drawings and specifications	417	1	5	4.51	5.00	0.90
Electrical drawings and specifications	417	1	5	4.43	5.00	0.89
Mechanical drawings and specifications	417	1	5	4.43	5.00	0.89
Bills of Quantities	417	1	5	4.38	5.00	0.88
Wrong Specifications/Preambles						
Architectural drawings and specifications	417	1	5	4.50	5.00	0.90
Structural drawings and specifications	417	1	5	4.00	5.00	0.80
Electrical drawings and specifications	417	1	5	4.25	5.00	0.85
Mechanical drawings and specifications	417	1	5	4.24	5.00	0.85
Bills of Quantities	417	1	5	4.35	5.00	0.87
Scanty Specifications/Preambles						
Architectural drawings and specifications	417	1	5	4.39	5.00	0.88
Structural drawings and specifications	417	1	5	4.38	5.00	0.88
Electrical drawings and specifications	417	1	5	4.29	5.00	0.86
Mechanical drawings and specifications	417	1	5	4.29	5.00	0.86
Bills of Quantities	417	1	5	4.32	5.00	0.86
Error in Labelling						

Architectural drawings and specifications	417	1	5	2.23	5.00	0.45
Structural drawings and specifications	417	1	5	2.24	5.00	0.45
Electrical drawings and specifications	417	1	5	2.26	5.00	0.45
Mechanical drawings and specifications	417	1	5	2.31	5.00	0.46
Bills of Quantities	417	1	5	2.15	5.00	0.43
Error in Arrangement of Items/Elements						
Architectural drawings and specifications	417	1	5	2.38	5.00	0.48
Structural drawings and specifications	417	1	5	2.38	5.00	0.48
Electrical drawings and specifications	417	1	5	2.37	5.00	0.47
Mechanical drawings and specifications	417	1	5	2.36	5.00	0.47
Bills of Quantities	417	1	5	2.38	5.00	0.48
Errors in Pagination						
Architectural drawings and specifications	417	1	5	0.00	5.00	0.00
Structural drawings and specifications	417	1	5	0.06	5.00	0.01
Electrical drawings and specifications	417	1	5	2.02	5.00	0.40
Mechanical drawings and specifications	417	1	5	2.04	5.00	0.41
Bills of Quantities	417	1	5	2.13	5.00	0.43

Table 5.5a: Analysis of the causes of error in construction documents by RII

Causes of Error	N	Min	Max	Mean	Factor	RII
Management Organisational Structure						
Architectural drawings and specifications	417	1.00	5.00	1.94	5.00	0.39
Structural drawings and specifications	417	1.00	5.00	1.94	5.00	0.39
Electrical drawings and specifications	417	1.00	5.00	1.93	5.00	0.39

Mechanical drawings and specifications	417	1.00	5.00	1.91	5.00	0.38
Bills of Quantities	417	1.00	5.00	1.92	5.00	0.38
Project Manager experience						
Architectural drawings and specifications	417	1.00	5.00	4.45	5.00	0.89
Electrical drawings and specifications	417	1.00	5.00	4.41	5.00	0.88
Mechanical drawings and specifications	417	1.00	5.00	4.51	5.00	0.90
Bills of Quantities	417	1.00	5.00	4.51	5.00	0.90
Change of Key Project Personnel						
Architectural drawings and specifications	417	1.00	5.00	1.88	5.00	0.38
Structural drawings and specifications	417	1.00	5.00	1.97	5.00	0.39
Electrical drawings and specifications	417	1.00	5.00	1.96	5.00	0.39
Mechanical drawings and specifications	417	1.00	5.00	1.78	5.00	0.36
Bills of Quantities	417	1.00	5.00	1.95	5.00	0.39
Group Organisation						
Architectural drawings and specifications	417	1.00	5.00	2.15	5.00	0.43
Structural drawings and specifications	417	1.00	5.00	2.21	5.00	0.44
Electrical drawings and specifications	417	1.00	5.00	2.22	5.00	0.44
Mechanical drawings and specifications	417	1.00	5.00	2.05	5.00	0.41
Bills of Quantities	417	1.00	5.00	2.12	5.00	0.42
Design/Documentation Process						
Architectural drawings and specifications	417	1.00	5.00	2.54	5.00	0.51
Structural drawings and specifications	417	1.00	5.00	2.35	5.00	0.47
Electrical drawings and specifications	417	1.00	5.00	2.51	5.00	0.50

Mechanical drawings and specifications	417	1.00	5.00	2.34	5.00	0.47
Bills of Quantities	417	1.00	5.00	2.52	5.00	0.50
Design Documentation Management Experience						
Architectural drawings and specifications	417	1.00	5.00	4.50	5.00	o.90
Structural drawings and specifications	417	1.00	5.00	4.00	5.00	0.80
Electrical drawings and specifications	417	1.00	5.00	4.00	5.00	0.80
Mechanical drawings and specifications	417	1.00	5.00	4.00	5.00	0.80
Bills of Quantities	417	1.00	5.00	4.50	5.00	0.90
Consultant Professional Education						
Architectural drawings and specifications	417	1.00	5.00	4.53	5.00	0.91
Structural drawings and specifications	417	1.00	5.00	4.41	5.00	0.88
Electrical drawings and specifications	417	1.00	5.00	4.42	5.00	0.88
Mechanical drawings and specifications	417	1.00	5.00	4.50	5.00	0.90
Bills of Quantities	417	1.00	5.00	4.53	5.00	0.91
Consultant Experience						
Architectural drawings and specifications	417	1.00	5.00	4.45	5.00	0.89
Structural drawings and specifications	417	1.00	5.00	4.47	5.00	0.89
Electrical drawings and specifications	417	1.00	5.00	4.44	5.00	0.89
Mechanical drawings and specifications	417	1.00	5.00	4.45	5.00	0.89
Bills of Quantities	417	1.00	5.00	4.46	5.00	0.89
Consultancy Fees						
Architectural drawings and specifications	417	1.00	5.00	4.50	5.00	0.90
Structural drawings and specifications	417	1.00	5.00	4.00	5.00	0.80

Electrical drawings and specifications	417	1.00	5.00	4.00	5.00	0.80
Mechanical drawings and specifications	417	1.00	5.00	4.00	5.00	0.80
Bills of Quantities	417	1.00	5.00	4.50	5.00	0.90
Design Documentation Preparation Time						
Architectural drawings and specifications	417	1.00	5.00	4.75	5.00	0.95
Structural drawings and specifications	417	1.00	5.00	4.00	5.00	0.80
Electrical drawings and specifications	417	1.00	5.00	4.00	5.00	0.80
Mechanical drawings and specifications	417	1.00	5.00	4.00	5.00	0.80
Bills of Quantities	417	1.00	5.00	4.60	5.00	0.92
Salary of Professionals						
Architectural drawings and specifications	417	1.00	5.00	4.75	5.00	0.95
Structural drawings and specifications	417	1.00	5.00	4.00	5.00	0.80
Electrical drawings and specifications	417	1.00	5.00	4.00	5.00	0.80
Mechanical drawings and specifications	417	1.00	5.00	4.00	5.00	0.80
Bills of Quantities	417	1.00	5.00	4.60	5.00	0.92
Number of Consultants						
Architectural drawings and specifications	417	1.00	5.00	1.94	5.00	0.39
Structural drawings and specifications	417	1.00	5.00	2.12	5.00	0.42
Electrical drawings and specifications	417	1.00	5.00	2.02	5.00	0.40
Mechanical drawings and specifications	417	1.00	5.00	2.02	5.00	0.40
Bills of Quantities	417	1.00	5.00	2.03	5.00	0.41
Work Load of Consultants						
Architectural drawings and specifications	417	1.00	5.00	4.25	5.00	0.85

Structural drawings and specifications	417	1.00	5.00	4.25	5.00	0.85
Electrical drawings and specifications	417	1.00	5.00	4.25	5.00	0.85
Mechanical drawings and specifications	417	1.00	5.00	4.00	5.00	0.80
Bills of Quantities	417	1.00	5.00	4.50	5.00	0.90
Reputation of Consultants						
Architectural drawings and specifications	417	1.00	5.00	3.37	5.00	0.67
Structural drawings and specifications	417	1.00	5.00	3.37	5.00	0.67
Electrical drawings and specifications	417	1.00	5.00	3.36	5.00	0.67
Mechanical drawings and specifications	417	1.00	5.00	3.44	5.00	0.69
Bills of Quantities	417	1.00	5.00	3.46	5.00	0.69
Procedure for Producing Documents						
Architectural drawings and specifications	417	1.00	5.00	2.21	5.00	0.44
Structural drawings and specifications	417	1.00	5.00	2.19	5.00	0.44
Electrical drawings and specifications	417	1.00	5.00	2.19	5.00	0.44
Mechanical drawings and specifications	417	1.00	5.00	2.18	5.00	0.44
Bills of Quantities	417	1.00	5.00	2.22	5.00	0.44
Design/Documentation Team Efficiencies						
Architectural drawings and specifications	417	1.00	5.00	2.33	5.00	0.47
Structural drawings and specifications	417	1.00	5.00	2.33	5.00	0.47
Electrical drawings and specifications	417	1.00	5.00	2.32	5.00	0.46
Mechanical drawings and specifications	417	1.00	5.00	2.32	5.00	0.46
Bills of Quantities	417	1.00	5.00	2.32	5.00	0.46
Concurrent Design/Documentation						

Architectural drawings and specifications	417	1.00	5.00	4.25	5.00	0.85
Structural drawings and specifications	416	1.00	5.00	4.25	5.00	0.85
Electrical drawings and specifications	417	1.00	5.00	4.00	5.00	0.80
Mechanical drawings and specifications	417	1.00	5.00	4.00	5.00	0.80
Bills of Quantities	417	1.00	5.00	4.05	5.00	0.90
Availability of Quality Management						
Architectural drawings and specifications	417	1.00	5.00	1.78	5.00	0.36
Structural drawings and specifications	417	1.00	5.00	1.80	5.00	0.36
Electrical drawings and specifications	417	1.00	5.00	1.76	5.00	0.35
Mechanical drawings and specifications	417	1.00	5.00	1.86	5.00	0.37
Bills of Quantities	417	1.00	5.00	1.90	5.00	0.38
Effective Consulting Team						
Architectural drawings and specifications	417	1.00	5.00	2.08	5.00	0.42
Structural drawings and specifications	417	1.00	5.00	2.09	5.00	0.42
Electrical drawings and specifications	417	1.00	5.00	2.07	5.00	0.41
Mechanical drawings and specifications	417	1.00	5.00	2.07	5.00	0.41
Bills of Quantities	417	1.00	5.00	2.10	5.00	0.42
Communication						
Architectural drawings and specifications	417	1.00	5.00	4.75	5.00	0.95
Structural drawings and specifications	417	1.00	5.00	4.81	5.00	0.96
Electrical drawings and specifications	417	1.00	5.00	4.80	5.00	0.96
Mechanical drawings and specifications	417	1.00	5.00	4.79	5.00	0.96
Bills of Quantities	417	1.00	5.00	4.81	5.00	0.96
Availability of Information						

Architectural drawings and specifications	417	1.00	5.00	4.84	5.00	0.97
Structural drawings and specifications	417	1.00	5.00	4.84	5.00	0.97
Electrical drawings and specifications	417	1.00	5.00	4.82	5.00	0.96
Mechanical drawings and specifications	417	1.00	5.00	4.82	5.00	0.96
Bills of Quantities	417	1.00	5.00	4.85	5.00	0.97
Transfer of Knowledge &Experience						
Architectural drawings and specifications	417	1.00	5.00	1.71	5.00	0.34
Structural drawings and specifications	417	1.00	5.00	1.67	5.00	0.33
Electrical drawings and specifications	417	1.00	5.00	1.66	5.00	0.33
Mechanical drawings and specifications	417	1.00	5.00	1.66	5.00	0.33
Bills of Quantities	417	1.00	5.00	1.68	5.00	0.34
Project Brief						
Architectural drawings and specifications	417	1.00	5.00	4.64	5.00	0.93
Structural drawings and specifications	417	1.00	5.00	4.61	5.00	0.92
Electrical drawings and specifications	417	1.00	5.00	4.59	5.00	0.92
Mechanical drawings and specifications	417	1.00	5.00	4.59	5.00	0.92
Bills of Quantities	417	1.00	5.00	4.61	5.00	0.92
Type of Clients						
Architectural drawings and specifications	417	1.00	5.00	1.67	5.00	0.33
Structural drawings and specifications	417	1.00	5.00	1.66	5.00	0.33
Electrical drawings and specifications	417	1.00	5.00	1.64	5.00	0.33
Mechanical drawings and specifications	417	1.00	5.00	1.63	5.00	0.33
Bills of Quantities	417	1.00	5.00	1.66	5.00	0.33
Client Experience						
Architectural drawings and specifications	417	1.00	5.00	2.08	5.00	0.42

Structural drawings and specifications	417	1.00	5.00	2.05	5.00	0.41
Electrical drawings and specifications	417	1.00	5.00	2.04	5.00	0.41
Mechanical drawings and specifications	417	1.00	5.00	2.05	5.00	0.41
Bills of Quantities	417	1.00	5.00	2.07	5.00	0.41
Construction Time Constraint						
Architectural drawings and specifications	417	1.00	5.00	2.77	5.00	0.55
Structural drawings and specifications	417	1.00	5.00	2.79	5.00	0.56
Electrical drawings and specifications	417	1.00	5.00	2.79	5.00	0.56
Mechanical drawings and specifications	417	1.00	5.00	2.78	5.00	0.56
Bills of Quantities	417	1.00	5.00	2.81	5.00	0.56
Client Point of Contact						
Architectural drawings and specifications	417	1.00	5.00	2.72	5.00	0.54
Structural drawings and specifications	417	1.00	5.00	2.70	5.00	0.54
Electrical drawings and specifications	417	1.00	5.00	2.68	5.00	0.54
Mechanical drawings and specifications	417	1.00	5.00	2.68	5.00	0.54
Planning of the Project	417	1.00	5.00	2.74	5.00	0.55
Planning of the Project						
Architectural drawings and specifications	417	1.00	5.00	4.34	5.00	0.87
Structural drawings and specifications	417	1.00	5.00	4.33	5.00	0.87
Electrical drawings and specifications	417	1.00	5.00	4.31	5.00	0.86
Mechanical drawings and specifications	417	1.00	5.00	4.31	5.00	0.86
Bills of Quantities	417	1.00	5.00	4.31	5.00	0.86
Identification of Project Risks						

Architectural drawings and specifications	417	1.00	5.00	4.55	5.00	0.91
Structural drawings and specifications	417	1.00	5.00	4.56	5.00	0.91
Electrical drawings and specifications	417	1.00	5.00	4.54	5.00	0.91
Mechanical drawings and specifications	417	1.00	5.00	4.52	5.00	0.90
Bills of Quantities	417	1.00	5.00	4.57	5.00	0.91
Attitude of Client						
Architectural drawings and specifications	417	1.00	5.00	2.04	5.00	0.41
Structural drawings and specifications	417	1.00	5.00	2.02	5.00	0.40
Electrical drawings and specifications	417	1.00	5.00	2.00	5.00	0.40
Mechanical drawings and specifications	417	1.00	5.00	2.01	5.00	0.40
Bills of Quantities	417	1.00	5.00	2.05	5.00	0.41
Uniqueness of the Project						
Architectural drawings and specifications	417	1.00	5.00	2.46	5.00	0.49
Structural drawings and specifications	417	1.00	5.00	2.45	5.00	0.49
Electrical drawings and specifications	417	1.00	5.00	2.42	5.00	0.48
Mechanical drawings and specifications	417	1.00	5.00	2.41	5.00	0.48
Bills of Quantities	417	1.00	5.00	2.45	5.00	0.49
Time Schedule Pressure						
Architectural drawings and specifications	417	1.00	5.00	4.30	5.00	0.86
Structural drawings and specifications	417	1.00	5.00	4.45	5.00	0.89
Electrical drawings and specifications	417	1.00	5.00	4.43	5.00	0.89
Mechanical drawings and specifications	417	1.00	5.00	4.42	5.00	0.88
Bills of Quantities	417	1.00	5.00	4.49	5.00	0.90
Project Budget Cost						

Architectural drawings and specifications	417	1.00	5.00	1.99	5.00	0.40
Structural drawings and specifications	417	1.00	5.00	1.98	5.00	0.40
Electrical drawings and specifications	417	1.00	5.00	1.96	5.00	0.39
Mechanical drawings and specifications	417	1.00	5.00	1.98	5.00	0.40
	417	1.00	5.00	2.01	5.00	0.40
Procurement Methods						
Architectural drawings and specifications	417	1.00	5.00	2.15	5.00	0.43
Structural drawings and specifications	417	1.00	5.00	2.13	5.00	0.43
Electrical drawings and specifications	417	1.00	5.00	2.11	5.00	0.42
Mechanical drawings and specifications	417	1.00	5.00	2.12	5.00	0.42
Size & Complexities	417	1.00	5.00	2.17	5.00	0.43
Size & Complexities						
Architectural drawings and specifications	417	1.00	5.00	4.32	5.00	0.86
Structural drawings and specifications	417	1.00	5.00	4.32	5.00	0.86
Electrical drawings and specifications	417	1.00	5.00	4.29	5.00	0.86
Mechanical drawings and specifications	417	1.00	5.00	4.29	5.00	0.86
Bills of Quantities	417	1.00	5.00	4.34	5.00	0.87
Quality						
Architectural drawings and specifications	417	1.00	5.00	2.01	5.00	0.40
Structural drawings and specifications	417	1.00	5.00	2.00	5.00	0.40
Electrical drawings and specifications	417	1.00	5.00	1.98	5.00	0.40
Mechanical drawings and specifications	417	1.00	5.00	1.98	5.00	0.40
Bills of Quantities	417	1.00	5.00	1.98	5.00	0.40
Compatibility with Consultant Goals						

Architectural drawings and specifications	417	1.00	5.00	2.31	5.00	0.46
Structural drawings and specifications	417	1.00	5.00	2.30	5.00	0.46
Electrical drawings and specifications	417	1.00	5.00	2.28	5.00	0.46
Mechanical drawings and specifications	417	1.00	5.00	2.28	5.00	0.46
Bills of Quantities	417	1.00	5.00	2.29	5.00	0.46
Subdivisions of Documentation into Separate Services for Experts						
Architectural drawings and specifications	417	1.00	5.00	2.01	5.00	0.40
Structural drawings and specifications	417	1.00	5.00	1.99	5.00	0.40
Electrical drawings and specifications	417	1.00	5.00	1.98	5.00	0.40
Mechanical drawings and specifications	417	1.00	5.00	1.99	5.00	0.40
Bills of Quantities	417	1.00	5.00	2.00	5.00	0.40
Planning Authority Approval						
Architectural drawings and specifications	417	1.00	5.00	1.86	5.00	0.37
Structural drawings and specifications	417	1.00	5.00	1.88	5.00	0.38
Electrical drawings and specifications	417	1.00	5.00	1.83	5.00	0.37
Mechanical drawings and specifications	417	1.00	5.00	1.82	5.00	0.36
Bills of Quantities	417	1.00	5.00	1.79	5.00	0.36

Key to Tables 5.4a and 5.5a:

N = Number of respondents

Min = Minimum value on likert

Max = Maximum value on likert

Factor = Factor on 5.0 scale

Mean = Mean of values responded to by respondents on the likert

RII = Relative Importance Index