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A FRAMEWORK TO IMPROVE DESIGN DOCUMENTATION QUALITY USING INTEGRATED PROJECT DELIVERY (IPD) APPROACH

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School of Construction Economics and Management

A Thesis Submitted to the Faculty of Engineering and the Built Environment, University of the Witwatersrand, Johannesburg, in Fulfilment of the Requirements for the Degree of Doctor of Philosophy (PhD)

Johannesburg, 2022

DECLARATION

I declare that this thesis is my own unaided work. It is being submitted for the Degree of Doctor of Philosophy (PhD) in Construction Project Management to the University of the Witwatersrand, Johannesburg. It has not been submitted before for any degree or examination to any other University.



Peter Dodzi Kwasi Agbaxode

19th day of September 2022

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Dr Sitsabo Dlamini

Associate Professor Ehsan Saghatforoush

ABSTRACT

The project delivery method can significantly impact project efficiency and determine the quality of design documentation. While there are numerous project delivery methods in use in the construction industry globally, the conventional project delivery approach is the most widely used method across the world. This approach has been widely criticized for its weaknesses particularly, the lack of collaboration and integration, at the design documentation stage. This often leads to poor design documentation quality and results in project delays, poor project quality, and upsurges in costs. Therefore, this study aims to improve design documentation quality by developing a framework using Integrated Project Delivery (IPD) approach. The research design followed a pragmatism philosophy and employed mixed methods based on a deductive approach. As a strategy, secondary data was collected through literature review followed by primary data using survey and semi-structured interviews. Descriptive and inferential statistics were used to analyze and interpret the survey data while content analysis was used for interview data with the aid of IBM SPSS and QSR Nvivo 12 Pro. The research ascertained that the current state of design documentation quality in practice under the conventional project delivery is poor. It identified weaknesses associated with the processes involved in producing design documentation including required capabilities to improve quality. It further identified enablers in IPD that can be adapted to improve design documentation quality. Subsequently, a framework to improve design documentation quality based on enablers adapted from IPD is developed. This will contribute to improving design documentation quality that will be produced under the conventional project delivery approach and significantly enhance value for money. The outcome will also pragmatically inform industry players on appropriate measures towards improving design documentation quality. It is expected that the implementation of the research results will help position the construction industry on the path of using IPD shortly. As a contribution to knowledge, the research offers a solution to bridge the gap in the literature on the processes within the conventional project delivery approach that often produces poor design documentation quality.

Keywords: Design documentation, construction documentation, quality, project delivery, project delivery methods, Integrated Project Delivery (IPD)

LIST OF PUBLICATIONS

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DEDICATION

This research work is dedicated to the Almighty God for his grace; to the memory of my mother, Mrs Rose Abla Agbaxode-Dzigba for her love and care; my virtuous wife, Mrs Henrietta Appiah-Mintah Agbaxode, and my lovely children, Peniel Kelie Agbaxode and Rospetra Yayra Nadom Agbaxode who withstood my absence for the duration of my research. Their love, care, understanding and tolerance have made this achievement a success.

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LIST OF ABBREVIATIONS

AOC -	Actual Outturn Cost
BIM -	Building Information Modelling
CASP -	Critical Appraisal Skills Program
CCTV -	Closed-Circuit Television
CD -	Construction document
CM -	Construction Manager
CMBOK -	Construction Management Body of Knowledge
CMAR -	Construction Manager at Risk
DB -	Design and Build
DBB -	Design Bid Build
DC -	Develop and Construct
DD -	Design development
DM -	Design and Manage
DMC -	Design, Manage and Construct
GC -	General Contractor
GDP -	Gross Domestic Product
GMP -	Guaranteed Maximum Price
IPD -	Integrated Project Delivery
KMO -	Kaiser-Meyer-Olkin
MM -	Maturity Model
PCA -	Principal Component Analysis
PMBoK -	Project Management Body of Knowledge
PMI -	Project Management Institute’s
PMMM -	Project Management Maturity Model
RFI -	Request for Information
RII -	Relative Importance Index
SD -	Schematic design
SEI -	Software Engineering Institute
SPSS -	Statistical Package for Social Sciences

CHAPTER 1

INTRODUCTION

1.1 Background

The project delivery approach adopted for a construction project significantly impacts the efficiency of the project (Hamzeh *et al.*, 2019). It determines the quality of design documentation, hence influencing the project delivery time, the quality, and the budget or cost. There are numerous project delivery methods in use in the construction industry globally. However, the conventional project delivery approach is the most widely used method across the world (Agbaxode, Dlamini and Saghatforoush, 2021*a*; Harper, Molenaar and Cannon, 2016; Mesa, Molenaar and Alarcón, 2016). This approach is also referred to as traditional project delivery (Rowlinson and McDermott, 2005). According to Masterman (2003), this approach is where the client uses the main contractor for the construction while the design and supervision are carried out by an architect with other specialist consultants.

Even though the conventional project delivery approach is the most widely used method in the industry globally, it is characterised by wide dissatisfaction as a result of its weaknesses (Agbaxode, Dlamini and Saghatforoush, 2021*b*; Viana *et al.,* 2020). This often leads to acrimonious conflicts between various project parties (Rowlinson and McDermott, 2005). As a result of its weaknesses, the *Design and Build* (DB) and *Construction Manager at Risk* (CMAR) delivery methods were introduced as improvements over the conventional approach. Therefore, these approaches were introduced to address the weaknesses associated with the processes to improve project delivery (Rowlinson and McDermott, 2005). This notwithstanding, the extent of collaboration within all these delivery approaches is questionable. This is why practitioners and researchers have argued that these methods lack collaboration and integration particularly, at the design stage, which often leads to poor design documentation quality (Durdyev *et al.*, 2019; Harper *et al.*, 2016; Mesa *et al.*, 2016; Nawi *et al.*, 2014). Therefore, there is a need for design documentation quality under the conventional project delivery approach to be improved since it is the widely used approach.

In achieving construction project efficiency, the quality of design documentation is required to be comprehensive, precise or accurate, and unambiguous (Agbaxode *et al.,* 2021*b*; Ajayi and Oyedele, 2018; Tilley, McFallan and Tucker, 2000). It has to be effective and ensure fitness for purpose by effectively communicating the design intent (Akampurira and Windapo, 2019; Tilley, Mcfallan and Sinclair, 2002). However, the reality is that design documentation in practice is generally poor and contains information that is incomplete, conflicting, or erroneous (Agbaxode *et al.,* 2021*a*; Akampurira and Windapo, 2018; Laryea, 2011; Tilley *et al.*, 2000). This is a result of the weaknesses that exist in the production of design documentation (Harper *et al.*, 2016; Mesa *et al.*, 2016; Nawi *et al.*, 2014).

Poor design documentation quality is predominant and is a major concern globally (Akampurira and Windapo, 2019). It often results in project delays, poor project quality, and upsurges in costs (Shoar and Payan, 2021; Tuhacek and Svoboda, 2019; Akampurira and Windapo, 2018; Abdallah, Assaf and Hassanain, 2018). It is worrying in the industry across the world, with some developed countries advancing in the use of integration and technology. A study in the Czech Republic by Tuhacek and Svoboda (2019) on the quality of project documentation argued that a large proportion of defects in construction projects often have roots in the defects of the project documentation. Their study indicated that design documentation in practice is poor hence, the need to improve the quality.

Researchers and practitioners have proposed various strategies aimed to improve design documentation quality. Akampurira and Windapo (2019) proposed the development of an instrument for evaluating design documentation quality. Others include using design checklists, establishing quality control departments (Abdallah *et al.,* 2018; Brown, 2002), and use of computer programs such as Building Information Modelling (BIM) (Dosumu and Aigbavboa, 2018). Some software vendors and practitioners in the industry have promoted the use of BIM as a panacea to design-related errors (Abdallah *et al.,* 2018; Love *et al.,* 2011). However, Pärn, Edwards and Sing (2018), in a study on BIM usage, and Love *et al.* (2011) on effective BIM usage all argued that BIM alone is not a panacea to poor design documentation quality.

It is indicative in the literature that, the conventional project delivery approach is the most widely used in the construction industry across the world (Addy *et al.*, 2018; Mesa *et al.,* 2016; Nawi *et al.,* 2014; Fish, 2011). This resonates with statistics that indicate that over 90% of construction projects in Ghana, particularly in the public sector are delivered using this approach (Ameyaw and Oteng-Seifah, 2010). Addy *et al.* (2018) also posit that this delivery approach will continue for a long time since the industry is not yet positioned to adopt new delivery methods. However, this approach has been widely criticized in the industry for its associated weaknesses, particularly during design documentation production (Shoar and Payan, 2021; Agbaxode *et al.*, 2021*b*; Zaneldin, 2020; Yap and Skitmore, 2018; Harper *et al.*, 2016; Mesa *et al.*, 2016; Nawi *et al.*, 2014). This often results in poor design documentation quality and has consequences of projects being completed behind schedule, to poor quality, and over cost (Shoar and Payan, 2021; Mesa *et al.,* 2016).

According to Ebrahimi and Dowlatabadi (2019), the conventional project delivery approach engages project professionals and firms at different phases of the project. Therefore, they work in isolation and independently of each other with a focus on their portion of work only (Durdyev *et al.*, 2019). According to Viana *et al.* (2020), over-reliance on multiple cultures by these professionals and firms that work in isolation renders the conventional project delivery fragmented. The fragmentation of the conventional approach is also due to its lack of collaboration or integration (Durdyev *et al.*, 2019). This has consequences of low productivity, schedule delays, cost overruns and poor quality project delivery (Zhang, Huang and Peng, 2018). This resonates with an earlier study by Tilley *et al.* (2002) which involved major stakeholders in construction. It indicated a lack of collaboration by project team members, particularly during the design documentation stage to guarantee consistency within the documents produced. It also indicated a lack of accountability by consultants for the consequences of deficiencies in design documentation they provide as part of the weaknesses, which contributes principally to poor design documentation quality.

Akampurira and Windapo (2019) on design documentation quality indicated that industry changes and initiatives are required to resolve the problems of

documentation quality within conventional project delivery. This aligns with Nawi *et al.* (2014) that process and team integration, especially during the design stage, are key drivers of change necessary for the industry to become successful. Some researchers and practitioners recommended the early involvement of consultants in the project especially at the design stage to enhance better planning and understanding (Ling *et al.*, 2020; Agbaxode *et al.*, 2020; Ma *et al.*, 2018). This will enhance design documentation quality especially when consultants work as a team and not as individuals (Maskil-Leitan and Reychav, 2018). Therefore, promoting effective collaboration among consultants to ensure better quality project delivery with enhanced efficiency is required (Pishdad-Bozorgi, 2017).

These notwithstanding, Integrated Project Delivery (IPD) has the potential to reduce the weaknesses in the conventional approach and provide improved performance (Mesa *et al.*, 2016). It ensures better collaboration and integration between participants, particularly, during design (Hamzeh *et al.*, 2019; Fish, 2011; Raisbeck, Millie and Maher, 2010). IPD is defined as a "project delivery approach that integrates people, systems, business structures, and practices into a process that collaboratively harnesses the talents and insights of all participants to optimize project results, increase value to the owner, reduce waste, and maximize efficiency throughout all project phases" (AIA and AIACC, 2007, *p.1*). It contributes to the success of a project and ensures integration (Nawi *et al.*, 2014). However, there are significant barriers that hinder IPD adoption and implementation across the world (Kahvandi *et al.*, 2019) despite its numerous benefits. Capital, organizational, and environmental factors are the main barriers identified by Kahvandi *et al.* (2019). An earlier study by Becerik-Gerber and Kensek (2010) also asserted legal, financial, cultural, and technological barriers.

There is a need to evaluate the processes involved in the conventional project delivery approach to determine the weaknesses in the production of design documentation and identify the capabilities required for improvement to enhance design documentation quality. Therefore, this research identified the required capabilities to develop a framework to improve design documentation quality by adapting enablers in the IPD approach. However, the research problem is very significant and must be clearly stated.

1.2 Problem Statement

The processes involved in the conventional project delivery approach result in poor design documentation quality (Shoar and Payan, 2021; Agbaxode *et al.*, 2021*b*; Zaneldin, 2020; Yap and Skitmore, 2018). It has consequences of undesirable high costs of projects, delays, and poor quality of completed projects (Shoar and Payan, 2021; Tuhacek and Svoboda, 2019; Akampurira and Windapo, 2018). This is due to the weaknesses associated with this approach (Agbaxode *et al.,* 2021*b*; Shoar and Payan, 2021; Zaneldin, 2020; Viana *et al.,* 2020; Durdyev *et al.,* 2019). Researchers and practitioners have all argued for efforts to improve design documentation quality (Agbaxode *et al.,* 2021*b*; Abdallah *et al.,* 2018; Dosumu and Aigbavboa, 2018). Some have recommended the development of a measuring instrument for evaluating design documentation quality (Akampurira and Windapo, 2019). Various tools for evaluating design documentation quality have been developed and used over the years by professionals in the industry (Harputlugil *et al.*, 2014; Giddings *et al.*, 2013; Construction Industry Council (UK), 2002). Yet, the problem of poor design documentation quality still exists (Shoar and Payan, 2021; Agbaxode *et al.,* 2021*b*; Zaneldin, 2020; Akampurira and Windapo, 2019; Yap and Skitmore, 2018; Abdallah *et al.,* 2018). However, research to improve design documentation quality within the conventional project delivery approach by adapting enablers in IPD does not exist.

Therefore, the problem statement is; Design documentation quality in practice is generally poor as a result of the weaknesses associated with the conventional approach to project delivery, which often results in project delay, low quality of work, and high-cost overruns of projects; however, IPD enablers can be applied toward improving the quality in the existing conventional approaches.

1.3 Research Aim

The research aims to determine the weaknesses in the conventional project delivery approach and adapt identified enablers inherent in IPD to develop a framework to improve design documentation quality.

1.4 Research Question

How can design documentation quality within the conventional project delivery approach be improved by adapting IPD approach?

1.4.1 Research Sub-Questions

i. What is the current state of design documentation quality in practice under the conventional project delivery approach?
ii. What are the inherent weaknesses and capabilities associated with the conventional project delivery approach in producing design documentation?
iii. What are the enablers inherent in IPD that can be adapted to improve design documentation quality?
iv. Can a framework be developed within the conventional project delivery approach to improve design documentation quality?

1.5 Research Objectives

The following objectives helped in achieving the research aim:

i. To ascertain the current state of design documentation quality in practice under the conventional project delivery approach.
ii. To identify the inherent weaknesses associated with the conventional project delivery approach and capabilities required in the production of design documentation.
iii. To identify enablers inherent in IPD that can be adapted to improve design documentation quality.
iv. To develop a framework within the conventional project delivery approach to improve design documentation quality.

1.6 Hypotheses

To address the specific research questions and objectives for this research, the following hypotheses were formulated:

Objective i	H_{01}	Poor design documentation quality has no relationship to the conventional project delivery approach.
	H_{A1}	Poor design documentation quality has a relationship to the conventional project delivery approach.

Objective ii	H_{02}	Design documentation quality will not improve when the weaknesses associated with the conventional project delivery approach are minimized using identified capabilities.
	H_{A2}	Design documentation quality will improve when the weaknesses associated with the conventional project delivery approach are minimized using identified capabilities.
Objective iii	H_{03}	Adaptation of inherent enablers in IPD will not improve design documentation quality under the conventional project delivery approach.
	H_{A3}	Adaptation of inherent enablers in IPD will improve design documentation quality under the conventional project delivery approach.

The first hypothesis (H_{01} and H_{A1}) examined the relationship that exists between design documentation quality and the conventional project delivery approach. The second hypothesis (H_{02} and H_{A2}) seeks to determine if design documentation quality will improve when the weaknesses associated with the conventional project delivery approach are minimized using identified capabilities. The third hypothesis (H_{03} and H_{A3}) seeks to determine if design documentation quality under the conventional project delivery approach will improve when enablers inherent in IPD are adapted. This notwithstanding, it is paramount to state the research gap which serves as the foundation for the research.

1.7 Identification of the Research Gap

The Project delivery method adopted for a construction project significantly impacts the efficiency of the project (Hamzeh *et al.*, 2019). This however determines the quality of design documentation for the project (Ajayi and Oyedele, 2018). It also influences the project delivery time, quality and budget or cost (Shoar and Payan, 2021; Hamzeh *et al.*, 2019). There are different project delivery methods in use in the building construction industry. However, Design Bid Build (DBB), Design and Build (DB) and Construction Manager at Risk (CMAR) are the widely used methods across the world and dominant in most

countries (Ma, Ma and Li, 2017; Mesa *et al.,* 2016; Harper *et al.*, 2016; Nawi *et al.*, 2014; Fish, 2011).

These methods have been widely criticized in the industry by practitioners and researchers for lack of the required level of integration or collaboration to project delivery, particularly during design documentation (Agbaxode *et al.,* 2021*b*; Durdyev *et al.*, 2019; Ma, Zhang and Li, 2018; Harper *et al.*, 2016; Mesa *et al.*, 2016; Nawi *et al.,* 2014). It has consequences of poor quality design documentation and is a major concern in the construction industry (Akampurira and Windapo, 2019; Tuhacek and Svoboda, 2019). This called for industry changes and initiatives to resolve the problems (Akampurira and Windapo, 2019). There is a need for process and team collaboration, especially during the design stage to avert this problem (Nawi *et al.,* 2014). It requires the early involvement of key participants especially at the design stage to improve planning decisions (Ling *et al.,* 2020; Agbaxode *et al.,* 2020). However, some developed nations are resorting to the use of integration and technology to avert the problem.

IPD on the other hand has the potential to provide better performance to meet owners' expectations (Mesa *et al.,* 2016). It promotes a more collaborative or integrated approach between participants during the design documentation phase and offers better quality (Hamzeh *et al.,* 2019; Fish, 2011). It contributes to the success of a project and ensures integration (Nawi *et al.,* 2014).

Globally, the adoption and use of IPD within the construction industry are on the increase in some developed countries. The increasing usage is particularly in the western world especially in Europe due to advances in technology (Akampurira and Windapo, 2019; Ma *et al.,* 2017; Shou *et al.*, 2015; Kiviniemi *et al.*, 2008). The story is different in developing countries since IPD adoption and usage have not even started in many developing countries with most countries lagging and challenged by a series of factors (Addy *et al.,* 2018; Ahmed, 2018; Smith, 2014). Research indicates that conventional project delivery will continue for a long time since the industry is not yet positioned to adopt new technologies such as IPD (Addy *et al.,* 2018). This is due to the barriers that hinder IPD adoption and

implementation (Kahvandi *et al.*, 2019) despite its numerous benefits (Roy, Malsane and Samanta, 2018; Li and Ma, 2017).

However, there are increasingly reported cases of the poor quality nature of design documentation associated with conventional project delivery in practice. Comparably, there are also reported cases of significant improvements in design documentation quality associated with IPD in the industry. Nonetheless, research aimed at adapting the enablers in IPD to develop a framework within the existing project delivery methods for improving the quality of design documentation does not exist. Therefore, this research seeks to address this gap by adapting some principles in IPD to improve the process within the conventional approach to producing design documentation since it lacks certain capabilities which often results in poor quality design documentation. The research scope and delimitations are very important for this research and hence presented.

1.8 Scope and Delimitations

The focus of this research is on the processes involved in producing design documentation within the conventional project delivery. The principles of integration and collaboration within IPD were critically considered and adapted to aid in developing the framework to improve design documentation quality within the conventional project delivery approach.

This research is limited to building construction projects only and involved clients, consultants, contractors, and other key stakeholders in both the private and public sectors who engage in building construction since these groups form the major key players in the building construction industry. The research was conducted within the Ghanaian building construction industry and this population provided homogeneous data for this research. The choice of this geographical location is because the dominant and widely used project delivery method in Ghana is the conventional approach (Ameyaw and Oteng-Seifah, 2010), and its usage is reported to continue for a long time (Addy *et al.*, 2018).

Statistics indicate that over 90% of construction projects in Ghana, particularly in the public sector are delivered using the conventional project delivery approach.

However, the use of the conventional approach is still on the rise even though it has been criticized for being ineffective (Addy *et al.*, 2018; Ameyaw and Oteng-Seifah, 2010). The majority of projects that were executed using some principles of integration in Ghana are within the private sector. Therefore, the inclusion of the private sector in this research provided information on the practices of collaboration and integration. This provided the premise on which in-depth data on the processes involved in the production of design documentation within these methods was collected. Moreover, the construction industry in Ghana is the third-largest economic sector based on value added to Gross Domestic Product (GDP). The industry has witnessed rapid growth with huge potential to help accelerate economic growth (Anaman and Osei-Amponsah, 2007). Therefore, the choice of Ghana for this research is considered appropriate. Some assumptions helped in executing this research; hence, presented in the next section.

1.9 Research Assumptions

In carrying out this research, it was assumed that:

- The development of a framework by adapting specific enablers in IPD for the production of design documentation will help reduce the weaknesses associated with the conventional project delivery approach, particularly during the production of design documentation.
- The developed framework will help improve design documentation quality.
- The developed framework will position the construction sector on the path to using IPD in the near future.
- The majority of construction projects delivered under the conventional project approach are bedevilled with poor design documentation quality.
- Poor design documentation quality has also significantly contributed to the undesirable high cost of construction projects, cost overruns, project delays, and low quality of completed projects.

These assumptions helped in framing the arguments for this research. The significance and justification are essential aspects of research hence presented.

1.10 Significance and Justification

While there are various project delivery methods in use in the construction industry globally, the major ones in use are the DBB, CMAR, and DB (Ma *et al.*, 2017; Mesa *et al.*, 2016; Harper *et al.*, 2016). The DBB is also referred to as the conventional project delivery (Rowlinson and McDermott, 2005). However, this project delivery is the dominant and widely used method in the industry globally compared to the other delivery methods (Salla, 2020; CMAA, 2012). This method alone accounts for about 60% of usage in the construction industry globally (Aldossari *et al.*, 2021; CMAA, 2012).

However, the processes involved in the conventional project delivery approach result in poor design documentation quality (Agbaxode *et al.*, 2021*b*; Akampurira and Windapo, 2018; Laryea, 2011; Tilley *et al.*, 2000). This is due to the weaknesses associated with this approach (Agbaxode *et al.*, 2021*b*; Shoar and Payan, 2021; Zaneldin, 2020; Viana *et al.*, 2020; Durdyev *et al.*, 2019; Mesa *et al.*, 2016; Nawi *et al.*, 2014). Researchers and practitioners have criticized this approach for its weaknesses particularly, the lack of integration and required level of collaboration during design (Durdyev *et al.*, 2019; Harper *et al.*, 2016; Mesa *et al.*, 2016). This often leads to poor design documentation quality (Shoar and Payan, 2021; Agbaxode *et al.*, 2021*b*; Zaneldin, 2020; Yap and Skitmore, 2018). It has consequences of the undesirable high cost of construction projects, project delays, and low quality of completed projects (Shoar and Payan, 2021; Tuhacek and Svoboda, 2019; Akampurira and Windapo, 2018). This further places financial constraints on countries with limited resources and a significant growth in population, which necessitates an increasing demand for infrastructure.

Researchers and practitioners have all called for efforts to improve design documentation quality (Agbaxode *et al.*, 2021*b*; Abdallah *et al.*, 2018; Dosumu and Aigbavboa, 2018; Brown, 2002). Some have recommended the development of a measuring instrument for evaluating design documentation quality (Akampurira and Windapo, 2019). However, various tools for evaluating design documentation quality have been developed and used over the years by professionals in the industry (Harputlugil *et al.*, 2014; Giddings *et al.*, 2013;

Construction Industry Council (UK), 2002). Yet, the problem of poor design documentation quality still exists (Akampurira and Windapo, 2019).

The DB and CMAR project delivery methods were introduced as improvements over the conventional approach to address the weaknesses (Rowlinson and McDermott, 2005). While the industry has seen a substantial increase in the use of CMAR and DB methods over the years, it is undeniable that the conventional approach is still the most prevalent and widely used method globally (Aldossari *et al.*, 2021; CMAA, 2012). This notwithstanding, the extent of collaboration within all these delivery methods is questionable (Agbaxode *et al.*, 2021*b*; Durdyev *et al.*, 2019; Ma *et al.*, 2018). It is on this premise that practitioners and researchers have argued that these methods lack collaboration and integration, particularly at the design stage. This often leads to poor design documentation quality (Durdyev *et al.*, 2019; Harper *et al.*, 2016; Mesa *et al.*, 2016). Therefore, there is a need for design documentation quality under the conventional approach to be improved since it is a widely used approach. It is also purported that this delivery approach will continue for a long time since the industry is not yet positioned to adopt new delivery methods (Addy *et al.*, 2018).

In finding a solution to the consequences of the conventional approach, IPD was introduced (AIA and AIACC, 2007). IPD ensures better collaboration and integration between participants, particularly during design (Hamzeh *et al.*, 2019; Fish, 2011; Raisbeck *et al.*, 2010). While IPD usage is extremely slow in the industry, it has seen some attention recently, particularly in some developed nations (Walker and Rowlinson, 2020). This is due to its potential of overcoming the weaknesses associated with the conventional project delivery approach (Walker and Rowlinson, 2020; Mesa *et al.*, 2016). However, there are significant barriers that hinder IPD adoption and implementation across the world despite its numerous benefits. These barriers include; capital, organizational, environmental, legal, financial, cultural, and technological (Kahvandi *et al.*, 2019; Becerik-Gerber and Kensek, 2010). As a result of these barriers, researchers have indicated that the conventional project delivery will continue for a long time since the industry is not yet positioned to adopt new technologies (Addy *et al.*, 2018).

This notwithstanding, the conventional project delivery approach remains the dominant and widely used method in the industry globally (Aldossari *et al.*, 2021; Salla, 2020; CMAA, 2012). Therefore, there is a need for research to consider how the potential of IPD could help improve the processes in the conventional project delivery approach toward improving design documentation quality. The next section presents the motivation behind the research.

1.11 Motivation

The driving motivation for this research is the continuous and persistent research that reports on the continuous decline in design documentation quality. This decline negatively affects project delivery, which results in project cost overruns, delays, and poor project quality. However, various countries, particularly developing nations, are challenged with an increasing demand for infrastructure for various purposes relying on limited resources. There is therefore a need to take a critical look at various rudiments that negatively impact construction project delivery. Hence, process and team integration during design documentation production are necessary to improve the quality. The format or structure within which this thesis report is presented is important and hence presented.

1.12 Organisation of the Thesis Report

This research developed a framework to improve design documentation quality by adapting specific enablers in IPD. The report is presented in seven chapters;

Chapter 1: Introduction; this chapter provides a total overview of the report. It gives background information on the research and provided the main problem statement that served as the basis for this research. It states the research aim, the main question including sub-questions, the specific objectives and the research scope. Assumptions made in conducting the research are presented including the significance and justification. This chapter presents the motivation for the research, and finally, a statement of how the thesis report is organised.

Chapter 2: Literature Review and Conceptual Framework; this chapter presents an overview of the construction industry and a literature review on design documentation in construction. The chapter begins by considering an overview of

the construction industry in general and how it contributes to the economy of nations across the world. The chapter also provides a comprehensive literature review on design documentation and quality issues in practice. It presents a literature review on project delivery phases and methods in the construction industry. Finally, the theoretical and conceptual framework for this research is presented.

Chapter 3: Research Design and Methodology; this chapter presents the research design and methodology that was employed for the research. It states the research philosophical paradigm, the research population and sampling techniques, the data collection, and analysis methods, including techniques and research strategies that were employed. The validity, reliability, and generalizability of the research cannot be overlooked for research of this kind and are therefore presented in this chapter. Finally, ethical considerations in researching human participants are presented.

Chapter 4: Quantitative Data Presentation and Analysis; this chapter presents the quantitative data that was collected using a questionnaire survey. It presents the various data analysis methods that were conducted on the data and the data analysis reports that helped in achieving the aim of the research.

Chapter 5: Qualitative Data Presentation and Analysis; this chapter presents the qualitative data that was collected using semi-structured interviews. The data analysis that was conducted is presented including the analysis reports that helped in achieving the research aim.

Chapter 6: Findings, Discussion and Framework Development; this chapter presents the research findings, the discussion of the findings, including the processes involved in the development of the framework and finally presented the developed framework, which is the aim of the research.

Chapter 7: Conclusion and Recommendations; this chapter concludes the research report, and presents the appropriate recommendations, and specific suggestions for future research.

1.13 Chapter Summary

This chapter presents the introduction to the research by indicating the background statement, the research problem statement, the aim, the research main and sub-questions, specific objectives, and the hypotheses that were formulated. Identification of the research gap was necessary and therefore presented including the research scope and delimitations, the assumptions made, and the significance and justification of the research. A statement on the motivation for conducting the research, and finally the structure or organisation of the thesis report are presented.

However, this research developed a framework to improve design documentation quality. This was achieved by adapting certain enablers in IPD and the need for this was a result of the weaknesses associated with the conventional approach to project delivery. These weaknesses often result in the production of poor quality design documentation and subsequently lead to project delays, low quality of work, and high-cost overruns of projects.

It is appropriate to consider the arguments that framed this research in a wider context after laying the background and the need for the research. Therefore, there is a need to consider a general overview of the construction industry within which this research was conducted. It is also important to briefly discuss the contribution of the construction industry to the economy of nations locally and globally. However, these must be done without forgetting to review the literature on design documentation and its quality issues in the construction industry.

CHAPTER 2

LITERATURE REVIEW AND CONCEPTUAL FRAMEWORK

2.1 Introduction

This chapter presents an overview of the construction industry, a literature review on design documentation, project delivery phases and project delivery methods in the construction industry. The chapter begins by considering an overview of the construction industry and how it contributes to the economy of nations globally. It considers the industry's contribution to the national socio-economic development of countries through the provision of physical infrastructure. The chapter also provides an inclusive literature review on design documentation and its quality issues in practice, problems and consequences of design documentation quality, and strategies for improving design documentation quality.

The chapter continues by considering the various phases of project delivery which include; the pre-design phase; design phase; pre-construction phase; construction phase; and finally the post-construction phase. There is also a literature review on project delivery methods in use in the industry. It considers; Design-Bid-Build (DBB) method; the Construction Manager At Risk (CMAR) method; Design-Build (DB) method; and Integrated Project Delivery (IPD).

It is important to present the theoretical orientation and the conceptual framework for this research. Therefore, this chapter begins by considering the theoretical basis for the research dwelling on the literature review. Theoretically, the common project delivery methods in use within the construction industry are presented. It also presented the use of the Systems theory and Maturity model in achieving the research aim and finally, presented the conceptual framework.

2.2 An Overview of the Construction Industry

The construction industry is a significant sector of the economy of nations across the world. It offers a significant contribution to the Gross Domestic Product (GDP), capital formation and employment (Hillebrandt, 2000) of nations globally. In economic terms globally, the industry contributes about 10% of GDP if

consideration is only based on raw site construction activities (Klakegg *et al.*, 2013). However, if a broader construction supply network definition is considered, then the construction industry contributes between 10% to 30% of a country's GDP (Klakegg *et al.*, 2013). Similarly, the industry also employs about 10% of the working population globally (Mustapha, Aigbavboa and Thwala, 2018; Klakegg *et al.,* 2013; Lopes, 2012; Ofori, 2012).

The industry contributes to the national socio-economic development of nations globally by providing physical infrastructure (Ofori, 2012; Voordijk, 2012) which is necessary for development. The gross output of the industry globally is the economic value of the infrastructure that it produces (Hampson, Kraatz and Sanchez, 2014; Hillebrandt, 2000). The industry is involved in the development of new infrastructures, maintenance and repair of existing ones, and the production of building materials. However, the significance of the construction industry is not merely based on the fact that it provides infrastructure that is required by almost every other sector, but it is a fact that the industry is large and relevant in its own right (Hampson *et al.,* 2014).

The construction industry serves as a driver of growth, and a catalyst for other industries to develop considering the significant linkage between activities in the industry and its contribution to the growth of GDP for Government policy making (Ruddock and Ruddock, 2008). Studies have indicated that the amount of economic stimulation that the construction industry offers globally is almost double compared to any other industry or sector (Hampson *et al.,* 2014). Therefore, any intentional improvement in the performance of the construction industry will have a rippling significant impact on the national GDP of the nation including the country's economic health (Hillebrandt, 2000). This notwithstanding, there is the need to consider factors that influence construction industry inefficiency to improve productivity. It is on this premise that improving the quality of design documentation within the conventional project delivery is very paramount for this research. However, to achieve this, there is a need to clearly define the composition and operations of the construction industry.

2.2.1 Construction Industry Defined

The construction industry has no specific accepted definition globally. The definitions given to the industry vary among countries. While some countries shallowly define their construction industry, others take a broader path to include supporting features making cross-country comparison difficult (Lewis, 2009). However, an Australian expert group on industry studies considers construction activities as a product-based system (Marceau *et al.*, 1999) because: (1) it is rich in both services and manufacturing, and (2) how innovation impacts products, processes and services. According to Hampson *et al.* (2014), construction activities involving building and civil engineering works can be classified into *General* and *Specialised* categories.

General construction in terms of buildings involves the construction of dwellings, office buildings, stores, farm buildings, and other public and utility buildings. In terms of civil engineering works; it involves the construction of motorways, roads, bridges, tunnels, railways, airfields, harbours, irrigation systems, sewerage systems, industrial facilities, pipelines, electric lines, sports facilities and other water projects (Hampson *et al.*, 2014).

Specialised construction on the other hand is the construction of certain parts of the building and civil engineering works without sole responsibility for the entire project. According to Hampson *et al.* (2014), specialised construction involves activities that are usually specialised in one aspect and common to different structures. They usually require specialised skills or equipment to execute, such as driving piles, foundation works, carcass works, concrete works, brick and stone laying, scaffolding, and roof covering. Others include new work, repair, additions and alterations, prefabricated buildings, repair works, and others. Such specialised construction activities are normally subcontracted.

The construction industry is considered an archetypal network where a coalition of firms and institutions assemble temporarily to undertake a project. There are often performance problems created due to the existence of inadequate inter-organisational cooperation and collaboration (Miozzo and Dewick, 2004).

Therefore, it is important to understand the characteristics and challenges that confront the industry to improve efficiency.

2.2.2 Characteristics and Challenges of the Construction Industry

The construction industry is complex, particularly with the existence of complex projects and undertakings. The industry is characterised by the coordination of numerous project participants and the assembling of professionals with specialist knowledge and experience. These often comprise small, medium, and large companies including diverse individuals and professionals working on a large site-based project (Hampson *et al.*, 2014).

According to Jonassen (2010), the specific characteristics of the construction industry that warrants a change to improve project efficiency are; (1) the segmentation or fragmentation into silos of interests; (2) little alignment of objectives among the silos with each optimised for its interests; (3) poor and discontinuous information flow between parties; (4) significant duplication of effort, inefficiency and waste with varying estimates; and (5) business models and contracts reinforce barriers to collaboration and integration.

The industry has also been very slow in adopting fully integrated technologies and practices that can significantly contribute to an improvement in project performance and productivity (Dubois and Gadde, 2002). In as much as the industry is large and of significant importance to the economies of nations globally, it has not kept pace with other large industries in adopting new technologies and improving productivity. The industry requires technical and process innovation. Transformational change in certain areas is also required to improve productivity (Hampson *et al.,* 2014).

The built environment which is dependent on the construction industry provides the space for modern human activities which range from buildings to neighbourhoods, to cities, and a lot more. The built environment is the largest and most significant asset of a country. It provides an enabling environment for the population to live and also work. It is estimated that the population spends an average of 97% in the built environment which includes homes, offices, shopping centres, and health facilities (Hampson *et al.*, 2014; Newton and Hampson, 2009).

However, the construction industry is expected to deliver construction projects successfully. A successful project in the industry is considered to have been completed on time, within budget, and according to quality standards (Patterson *et al.*, 2021). This achievement is however to a large extent dependent on the quality of design documentation provided for use.

2.3 Design Documentation

This section presents a review of literature on design documentation and its quality in practice, problems and consequences of design documentation quality, improvements in the quality, and industry changes. Normally, clients engage consultants to design a project and select a suitable company to undertake the construction in accordance with the documentation provided (Akampurira and Windapo, 2019; Loushine *et al.*, 2006). Hence the basis for executing the project is the design documentation provided by the consultants (Agnar *et al.*, 2019; Messner, 2019). Therefore, an effort is required at this stage to produce documents that are clear and accurate. Love, Edwards and Smith (2005) argued that contractors would understand better, price and construct a project better when the design documentation is clear and complete. Therefore, documents must effectively communicate the intent and provide sufficient information since it is a significant product of a project (Akampurira and Windapo, 2019).

There are different types of design documentation in practice. The major ones among a comprehensive collection of documents during design and construction are: design drawings; specifications; bill of quantities; schedule of rates and basic prices; form of tender or contract; conditions of contract; and others (Akampurira and Windapo, 2019; Yuni *et al.*, 2017; Sunday and Afolarin, 2013; Mena *et al.*, 2010; Laryea, 2011, 2008; Hajjar and AbouRizk, 2000). This results in a large quantum of document exchange among parties and other stakeholders (Mohemad *et al.*, 2010; Halaris *et al.*, 2003). Therefore, it is significant to take a critical look at the quality of the documents that are produced since these documents drive the construction process.

2.3.1 Design Documentation Quality in Practice

Quality is defined by the International Standards Organization as "the degree to which a set of inherent characteristics fulfils requirements" (ISO 9000, 2015). It further states that quality can be used with adjectives such as poor, good and excellent. In defining design quality, McGeorge (1988, *p. 357*) indicated that: "a good design will be effective (i.e. serve the purpose for which it was intended) and be constructible with the best possible economy and safety". Therefore, in the successful execution of construction projects in general, it is important to consider design documentation quality. Arditi and Gunaydin (1997) argued that to achieve value for money, design documents must be clear, concise, and uniform.

Tilley and McFallan (2000*a*,*b*) after a study on design and documentation quality recommended ten attributes associated with design documentation quality which are: "completeness, relevance, clarity, timeliness, accuracy, coordination, final checking, certainty, standardization of documentation and conformity". This is consistent with a study conducted by Laryea (2011) on the quality of tender documents in the UK. Therefore, to determine design documentation quality, there is a need to evaluate the degree to which these quality attributes are combined.

From a global perspective, design documentation quality is predominantly poor and is a major disquiet in the construction industry (Akampurira and Windapo, 2019). It is an increasing canker in the industry worldwide including in the Czech Republic (Tuhacek and Svoboda, 2019), South Africa (Akampurira and Windapo, 2019, 2018, 2016; Malinda, 2017), Nigeria (Dosumu and Aigbavboa, 2018; Dosumu, Idoro and Onukwube, 2017; Sunday and Afolarin, 2013), Ghana (Fatawu, 2016), Malaysia (Suratkon and Jusoh, 2015), Kuwait (Jarkas, 2014), Australia (Philips-Ryder, Zuo and Jin, 2013; Slater and Radford, 2012; Love *et al.*, 2005; Tilley, 2005,1998; Tilley *et al.*, 2002; Tilley and McFallan, 2000c, 2000b, 2000a; Tilley *et al.*, 2000; Tilley *et al.*, 1997; Tilley and Barton, 1997), UK (Laryea, 2011; Gann, Salter and Whyte, 2003; Whyte and Gann, 2003), Spain (Mena *et al.*, 2010), Gaza (Abdalaziz, 2009), Netherlands (Volker *et al.*, 2008), Saudi Arabia (Darwish, 2007), Japan (Andi and Minato, 2003), USA (Burati, Farrington and Ledbetter, 1992).

Laryea (2011) asserted that design documentation in many cases practically contains unclear, inconsistent and inadequate information. This means design documents lack accuracy and completeness. Most researchers concluded that the quality of design documentation is poor hence efforts must be directed toward improving the quality to ensure project efficiency (Lappalainen *et al.,* 2022; Govender *et al.,* 2022; Akampurira and Windapo, 2018).

Several studies indicate that design documentation quality in practice is poor (Philips-Ryder *et al.,* 2013; Slater and Radford, 2012; Laryea, 2011). They further argued that the standards are getting worse by the days without any improvement due to the weaknesses associated with the project delivery methods under which design documentation production is carried out. This is consistent with a study by Fatawu (2016). As a result of this, clients are prevented from achieving value for money which is the core reason why they constitute tendering process in the industry (Laryea, 2008). Therefore, design documentation quality problems in practice must be critically considered.

2.3.2 Problems and Consequences of Design Documentation Quality

Design documentation quality problems in practice include; poor specifications, and discrepancies in the bill of quantities, drawings and specifications (Agbaxode *et al.,* 2021*a*,*b*; Laryea, 2011; Tilley and McFallan, 2000c). Others are documents issued with conflicting and inaccurate information, documents lacking clarity, documents issued with insufficient details, issuance of un-amended standard specifications, and reliance on specification notes only when drawings are required (Tilley and McFallan, 2000b). Dosumu and Aigbavboa (2018) in an assessment of the causes and effects of design error concluded that poor design drawings, lack of coordination among design documents, omission in designs, and mistakes, are the major causes of poor quality design documentation.

This poor quality has a consequential influence on project delivery which in many instances leads to rework, unnecessary claims, disputes, shoddy works, and litigation in construction projects (Philips-Ryder *et al.,* 2013; Lopez *et al.*, 2010; Love *et al.*, 2010; Mohamad and Madon, 2006; Love and Li, 2000). This phenomenon is a significant factor responsible for inaccurate cost estimates and

higher margins in bids (Laryea, 2011; Akintoye and Fitzgerald, 2000). It also leads to project cost overruns (Shoar and Payan, 2021; Tilley *et al.*, 2000) and influences project markups in construction (Liu and Ling, 2005). However, any improvement in the quality will result in improvements in the efficiency of the construction process (Tilley, 2005) and will lead to quality performance, owner satisfaction, and profitability of a project (Ling *et al.*, 2009).

2.3.3 Design Documentation Quality in the Construction Industry

In an attempt to determine the quality of design documentation in the construction industry, a meta-synthesis of the literature was carried out using the six main steps involved in a meta-synthesis to ensure an effective study. The Critical Appraisal Skills Program (CASP) was also applied to ensure the quality of the process. To analyze the data obtained from the meta-synthesis approach, descriptive analysis and pattern coding were employed using Nvivo to bring order and structure to the data (Agbaxode *et al.*, 2021*b*). The synthesis covered literature on design documentation quality in the construction industry between 1992 and 2020.

A total of 139 micro factors on design documentation quality were identified as presented in Table 2.1. A further coding and classification of the factors into macro and micro factors was done to clearly explain the relevance and significance of each factor in the production of design documentation. The macro factors are a larger collection of micro factors on design documentation quality. A framework of the synthesized data is presented in Figure 2.1 and subsequently elaborated in Table 2.2 to Table 2.8.

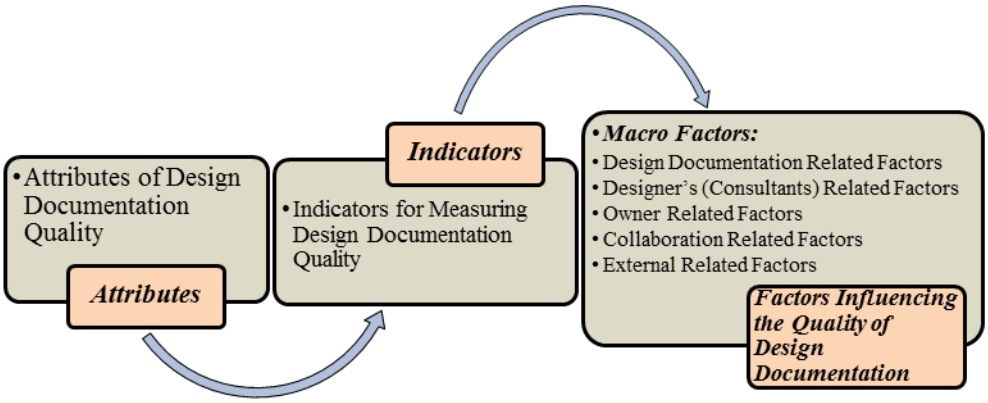

Figure 2.1: Framework of Design Documentation Quality Review
Source: (Agbaxode et al., 2021b)

There is a total of 19 micro factors on quality attributes of design documentation and 11 micro factors on indicators for measuring design documentation quality as presented in Table 2.2 and Table 2.3 respectively.

Table 2.1: Collection of design documentation quality factors

Classifications	Number of Macro Factors	Number of Micro Factors
Design documentation quality attributes	1	19
Design documentation quality assessment indicators	1	11
Design documentation quality influential factors	5	109
TOTAL	**7**	**139**

Source: Researcher

A total of 109 micro factors that influences design documentation quality were synthesized and classified under five macro factors which are; Design documentation-related factors; Designer (Consultants) related factors; Owner related factors; Collaboration related factors and External related factors. These factors are however influenced by quality attributes of design documentation.

2.3.3.1 Design Documentation Quality Attributes

According to Agbaxode *et al.* (2021*b*), design documentation is very significant, especially in the successful delivery of construction projects. It inevitably influences the efficiency of a project. This necessitated the need for periodic evaluation of the quality of design documentation by researchers and practitioners (Prasad, 2004). Therefore, there are quality attributes that construction project design documentation must possess if achieving value for money is of great concern (Arditi and Gunaydin, 1997). These attributes are presented in Table 2.2 as findings from the meta-synthesis (Agbaxode *et al.*, 2021*b*).

The meta-synthesis indicated that design documentation quality depends on clarity, conciseness, uniformity, completeness, relevance, accurateness, coherency, unambiguousness and fitness for purpose of the documents in practice (Agbaxode *et al.*, 2021*b*). This is consistent with studies by Dosumu and Aigbavboa (2018); Akampurira and Windapo (2018); Malinda (2017); and Akampurira and Windapo (2016).

Table 2.2: Design Documentation Quality Attributes

Macro Factors	***Micro Factor Codes***	***References***
Quality Attributes of Design Documentation	Fit for purpose	(Abdalaziz, 2009)
	Completeness	(Akampurira and Windapo, 2019; Phillips-Ryder *et al.*, 2013; Andi and Minato, 2003; Tilley and McFallan, 2000a, b and c; Tilley *et al.*, 1999; Tilley *et al.*, 1997)
	Relevance	(Akampurira and Windapo, 2019; Phillips-Ryder *et al.*, 2013; Andi and Minato, 2003; Tilley and McFallan, 2000a, b and c; Tilley *et al.*, 1999)
	Clarity	(Akampurira and Windapo, 2019; Andi and Minato, 2003; Tilley and McFallan, 2000a,b,c;)
	Timeliness	(Akampurira and Windapo, 2019; Phillips-Ryder *et al.*, 2013; Andi and Minato, 2003; Tilley and McFallan, 2000a, b and c; Tilley *et al.*, 1999; Tilley *et al.*, 1997)
	Accuracy	(Akampurira and Windapo, 2019; Phillips-Ryder *et al.*, 2013; Andi and Minato, 2003; Tilley and McFallan, 2000a, b and c; Tilley *et al.*, 1999; Tilley *et al.*, 1997)
	Coordination	(Akampurira and Windapo, 2019; Phillips-Ryder *et al.*, 2013Andi and Minato, 2003; Tilley and McFallan, 2000a, b and c; Tilley *et al.*, 1999; Tilley *et al.*, 1997)
	Final Checking	(Akampurira and Windapo, 2019; Phillips-Ryder *et al.*, 2013; Tilley and McFallan, 2000a, b and c)
	Certainty	(Akampurira and Windapo, 2019; Phillips-Ryder *et al.*, 2013; Andi and Minato, 2003; Tilley and McFallan, 2000a, b and c; Tilley *et al.*, 1999)
	Standardization of documentation	(Akampurira and Windapo, 2019; Phillips-Ryder *et al.*, 2013; Andi and Minato, 2003; Tilley and McFallan, 2000a, b and c; Tilley *et al.*, 1999)
	Conformity	(Akampurira and Windapo, 2019; Phillips-Ryder *et al.*, 2013; Andi and Minato, 2003; Tilley and McFallan, 2000a, b and c; Tilley *et al.*, 1999; Tilley *et al.*, 1997)
	Concise	(Tilley and McFallan, 2000a, b and c; Arditi and Gunaydin, 1997)
	Unambiguous and coherent.	(Abdalaziz, 2009)
	Consistent	(Akampurira and Windapo, 2019; Andi and Minato, 2003; Tilley and McFallan, 2000a, b and c)
	Legibility	(Akampurira and Windapo, 2019; Dosumu *et al.*, 2017)
	Easy to communicate and construct with the best possible economy and safety.	(Oyewobi *et al.*, 2011; Abdalaziz, 2009)
	Consistent with the owner's requirements as in the project brief.	(Abdalaziz, 2009)
	Topographical representation.	(Akampurira and Windapo, 2019; Andi and Minato, 2003)
	Geological representation.	(Akampurira and Windapo, 2019; Andi and Minato, 2003)

Source: (Agbaxode et al., 2021a and b)

Therefore, design documentation must be effective and well communicated to ensure quality project delivery (Agbaxode *et al.,* 2021*b;* McFallan and Tilley, 2000). This can be achieved when design professionals consider these quality attributes as a checklist since project quality is closely linked to the overall degree of professional services provided (DeFraites, 1989). Therefore, there is a need to evaluate the degree, to which these quality attributes are combined in determining the quality of design documentation.

2.3.3.2 Indicators for Measuring Design Documentation Quality

The results of the meta-synthesis indicate that determining design documentation quality is complex and must be done based on the content of the available information. This can be achieved by the use of varying indicators (Philips-Ryder *et al.,* 2013) as identified in the meta-synthesis and presented in Table 2.3.

Table 2.3: Design Documentation Quality Assessment Indicators

Macro Factors	***Micro Factor Codes***	***References***
Design Documentation Quality Assessment Indicators	Request for Information (RFI) number and Analysis.	(Phillips-Ryder *et al.,* 2013; Wong and Zhang, 2013; Tilley *et al.,* 1997)
	Quantity and analysis of revisions to drawing registers.	(Phillips-Ryder *et al.,* 2013; Wong and Zhang, 2013; Tilley *et al.,* 1997)
	Revisions to Drawings.	(Phillips-Ryder *et al.,* 2013; Tilley *et al.,* 1997)
	The issuance of new drawings.	(Phillips-Ryder *et al.,* 2013; Tilley *et al.,* 1997)
	Increasing quantum of variation orders.	(Phillips-Ryder *et al.,* 2013; Tilley *et al.,* 2002)
	Early Warnings submission (NEC contract).	(Hughes and Thorpe, 2014)
	The submission of Field technical queries.	(Akampurira and Windapo, 2016)
	Value of rework.	(Phillips-Ryder *et al*., 2013; Love *et al.,* 1998; Love and Edwards, 2004)
	Lost or non-productive time.	(Phillips-Ryder *et al*., 2013; Han *et al.,* 2011; Tilley *et al.,* 1997)
	Scope disputes.	(Phillips-Ryder *et al*., 2013; Han *et al.,* 2011; Tilley *et al.,* 1997)
	Paid delays.	(Phillips-Ryder *et al*., 2013; Bubshait, Al-Said and Abolnour, 1994)

Source: (Agbaxode et al., 2021a and b)

Some of the indicators for determining design documentation quality in practice as found from the synthesis include; the quantity and analysis of Requests for Information (RFI), revisions to drawing registers, issuance of new drawings, variation orders, and value of rework, (Agbaxode *et al.,* 2021*b*; Dosumu and Aigbavboa, 2018; Akampurira and Windapo, 2018; Malinda, 2017). The synthesis

also indicated that the availability of several revisions, variations, and a large amount of RFI in a document register is an indication of poor quality design documentation (Agbaxode *et al.,* 2021*b;* Philips-Ryder *et al.,* 2013). However, there are underlining factors that are the causes of all these.

2.3.3.3 Factors Influencing the Quality of Design Documentation

In synthesizing the literature on factors that influence design documentation quality, there was an indication that good quality design documentation often results in successful project delivery (Agbaxode *et al.,* 2021*b;* Abdallah *et al.*, 2018). Therefore, poor quality design documentation may have significant adverse effects on the delivery of construction projects in general. However, the literature synthesis indicates various factors that influence the quality of design documentation as presented in Table 2.4 to Table 2.8. These factors have been put into the following five appropriate categories (Agbaxode *et al.*, 2021*b*):

i. Design documentation-related factors; (Presented in Table 2.4)
ii. Designers (Consultants) related factors; (Presented in Table 2.5)
iii. Owner-related factors; (Presented in Table 2.6)
iv. Collaboration-related factors; (Presented in Table 2.7)
v. External related factors; (Presented in Table 2.8)

On *Design documentation-related factors* as presented in Table 2.4, it was ascertained that design documentation in practice contains a significant amount of errors and omissions including inadequate, incomplete, dubious and deficient information which adversely affects project delivery despite numerous efforts by researchers and practitioners to help address the problem over the years (Agbaxode *et al.*, 2021*b*).

Table 2.4: Design Documentation Quality Influential Factors; Design Documentation Related Factors

Macro Factors	*Micro Factor Codes*	*References*
1 Design Documentation Related Factors	Inadequate and insufficient documentation.	(Akampurira and Windapo, 2018; Sunday and Afolarin, 2013)
	Incomplete and inexplicit drawings.	(Baloyi and Agumba, 2014; Sunday and Afolarin, 2013; Ramabodu and Verster, 2013)
	Incorrect drawings.	(Sunday and Afolarin, 2013; Alarcón and Mardones, 1998)
	Changes to specifications.	(Sunday and Afolarin, 2013)
	Poor and Incomplete specification writing.	(Ramabodu and Verster, 2013; Laryea, 2011)
	Unavailability of detailed information.	(Sunday and Afolarin, 2013)
	Inaccurate details.	(Sunday and Afolarin, 2013; Ramabodu and Verster, 2013)
	Deficient or missing information.	(Sunday and Afolarin, 2013; Alarcón and Mardones, 1998)
	Design error.	(Tuhacek and Svoboda, 2019; Baloyi and Agumba, 2014); Jarkas, 2014)
	Error in design calculation.	(Baloyi and Agumba, 2014; Dosumu and Aigbavboa, 2018)
	Dimensional errors.	(Dosumu and Aigbavboa, 2018; Baloyi and Agumba, 2014; Sunday and Afolarin, 2013)
	Symbol and abbreviation errors.	(Baloyi and Agumba, 2014; Sunday and Afolarin, 2013)
	Approximation error.	(Baloyi and Agumba, 2014; Sunday and Afolarin, 2013)
	Measurement errors.	(Baloyi and Agumba, 2014; Sunday and Afolarin, 2013)
	Random errors.	(Baloyi and Agumba, 2014; Sunday and Afolarin, 2013)
	Arithmetic errors.	(Baloyi and Agumba, 2014; Sunday and Afolarin, 2013)
	Pricing errors.	(Baloyi and Agumba, 2014; Sunday and Afolarin, 2013)
	Omissions and Ambiguity in documents.	(Dosumu and Aigbavboa, 2018; Baloyi and Agumba, 2014; Jarkas, 2014)
	Documents do not conform to Code and Building Regulation.	(Sunday and Afolarin, 2013)
	Quantum of Requests for Information.	(Philips-Ryder et al., 2013)
	Variations and revisions to the design.	(Philips-Ryder et al., 2013)
	Reliance upon generic specifications documents.	(Philips-Ryder et al., 2013; Darwish, 2005; Gallo *et al.*, 2002)
	Provision of voluminous and irrelevant documentation.	(Philips-Ryder et al., 2013)
	Discrepancies between the specification and the design drawings.	(Philips-Ryder *et al.*, 2013; Ramabodu and Verster, 2013)
	Disparities between bills of quantities, drawings, and specifications.	(Baloyi and Agumba, 2014; Ramabodu and Verster, 2013; Laryea, 2011)
	Unworkable details and unachievable tolerances.	(Philips-Ryder *et al.*, 2013)
	Discrepancy and conflict in contract documents.	(Jarkas, 2014; Baloyi and Agumba, 2014)
	Outdated and unclear technical specifications.	(Jarkas, 2014)
	Poor working drawings.	(Dosumu and Aigbavboa, 2018)
	Wrong/inadequate description in specifications.	(Dosumu and Aigbavboa, 2018)
	Lack of clarity and legibility.	(Dosumu *et al.*, 2017; Ramabodu and Verster, 2013)
	Incomplete designs.	(Ramabodu and Verster, 2013; Alarcón and Mardones, 1998)
	Design Changes and Frequent Change orders.	(Abdallah *et al.*, 2018; Yap and Skitmore, 2018; Ali *et al.*, 2010; Andi and Minato, 2003)

Source: (Agbaxode et al., 2021a and b)

On *Designer's (Consultants) related factors* as presented in Table 2.5, it was ascertained that; consultants having inadequate design staff; concurrent or overlapping activities; insufficient planning of workload; negligence of professionals and a host of factors influence design documentation quality significantly (Agbaxode *et al.,* 2021*b*). It was indicated that the quality of design documentation is dependent on the degree of professional services provided by designers or consultants, the mode of selection of the services of consultants, the amount of their negotiated fees and other factors. Therefore, designers or consultants often deliver inadequate services when they are contracted on low fees as remuneration which does not motivate them (Philips-Ryder *et al.,* 2013; Slater and Radford, 2012; Tilley and McFallan, 2000*a,b* and *c*).

Table 2.5: Design Documentation Quality Influential Factors; Designer's (Consultants) Related Factors

Macro Factors	*Micro Factor Codes*	*References*
2 Designer's (Consultants) Related Factors	Inadequate design staff.	(Dosumu *et al.,* 2017; Malinda, 2017)
	Concurrent or overlapping activities.	(Dosumu *et al.,* 2017)
	Insufficient planning of workload.	(Sunday and Afolarin, 2013; Love *et al.,* 2005; Alarcón and Mardones, 1998)
	Negligence of the Professional.	(Sunday and Afolarin, 2013; Burati *et al.,* 1992)
	Tight design schedule.	(Abdalaziz, 2009; Tilley et al., 2002)
	Lack of quality assurance systems and procedures in the consultant's team.	(Malinda, 2017; Phillips-Ryder *et al.,* 2013; Love and Li, 2000)
	Failure to adopt quality assurance systems e.g. ISO 9001.	(Andi and Minato, 2003; Slater and Radford, 2012; Phillips-Ryder *et al.,* 2013)
	Terms of reference not consistent with expected deliverables.	(Malinda, 2017)
	Consultant's Professional experience.	(Malinda, 2017; Sunday and Afolarin, 2013)
	Inadequate experience of designers.	(Dosumu and Aigbavboa, 2018; Malinda, 2017; Jarkas, 2014; Sunday and Afolarin, 2013; Slater and Radford, 2012; Abdalaziz, 2009; Darwish, 2007; Andi and Minato, 2003)
	Lack of experience on similar projects.	(Abdalaziz, 2009; ICE, 1996)
	Absence of an experienced overall design manager.	(Malinda, 2017; ASCE, 2002)
	Low professional fees.	(Malinda, 2017; Darwish, 2005; Andi and Minato, 2003, Tilley *et al.,* 2002)
	Lack of innovation and design options due to low fees.	(Malinda, 2017; Andi and Minato, 2003)
	Unrealistic contract durations imposed by the client.	(Malinda, 2017; Oyedele, 2003)
	Designer's workload.	(Jarkas, 2014; Slater and Radford, 2012; Abdalaziz, 2009; Darwish, 2007; Andi and Minato, 2003; Abolnour, 1994)
	Improper use of design software.	(Slater and Radford, 2012; Darwish, 2007; Love *et al.,* 2005; Andi and Minato, 2003)
	Lack of or improper use of modern design software.	(Malinda, 2017; Jarkas, 2014; Slater and Radford, 2012)
	Inadequate or ineffective use of new technology.	(Malinda, 2017; Li and Love, 1998)
	Incorrect assumptions.	(Dosumu and Aigbavboa, 2018)

Source: (Agbaxode et al., 2021a and b)

Table 2.5: Continued

Macro Factors	*Micro Factor Codes*	*References*
	Absence of 'in-house' design management policies and procedures.	(Jarkas, 2014)
	Failure to provide relevant training to staff.	(Abdalaziz, 2009; Darwish, 2007; Andi and Minato, 2003)
	Inadequate supervision of junior design staff.	(Akampurira and Windapo, 2019; Darwish, 2007)
	Poor allocation of time with consideration to available workload.	(Abdalaziz, 2009; Love *et al.*, 2005)
	Reuse of design documents and details from previous projects without effective review by the designer.	(Abdalaziz, 2009; Darwish, 2007; Gallo *et al.*, 2002)
	Designer's unfamiliarity with construction techniques and materials.	(Slater and Radford, 2012; Abdalaziz, 2009; Andi and Minato, 2003; Arditi and Gunaydin, 1997)
	Designer's failure to clearly understand the client's brief.	(Malinda, 2017; Andi and Minato, 2003)
	Designer's lack of experience on similar projects.	(Malinda, 2017; Abdalaziz, 2009)
	Lack of time available for checking and correlating information's on all design documents.	(Malinda, 2017)
	Leaving design issues to be sorted out in the construction process.	(Malinda, 2017)
	Increase design staff members, rather than increasing the number of hours of work.	(Love *et al.*, 2005)
	Allocation of staff to many projects at the same time.	(Abdalaziz, 2009; Love *et al.*, 2005)

Source: (Agbaxode et al., 2021a and b)

On *Owner related factors* as presented in Table 2.6, unwillingness on the part of clients to pay fees commensurate with high-quality services often results in the delivery of poor-quality design documentation. Another significant factor is the selection of consultants based on the lowest price selection strategy (Lowest bid approach). This approach often results in the production of poor-quality design documentation. Therefore, project owners should be willing to pay appropriate fees to consultants to achieve quality services. It is also important for project owners to allow sufficient time for design documentation to be produced. There should also be the adoption of appropriate procurement methods that will aid in

the production of better quality design documentation (Agbaxode *et al.*, 2021*b*).

Table 2.6: Design Documentation Quality Influential Factors; Owner Related Factors

Macro Factors	*Micro Factor Codes*	*References*
3 Owner Related Factors	Low design fees (Unwillingness of clients to pay fees commensurate with the design of high-quality services).	(Dosumu *et al.*, 2017; Jarkas, 2014; Slater and Radford, 2012; Abdalaziz, 2009; Darwish, 2007)
	Selection of designers based on lowest price selection strategy (Lowest bid approach).	(Slater and Radford, 2012; Abdalaziz, 2009; Darwish, 2007; Andi and Minato, 2003)
	Selection of designers based on reputation instead of efficiency.	(Abdalaziz, 2009; Gallo *et al.*, 2002)
	Erroneous and Conflicting information from the client.	(Abdalaziz, 2009; Tilley *et al.*, 2002)
	Provision of wrong or Insufficient information by the client.	(Abdalaziz, 2009; Andi and Minato, 2003; Tilley *et al.*, 2002)
	Frequent design changes by the client.	(Jarkas, 2014; Darwish, 2007; Andi and Minato, 2003)
	Change in project requirements by the client at later stages.	(Abdalaziz, 2009; Barrett and Stanley, 1999)
	Change in the scope of work by the client.	(Dosumu and Aigbavboa, 2018)
	The quality of the project brief provided by the client.	(Jarkas, 2014; Slater and Radford, 2012; Darwish, 2007; Love *et al.*, 2005; Andi and Minato, 2003)
	No focal person on the client team responsible for design coordination and providing information.	(Abdalaziz, 2009; Darwish, 2007; Andi and Minato, 2003)
	Clients lack relevant project experience.	(Darwish, 2007; Andi and Minato, 2003)
	Low emphasis on professional standards.	(Slater and Radford, 2012; Darwish, 2007)
	Unrealistic or Inadequate design duration.	(Dosumu *et al.*, 2017; Jarkas, 2014; Slater and Radford, 2012; Darwish, 2007)
	Lack of client knowledge of the importance of the design phase to the construction economy and maintenance operation.	(Jarkas, 2014)
	Client's inefficiency in the decision-making process.	(Jarkas, 2014; Tilley, 2005a)
	Client's delay in processing designer's payments.	(Jarkas, 2014; Abolnour, 1994)
	Lack or inadequate client's review of interim and final design documents submission.	(Jarkas, 2014; Abdalaziz, 2009; Darwish, 2007; Andi and Minato, 2003)
	Client type (Public or private).	(Dosumu *et al.*, 2017; Jarkas, 2014)
	Owner's financial difficulties.	(Dosumu and Aigbavboa, 2018)
	Lack of motivation to consultants.	(Dosumu *et al.*, 2017)
	Unrealistic client demand.	(Dosumu *et al.*, 2017)

Source: (Agbaxode et al., 2021a and b)

On *Collaboration related factors* as presented in Table 2.7, Inadequate and poor communication between Consultants (design team members) as well as the Client is a major factor that contributes to poor quality design documentation. There is also a significant lack of coordination among design team members, particularly during design (Agbaxode *et al.,* 2021*b*). Therefore, project consultants (designers) should effectively collaborate during the preparation of design documentation to enhance design documentation quality (Sunday and Afolarin, 2013).

Table 2.7: Design Documentation Quality Influential Factors; Collaboration Related Factors

Macro Factors	*Micro Factor Codes*	*References*
4 Collaboration Related Factors	Inadequate and poor communication between Consultants and the Client.	(Malinda, 2017; Sunday and Afolarin, 2013; Love and Edwards, 2004; Burati *et al.,* 1992)
	Lack of continuous and effective communication between parties.	(Malinda, 2017)
	Poor communication among design team members.	(Malinda, 2017; Jarkas, 2014 ; Slater and Radford, 2012; Andi and Minato, 2003)
	Lack of data integration across design disciplines.	(Malinda, 2017; Abdalaziz, 2009; Tilley *et al.,* 2002)
	Limited time available for checking and coordinating all design documentation.	(Abdalaziz, 2009; Love *et al.,* 2005; Andi and Minato, 2003; Tilley *et al.,* 2002)
	Lack of coordination among design team members during design.	(Dosumu and Aigbavboa, 2018; Baloyi and Agumba, 2014; Jarkas, 2014; Philips-Ryder *et al.,* 2013; Abdalaziz, 2009; Love *et al.,* 2005)
	Lack of clear and Inadequate project objectives.	(Dosumu and Aigbavboa, 2018; Jarkas, 2014)
	Insufficient and Poor pre-design project meetings.	(Jarkas, 2014; Oyedele, 2003)
	Inadequate design review processes.	(Jarkas, 2014; Abdalaziz, 2009; Tilley *et al.,* 2002; Bubshait, Al-Said and Abolnour, 1998)
	Transfer of knowledge and experience between designers.	(Dosumu *et al.,* 2017)
	Discrepancies between different design disciplines.	(Philips-Ryder *et al.,* 2013)

Source: (Agbaxode et al., 2021a and b)

On *External related factors* as presented in Table 2.8; lack of quality control criteria imposed by statutory authorities on design outputs, lack of statutory requirements for periodical training and continuous development of design staff including; lack of a mandatory code of professional ethics and engineering practice are some significant factors that influence design documentation quality

in practice. Since these factors are beyond the control of the project owner, designers or contractors, then local authorities must put appropriate measures in place to address these challenges (Agbaxode *et al.*, 2021*b*).

Table 2.8: Design Documentation Quality Influential Factors; External Related Factors

Macro Factors	*Micro Factor Codes*	*References*
5 External Related Factors	Lack of 'quality controlling criteria' imposed by statutory authorities on design outputs.	(Jarkas, 2014; Love and Li, 2000)
	Lack of statutory requirements for periodical training and continuous development of design staff.	(Jarkas, 2014)
	Lack of a mandatory code of professional ethics and engineering practice.	(Jarkas, 2014)
	Frequent statutory changes in regulations and requirements.	(Jarkas, 2014)
	Weak licensure procedures for design professionals.	(Jarkas, 2014)
	Procurement system and processes.	(Dosumu *et al.*, 2017; Abdul Rashid *et al.*, 2006)
	Fragmented nature of the industry.	(Dosumu *et al.*, 2017)
	The uniqueness of the project.	(Dosumu *et al.*, 2017)
	Size of project.	(Dosumu *et al.*, 2017)
	Non-request for a certificate of insurance covering design and errors.	(Dosumu *et al.*, 2017)
	Absence of high-cost experienced design team to projects.	(Abdalaziz, 2009)
	Long period between the time of bidding/tendering and award.	(Sunday and Afolarin, 2013)

Source: (Agbaxode et al., 2021a and b)

Findings from the meta-synthesis indicate that the number of requests for information from contractors, coupled with persistent revisions to drawings and variation orders, among others are the key indicators in evaluating the quality of design documentation in practice (Akampurira and Windapo, 2016; Phillips-Ryder *et al.*, 2013). It was indicative that incomplete and inexplicit drawings, disparities between bill of quantities, drawings, and specifications, and lack of coordination and collaboration among design team members are some significant factors that influence the quality of design documentation in practice (Dosumu *et al.*, 2017; Jarkas, 2014; Slater and Radford, 2012; Abdalaziz, 2009; Tilley *et al.*, 2002). Therefore, the project owner, consultants, end-users and other project team members must collaborate during the production of design documentation to improve quality (Agbaxode *et al.*, 2021*b*).

There is poor quality design documentation in construction projects and it is prominent among consultants' documentation (Ismail *et al.*, 2016; Jamaludin *et al.*, 2014; Sani and Othman, 2012). Considering all the findings from the meta-synthesis, it is indicative that design documentation quality in the industry is unsatisfactory hence appropriate steps must be taken towards addressing the canker. However, there are various attempts aimed at improving the quality of design documentation in the construction sector over the years.

2.3.4 Approaches to Improving Design Documentation Quality

There have been numerous efforts by researchers and industry players to help address the problem of poor quality design documentation (Agbaxode *et al.*, 2021*a and b*). Studies indicate that attempts to improve the quality over the years have not yielded much results (Agbaxode *et al.*, 2021*a and b*; Philips-Ryder *et al.*, 2013; Slater and Radford, 2012). Researchers and practitioners have all argued that there is a need for industry changes and initiatives to resolve the problems of design documentation quality (Lappalainen *et al.*, 2022; Akampurira and Windapo, 2019; Abdallah *et al.*, 2018; Dosumu and Aigbavboa, 2018).

2.3.4.1 Proposed Strategies for improving design documentation quality

Strategies proposed for addressing the problem include rechecking documents before use (Govender *et al.*, 2022), use of computer programs such as BIM, having design checklists and establishing quality control departments (Abdallah *et al.*, 2018; Dosumu and Aigbavboa, 2018; Brown, 2002). Akampurira and Windapo (2019) in evaluating design documentation quality attributes recommended the need for a measuring instrument to be developed for appraising the quality of design documents. However, various tools for evaluating building design quality by professionals exist in the industry (Harputlugil *et al.*, 2014; Giddings *et al.*, 2013; Construction Industry Council (UK), 2002). Despite the existence of all these strategies, poor design documentation quality still exists. Therefore, it is important to identify industry changes over the years that aimed at improving design documentation quality in the construction industry.

2.3.4.2 BIM and Shortfalls towards improving design documentation quality

The adoption of BIM is a result of advancements in technology (Akampurira and Windapo, 2019). BIM is defined by Kiviniemi *et al.* (2008) as "an object-oriented, Architectural Engineering and Construction (AEC) specific model which is a digital representation of a building to facilitate exchange and interoperability of information in digital format". BIM usage across the world has been increasing particularly in the western world and especially in Europe due to advances in technology (Akampurira and Windapo, 2019; Shou *et al.*, 2015; Kiviniemi *et al.*, 2008). While BIM adoption and usage are on the ascendency in some developed countries (Smith, 2014), its adoption has not even started in many developing countries due to challenging factors (Addy *et al.*, 2018; Ahmed, 2018).

Some software vendors and practitioners have promoted the use of BIM to significantly reduce design errors (Abdallah *et al.*, 2018; Love *et al.*, 2011). Some have advocated it as a panacea to design-related errors. However, a study by Pärn *et al.* (2018, *p. 217*) concluded that; "Despite the euphoria that often surrounds digital construction within extant literature, this research has shown that BIM is not yet a panacea to mitigating design errors". This is consistent with earlier research by Love *et al.* (2011) that BIM alone is not a panacea to poor design quality problems. Therefore, in a bid to reduce errors in design documents, it is apparent to combine different error containment and reduction strategies that can work in unison (Love *et al.*, 2011). Hence poor quality design documentation still exists despite the existence and use of BIM (Pärn *et al.*, 2018).

In contrast to the significant benefits that BIM offers are the barriers to its adoption and implementation. Globally, some of the barriers include; investment, training, professional liability, process problems, trust, intellectual property (Addy *et al.*, 2018; Won *et al.*, 2013), and contractual arrangements (Migilinskas *et al.*, 2013). Others are; software compatibility; BIM cost setup; and cultural resistance (Armah, 2015). Consultants and contractors must strongly cooperate to achieve BIM implementation (Abdallah *et al.*, 2018). Based on these assertions, industry changes are required towards the production of design documentation to improve the quality particularly, under the conventional project delivery.

2.4 Project Delivery Phases

There are processes involved in the successful delivery of construction projects (Patterson *et al.*, 2021; Klinger and Susong, 2006). It is normally a sequential process; however, some phases may overlap each other based on the project delivery method chosen (Project Management Institute, 2013). These processes can be put into five phases termed project delivery phases (Project Management Institute, 2013; Greenhalgh and Squires, 2011; Klinger and Susong, 2006). They include; (1) pre-design phase; (2) design phase; (3) pre-construction phase; (4) construction phase; and (5) post-construction phase.

2.4.1 Pre-design Phase

The pre-design phase is also called the planning or programming phase of a project (Al-Reshaid *et al.*, 2005). This phase is considered the most critical stage of all the phases in project delivery (Klinger and Susong, 2006) because this is where critical decisions are made. It is usually managed by the project owner and the architect or a project manager based on the project delivery method chosen (Al-Reshaid *et al.*, 2005). This phase is where the project is defined in terms of its function, purpose, scope, size, and economics (Project Management Institute, 2013; Klinger and Susong, 2006). The management decisions taken at this phase determine the success or failure of the project (Al-Reshaid *et al.*, 2005).

To successfully progress to the subsequent phases of the project, the pre-design phase must clearly define the project (Project Management Institute, 2013). Some activities that are carried out during this phase include; the preparation and detailing of the project's program; and project economic feasibility assessment including the overall budget and financing (Al-Reshaid *et al.*, 2005). Others are; project site assessment (verifying the site's appropriateness, and determination of its designated use by the local authorities); an assessment of local authorities' constraints such as building code and zoning constraints including other legal aspects of the project; and selection of project design team (Al-Reshaid *et al.*, 2005). The sequel to the pre-design phase is the design phase of the project.

2.4.2 Design Phase

The design phase follows right after the pre-design phase normally after the selection of the project design team. The composition of the design team is dependent on the type of project and the delivery method to be adopted (Klinger and Susong, 2006). Therefore, some design teams may require several different and more specialized consultants in addition to the architect depending on the size and scope of the project (Klinger and Susong, 2006; Al-Reshaid *et al.*, 2005). Depending on the nature and scope of the project, the design team may comprise architects, civil and structural engineers, mechanical engineers, electrical engineers, plumbing consultants, cost consultants, acoustical consultants, roofing and waterproofing consultants, signage consultants, interior designers (Klinger and Susong, 2006) and a host of other specialists.

In situations where the design firm has a composition of the required design team professionals on staff, the project owner only contracts that single firm as designers. However, in most cases, the design team is a composition of several different design firms or professionals that are brought together by the architect on behalf of the project owner (Klinger and Susong, 2006; Al-Reshaid *et al.*, 2005).

Some specialist consultants may be directly contracted by the project owner depending on the nature and scope of the project. These specialist consultants may be engaged before, after or at the same time with the architect (Al-Reshaid *et al.*, 2005). In ideal cases, the architect retains some liability for the consultant's work even when a consultant is contracted directly by the project owner. This is because the architect is the prime design professional and must coordinate the entire design process (Klinger and Susong, 2006; Al-Reshaid *et al.*, 2005). There is always a working relationship between the architect and the other consultants. However, in situations where architectural design is a minor component of a large-scale highly technical and engineering project, an engineer or another professional may coordinate the design process (Al-Reshaid *et al.*, 2005).

There are three sequential stages in a typical design phase for most construction projects. The sequence and the required activities undertaken at each stage are presented in Figure 2.2. The sequential stages involved are; (1) schematic design

(SD) stage; (2) design development (DD) stage; and (3) construction document (CD) stage (Klinger and Susong, 2006; Al-Reshaid *et al.*, 2005).

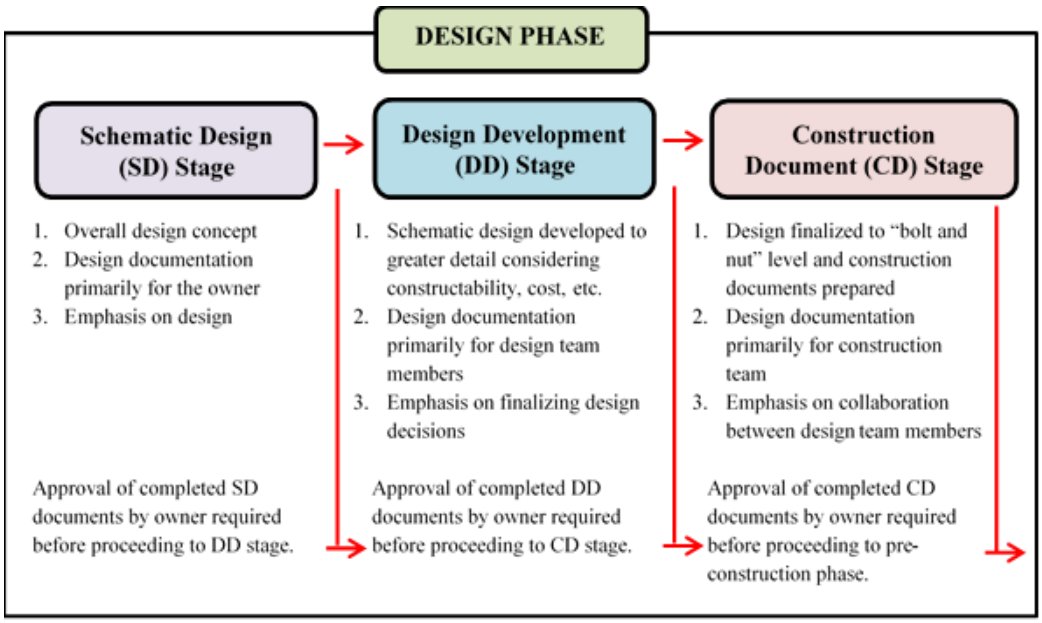

Figure 2.2: Three sequential stages of the design phase
Source: (Klinger and Susong, 2006; Al-Reshaid et al., 2005; Han, 2005)

2.4.2.1 Schematic Design Stage—Emphasis on Design

The schematic design development is mainly the responsibility of the architect who considers several design options normally with limited help from the other consultants on the project (Al-Reshaid *et al.*, 2005). The schematic design gives a graphic representation of the proposed project by illustrating key and critical ideas of the proposed design (Klinger and Susong, 2006). At this stage, a probable estimate of the project cost is generally produced to ensure that the proposed project is within budget (Al-Reshaid *et al.*, 2005).

There are usually several revisions to the schematic design by the architect until the project owner finally approves the design (Al-Reshaid *et al.*, 2005). The schematic design proposals come in various forms of drawings such as plans, elevations, sections, freehand sketches, and even three-dimensional scale model views in some cases (Klinger and Susong, 2006). However, in recent times due to significant improvements in technology, computer-generated images are gaining ground in architecture and related engineering fields making the understanding of schematic designs by the project owner easier. Therefore, computer-generated

walk-through and flyover simulations are now available to aid in communicating the architect's design intent to the project owner at this stage.

The sole aim of the schematic design is to communicate the architect's design scheme to the project owner and other consultants (Al-Reshaid *et al.*, 2005). Therefore, the schematic designs, regardless of how well they are produced, are not adequate to be used for the project construction (Klinger and Susong, 2006), hence the design development stage with emphasis on detailing.

2.4.2.2 Design Development Stage—Emphasis on Decision Making

This stage is where the schematic design that is approved by the project owner is further developed in greater detail (Al-Reshaid *et al.*, 2005). It involves strategic consultations with all members of the design team to ensure a more practical, pragmatic, and constructible design development (Klinger and Susong, 2006). Decision-making on broad design aspects to finer details is the most critical feature at this stage. It also involves decisions on products, materials, and equipment for the project (Al-Reshaid *et al.*, 2005). The efficient management of the design development determines the quality of the construction documents. Therefore, documentation is required where the specifications and probable cost of the project are more detailed (Klinger and Susong, 2006).

2.4.2.3 Construction Documents Stage—Emphasis on Documentation

All the necessary documents that will be required by the contractor(s) to execute the project are prepared at this stage. It is at this stage that the architect and the other consultants need to effectively collaborate to work out the "bolts and nuts" of the project and develop the required documentation with the highest level of quality (Klinger and Susong, 2006; Al-Reshaid *et al.*, 2005).

2.4.3 Pre-construction Phase

The two significant activities that are carried out during this phase are; (1) preparation of bidding or tendering documents; and (2) selecting of the General Contractor (GC) for the project (Klinger and Susong, 2006; Masterman, 2003).

2.4.3.1 Preparation of bidding or tendering documents

The preparation of the bidding or tendering documents is the responsibility of the entire design team of professionals (Al-Reshaid *et al.*, 2005). These documents are required for the successful construction of the proposed project. Under the DBB project delivery; these documents are needed by the GC to tender for the proposed project (Klinger and Susong, 2006; Masterman, 2003). These documents can be put into the following two main categories (Al-Reshaid *et al.*, 2005): (1) *construction documents* (construction drawings and specifications); and (2) *procurement and contracting requirements* which contain legal and contractual information that the GCs will require before preparing their tenders (Klinger and Susong, 2006; Al-Reshaid *et al.*, 2005).

2.4.3.2 Selecting the General Contractor (GC) and Project Delivery

The selection of the GC is carried out after the bidding or tendering documents are ready for the project. The selection is a very critical stage in the project life cycle and must be executed with enough care (Al-Reshaid *et al.*, 2005). However, the next two phases are the construction and post-construction phase but are not relevant to this research and therefore not presented since the focus of the research is on the early phases of project delivery.

2.5 Project Delivery Methods

This section presents a comprehensive literature review on various project delivery methods in use in the construction industry. It focused on the DBB, DB, CMAR and IPD Methods. The significant differences between the various delivery methods are also stated.

However, it is important to define a project delivery method before proceeding to the types. According to Touran *et al.* (2009, *p. 10*), "Project delivery method is a term used to refer to all the contractual relations, roles, and responsibilities of the entities involved in a project". Therefore, a *project delivery method* is a system well designed to achieve the satisfactory completion of a construction project from conception to occupancy. It may employ any one or more contracting methods to achieve its delivery (Patterson *et al.*, 2021; CMAA, 2012). According to Patterson *et al.* (2021), the method of project delivery chosen for a construction

project determines the processes by which the design, construction, and finance will go through. Most project delivery methods have evolved to fit a particular project and owner's needs because of financial, organizational and time constraints. However, most delivery methods used today are variations of three methods which are; Design-Bid-Build; Construction Management At-Risk; and Design-Build (Ashcraft, 2022; Patterson *et al.*, 2021; CMAA, 2012; Tenah, 2001).

A fourth project delivery method called the *Integrated Project Delivery*, although to date not widely used but on course to becoming the industry's favourite delivery method is also in existence. There are other project delivery methods but they are variations of these four (Patterson *et al.*, 2021; Aldossari *et al.*, 2021). Each project delivery method carries a different level of risk for the project owner (CMAA, 2012). However, none of these delivery methods is the perfect or right choice for every project. Therefore, the project owner must conduct a careful evaluation of the specific project requirements, goals, and potential challenges to choose the delivery method that offers the best opportunity for the project's success (Patterson *et al.*, 2021; CMAA, 2012). The use of the various project delivery methods in the construction industry is indicated in Figure 2.3.

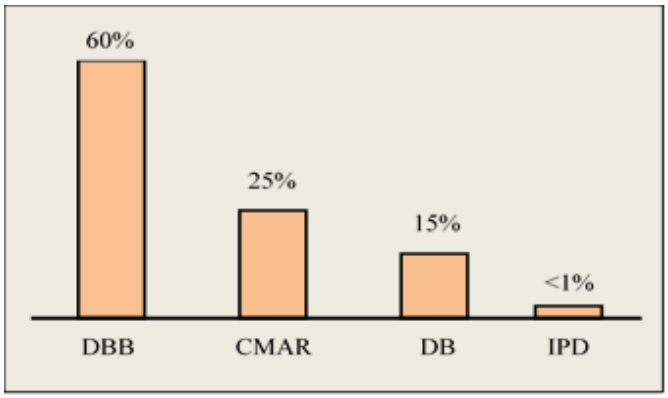

Figure 2.3: Approximate market shares of the various project delivery methods
Source: (CMAA, 2012)

From Figure 2.3, the conventional project delivery approach (DBB) alone accounts for about 60% of usage in the industry globally while the CMAR accounts for 25% of usage. The DB also represents 15% of use in the industry while IPD which is considered to be more efficient in delivering projects accounts for less than 1% of use in the industry. The industry has seen a substantial increase in the use of CMAR and DB methods over the years. The use of IPD has

also seen some attention recently, particularly in some developed nations. However, DBB is still the most prevalent and mainly used method globally (Aldossari *et al.*, 2021; CMAA, 2012). It is a widely used method in the industry globally despite its associated weaknesses (Nawi *et al.*, 2014).

2.5.1 Design-Bid-Build (DBB) Method

The DBB method is probably the most popular and common project delivery method in the construction industry to date (Salla, 2020; Sacks, 2013; Kululanga, Price and McCaffer, 2002). It is the most frequently used project delivery method for construction projects globally (Ashcraft, 2022; Salla, 2020; CMAA, 2012). This method makes use of a General Contractor normally referred to as the GC whose selection is carried out competitively. Under this method, design and construction are carried out by separate parties under separate contracts as two distinct and separate processes (Salla, 2020; Hutchinson, 1993).

This method encompasses all the processes in the delivery of a project from getting the owners brief, through design and documentation to actual project construction (Sacks, 2013; Osei-Tutu, 1999). The method involves three sequential phases of a project; the design phase where the project is designed; the bid or tender phase where a GC is procured; and the construction phase where the actual project construction is carried out by the GC (Sacks, 2013; CMAA, 2012).
With this method, tender or bid documents prepared by selected consultants are used (Ameyaw, 2009). These consultants are engaged by the project owner to design the project by producing drawings, specifications and other documentation necessary for the project (CMAA, 2012). The project owner receives tenders or bids from different GCs and the GC with the lowest competitive and responsive tender or bid that will offer the best value for money is selected to execute the project. The selected GC is then awarded the contract to carry out the construction activities in accordance with the contract documents provided normally together with specialist subcontractors on some projects (Ashcraft, 2022; Sacks, 2013; CMAA, 2012). The designer keeps an oversight responsibility of the project and is responsible for queries on behalf of the owner. The designer normally assists the project owner in administering the contract which includes determination of the progress of work, validation of interim payments, and others (CMAA, 2012).

However, the DBB method has been widely criticized for lack of collaboration and integration as weaknesses to project delivery (Nawi *et al.*, 2014). This results in cost overruns, delays and low quality of completed projects (Shoar and Payan, 2021; Mesa *et al.,* 2016). Other consequences are project reworks, lack of communication and coordination, wastages, conflicts and misunderstanding between design consultants and contractors (Nawi *et al.*, 2014; Nawi *et al.*, 2012; Kamar and Anuar, 2011; Nawi, Lee and Nor, 2011).

2.5.2 Construction Manager at Risk (CMAR) Method

This method is also *called CM at Risk* and is similar to the DBB. The difference is that the CMAR is considered a GC during the construction phase. The CMAR bears the risk of construction and guarantees project completion for a negotiated price usually established when the project design is about 50% to 90% developed (Sacks, 2013; CMAA, 2012). The CMAR also offers advisory and professional management services to the project owner prior to construction including schedule, budget and constructability advice during the planning and design phases. Therefore, the project owner deals with a hybrid CM who also doubles as the GC (Aldossari *et al.*, 2021; Gransberg and Gransberg, 2020; CMAA, 2012).

This method makes use of a Construction Manager (CM) and the GC. The approach is such that the roles of the CM and GC are performed by one entity, but the compensation for these roles is paid separately by the project owner (Gransberg and Gransberg, 2020). There is competitive bidding by subcontractors after design documents are produced and the work is usually awarded to subcontractors with the lowest bids (Aldossari *et al.*, 2021; Mesa *et al.*, 2016). The CMAR Company assumes all responsibilities for subcontractors' work as would a GC (Ashcraft, 2022; Gransberg and Gransberg, 2020).

2.5.3 Design-Build (DB) Method

The DB method integrates design and construction activities into one entity and entrusts it to one GC. It combines architectural and engineering design services with construction activities under one contract (Sacks, 2013; CMAA, 2012). Therefore, the project owner awards the contract to one firm with the

responsibility of designing the project and executing the construction (Ameyaw, 2009). The degree of design to be carried out by a GC is relative to the complexity of the project (Ashcraft, 2022; Knight, Griffith and King, 2002).

The DB firm is usually a GC that has a design team comprising of architects and engineers within the firm or uses a closely allied separate design firm (Sacks, 2013; Knight *et al.*, 2002). In this method, the owner loses some amount of control over the project when the contract is awarded to a DB firm and the architect does not represent the owner, as in the DBB method. Therefore, the result of the DB method must be well defined prior to the award of the contract for this method to succeed (Ameyaw, 2009; Rowlinson and McDermott, 1999).

However, a special version of the DB method is called the *turnkey method*, where the DB firm is responsible for securing the land, designing the project, undergoing the construction and also financing the project to completion.

2.5.4 Integrated Project Delivery (IPD)

IPD is a relatively new entry into the construction industry and very few projects have been executed using this contract (Walker and Rowlinson, 2020). However, the concept of IPD has been around for many years (CMAA, 2012). Generally, IPD started in the United States (US) construction industry (Nawi *et al.*, 2014). The concept was used on some health projects where the collaboration of all key participants was very paramount in its implementation (Liu, 2013).

Up until around 2006, there was a need for significant changes in the construction process globally to enhance quality project delivery (Walker and Rowlinson, 2020). Therefore, a shift from the conventional approaches to project delivery was paramount (Walker and Rowlinson, 2020). Based on this, the American Institute of Architects (AIA) and American Institute of Architects California Council (AIACC) collaboratively issued *Integrated Project Delivery: A Working Definition* (AIA and Construction, 2007) and *Integrated Project Delivery: A Guide* (AIA and AIACC, 2007) all in 2007. These documents provided the theoretical framework for IPD implementation and offered project owners and professionals the green light to operate IPD projects (Liu, 2013).

Contextually, IPD is a project delivery method that shares the risk, responsibility and liability for project delivery equally among the key participants whether through partnership agreements or multi-party contracts (Ashcraft, 2022; Walker and Rowlinson, 2020). It contractually requires collaboration among the key participants to aid in risk, responsibility and liability for project delivery (CMAA, 2012). Therefore, it is important to define IPD as being used in the industry.

2.5.4.1 Definition of IPD

Despite the varying definitions of IPD, the appropriate definition given by the American Institute of Architects (AIA) and American Institute of Architects California Council (AIACC) is a: *"project delivery approach that integrates people, systems, business structures, and practices into a process that collaboratively harnesses the talents and insights of all participants to optimize project results, increase value to the owner, reduce waste, and maximize efficiency through all phases of design, fabrication, and construction"* (AIA and AIACC, 2007, *p.1*). IPD brings key project members together at an early stage (El Asmar, Hanna and Loh, 2013) who have good interests and will ensure that project success is achieved (Fish, 2011). Various experts are brought together based on agreements that ensure risk and reward sharing, equal contribution, and the use of alternative processes and techniques aimed to achieve a project that is delivered at a reduced cost, time, and waste (Ilozor and Kelly, 2012).

IPD promotes harmony, collaboration, and integration among all team members. The members of the triad (owner, architect-engineer team, and contracting team) are integrated fully into one entity in IPD unlike DBB, DB and CMAR methods of project delivery (Ashcraft, 2022; Walker and Rowlinson, 2020). A pure IPD implementation contractually requires a multiparty agreement among the key participants in the design and construction process. However, this agreement can include many of the important sub-consultants and subcontractors as well. The reason for the multiparty is to have a team-based approach (CMAA, 2012).

IPD is aimed at assisting owners or clients, designers and constructors to improve construction productivity (AIA and Construction, 2007). In most cases, the "Big Room" concept where all the key project participants collaboratively work in the

same room to discuss, define and plan the sustainability and cost goals for the project is used to facilitate the process (Jones, 2014). Therefore, IPD projects are characterized by substantial co-location of team members who share office space and discuss issues in a collaborative manner (Walker and Rowlinson, 2020). IPD brings together all stakeholders who will contribute to the project (owner, architect, engineers, GC, subcontractors, fabricators, material suppliers, and users) at an earlier stage or design stage of the project (Walker and Rowlinson, 2020). It is an open project delivery process from inception to completion where participants promote continuous sharing of knowledge and expertise.

DBB and other conventional project delivery approaches are characterized by major project inefficiencies in practice due to the separation of responsibilities. Therefore, projects that are delivered under such approaches suffer because participants' success and project success are not necessarily related (Walker and Rowlinson, 2020). Consequently, there is a high possibility for some project team members to "succeed" notwithstanding the failure of the project. It is on this premise that IPD was brought into the construction industry. It seeks to introduce a behavioural change by removing the concept of separation of project participants and injecting the concept of close cooperation among all major participants, by aligning their success to project success (AIA and AIACC, 2007).

Compensation is very important in an IPD project. It serves as a motivation in most cases to project participants. Therefore, the key participants all sign one contract (multi-party contract) before starting the project in an IPD system (Becerik-Gerber and Kensek, 2010; AIA and AIACC, 2007). The aim is to create a group that is one by eliminating separate motives and separate contracts (Becerik-Gerber and Kensek, 2010). This principle drives the project participants to work toward a set of common goals (Nawi *et al.*, 2014). It significantly enhances collaboration among participants throughout the project by tying key participants' success to project success (Jayasena and Senevirathna, 2012; AIA and AIACC, 2007).

However, there are varying degrees of collaboration among project participants and it is the level of collaboration that determines IPD as a *Philosophy* or as a

Delivery method (Jayasena and Senevirathna, 2012). IPD as a Philosophy happens when a multi-party contract is not used and contrarily, it is thought of as a delivery method when a multi-party contract is signed by participants that employ the full principles of IPD (Jayasena and Senevirathna, 2012). Therefore, the principles on which IPD operates are very important in project delivery.

2.5.4.2 IPD Principles

There are numerous benefits of IPD that can be achieved in project delivery. However, these significant benefits can be achieved when all project participants embrace the embodiment of contractual and behavioural principles in IPD (AIA and AIACC, 2007). It is paramount for project participants to understand that the foundation of IPD is collaboration, which is tied to trust. Therefore, the existence of an effective and well-structured trust-based collaboration boosts the courage of project participants to mainly focus on the project outcome rather than their individual goals (Walker and Rowlinson, 2020).

It is also imperative to note that the enormous benefits of IPD cannot be achieved in the absence of trust-based collaboration. Therefore, the project participants in an IPD project must be willing to change from conventional practices and behaviours toward project delivery to enjoy the full benefits of IPD (Walker and Rowlinson, 2020). These changes are the principles on which IPD is founded. IPD has an embodiment of *contractual, behavioural* and *early involvement and collaboration of key participants* as categorized in Table 2.9 to Table 2.11.

Table 2.9 presents the contractual principles that are embedded in IPD. These principles are very significant in ensuring efficient project delivery (Agbaxode *et al.,* 2020). According to El Asmar *et al.,* (2013), the early involvement of key participants is necessary for delivering a successful project. It also enhances the process and team integration which is necessary for project success (Nawi *et al.,* 2014). The early contribution of knowledge and expertise by key participants enhances pro-activeness (Jayasena and Senevirathna, 2012) and improves critical collaborative value-based decision-making (Thomsen *et al.,* 2010) on a project. It also results in jointly and early developed project target criteria that lead to project success (Fish, 2011).

Table 2.9: IPD Contractual Principles

S/N	IPD Contractual Principles
1	Early involvement of key participants in the project.
2	Early contributions of knowledge and expertise by participants.
3	Making Collaborative value-based decisions.
4	Key participants are bound together as equals.
5	Jointly and early developed project target criteria.
6	When the success of key participants is tied to project success.
7	Key participants are jointly accountable for any errors in design.
8	Sharing financial reward (compensation) based on project outcome.
9	Sharing financial risk among key participants.
10	Utilization of new technologies and approaches.
11	Waiving liabilities between key participants.
12	When there is fiscal transparency between key participants.

Source: *(Agbaxode et al., 2020; Jayasena and Senevirathna, 2012; NASFA, COAA, APPA, AGC and AIA, 2010)*

Behavioural principles are very important in the successful delivery of construction projects (Agbaxode *et al.*, 2020). To maintain good relationships and conduct, key participants must have mutual respect and trust for each other (El-adaway, 2010). They must be determined to work towards achieving a set of common goals (Nawi *et al.*, 2014). They must also be willing to collaborate effectively as key participants (Hamzeh *et al.*, 2019; Nawi *et al.*, 2014).

Table 2.10: IPD Behavioural Principles

S/N	IPD Behavioural Principles
1	Key participants have mutual respect for each other.
2	Willingness to collaborate as key participants.
3	Effective collaboration as key participants.
4	Having mutual trust for each other.
5	Open communication among key participants.
6	Open information sharing among key participants.
7	Ensuring transparent processes throughout the project.

Source: *(Agbaxode et al., 2020; Jayasena and Senevirathna, 2012; NASFA, COAA, APPA, AGC and AIA, 2010)*

The principles of early involvement and collaboration of key participants are very significant in ensuring an efficient project delivery (Ashcraft, 2022; Agbaxode *et al.*, 2020). It enhances and strengthens the understanding of key participants about the owner's desired outcomes. It also enhances critical decision-making (Thomsen *et al.*, 2010) that significantly influences the successful delivery of the project. These notwithstanding, it offers an opportunity for adequate pre-design, design and pre-construction planning (AIA and AIACC, 2007).

Table 2.11: Principles of Early involvement and collaboration of key participants

S/N	Early Involvement and Collaboration of Key Participants
1	Key participants' understanding of the owner's desired outcomes is enhanced and strengthened.
2	Effective collaboration by all participants improves the quality of design documentation.
3	There is a more timely and informed understanding of the design.
4	Improvement in cost control, budget management and financial performance.
5	Providing an opportunity for adequate pre-design and design planning.
6	Providing an opportunity for strong pre-construction planning.
7	An improvement in the quality of the project.
8	Provides early and pre-construction anticipation and resolution of design-related issues.
9	Improvement in financial performance during the construction phase.
10	Early visualization of construction sequencing prior to commencing project.
11	There is the provision of adequate budget estimates to inform design decisions.
12	An increase in the level of effort by key participants during design phases results in reduced documentation time.

Source: *(Agbaxode et al., 2020; Jayasena and Senevirathna, 2012; NASFA, COAA, APPA, AGC and AIA, 2010)*

2.5.4.3 IPD Benefits

Substantial benefits and characteristics of IPD have given it the potential to become an international standard in the industry (Jayasena and Senevirathna, 2012). According to the AIA and AIACC (2007), IPD offers significant benefits to key participants. However, as a requirement for IPD implementation, there is a need for the key project participants to get involved from the earliest practical stage. This ensures an early and proactive involvement of key participants that can contribute their expertise at an early stage (Jayasena and Senevirathna, 2012). There is, therefore, an improvement in critical decision-making due to the expertise of key members, especially in the early phase of the project where decisions taken have a great effect (Thomsen *et al.*, 2010). This, therefore, enhances the quality of design documentation provided for project execution.

Motivation is very paramount for the success of IPD (Jayasena and Senevirathna, 2012), therefore, incentives are needed to enhance the process. A well-fashioned IPD contract uses economic incentives. It also creates an environment that reinforces teamwork and social incentives (O'Connor, 2009). The key focus of IPD is to increase collaboration amongst project participants, introduce incentives and increase value for money for owners (Raisbeck *et al.,* 2010). Apart from the early involvement of key suppliers and manufacturers, incentives, internal dispute resolution and collaboration, there is also a good relationship among project members and their conduct (El-adaway, 2010).

Despite the numerous benefits associated with IPD, there are barriers to its implementation. Kahvandi *et al.* (2019) in a study on analysis of Barriers to IPD implementation identified major factors as capital, organizational and environmental factors in various countries. Earlier research by Becerik-Gerber and Kensek (2010) asserts legal issues; financial; cultural; and technological factors as barriers. Therefore, the implementation of IPD in most countries is hindered by these barriers. However, there is a need to build a team in IPD.

2.6 Literature Gaps

There are various project delivery methods in use in the construction industry. The major delivery methods in use are the DBB, CMAR, and DB (Ma *et al.*, 2017; Mesa *et al.*, 2016; Harper *et al.*, 2016). However, the conventional project delivery approach (DBB) is the dominant and widely used method in the industry globally (Salla, 2020; CMAA, 2012). The DBB alone accounts for about 60% of usage in the construction industry globally while the CMAR accounts for 25% usage. The DB also represents 15% of use in the industry while IPD which is considered to be more efficient in delivering projects accounts for less than 1% of use in the industry (Aldossari *et al.*, 2021; CMAA, 2012).

The DBB is characterised by wide dissatisfaction as a result of its weaknesses (Agbaxode *et al.*, 2021*b*; Viana *et al.*, 2020). This often leads to acrimonious conflicts between various project parties (Rowlinson and McDermott, 2005). As a result of the weaknesses in the DBB, the DB and CMAR delivery methods were introduced as improvements over the conventional approach to address the weaknesses (Ashcraft, 2022; Rowlinson and McDermott, 2005).

The construction industry has seen a substantial increase in the use of CMAR and DB methods over the years. However, the DBB is still the most prevalent and mainly used method of project delivery globally (Aldossari *et al.*, 2021; CMAA, 2012). This notwithstanding, the extent of collaboration within all these delivery approaches is questionable (Agbaxode *et al.*, 2021*b*; Durdyev *et al.*, 2019; Ma *et al.*, 2018; Harper *et al.*, 2016; Mesa *et al.*, 2016). This is why practitioners and researchers have argued that these methods lack collaboration and integration, particularly at the design stage, which often leads to poor design documentation

quality (Durdyev *et al.*, 2019; Harper *et al.*, 2016; Mesa *et al.*, 2016; Nawi *et al.*, 2014). Therefore, there is a need for design documentation quality under the conventional approach to be improved since it is the widely used approach and at the same time embodies weaknesses that result in poor quality.

The weaknesses in the conventional project delivery approach result in poor quality design documentation (Agbaxode *et al.*, 2021*b*; Viana *et al.*, 2020). This leads to cost overruns, delays and low quality of completed projects (Shoar and Payan, 2021; Mesa *et al.*, 2016). Other consequences are project reworks, lack of communication and coordination, wastages, conflicts and misunderstanding between design consultants and contractors (Nawi *et al.*, 2014; Nawi *et al.*, 2012; Kamar and Anuar, 2011; Nawi *et al.*, 2011).

In an attempt to curb these consequences of the conventional approach, IPD was introduced (AIA and AIACC, 2007). While IPD usage is extremely slow in the industry, it has seen some attention recently, particularly in some developed nations (Walker and Rowlinson, 2020). This is due to its ability to overcome the weaknesses associated with the conventional project delivery approach (Walker and Rowlinson, 2020; Mesa *et al.*, 2016). IPD ensures better collaboration and integration between participants, particularly during design (Ashcraft, 2022; Hamzeh *et al.*, 2019; Fish, 2011; Raisbeck *et al.*, 2010).

There are significant barriers that hinder IPD adoption and implementation across the world (Kahvandi *et al.*, 2019) despite its numerous benefits. Capital, organizational, and environmental factors are the main barriers identified by Kahvandi *et al.* (2019). An earlier study by Becerik-Gerber and Kensek (2010) also asserted legal issues, financial, cultural, and technology as barriers. As a result of these barriers, researchers have indicated that the conventional approach to project delivery will continue for a long time since the industry is not yet positioned to adopt new technologies (Addy *et al.*, 2018). Therefore, there is a need for research to consider how the potential of IPD could help improve the processes in the conventional project delivery approach toward improving design documentation quality.

2.7 Theoretical and Conceptual Basis

Construction projects are delivered using project delivery methods. However, there are numerous methods in use in the industry globally. Most of these project delivery methods have evolved to fit a particular project and the owner's needs. The conventional project delivery approach is the widely used method in the industry across the world (Addy *et al.*, 2018; Mesa *et al.*, 2016; Nawi *et al.*, 2014; Fish, 2011). However, there has been wide dissatisfaction with this delivery approach as a result of its weaknesses in project delivery. The extent of collaboration among team members in this delivery approach is questionable. Industry practitioners and researchers have argued that this method lacks collaboration and integration, particularly during design, which often results in poor design documentation quality (Harper *et al.*, 2016; Mesa *et al.*, 2016). This has consequences of late completion of projects, poor project quality, and unnecessary cost-overrun (Shoar and Payan, 2021; Mesa *et al.*, 2016).

While the conventional approach is the widely used method in the industry, it requires a review, particularly towards the production of design documentation to enhance quality. This is because, it is important for design documentation to be of good quality by effectively communicating the design intent and be fit for purpose (Akampurira and Windapo, 2019; Tilley *et al.*, 2002). This is however not the case, particularly under the conventional project delivery approach. Instead, design documentation in practice is generally of poor quality and contains incomplete, inaccurate, and conflicting information (Akampurira and Windapo, 2019; Akampurira and Windapo, 2018; Laryea, 2011). This is attributed to the weaknesses that exist in the processes involved in producing design documentation under this approach (Harper *et al.*, 2016; Mesa *et al.*, 2016).

Construction industry changes and initiatives are required to resolve the problems of design documentation quality (Akampurira and Windapo, 2019). Effective collaboration and integration among the project team members are necessary particularly, during design to address the weaknesses. However, IPD as a delivery method offers improved project performance (Mesa *et al.*, 2016), and ensures

better collaboration and integration between participants, particularly during design (Hamzeh *et al.*, 2019; Fish, 2011; Raisbeck *et al.*, 2010).

Despite the numerous benefits associated with IPD, there are significant barriers that hinder its adoption and implementation in the industry across the world (Ashcraft, 2022; Kahvandi *et al.*, 2019; Becerik-Gerber and Kensek, 2010). Identification and use of the inherent potentials in IPD that ensures collaboration and integration are necessary to improve the conventional project delivery towards improving design documentation quality. Therefore, this research seeks to develop a framework to improve design documentation quality under the conventional project delivery approach by adapting the principles in IPD.

To achieve the research aim, *Systems Theory* and *Maturity Model* (MM) (Crawford, 2014) served as the foundation for this research. This was important considering their use in the construction industry when evaluation of an existing approach is required and also when there is the need to improve on the current level of productivity. Systems theory served as the basis to ascertain the current state of design documentation quality in practice under the conventional project delivery approach. It also helped in determining the weaknesses associated with the conventional project delivery approach.

Maturity model, on the other hand, helped in determining the required capabilities that must be acquired to improve performance under the conventional project delivery, particularly during design documentation production. It also helped to identify enablers inherent in IPD that can be adapted to improve design documentation quality under the conventional project delivery approach. Therefore, it is important to discuss both the systems theory and maturity model.

2.7.1 Systems Theory

By definition, systems theory is considered a universal theory about systems in nature, society, and scientific settings (Mele, Pels and Polese, 2010; Capra, 1996). Due to its universal nature, it has been used extensively in various fields and industries ranging from engineering to the sciences. It is a framework with which a phenomenon or any group of objects that work together to produce some result can be investigated or described (Mele *et al.*, 2010; Capra, 1996). Based on

these principles, the conventional project delivery approach was evaluated to determine its associated weaknesses and required capabilities. According to Bailey (1970), systems theory idea was developed and revealed by Ludwig von Bertalanffy, a biologist. Mesarovic and Takahara (1975) also described this theory as a scientific discipline that involves an explanation of various phenomena concerning the relationship between the factors involved.

Therefore, systems theory focuses on the relationships between the components relative to the functions of organizations and how they work together as a whole rather than the nature of the mechanisms involved (Chikere and Nwoka, 2015; Mesarovic and Takahara, 1975). Chikere and Nwoka (2015) regarded an organization as a system with integrated compositions that are coordinated to achieve efficiency. However, the effectiveness and efficiency of the system are determined by the organization and interaction of the components with each other (Clawson, 2008). Morris (1994) posited that systems theory is significant to how firms organize internally and how their response to tasks impacts project management. In this instance, the construction industry is considered as an organization in the context of systems theory and there was a determination of the functions of the industry. The industry function that is considered based on the research aim is the delivery of construction projects under the conventional project delivery approach with focus on the production of design documentation. It considers the relationships that exists among the project team members under the various project delivery methods and how this affects project delivery.

There have been conscious efforts by researchers and practitioners in understanding the contents and functions of systems (Mele *et al.*, 2010). This, however, historically evolved during the 19th century into the "systems theory" (Bogdanov, 1980; 1922; Von Bertalanffy, 1968). However, the main focus of systems theory is the relationship among observed features or attributes (Mesarovic and Takahara, 1975). Systems theory uses fundamental concepts and aspects of systems that aim to describe and explain complex phenomena (Mesarovic and Takahara, 1975). It views systems as processes and endeavours to ascertain the general relationships that exist among the components of any system and may be regarded as a conceptual approach to systems (Bailey, 1970). A

system from a management perspective involves a varying set of independent compositions that are interrelated and work together to achieve a whole (Chikere and Nwoka, 2015).

The objective of using systems theory in this research is to use the principles of this theory to understand construction project delivery particularly, the conventional project delivery. The focus is on the production of design documentation and the associated quality. It considered various project delivery methods in existence in the construction industry. The effectiveness of these delivery methods towards project delivery is considered. The focus was on the conventional project delivery and IPD approaches. The nature of these project delivery approaches was determined. This resulted in determining the weaknesses of the conventional approach and enablers that are required to improve design documentation quality. The assumption was that these approaches can be viewed as a system of project delivery and be described within the framework of systems theory. To achieve the research aim, it was necessary to determine whether the conventional project delivery approach is effective in delivering quality design documentation. Therefore, the maturity model was considered important in carrying out this research.

2.7.2 Maturity Model (MM)

By definition, the maturity model is a tool that aids in evaluating the current state of the effectiveness of a system (Fowler, 2014). The principles of the maturity model helped in ascertaining the current state of design documentation quality in practice under the conventional project delivery approach. It also helped to determine capabilities that must be acquired from a system to improve upon performance or to advance to the next level (Fowler, 2014). This principle leads to the identification of inherent weaknesses associated with the conventional project delivery approach and the capabilities required to improve the quality of design documentation.

The purpose of a maturity model according to Kerzner (2019, *p. 21*) "is to assess the execution of the delivery system, seek out areas for improvement, establish a continuous improvement baseline, and then reassess performance periodically to

see if continuous improvements were implemented". The outcome will indicate appropriate changes to be made to project management processes to enhance performance (Kerzner, 2019). This led to the identification of enablers inherent in IPD that can be adapted to improve design documentation quality. However, "the purpose of conducting maturity model assessments is not only to improve the project delivery system but also to improve the deliverables and outcomes of the system" (Kerzner, 2019, *p. 22*). This supported the premise of this research which is to improve design documentation quality which is a deliverable under the conventional project delivery.

While there are variations of maturity models applicable in different sectors, the Project Management Institute's (PMI) Guide to the Project Management Body of Knowledge (PMBoK) MM was considered more appropriate for this research. This is because this research seats within the project management domain. According to Crawford (2015, *p. 4*), the PMI-PMBoK "is an excellent point of reference for starting an examination of project management capability". The PMI-PMBoK is an established and accepted standard encompassing best practices in the project management sector (Crawford, 2015). This includes the effective management of construction works and their related activities. The PMI-PMBoK maturity model is based on all project management knowledge areas and is carved after the Capability Maturity Models of the Software Engineering Institute (SEI) (Crawford, 2015). The project management maturity model (PMMM) provides the foundation for achieving effective project management (Kerzner, 2019).

On this premise, it is important to refer to the appropriate body of knowledge in research on design documentation which is a deliverable under construction project delivery. Therefore, the choice of the PMI-PMBoK maturity model in carrying out this research is considered appropriate. The PMMM by the PMI-PMBoK is presented in Figure 2.4 showing the five levels of maturity. Each level in project management represents a different degree of maturity (Kerzner, 2019).

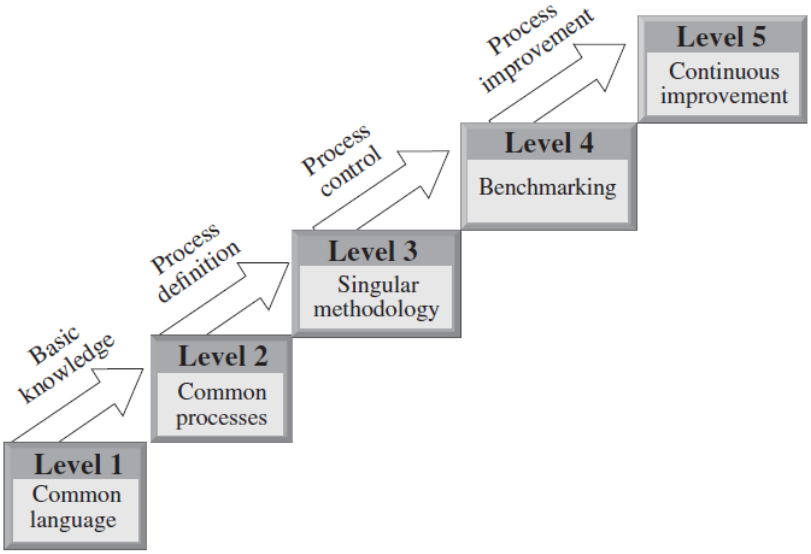

Figure 2.4: Levels of PMMM according to the PMI
Source: (Kerzner, 2019)

The levels as described by Kerzner (2019) are as follows: *Level 1: Common language;* the need to recognize the importance of project management and the need for a good understanding of its basic knowledge and the accompanying language or terminology. *Level 2: Common processes;* the need to identify common processes with good definitions and well-developed for repetitive use on other projects to achieve success. *Level 3: Singular methodology;* the organization recognizes the effect of combining all corporate methodologies in project management into a singular methodology. This makes process control easier than having multiple methodologies. *Level 4: Benchmarking;* process improvement is very necessary to maintain a competitive advantage at this level. Therefore, benchmarking must be continuous and the organisation must decide whom and what to benchmark. *Level 5: Continuous improvement;* the information obtained through benchmarking must be well evaluated to determine the potential of the information for enhancing project management processes.

According to Kerzner (2019, *p. 21*), the purpose of the PMMM is; "to assess the execution of the delivery system, seek out areas for improvement, establish a continuous improvement baseline, and then reassess performance periodically to see if continuous improvements were implemented". The results may indicate required changes to project management processes. Moreover, the purpose of the

PMMM evaluation is not only to improve the project delivery system but also to improve the various deliverables and outcomes of the system (Kerzner, 2019).

The application of MM helps in achieving excellence in project management (Crawford, 2014); therefore considered appropriate for research that seeks to improve the quality of design documentation. MM helps to improve quality and aid in successful project delivery (Demir and Kocabaş, 2010). As a result, it is appropriately helpful in improving the processes involved in the delivery of design documentation under the conventional project delivery approach.

In elaborating on the PMI-PMBoK PMMM, Erickson (2016) and Fowler (2014) further presented the characteristics of the various levels of maturity as presented in Figure 2.5 and Figure 2.6. The model is structured as a series of levels of performance effectiveness (Demir and Kocabaş, 2010), comprising five levels. However, each level represents a different stage of maturity (Crawford, 2014; Wysocki, 2004). The characteristics of the amount of collaboration, automation and the process involved at each stage are presented in Figure 2.5. This includes; the initial stage, the managed stage, the defined stage, the measured stage and finally the optimized stage. Each stage is unique and requires certain characteristics to keep it functional. The initial stage is considered the infant stage while the optimized stage is considered the matured stage of a project.

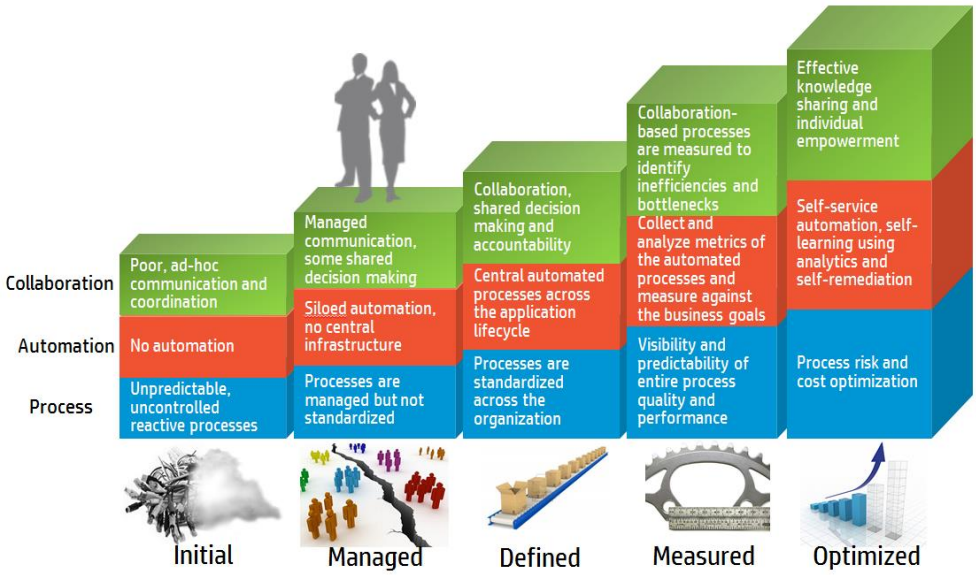

Figure 2.5: Maturity Model
Source: (Erickson, 2016)

It is important to understand that the real outcome of a maturity model is not what level a system is currently operating, but more importantly, the list of capabilities that must be acquired to improve to the next level, as indicated in Figure 2.6.

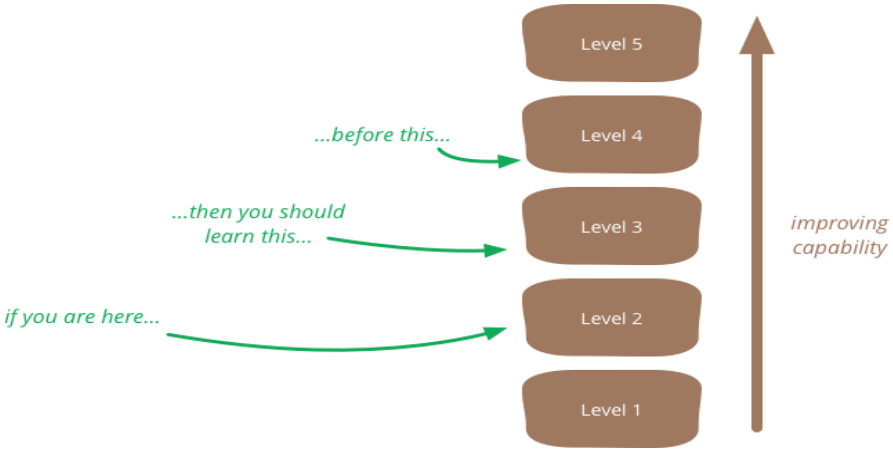

Figure 2.6: Levels of Maturity Model
Source: (Fowler, 2014)

A maturity model posits that the current state of the effectiveness of a system needs to be evaluated to determine the required capabilities that must be acquired to improve performance to the next level. In light of this, since the conventional project delivery approach produces poor design documentation quality, there was the need to look out for capabilities required that must be incorporated into the system to improve performance. Determination of the level at which this project delivery approach is currently performing is important to consider the capabilities required to mature to the next level to improve performance. There is a need for better collaboration, integration, application of incentives, and accountability in this project delivery approach to improve design documentation quality. Based on these foregoing discussions, the systems theory and maturity model influenced the conceptual framework for this research.

2.7.3 The Research Conceptual Framework

The foregoing discussions on the development of a framework within the conventional project delivery to improve design documentation quality by adapting IPD approach are summarised in the conceptual framework in Figure 2.7. It focused on the identification of inherent weaknesses associated with the conventional project delivery approach and the capabilities required in the

approach, particularly during the production of design documentation. It further identified enablers inherent in IPD that can be adapted to improve design documentation quality within the conventional project delivery approach. All these were achieved based on the application of the principles in systems theory and maturity model as presented earlier in this chapter.

The specific enablers that were identified to improve design documentation quality as used in developing the framework include effective collaboration; enhanced understanding of owner's desire; better understanding of the design; participants' success equals project success; transparent processes; early involvement of key participants; accountability for errors in design; sharing financial risk; fiscal transparency; mutual respect and trust for each other; and new technologies and approaches.

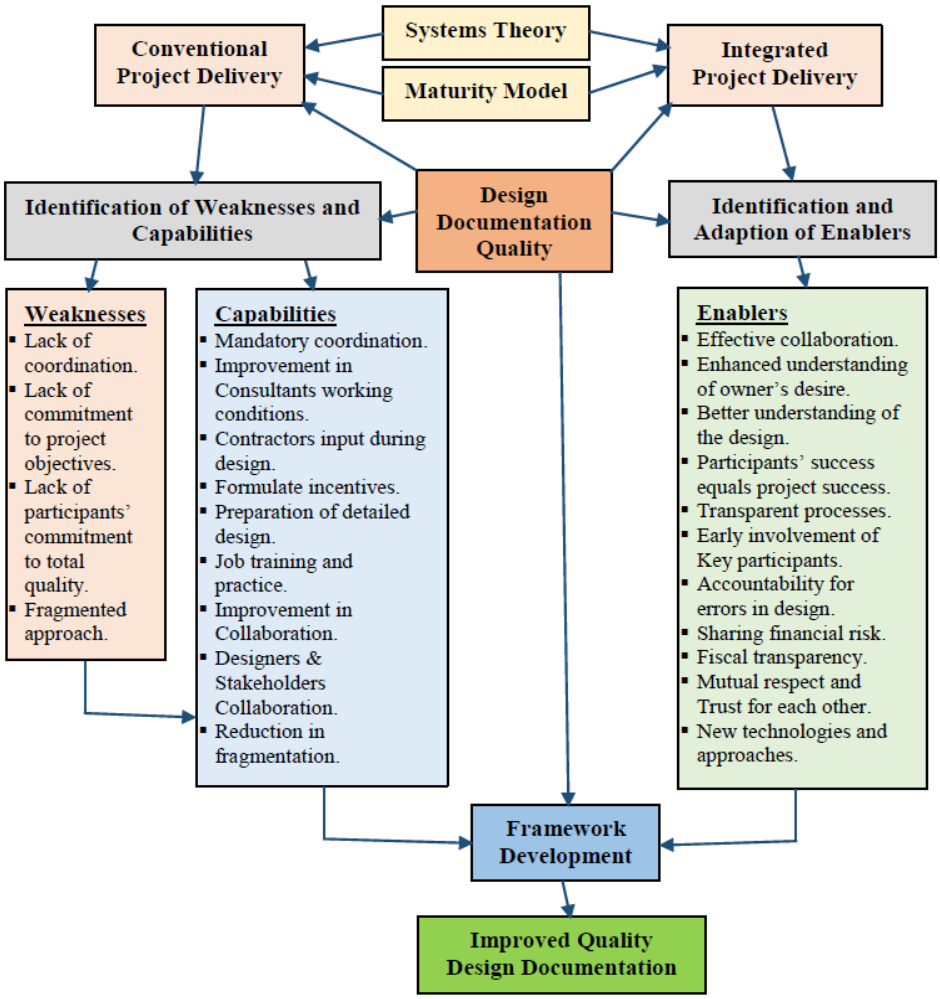

Figure 2.7: Conceptual Framework
Source: Researcher

It is important to indicate the relevant bodies of knowledge within which this research seats since it tends to influence the research findings.

2.8 Relevant Bodies of Knowledge

Different project management practices exist globally. The major ones are; Project Management Body of Knowledge (PMBOK); Association of Project Management Body of Knowledge (APMBOK); and Contract Management Body of Knowledge (CMBOK) (Chin, Yap and Spowage, 2010; Norby, Smith and Smith, 2004).

2.8.1 The Project Management Body of Knowledge (PMBOK)

The Project Management Body of Knowledge (PMBOK) is developed by the United States Project Management Institute (PMI) and is considered a global project management framework (Karaman and Murat, 2015; Chin *et al.,* 2010). It is also considered the most authoritative and best practice guide to project management and is globally seen as the de-facto standard of project management knowledge (Norby *et al.,* 2004; Morris, 2002). It contains global standards for managing projects with ten knowledge areas, five process groups and 47 processes (Morris, 2002). The *knowledge areas* are; scope, integration, time, cost, quality, human resource, communications, procurement, risk, and stakeholder management while *process groups* involve; initiating, planning, executing, monitoring and controlling and closing (Morris, 2002).

2.8.2 Association for Project Management Body of Knowledge (APMBOK)

The Association for Project Management (APM) in the United Kingdom developed the Association of Project Management Body of Knowledge (APMBOK) (Norby *et al.,* 2004; Morris, 2002). The APMBOK consists of 40 key areas which are into four major groups; project management, organization and people, processes and procedures and general management (Norby *et al.,* 2004). The APMBOK is regarded as one of the most influential and comprehensive considering the required knowledge for successful project completion (Norby *et al.,* 2004).

2.8.3 The Contract Management Body of Knowledge (CMBOK)

The Contract Management Body of Knowledge (CMBOK) defines the knowledge requirements for contract management (Norby *et al.,* 2004). It is often used by practitioners, researchers and governing bodies to advance contract management. The CMBOK includes generally accepted contract management practices and modified practices with three main sections which are; foundation or core competencies; subject matter competencies; and job or task level competencies (Norby *et al.,* 2004).

2.8.4 Comparison of Relevant Bodies of Knowledge

The PMBOK is the most widely accepted project management standard globally compared to other existing standards while having a broader and higher level overview of project management than the others (Ghosh *et al.,* 2012). The strength and capabilities of the PMBOK far outweigh that of the others (Norby *et al.,* 2004). The PMBOK is regarded as a well-structured approach to project management which has been used in various industries and sectors to manage projects regardless of the project nature or scope unlike the other bodies of knowledge (Norby *et al.,* 2004; Morris, 2002). It has the most descriptive body of knowledge areas compared to the others making its concept easier to understand and comprehend (Norby *et al.,* 2004).

The PMBOK has more focus on project stakeholder management which considers stakeholder satisfaction as one of the key goals of the project including user involvement unlike the other bodies of knowledge (Morris, 2002). The APMBOK usage is more locally dominant unlike the PMBOK however, it is comprehensive in managing projects in various industries and its use is targeted at project management professionals who have the requisite knowledge and experience (Norby *et al.,* 2004). However, design documentation production falls within these three main relevant bodies of knowledge, as presented in Figure 2.8.

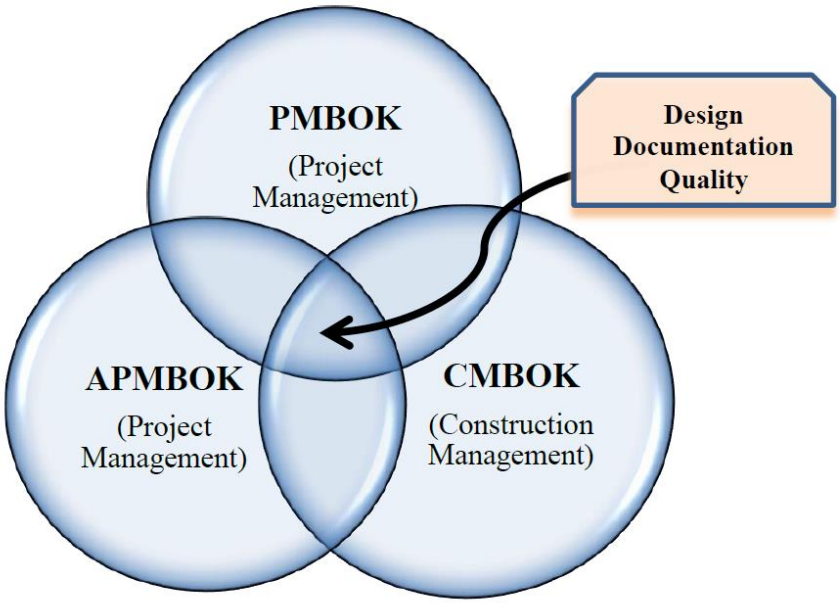

Figure 2.8: Relevant Bodies of knowledge
Source: Researcher

These bodies of knowledge serve as the basis for design documentation production for construction projects. They provided the basis for identifying the body of knowledge within which this research seats in the construction industry.

In consideration of the foregoing discussions on the bodies of knowledge, research on design documentation quality is best positioned within these three main bodies of knowledge as presented in Figure 2.8. However, it is more appropriate based on the enormous benefits and strengths of the PMBOK over the others as gathered from the ensuing comparison to further align this research to the PMI-PMBOK.

2.9 Chapter Summary

An overview of the construction industry is presented in this chapter. There is a consideration of the contributions the industry makes to the national socio-economic development of nations globally and locally. It further discusses the literature on design documentation and its quality issues in practice since the aim of this research is to improve the quality of design documentation in practice. Literature indicates that design documentation in practice is generally poor or deficient under the conventional project delivery approach and is a major concern due to its global dominance. The chapter also presents literature on project

delivery phases and methods in the construction industry since these methods influence the quality of design documentation. The phases can be put into five termed project delivery phases which are; the pre-design phase; design phase; pre-construction phase; construction phase; and post-construction phase.

The execution of the project is done through project delivery methods which are; DBB; CMAR; DB; and IPD. The oldest and the most familiar and widely used method in the industry is the DBB (conventional project delivery). However, IPD is the newest project delivery method and it is still evolving in the industry. While the conventional approach is characterised by numerous weaknesses, particularly during the production of design documentation, the enablers in IPD can be adapted to this approach to improve the processes involved.

It is important to consider the theoretical orientation and the conceptual framework for this research to achieve the aim. Therefore, *Systems Theory* and *Maturity Model* (MM) served as the foundation for this research. Systems theory served as the basis to ascertain the current state of design documentation quality in practice. It also helped in determining the weaknesses associated with the approach. The maturity model, on the other hand, helped in determining the required capabilities that must be acquired to improve performance. It also helped to identify enablers inherent in IPD that can be adapted to improve design documentation quality. This subsequently helped in the formulation of the conceptual framework for this research.

CHAPTER 3

RESEARCH DESIGN AND METHODOLOGY

3.1 Introduction

This chapter contains the research design, methods employed, data gathering, and analysis techniques that were used for this research. Research methodology can be explained as a systematic investigation or inquiry that deals with data collection, analysis, and interpretation (Burns, 1997). It is done to enhance understanding, description, prediction, or control of a phenomenon (Mackenzie and Knipe, 2006). It can be seen as a blueprint that specifies strategies for data collection, analysis, and presentation (Burns and Bush, 2003). It is an all-encompassing framework that embodies philosophies and assumptions that are paradigmatic to validate various reasoning. Research methodology provides strategies and techniques for conducting a study and can be classified as quantitative (positivism) and qualitative (phenomenology) (Denzin and Lincoln, 2011). The research design onion in Figure 3.1 presents the research philosophy, approach, methodological choice, strategies, time horizon, techniques, and procedures as used in this study.

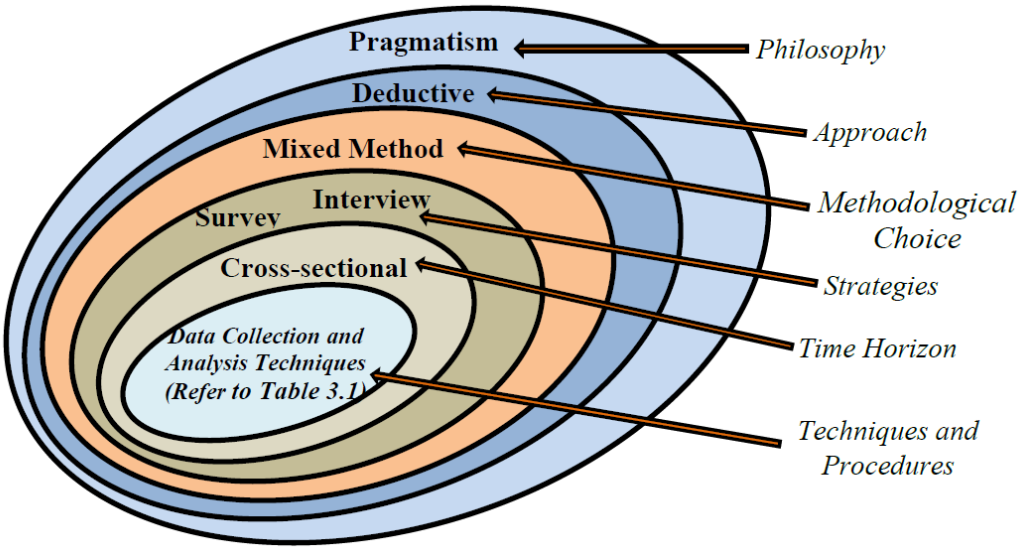

Figure 3.1: Research Design Onion
Source: (Adapted from Saunders, Lewis, and Thornhill, 2016, p.164)

However, the research methodology that was employed for this research is presented in a simplified form in Table 3.1.

Table 3.1: Methodology

S/N	Objectives	Hypotheses	Research Method	Data Collection Strategy	Tools	Data Analysis and Presentation
1	To ascertain the current state of design documentation quality in practice under the conventional project delivery approach.	H_{A1}	Literature Review	Meta-synthesis	NVivo	Qualitative Data Analysis (Descriptive and Pattern coding)
			Survey	Questionnaire	SPSS	Factor Analysis, Correlation, Regression
2	To identify inherent weaknesses associated with the conventional project delivery approach and capabilities required in the production of design documentation.	H_{A2}	Literature Review	Meta-synthesis	NVivo	Qualitative Data Analysis (Descriptive and Pattern coding)
			Survey	Questionnaire	SPSS	Factor Analysis, Correlation, Regression
				Semi-structured Interviews	NVivo	Qualitative Data Analysis (Descriptive and Pattern coding)
3	To identify enablers inherent in IPD that can be adapted to improve design documentation quality.	H_{A3}	Literature Review	Meta-synthesis	NVivo	Qualitative Data Analysis (Descriptive and Pattern coding)
			Survey	Questionnaire	SPSS	Factor Analysis, Correlation, Regression
				Semi-structured Interviews	NVivo	Qualitative Data Analysis (Descriptive and Pattern coding)
4	To develop a framework within the conventional project delivery approach to improve design documentation quality.		Literature Review and Survey data	Content analysis Content analysis	NVivo	Framework development

Source: Researcher

The research methodology, as presented in Table 3.1, indicates the specific objectives as set for this research with corresponding research methods, data collection and analysis tools and research hypotheses. This notwithstanding, the research philosophy and the philosophical stance for this research are very significant.

3.2 Research Philosophies

Research philosophy can be regarded as a system of beliefs and assumptions about the development of knowledge in a specific field (Saunders, Lewis and Thornhill, 2016). Research philosophies are mainly distinguished by three types of research assumptions: ontology, epistemology, and axiology (Opoku, Ahmed and Akotia, 2016). *Ontology* refers to assumptions about the nature of reality while *Epistemology* refers to assumptions about knowledge and is concerned with what constitutes acceptable, valid and legitimate knowledge (Saunders, Lewis and Thornhill, 2019). *Axiology* refers to how researchers' values and ethics influence the research process (Saunders *et al.,* 2016; Fellows, 2009). The two main arguments that influences research are; *objectivism and subjectivism* (Knight and Ruddock, 2009).

Objectivism argues that the social reality of research (social actors) is external to the researcher and the research is independent of the researcher (Saunders *et al.,* 2019). Axiologically, objectivists pursue research that is free of values that could bias their findings because social entities and social actors exist independently of each other (Saunders *et al.,* 2019; Opoku *et al.,* 2016). They try as much as possible to detach themselves from their values and beliefs throughout the research process.

Subjectivism, argues that social reality is made from the perceptions and consequent actions of social actors (Saunders *et al.,* 2019). While objectivism seeks to discover universal facts and laws governing social behaviour, subjectivism seeks different opinions and narratives to account for different social realities (Saunders *et al.,* 2019; Fellows, 2009). The focus of this research is to improve design documentation quality; therefore, both objective and subjective views of respondents and participants are important in achieving the aim. This resulted in analyzing and presenting the data collected in its true state to prevent bias and researcher's influence.

3.2.1 Types of Research Philosophies

There are five major philosophies in research which are: positivism, critical realism, interpretivism, postmodernism, and pragmatism (Saunders *et al.,* 2019). *Positivism* involves working with an observable social reality to produce generalizations. It is designed to produce pure data and facts that are free from bias (Opoku *et al.,* 2016; Saunders *et al.,* 2016). *Critical Realism* aims to explain what is seen and experienced based on the underlying structures of reality (Saunders *et al.,* 2019). *Interpretivism* aims at the creation of new, richer, and deeper understandings and interpretations of social worlds and contexts (Knight and Ruddock, 2009). *Postmodernism* aims to radically challenge established ways of thought and knowledge (Kilduff and Mehra, 1997). The fifth philosophy (i.e. pragmatism) is presented in the ensuing section.

3.2.2 Philosophical Choice for this Research

The philosophical basis for this mixed-method research is consistent with pragmatism as presented in Figure 3.1. This enabled the use of quantitative and qualitative research methods to explore data. Pragmatist starts research based on a problem with a focus on contributing solutions that are practical. They value reality as the practical effects of ideas and knowledge. Pragmatism posits that concepts are only relevant when they support action (Kelemen and Rumens, 2008). Pragmatism helped provide practical solutions rather than abstract distinctions and allowed for variations in the research in terms of objectivity and subjectivity (Saunders *et al.,* 2019). Pragmatism for mixed methods opens the door to multiple methods, different worldviews, assumptions, and different forms of data collection and analysis (Creswell, 2003). Another important element is the approaches to theory development.

3.3 Approaches to Theory Development

There are three contrasting approaches to reasoning in terms of a theory which are; *deductive, inductive,* and *abductive* (Saunders *et al.,* 2019; Opoku *et al.,* 2016). Saunders *et al.* (2019) explained these approaches as follows. The *deductive approach* starts with a theory mainly developed from the literature and designing a

strategy to test it. Conversely, the *inductive approach* starts by collecting data to explore a phenomenon and often results in building a theory. The *abductive approach* involves collecting data to explore a phenomenon usually resulting in the generation of a new or modification of an existing theory. However, the nature of the research aim and emphasis determines the direction of reasoning (Saunders *et al.,* 2019).

Therefore, a deductive approach was employed to address the aim of this research as presented in Figure 3.1. It sought to design a strategy to address the research aim by thoroughly reviewing literature and conducting surveys, which are the basis of a deductive approach (Saunders *et al.,* 2019; Knight and Ruddock, 2009). However, the research design is an important part of research and hence necessary in this research.

3.4 Research Design

The research design is the general plan of how the research questions are answered, and must clearly define the means. The research design should contain the research objectives, data collection (sources and methods), analysis, ethical issues and likely constraints (Saunders *et al.,* 2019; Opoku *et al.,* 2016). It includes; methodological choice, research purpose, research strategy(ies), and choice of time horizon.

It is the research design that drives the research; hence, there is a need to recap the focus of the research at this stage. As indicated in the background statement, the project delivery method adopted significantly impacts the efficiency of the project (Hamzeh *et al.*, 2019). It determines design documentation quality, hence influencing project delivery (Tuhacek and Svoboda, 2019; Akampurira and Windapo, 2018; Abdallah *et al.,* 2018). There are numerous project delivery methods in use; however, the conventional approach is the most widely used method across the world (Harper *et al.,* 2016; Mesa *et al.,* 2016). Its usage will continue for a long time since the industry is not yet positioned to adopt new delivery methods (Addy *et al.,* 2018). However, practitioners and researchers have argued that there are significant weaknesses in the processes involved with this delivery approach particularly in producing design documentation. This often leads to poor design documentation quality (Harper *et al.*, 2016; Mesa *et al.*, 2016; Nawi *et al.*, 2014).

It is indicative in the literature that design documentation in practice is generally poor and contains information that is incomplete, conflicting, or erroneous (Akampurira and Windapo, 2018; Laryea, 2011). This warrants industry changes and initiatives to resolve the problems of design documentation quality (Tilley *et al.*, 2002). However, Nawi *et al.* (2014) posited that there is a need for integrating processes and teams, particularly during the design stage as a key driver of change for a successful industry. Therefore, this research aims to develop a framework to improve design documentation quality by adapting IPD approach using the following objectives:

i. To ascertain the current state of design documentation quality in practice under the conventional project delivery approach.
ii. To identify the inherent weaknesses associated with the conventional project delivery approach and capabilities required in the production of design documentation.
iii. To identify enablers inherent in IPD that can be adapted to improve design documentation quality.
iv. To develop a framework within the conventional project delivery approach to improve design documentation quality.

In achieving these objectives, the mixed methods research design presented in Figure 3.2 was employed. The relevance of the mixed method is to combine both quantitative and qualitative features to tackle a specific research problem (Creswell and Creswell, 2017; Knight and Ruddock, 2009). This gives more vigorous research in addressing a specific problem rather than using just one approach. It focuses on the processes of designing the research by stating how the research questions will be turned into a research project by ensuring coherence throughout the process (Saunders *et al.*, 2019; Opoku *et al.*, 2016). The diagrammatic view in Figure 3.2 shows how both quantitative and qualitative methods were used in carrying out this research to achieve the specific objectives.

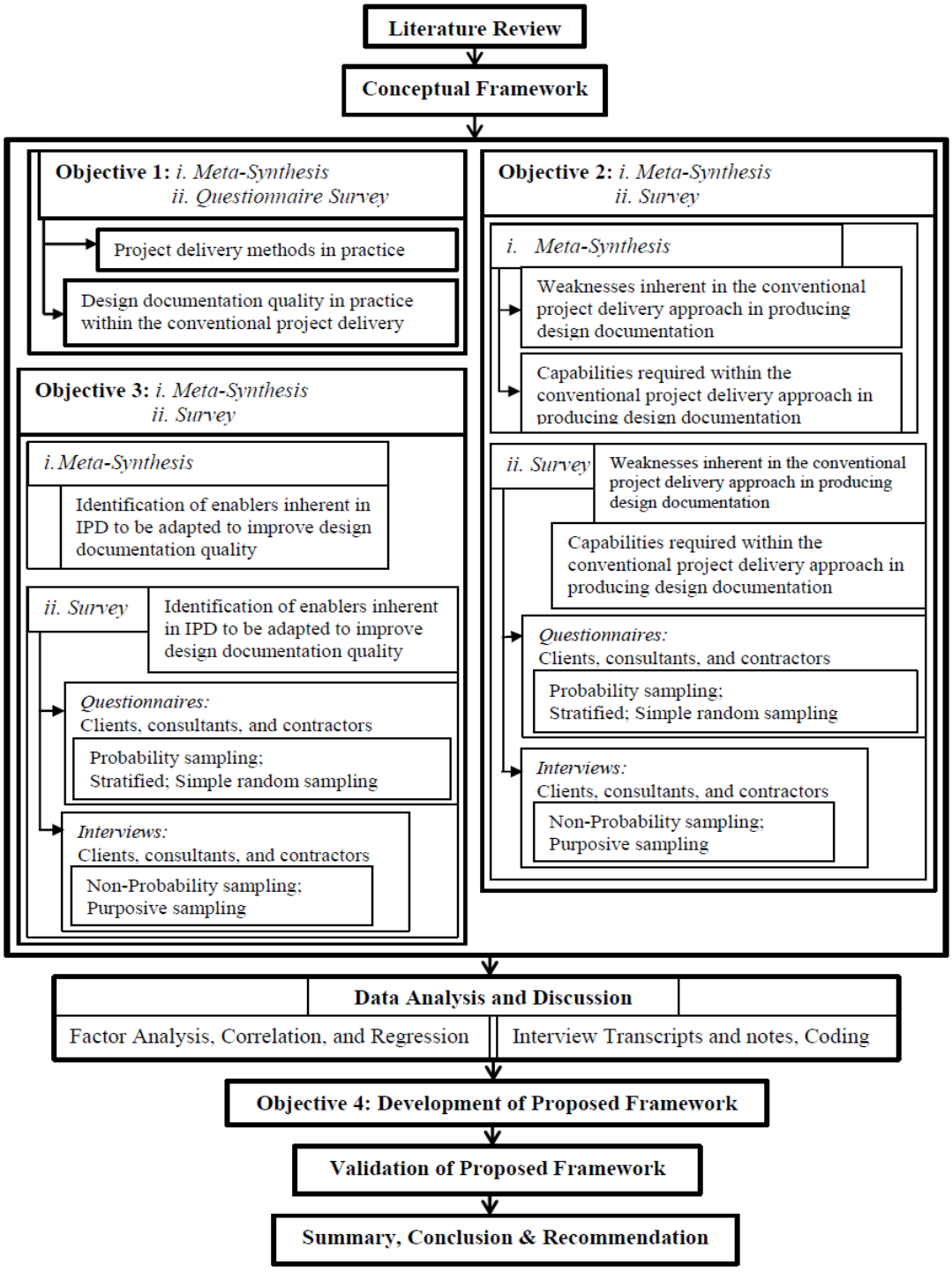

Figure 3.2: A mixed method research design
Source: Researcher

Table 3.1 presents the research tactics which specify details of data collection and analysis (Saunders *et al.*, 2019). There is a need to present the methodological choice.

3.4.1 Methodological Choice

The first decision in carrying out research is the consideration of a methodological choice. The choice of a particular approach takes into account the kind of research problem under investigation and the possibility of the chosen method to effectively provide reliable solutions. The three main choices in use are; *quantitative*, *qualitative*, and *mixed* methods (Creswell and Creswell, 2017; Saunders *et al.,* 2016). To enhance coherence in research, the choices may be mixed (Saunders *et al.,* 2019).

3.4.1.1 Quantitative Research Method

A quantitative approach is associated with positivism, especially when predetermined and highly-structured data collection techniques are used (Saunders *et al.,* 2019). The focus is to collect data that is factual to critically examine specific trends that exist between facts and their relationship with theories and existing literature (Creswell and Creswell, 2017; Saunders *et al.,* 2016). In choosing this approach, the problem to be investigated must be measured, and the cause must exist as well as the ability to generalize (Bryman and Becker, 2012). It is usually characterized by a deductive approach and may at times follow an inductive approach (Leedy and Ormrod, 2013).

3.4.1.2 Qualitative Research Method

Qualitative research is associated with interpretive philosophy because the meanings expressed about the phenomenon under study must make sense both subjectively and socially (Saunders *et al.,* 2019). It results in robust and detailed findings that ensure that the opinions of respondents are intact in carrying out the research (Yin, 2015). The views of respondents on different problems are the hallmark of qualitative research (Creswell and Creswell, 2017). This method demonstrates methodological rigour and theoretical contributions (Saunders *et al.,* 2019; Bansal and Corley, 2011).

3.4.1.3 Justification for Adopting the Mixed Method Research Approach

The mixed-method research was used to sufficiently tackle the research problem and accomplish the objectives of this research. It provided a premise for a better understanding of the research problem and allowed for an in-depth exploration and data collection (Creswell and Creswell, 2017; Saunders *et al.,* 2016). It aims to

combine both quantitative and qualitative features to sufficiently address the research problem (Creswell and Creswell, 2017; Tashakkori and Teddlie, 2010). It offers a more robust approach compared to using just one method. Since more than one phase of data collection was involved, a mixed sequential research design (quantitative followed by qualitative) was employed (Saunders *et al.,* 2019; Opoku *et al.,* 2016).

In a mixed-method, knowledge claims are based on pragmatic grounds such as problem-centred (Creswell, 2003). This is because the method is highly influenced by pragmatism and may employ a deductive, inductive, or abductive approach in the development of a theory (Saunders *et al.,* 2019). Therefore, this approach allowed different kinds of data to be collected and interpreted using different techniques. It helped in generalizing the research findings to the population for a more elaborate meaning (Creswell and Creswell, 2017). According to Dudwick *et al.* (2006), a mixed-method gives better hypotheses development, better data collection, deeper insight into the analysis and results; and triangulation of the findings. However, the research design chosen and its purpose is paramount in research.

3.4.2 Research Design and Justification

Research design is based on its nature; thus *exploratory, descriptive, explanatory,* or *evaluative* in purpose, or a *combination* of two or more (Saunders *et al.,* 2019; Opoku *et al.,* 2016; Knight and Ruddock, 2009). It is important to critically think about the research in terms of the questions to be asked, as this determines the research focus (Saunders *et al.,* 2019). This research is aimed at developing a framework to improve design documentation quality by adapting IPD approach. Therefore, a combination of exploratory and evaluative nature was assumed to efficiently address the aim.

An evaluative approach helped in finding out the performance of the conventional project delivery approach (Saunders *et al.,* 2019). This approach helped address the first and second objectives which are; *"to ascertain the current state of design documentation quality in practice, and to identify inherent weaknesses associated with the conventional project delivery approach and capabilities required in the production of design documentation"*. This approach allowed an assessment of the

performance of project delivery methods in producing design documentation. It allowed for comparison of the various methods to enable a theoretical contribution by emphasizing an understanding of both 'how effective' the conventional approach is and, 'why', by comparing this to IPD (Saunders *et al.,* 2019; Fellows, 2009).

However, an exploratory approach allowed open-ended questions to be asked to discover happenings and gain a deeper understanding of the problem or phenomenon (Saunders *et al.,* 2019). This helped address the third and fourth objectives of this research, which are *"to identify enablers inherent in IPD that can be adapted and to develop a framework within the conventional project delivery approach to improve design documentation quality"*. This allowed an extensive literature search and an in-depth interview of experts in the subject area to collect data (Saunders *et al.,* 2019). However, the research design is driven by the research strategy that is employed.

3.4.3 Research Strategy

A research strategy is a plan of how the research questions will be answered (Saunders *et al.,* 2019; Opoku *et al.,* 2016; Knight and Ruddock, 2009). It is the methodological link between the research philosophy and the choice of data collection and analysis methods, hence it must be carefully done to achieve a reasonable level of coherence in the design (Saunders *et al.,* 2019; Denzin and Lincoln, 2011). Research strategies are not mutually exclusive; therefore, it is possible to mix various strategies within research as used for this mixed methods research (Saunders *et al.,* 2019; Fellows, 2009).

Both primary and secondary data sources were explored to collect relevant data for this research (Hox and Boeije, 2005). In addressing the research objectives, primary data was collected using questionnaires and interviews and an analysis of secondary data from journals, books and other relevant peered reviewed publications. The specific strategies adopted in carrying out this research are; a thorough review of the literature (systematic review) on the research area followed by a questionnaire survey and subsequently, semi-structured interviews to collect relevant data.

3.4.3.1 Literature Review

A literature review on the first three objectives of this research was employed as the first step to provide a better understanding and deeper insight into relevant previous research and the trends that have emerged (Saunders *et al.,* 2019). It prepared a solid foundation on which this research is built. This enabled a constructively critical analysis of published literature and helped develop a clear argument on design documentation quality and IPD (Saunders *et al.,* 2019; Wallace and Wray, 2011).

The widely used reviews are; *integrative review, historical review, theoretical review, methodological review,* and *systematic review* (Saunders *et al.,* 2019; Fellows, 2009). *Integrative review,* critique, and synthesize literature to generate new frameworks and perspectives. *Historical review* examines the evolution of research on a particular topic over a period of time to place it in a historical context. *Theoretical review* examines the body of theory on an issue, concept, theory, or phenomenon while *Methodological review* focuses on research approaches, strategies, data collection techniques, and analysis procedures. *Systematic Review* uses a comprehensive pre-planned strategy for locating, critically appraising, analyzing, and synthesizing existing research pertinent to a formulated research question to allow conclusions to be reached about what is known. Particular research may be a combination of these reviews depending on the focus of the research (Saunders *et al.,* 2019).

Systematic Literature Review

A systematic literature review is used in this research. This strategy has taken different approaches to aggregate, summarize, analyze, and synthesize qualitative data from a variety of studies (Chenail *et al.,* 2018). The systematic review usually focuses on practical questions with an emphasis on informing an action to be taken (Denyer and Tranfield, 2009). However, it is a time-consuming approach and needs the involvement of other people in the process (Saunders *et al.,* 2019).

One major approach to conducting a systematic literature review that was used in this research is meta-synthesis which is aimed at "Synthesizing a collective body of qualitative or ethnographic research to identify common themes and or to compare

and contrast different groups on a general topic and provide deeper insights that might not be available in a single study" (Erwin, Brotherson and Summers, 2011). It is a type of qualitative study that utilizes results and findings obtained from other studies that are connected or related to the same topical area (Zimmer, 2006). This approach seeks to incorporate and provide an interpretation and understanding of information methodically across various studies (Hoon, 2013; Erwin *et al.*, 2011).

Analysis of data obtained from the meta-synthesis approach for this research was done using QSR Nvivo 12 Pro to bring order and structure to the data. This software helped analyze texts since it is developed to manage qualitative data analysis and to provide good coding procedures (AlYahmady and Al Abri, 2013).

The Meta-Synthesis Approach

There are six steps to follow in conducting a meta-synthesis (Chenail *et al.*, 2018; Erwin *et al.*, 2011; Sandelowski and Barroso, 2007) as presented in Figure 3.3. To ensure the quality of the literature by enhancing the validity and reliability of the meta-synthesis, the Critical Appraisal Skills Program (CASP) was used (Creative Commons, 2018; Campbell *et al.*, 2003).

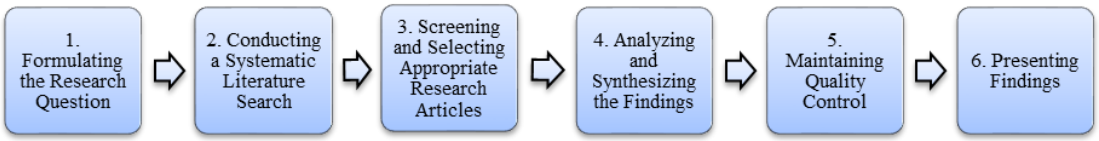

Figure 3.3: Meta-Synthesis steps
Source: (Chenail et al., 2018; Erwin et al., 2011; Sandelowski and Barroso, 2007)

The meta-synthesis steps used in this research are presented as follows:

Step 1: Formulating the Research Question

The first step is to formulate the research question (Sandelowski and Barroso, 2007) based on integrating published knowledge to draw conclusions for practice (Chenail *et al.*, 2018). The findings of this published knowledge serve as data by harmonizing different findings to provide a new interpretation (Popay *et al.*, 2006) and as a guide in formulating the research question.

Step 2: Conducting a Systematic Literature Search

The second step involves a systematic literature search for relevant articles in line with the research aim. In ensuring the quality of articles, reliable scientific databases were searched using selected keywords that are related to the research question.

Step 3: Screening and Selecting Appropriate Research articles

The third step involved the screening and selection of relevant research articles. To achieve this, a set of inclusion and exclusion criteria was specified to satisfy the research question (Yahyapour, Shamizanjani and Mosakhani, 2015).

Step 4: Analyzing and Synthesizing the Findings

The fourth step was to analyze and synthesize the findings. A thorough review was carried out at this stage (Sandelowski and Barroso, 2007). Codes were assigned to every finding (descriptive analysis) and similar or related codes with common content were integrated into a group with a common code (Pattern coding) to form categories.

Step 5: Maintaining Quality Control

The fifth step is maintaining quality which is very significant in conducting the meta-synthesis hence the Critical Appraisal Skills Program (CASP) was used. The CASP systematically determined the strengths and weaknesses of the research. According to Singh (2013, *p. 76*), CASP is regarded as "sift the grain from the chaff" and it helps in "making sense of research methodologies, ensuring reliability, and for drawing the right conclusions in a particular situation". CASP usage dates back to 1993 when it was developed by Dr Amanda Burls in Oxford as a formal methodology for a critical appraisal (Singh, 2013). Its application enhances the usefulness of the findings of this research. The CASP tool presents a varying set of questions centred on three broad issues which are rigour, credibility, and relevance (Yahyapour *et al.*, 2015). These broad issues guided the quality control for the meta-synthesis.

Step 6: Presenting the Findings

The final step in a meta-synthesis is to present the findings hence the findings after going through all the steps are presented in this research report in section 3.6.1.

3.4.3.2 Questionnaires

This research adopted a questionnaire survey to elicit relevant quantitative data on the first three objectives. It focused on questions that helped ascertain the current state of design documentation quality and identified inherent weaknesses and capabilities required in producing design documentation. It finally identified enablers in IPD to improve design documentation quality. Each respondent was required to respond to the same set of questions in a determined order which provided a more efficient means of data collection (Saunders *et al.,* 2019). The questions were carefully designed and pilot tested to enhance validity and reliability (Opoku *et al.,* 2016).

3.4.3.3 Interviews

Semi-structured interviews were carried out on the second and third objectives of this research. It aimed to collect data on the weaknesses associated with the conventional project delivery approach; capabilities required in producing design documentation; and enablers in IPD. The interviews served as a purposeful conversation between the researcher and the participants where concise and unambiguous questions were asked to collect reliable data based on the research questions (Saunders *et al.,* 2019).

A list of themes and some key questions were prepared and used by the researcher as a guide (Opoku *et al.,* 2016; Knight and Ruddock, 2009). However, the order of some questions varied based on the flow of the conversation. The duration of the interviews was between 20 to 30 minutes per session while data was captured through audio-recording and note-taking (Saunders *et al.,* 2019). The interviews were conducted via telephone and face-to-face. Bryman and Bell (2007) promoted the use of interviews as an efficient method of data collection in qualitative research. However, it is important to justify the choice of the specific research strategies for this research.

3.4.3.4 Justification for Choice of Research Strategy

To achieve the aim and appropriately address the specific objectives of this research, a three-tier strategy was adopted as presented in Table 3.1. This includes a review of the literature, a questionnaire survey, and subsequently, semi-structured interviews.

A literature review was employed as the first step to provide a better understanding and deeper insight into relevant previous research and prepare a solid foundation for the research. It allowed for a constructively critical analysis of published literature on design documentation quality and IPD to develop a clear argument based on the research objectives (Saunders *et al.,* 2019; Wallace and Wray, 2011; Fellows, 2009).

As a second step, a questionnaire survey was conducted to allow the collection of relevant data from respondents. The survey was estimated to take about 20 minutes to complete and this strategy facilitated data collection that sufficiently addressed the research objectives. Semi-structured interviews were conducted as a sequel to the survey. It helped in collecting both objective and subjective views of interviewees (Saunders *et al.,* 2019). The duration of the interviews was between 20 to 30 minutes per session. The research-specific objectives with their corresponding data collection and analysis techniques as stated in Table 3.1 are presented as follows:

Objective One: the first objective is to ascertain the current state of design documentation quality in practice. To achieve this, a two-stage methodology was employed. The *first stage* was a literature review to collect qualitative data that was analyzed using descriptive and pattern coding. The *second stage* was a questionnaire survey to collect relevant quantitative data. Data analysis and presentation focused on factor analysis, correlation, and regression analysis.

Objective Two: the second objective is to identify weaknesses associated with the conventional project delivery and capabilities required in the production of design documentation. To achieve this, a three-tier strategy was employed. The *first stage* was a literature review. The *second stage* was a questionnaire survey to collect quantitative data. Data analysis and presentation focused on factor analysis, correlation, and regression analysis. The *third stage* involved semi-structured interviews with purposefully selected professionals in the construction industry. The data collected was analyzed using descriptive and pattern coding techniques.

Objective Three: the third objective was to identify enablers inherent in IPD that can be adapted to improve design documentation quality. To achieve this, a three-tier

strategy was employed. The *first stage* was a literature review followed by a survey to collect quantitative data. Data analysis and presentation focused on factor analysis, correlation, and regression. The *third stage* involved semi-structured interviews with purposefully selected construction professionals. The data collected was qualitative and analyzed using descriptive and pattern coding.

Objective Four: the final objective is to develop a framework within the conventional project delivery approach to improve design documentation quality. At this stage, a synthesis of the data collected served as the basis for developing the framework. The choice of a time horizon is very significant in fulfilling the research aim.

3.4.4 Time Horizon

Time horizon is very crucial in the design and conduct of research and it includes cross-sectional and longitudinal times. A *cross-sectional* refers to a 'snapshot' time horizon that is conducted at a particular time while the *longitudinal* is considered as a diary or a series of snapshots of events over a given period (Saunders *et al.,* 2019). To address the aim and specific objectives of this research, a cross-sectional time horizon was adopted to collect relevant information within a particular time frame.

3.5 Population and Sampling

A population in research includes the totality of all the elements that are the focal points for a study and conform to a set of specifications from which a sample is taken (Creswell and Creswell, 2017; Saunders *et al.,* 2016). The *target population* is the subset of the population that is often redefined as a more manageable population (Saunders *et al.,* 2019). A *census,* on the other hand, refers to the situation where data collection and analysis are carried out on the entire population due to its manageable size (Saunders *et al.,* 2019; Fellows, 2009). However, because of time, money, and often access restrictions, it often becomes impossible to use the entire population (Saunders *et al.,* 2019), hence the need for sampling. Sampling helps to choose a representation without using the entire population, hence focusing on a subgroup and the sample is dependent on the sampling frame, particularly for probability samples.

3.5.1 Sampling Frame

The sampling frame for any probability sample "is a complete list of all the cases in the target population from which a sample will be drawn" (Saunders *et al.,* 2016, *p. 277*). The sampling frame for this research is drawn from professionals and clients in the construction industry in Ghana which includes; architects, quantity surveyors, project managers, engineers, managing directors, contractors, site supervisors, and clients in the industry. This served as the full set of cases or elements from which samples were taken (Saunders *et al.,* 2019; Creswell and Creswell, 2017). This notwithstanding, the sample size significantly influences the research quality.

3.5.2 Sample Size

The sample size is purely dependent on the research question(s) and objectives (Saunders *et al.,* 2019; Knight and Ruddock, 2009). However, it was necessary to determine the sample size for both the quantitative and qualitative data collection for this research. The formula for calculating the actual sample size for a quantitative study that was used in this research according to Saunders *et al.* (2016, *p. 283*) is;

$$n^a = \frac{n\ x\ 100}{re\%}$$

Where; n^a is the actual sample size required; n is the minimum sample size, and $re\%$ is the estimated response rate expressed as a percentage. However, the minimum sample size required for this research is 229, and the estimated response rate in percentage is 53%. These figures are averages from two separate studies conducted in the same geographical location as this research by Agbaxode *et al.* (2021*a*) and Agbaxode *et al.* (2020). Therefore, the actual sample size for this research is;

$$n^a = \frac{229\ x\ 100}{53}$$

Actual sample size = 432

This notwithstanding, the research recorded a total of 235 responses representing 54% response rate out of a sample of 432.

In addressing the issue of sample size for the qualitative data collection, interviews were conducted until data saturation was reached where it was determined that the

additional data being collected provided very little and in most cases no new information compared to the earlier interviews (Saunders *et al.,* 2019). This resulted in 15 interviews with experts in the construction industry. Having determined the sample size, the choice of sampling techniques is paramount.

3.5.3 Sampling Techniques

The next step after choosing a suitable sampling frame and establishing the actual sample size is to select an appropriate sampling technique (Saunders *et al.,* 2019; Opoku *et al.,* 2016). This is divided into *Probability (representative),* and *Non-probability sampling* (Fellows, 2009). With probability samples, the probability of selecting a case from the target population is known and normally equal for all cases (Saunders *et al.,* 2019). It is often associated with survey and experimental research strategies. For non-probability samples, the probability of a case selection from the target population is not known (Saunders *et al.,* 2019; Knight and Ruddock, 2009).

3.5.3.1 Probability Sampling

Probability sampling can be put into five main techniques (Saunders *et al.,* 2019; Fellows, 2009): *simple random, systematic random, stratified random, cluster, and multi-stage.* To achieve the research aim, stratified and simple random probability sampling techniques were used to collect data with a questionnaire survey.

Simple Random Sampling (random sampling) refers to selecting the sample for the research at random from the sampling frame (Saunders *et al.,* 2019). It is also suitable for geographically dispersed areas if an alternative technique of data collection such as web or postal questionnaires or telephone interviews will be used. *Stratified Random Sampling* is a modified simple random sampling, where the target population is divided into two or more significant strata. In other cases, the sampling frame is divided into a number of subsets based on one or several attributes, and thereafter, a random sample is drawn from each strata (Saunders *et al.,* 2019; Opoku *et al.,* 2016).

3.5.3.2 Non-Probability Sampling

This does not rely on choosing samples at random like probability sampling and does not depend on the possibility that any has the probability of being included in the

sample (Saunders *et al.,* 2019). It offers a wide range of techniques to select mostly subjective samples. It provides cases that have rich information within which the research question can be explored to gain theoretical insights (Saunders *et al.,* 2016). The various types in use are *quota sampling, purposive sampling, volunteer sampling,* and *haphazard sampling*. However, a purposive sampling technique was chosen for interviews to achieve the research aim. This is sometimes referred to as judgmental sampling because judgements are used to select cases that are informative enough to address the research questions (Saunders *et al.,* 2019; Fellows, 2009). There is a need to justify the choice of population and sampling techniques used in this research.

3.5.4 Justification for Choice of Population and Sampling Techniques

The population for this research is the building construction industry in Ghana. The target population comprises construction clients and professionals in consulting and construction firms in the industry across all 16 regions of Ghana. This involved both the private and public sectors that engage in infrastructure projects. According to the ministry of local government and rural development, there are over 1000 construction sector professionals in Ghana who served as the population for this study. The sampling frame includes architects, quantity surveyors, project managers, engineers, managing directors, contractors, site supervisors, and other relevant professionals. This served as the full set of cases or elements from which samples were taken (Saunders *et al.,* 2019; Creswell and Creswell, 2017).

This personnel were drawn from various ministries that are involved in infrastructure projects, works departments of Metropolitan, Municipal and District Assemblies (MMDAs), other agencies and contractors in both the public and private sector. The focus was on personnel of professional bodies such as; the Ghana Institution of Surveyors (GhIS), Ghana Institution of Architects (GhIA), Ghana Institution of Engineers (GhIE), and private consultants who do not belong to any of these professional bodies but engage in infrastructure projects.

Both probability and non-probability sampling techniques were employed to ensure that the sample selected will help answer the research questions (Saunders *et al.,*

2016). *Stratified and simple random* probability sampling was used for the *questionnaire* survey. The target population was divided into mutually exclusive, homogeneous segments (strata) then a simple random sampling was used in each strata (Saunders *et al.,* 2019). The stratified sampling was based on the 16 regions where each region served as strata of the target population as presented in Table 3.2 and thereafter, a simple random sampling was used to reach out to respondents.

Table 3.2: Regions (Strata) of Ghana and Research Participants

S/n	Regions (Strata)	Capitals	Number of Participants
1	Greater Accra Region	Accra	3
2	Ashanti Region	Kumasi	2
3	Eastern Region	Koforidua	1
4	Central Region	Cape Coast	1
5	Northern Region	Tamale	1
6	Western Region	Sekondi	1
7	Volta Region	Ho	3
8	Upper East Region	Bolgatanga	1
9	Bono Region	Sunyani	
10	Bono East Region	Techiman	
11	Upper West Region	Wa	1
12	Western North Region	Sefwi Wiawso	
13	Oti Region	Dambai	1
14	North East Region	Nalerigu	
15	Savannah Region	Damango	
16	Ahafo Region	Goaso	
TOTAL			**15**

Source: Researcher

On the other hand, a *purposive* sampling technique was employed to reach out to participants for *interviews* to collect relevant data (Saunders *et al.,* 2019) for this research. This involved a deliberate selection of research participants based on their role and qualities (Etikan, 2016) using a judgmental selection that would help answer the research questions (Saunders *et al.,* 2019). The selection criteria was based on the profession, level of education, and years of experience in the industry. This involved the selection of quantity surveyors, architects, and construction managers with over five years of experience and with a minimum of a First degree (Hons) certificate. The research data analysis and interpretation are presented in the ensuing section.

3.6 Data Analysis and Interpretation

A systematic literature review and semi-structured interviews were used for qualitative data collection, while questionnaires were used to collect quantitative data. Analysis and interpretation of data were carried out by employing descriptive and inferential statistics for quantitative data, and content analysis for qualitative data. Quantitative data analysis and presentation in this research include Relative Importance Index (RII), factor analysis, correlation, and regression calculations. These analyses that were carried out on the data to address the research objectives and achieve the research aim are explained in the ensuing sub-sections.

3.6.1 Developing the questionnaire Survey Instrument

In developing the questionnaire survey for this research, a meta-synthesis approach was adopted to synthesize a collective body of data from other studies to identify common themes that are related to the topical area. This was done based on the specific research questions of this research. The findings were developed into a questionnaire survey that was used to collect quantitative data for this research as presented in appendix "C" including participant information.

3.6.1.1 The Meta-Synthesis Approach

The meta-synthesis approach was conducted according to the six main steps presented in the research strategy to ensure an effective study.

Step 1: Formulating the Research Question

The first three research questions for this research served as the research questions for the meta-synthesis which are;

- What is the current state of design documentation quality in practice under the conventional project delivery approach?
- What are the inherent weaknesses and capabilities associated with the conventional project delivery approach in producing design documentation?
- What are the enablers inherent in IPD that can be adapted to improve design documentation quality?

Three main parameters served as inclusion and exclusion criteria for the review which are; What, Who, and When. *"What?"* in this research refers to the three main research questions; *"Who?"* includes reliable databases and scientific journals; *"When?"* is the period from the year 1992 to 2020 which constitutes the major period within which research relating to the research questions were done.

Step 2: Conducting a Systematic Literature Search

A systematic search of the literature was carried out in reliable and appropriate scientific databases using keywords based on the research questions. These databases include; Scopus, web of science, science direct, ProQuest and google scholar.

Step 3: Screening and Selecting Appropriate Research articles

Keywords were used as the first step in obtaining relevant articles in connection with the research questions followed by a review of titles and abstracts and subsequently, a review of the content of the remaining articles. The CASP was employed to review the quality of the articles. In doing this, three broad issues according to Creative Commons, 2018 were considered; *Are the results of the study valid? What are the results? and Will the results help the study?* Relevant articles were collated in accordance with the CASP quality criterion and irrelevant articles were excluded after the initial review. This was achieved based on the CASP Template adapted from Public Health Resource Unit, England (CASP, 2006) as presented in appendix "B1". The template contains ten questions and any article that scores "No" under any of the CASP quality screening as presented in appendix "B2" is excluded. All the extracted variables were collated and coded based on their content and later categorized.

Step 4: Analysing and Synthesizing the Findings

All identified variables were considered as codes and all overlapping codes and overlays were removed. With the aid of QSR Nvivo 12 Pro, descriptive analysis and pattern coding were carried out at this stage and all subgroups were given new codes.

Step 5: Maintaining Quality Control

The CASP tool was used to evaluate the quality of the articles. The application of coding enhanced the quality of the data by reviewing the information again and classifying the required data appropriately with the aid of QSR Nvivo 12 Pro.

Step 6: Presenting the findings and the Questionnaire Survey

The findings from the meta-synthesis are presented in Table 3.3, Table 3.4, Table 3.5, Table 3.6 and Table 3.7 and a total of 84 variables were identified. After coding and classifying all the variables synthesized, the data were categorized. This resulted in 15 variables on the state of design documentation quality in practice; 24 variables on weaknesses associated with the conventional project delivery; 20 variables on capabilities required in the production of design documentation; and 25 variables on enablers in IPD that can be adapted to improve design documentation quality. Out of these 25 variables, 12 are linked to Contractual principles; six are Behavioural principles, and seven are early involvement and collaboration of key participants.

The survey instrument as presented in appendix "C" is in five sections; Section A is the respondent's background information; Section B is on the state of design documentation quality in practice; Section C seeks to identify weaknesses associated with the conventional project delivery and capabilities required in the production of design documentation; Section D seeks to identify enablers in IPD that can be adapted to improve design documentation quality, and Section E allows respondents to provide additional information considered relevant for the research.

The variables in the instrument are weighed on a scale of one to five where 5 indicates Strongly Agree (SA); 4 indicates Agree (A); 3 indicates Undecided (U); 2 indicates Disagree (D) and 1 indicates Strongly Disagree (SD).

Table 3.3: The state of design documentation quality in practice under the conventional project delivery approach

Macro Factor	Micro Factors	Design Documentation Quality in Practice	References
Design Documentation Quality (DDQ*)	DDQ1	Design drawings usually contain errors and omissions.	(Zaneldin, 2020; Dosumu and Aigbavboa, 2018)
	DDQ2	Specifications usually contain errors and omissions.	(Assaf *et al.*, 2018; Sunday and Afolarin, 2013)
	DDQ3	Bills of quantities usually contain errors and omissions.	(Sunday and Afolarin, 2013; Alarcón and Mardones, 1998; Tilley and Barton, 1997)
	DDQ4	There is a lack of coordination among design documents.	(Jarkas, 2014; Baloyi and Agumba, 2014)
	DDQ5	There are discrepancies between bill of quantities, drawings and specifications.	(Yap and Skitmore, 2018; Baloyi and Agumba, 2014; Ramabodu and Verster, 2013)
	DDQ6	There are disparities between drawings and specifications only.	(Yap and Skitmore, 2018; Philips-Ryder *et al.*, 2013; Ramabodu and Verster, 2013)
	DDQ7	Documents are often issued with conflicting, inaccurate, and ambiguous information.	(Jarkas, 2014; Baloyi and Agumba, 2014)
	DDQ8	Documents lacking clarity.	(Dosumu *et al.*, 2017; Ramabodu and Verster, 2013)
	DDQ9	Documents are often issued with insufficient details.	(Akampurira and Windapo, 2018; Sunday and Afolarin, 2013)
	DDQ10	Issuance of un-amended standard specifications.	(Philips-Ryder *et al.*, 2013; Darwish, 2007)
	DDQ11	Issuance of incomplete design drawings.	(Baloyi and Agumba, 2014; Sunday and Afolarin, 2013)
	DDQ12	Issuance of incomplete specifications.	(Ramabodu and Verster, 2013; Laryea, 2011)
	DDQ13	Issuance of incomplete bills of quantities.	(Muhwezi, Acai and Otim, 2014)
	DDQ14	Issuance of bulky documents containing irrelevant information.	(Philips-Ryder *et al.*, 2013)
	DDQ15	There is often a lack of accuracy in design documentation.	(Akampurira and Windapo, 2019; Sunday and Afolarin, 2013; Ramabodu and Verster, 2013)

*DDQ = Design Documentation Quality

Table 3.4: Weaknesses associated with the conventional project delivery approach

Macro Factors	Micro Factor s	Weaknesses in the Conventional Approach	References
Weaknesses (W*)	W1	Lack of coordination among design consultants.	(Dosumu and Aigbavboa, 2018; Assaf *et al.*, 2018; Tilley and Barton, 1997)
	W2	Lack of cooperation and collaboration among project participants.	Durdyev *et al.*, 2019; Yap and Skitmore, 2018; Philips-Ryder *et al.*, 2013)
	W3	Lack of coordination among design documents.	(Assaf *et al.*, 2017).
	W4	Discrepancies between bill of quantities, drawings and specifications.	(Park and Kwak, 2017; Mosly, 2016; Arain, Assaf, and Pheng, 2004)
	W5	Reliance on specification notes only when drawings are required.	(Mosly, 2016; Tilley, 1998; Tilley and Barton, 1997)
	W6	Projects always experience cost escalation, shoddy workmanship, project abandonment and other manifestations of project failure.	(Park and Kwak, 2017; Mosly, 2016; Kaliba *et al.*, 2009)
	W7	There is high inflation or escalation of final contract cost.	(Park and Kwak, 2017; Mosly, 2016; Muhwezi *et al.*, 2014)
	W8	No guarantee of certainty of project final cost, only initial cost.	(Dada, 2013; Masterman, 2003)
	W9	It encourages claim consciousness among project participants.	(Park and Kwak, 2017; Dada, 2013; Ofori, 1990)
	W10	There is too much focus on lowest price instead of best price.	(Dada, 2013; Dozzi *et al.*, 1996)
	W11	It encourages participants to be more profit conscious instead of project quality conscious.	(Park and Kwak, 2017; Mosly, 2016; Dada, 2013)
	W12	Individual project participants are exploitative of loopholes in contract documents.	(Park and Kwak, 2017; Mosly, 2016; Dada, 2013)
	W13	Contracts are deliberately let at an excessively low price, with the intention of hiking the price (claim for reward) later through deliberate manipulation or exploitation of loopholes in the contract documents.	(Park and Kwak, 2017; Dada, 2013)
	W14	Adversarial relationships among project participants threatening project goals; party spirit instead of team spirit.	(Dada, 2013; Odeh and Battaineh, 2002; De la Garza *et al.*, 1994)

*W = Weakness

Table 3.4: Continued

Macro Factors	Micro Factors	Weaknesses in the Conventional Approach	References
	W15	It does not encourage commitment to project objectives rather individual participants' objectives and gain.	(Durdyev *et al.*, 2019; Mosly, 2016)
	W16	Each party has its own agenda based on its singular interest.	(Mosly, 2016; Dada, 2013)
	W17	Lack of contractor's input at the design stage and not taking advantage of their experience.	(Dada, 2013; Arain *et al.*, 2004)
	W18	It does not encourage commitment of all participants to total quality right from project design.	(Dada, 2013; De-Valence and Houn, 1999; Ofori, 1990)
	W19	The rigid definition of roles and responsibilities provides no basis for shared vision or goals.	(Mosly, 2016; Dada, 2013)
	W20	Hierarchical relationships making communication and transfer of useful knowledge among project participants difficult.	(Park and Kwak, 2017; Dada, 2013; Hui *et al.*, 2011)
	W21	Compartmentalization of project participants around functional and professional lines is seen to lead to poor communication, undermine relationships among team members and leads to poor design documentation.	(Ebrahimi and Dowlatabadi, 2019; Assaf *et al.*, 2017; Dosumu *et al.*, 2017; Dada, 2013; Hui *et al.*, 2011)
	W22	There is uneven, unclear and unfair allocation of risks to some participants.	(Mosly, 2016; Dada, 2013)
	W23	It does not create a win-win situation among project participants.	(Dada, 2013; Masterman, 2003)
	W24	Relationships among project participants encourage professional mistrust and rivalry.	(Mosly, 2016; Dada, 2013; De-Valence and Houn, 1999)

Table 3.5: Capabilities required in the production of design documentation

Macro Factors	Micro Factors	Weaknesses in the Conventional Approach	References
Capabilities (C*)	C1	Holding consultants accountable for producing poor design documentation quality (penalty).	(Muhwezi *et al.*, 2014; Tilley *et al.*, 2002)
	C2	Incentives for producing good design documentation quality.	(Dosumu and Aigbavboa, 2018; Dosumu, *et al.*, 2017; Tilley *et al.*, 2002)
	C3	Paying appropriate fees to consultants.	(Dosumu and Aigbavboa, 2018; Tilley *et al.*, 2002)
	C4	Improving consultants working conditions and procedures.	(Maskil-Leitan and Reychav, 2018; Mosly, 2016)
	C5	Clients allowing adequate time for the preparation of design documents.	(Muhwezi *et al.*, 2014; Tilley *et al.*, 2002)
	C6	Mandatory coordination of design documentation by a supervisor with requisite skills and knowledge.	(Dosumu and Aigbavboa, 2018; Assaf *et al.*, 2017)
	C7	Independent review of design documentation by a supervisor with requisite skills and knowledge.	(Muhwezi *et al.*, 2014; Tilley *et al.*, 2002)
	C8	Encourage self-check practice and independent verification.	(Muhwezi *et al.*, 2014; Tilley *et al.*, 2002)
	C9	Rechecking design documentation for accuracy.	(Arain *et al.*, 2004; Tilley *et al.*, 2002)
	C10	Use of checklists.	(Muhwezi *et al.*, 2014; Tilley *et al.*, 2002)
	C11	Setting up quality control departments.	(Tilley *et al.*, 2002; Tilley and Barton, 1997)
	C12	Increased quality control by setting minimum quality and service standards.	(Muhwezi *et al.*, 2014; Tilley *et al.*, 2002)
	C13	Designers partnering with other designers while preparing design documents.	(Assaf *et al.*, 2017; Tilley *et al.*, 2002; Tilley, 1998)
	C14	Improving collaboration among consultants.	(Dosumu and Aigbavboa, 2018; Tilley *et al.*, 2002; Tilley, 1998)
	C15	Specialists' involvement in design planning and processing.	(Arain *et al.*, 2004; Tilley *et al.*, 2002; Tilley, 1998)
	C16	Use of computer programs such as BIM.	(Mosly, 2016; Arain *et al.*, 2004)
	C17	Job-relevant training and practice.	(Dosumu and Aigbavboa, 2018; Tilley *et al.*, 2002)
	C18	Provision of an elaborate and improved project brief.	(Muhwezi *et al.*, 2014; Tilley *et al.*, 2002)
	C19	Systematic audit to ensure the quality of briefs.	(Muhwezi *et al.*, 2014; Tilley *et al.*, 2002)
	C20	Preparation of detailed design.	(Dosumu and Aigbavboa, 2018; Assaf *et al.*, 2017)

*C = Capabilities

Table 3.6: Enablers in IPD (CP) that can be adapted to improve design documentation quality

Macro Factors	Micro Factors	Enablers Inherent in IPD	References
IPD Contractual Principles (ECP*)	ECP1	Key participants' early involvement in the project.	(Jadidoleslami *et al.*, 2019; El Asmar *et al.*, 2013)
	ECP2	Key participants' early contributions of knowledge and expertise.	(Viana *et al.*, 2020; Agbaxode, *et al.*, 2020; Yee *et al.*, 2017; Jayasena and Senevirathna, 2012)
	ECP3	Making collaborative value-based decisions by all participants.	(Agbaxode, *et al.*, 2020; Yee *et al.*, 2017; Rahim *et al.*, 2016; Thomsen *et al.*, 2010)
	ECP4	Key participants are bound together as equals.	(Rahim *et al.*, 2016; Becerik-Gerber and Kensek, 2010; AIA and AIACC, 2007)
	ECP5	Jointly and early developed project target criteria.	(Maskil-Leitan and Reychav, 2018; Fish, 2011)
	ECP6	Tying the success of key participants to the success of the project.	(Jadidoleslami *et al.*, 2019; Nawi *et al.*, 2014; Jayasena and Senevirathna, 2012)
	ECP7	Key participants jointly accountable for any errors in design.	(Agbaxode, *et al.*, 2020; Fish, 2011)
	ECP8	Key participants share financial rewards (compensation) based on project outcomes.	(Ilozor and Kelly, 2012; Raisbeck *et al.*, 2010; O'Connor, 2009)
	ECP9	Sharing financial risk among key participants.	(Agbaxode, *et al.*, 2020; Ilozor and Kelly, 2012)
	ECP10	Utilization of new technologies and approaches during design and construction.	(Viana *et al.*, 2020; Agbaxode, *et al.*, 2020; Yee *et al.*, 2017; Rahim *et al.*, 2016)
	ECP11	Waiving liabilities between key participants.	(Agbaxode, *et al.*, 2020; Yee *et al.*, 2017)
	ECP12	Encourage fiscal transparency between key participants.	(Viana *et al.*, 2020; Agbaxode, *et al.*, 2020; Yee *et al.*, 2017)

*ECP = Enabler; Contractual Principles

Table 3.7: Enablers in IPD (BP and EICKP) to improve design documentation quality

Macro Factors	Micro Factor s	Enablers Inherent in IPD	References
IPD Behavioural Principles (EBP*)	EBP1	Key participants having mutual respect for each other.	(Agbaxode, *et al.*, 2020; El-adaway, 2010)
	EBP2	Key participants having mutual trust for each other.	(Viana *et al.*, 2020; El-adaway, 2010)
	EBP3	Willingness to collaborate as key participants.	(Hamzeh *et al.*, 2019; Rahim *et al.*, 2016; Nawi *et al.*, 2014; Raisbeck *et al.*, 2010)
	EBP4	Open communication among key participants.	(Agbaxode, *et al.*, 2020; Yee *et al.*, 2017)
	EBP5	Open information sharing among key participants.	(Viana *et al.*, 2020; Rahim *et al.*, 2016))
	EBP6	Ensuring transparent processes throughout the project.	(Agbaxode, *et al.*, 2020; Yee *et al.*, 2017)
Early Involvement and Collaboration of Key Participants (EIKP*)	EIKP1	It enhances and strengthens key participants' understanding of the owner's desired outcome.	(Viana *et al.*, 2020; Agbaxode, *et al.*, 2020; Yee *et al.*, 2017; Rahim *et al.*, 2016)
	EIKP2	Effective collaboration by all participants improves design documentation quality.	(Agbaxode, *et al.*, 2020; Yee *et al.*, 2017; Mesa *et al.*, 2016; Rahim *et al.*, 2016)
	EIKP3	There is a more timely and informed understanding of the design.	(Viana *et al.*, 2020; Agbaxode, *et al.*, 2020; Rahim *et al.*, 2016; Thomsen *et al.*, 2010)
	EIKP4	Provides an opportunity for adequate pre-design, design, and documentation planning.	(Agbaxode, *et al.*, 2020; Yee *et al.*, 2017; Rahim *et al.*, 2016; AIA and AIACC, 2007)
	EKPI5	Provides an opportunity for strong pre-construction planning.	(Viana *et al.*, 2020; Agbaxode, *et al.*, 2020; Yee *et al.*, 2017)
	EIKP6	Early visualization of construction sequencing prior to commencing the project.	(Viana *et al.*, 2020; Agbaxode, *et al.*, 2020; Yee *et al.*, 2017; Rahim *et al.*, 2016)
	EIKP7	An increase in the level of effort by key participants during design documentation results in better documentation quality.	(Hamzeh *et al.*, 2019; Rahim *et al.*, 2016; Fish, 2011; Raisbeck *et al.*, 2010)

*EBP = Enabler; Behavioural Principles

*EIKP = Early Involvement of Key Participants

3.6.2 The Semi-Structured Interview Instrument

Semi-structured interview questions as presented in appendix "H" were formulated. Participants' background information includes; position and experience in the construction industry, level of education, whether participant works in the private or public sector and also contractors or consultants outfit.

The first part of the questions was based on the second research objective. It seeks to determine *weaknesses* that are associated with the conventional project delivery during the production of design documentation and the potential *capabilities* required to improve design documentation quality. The second part of the questions is on the third research objective which seeks to identify *enablers* in IPD that can be adapted and used within the conventional project delivery to improve design documentation quality. The instrument makes a provision for interviewees to provide additional information they deemed important in achieving the aim of the research.

3.6.3 Preliminary Analysis of Questionnaire Survey Data

A preliminary analysis of the quantitative data was done using the RII to rank the variables used in the survey. This was necessary to determine the significance of each variable and served as the basis for the interviews. RII is used to understand the significance of different factors in construction project management and was used by Ribeiro and Fernandes (2010, *p. 170*) in exploring agile methods in construction and by Zeng, Tian and Tam (2005, *p. 684*) in identifying factors affecting design quality. According to Holt (2014, *p. 6*), the following equation is the most frequently used RII in construction project management hence used in this research; $RII=\sum W/A \times N$.

Where; RII = Relative Importance Index; W = weighting for each factor on a scale of 1 to 5 with 1 implying the least and 5 the highest; A = highest weight (i.e., 5 in this case); and N = total number of respondents (which is 235 in this case). RII values have a range from 0 to 1 and the higher the value, the more important the factor. However, five important levels were transformed for the RII in this research as presented in Table 3.8.

Table 3.8: RII values importance levels

RII values	Importance Level
0.8≤RII≤1	High (H)
0.6≤RII≤0.8	High-Medium (H-M)
0.4≤RII≤0.6	Medium (M)
0.2≤RII≤0.4	Medium-Low (M-L)
0≤RII≤0.2	Low (L)

3.6.4 Qualitative Data Collection and Analysis

Qualitative data on the second and third objectives of this research was collected through semi-structured interviews with experts in the construction industry to harness relevant and reliable information that helped in achieving the research aim. The semi-structured interviews resulted in collecting both objective and subjective views of participants. The interviews were carried out both online and physical. The online interviews were carried out via voice calls and audio recorded while a digital recorder (Philips voice tracer) was used to record the physical interviews. There were 15 interviews with construction experts and purposive sampling was employed to reach out to these experts based on their position and experience in the construction industry. The duration of the interviews was between 20 to 30 minutes per session depending on how well informed the interview participant was on the research focus.

To get the interview started, semi-structured questions with a sample presented in appendix "H" was compiled. Consent from probable interview participants was obtained before the interviews with a sample presented in appendix "I". Participant Information Sheet as presented in appendix "J" was also given to interviewees to provide them with enough information to enhance their understanding of the research.

The interview data collected in audio formats were transcribed in two stages and the transcripts served as a data source for analysis. The first stage was based on intelligent verbatim transcription (Kawahara, 2007), where the researcher listened to the audio recordings and transcribed verbatim the participants' responses into text. The second stage was the application of the principles of edited transcription (Types of transcription: Verbatim vs. Intelligent vs. Edited Transcription, 2014). This stage

involved the cleaning of the individual interview transcripts to correct all forms of transcribing errors and to bring order into the data.

The transcribed data were analyzed using content analysis by employing descriptive and pattern coding with the aid of QSR Nvivo 12 Pro software. It sought to describe and identify patterns of themes and categories in the transcripts and provided a systematic collection and analysis of the data. The occurrence of certain words, phrases, or themes in the transcripts was determined and properly categorized. This helped determine descriptions and patterns in the data. Themes were built out of the research objectives hence coding into categories. The themes include; weaknesses and potential capabilities of the conventional project delivery; the possibility of the capabilities towards improving design documentation quality; enablers in IPD that can be adapted and used within the conventional project delivery approach.

To ensure the confidentiality and anonymity of interviewees, pseudonyms were assigned to every interview transcript to prevent the direct use of interviewees' names. Therefore, the interview participants are represented with P1, P2, P3, P4, P5, P6, P7, P8, P9, P10, P11, P12, P13, P14, and P15 as presented in Table 5.1. These pseudonyms were used throughout the entire interview data presentation and analysis denoting Participant 1, Participant 2 in that order up to Participant 15.

The content analysis followed these steps to bring order into the interview data; (1) *Selection of content to analyze:* the interview transcripts served as the data for the content analysis; (2) *Definition of units and categories of analysis:* the frequency of words, phrases, and themes were used to define the categories of codes; (3) *Coding:* relevant data was recorded in appropriate categories; (4) *Analysis of the results and conclusions:* the data were examined to determine descriptions and patterns from it.

Validity and reliability of the coding were necessary and this was done to ensure the codes are consistent with the information they are required to contain. The validity and reliability of the codes were determined by ensuring that the composition of the categories and sub-categories of similar words or phrases belong to the appropriate category and remained constant throughout the coding process.

3.6.5 Quantitative Data Analysis

This includes; factor analysis, correlation, and regression that were carried out first of all to determine the possibility of reducing the number of variables in the research data set using factor analysis; secondly, to determine the correlation between the variables; and finally, to further check the degree of relationship between the variables through regression analysis. These analyses helped in testing the hypotheses and also determined the main variables for developing the framework for the research. The sample size of the data set used in this research is 235 and IBM SPSS Statistics for Windows, Version 27.0 was used to execute all these tests.

3.6.5.1 Factor Analysis

Factor Analysis is used for either data reduction or structure detection for a sample of data (IBM SPSS Case Studies, Version 27.0). It is primarily used to reduce a set of observed variables that is large to a new, smaller set of variables. Depending on the method used, the smaller set of variables preserves the majority of the information contained in the original set of variables (Guadagnoli and Velicer, 1988). It is based on the postulation that there are different relations between the variables in a data set as a result of several general factors which increase the number of the variables. This is most often considered as a pattern of inter-relations between the variables in question for a set of data (Schilderinck, 2012). Statistically, observations are made to determine the relations between the variables.

In any Factor analysis method, the two questions that a good solution should try to answer are "How many components (factors) are needed to represent the variables?" and "What do these components represent?" (IBM SPSS Case Studies, Version 27.0). However, in this research, Factor Analysis using *Principal Component Analysis (PCA)* and *Factor Rotation* were used to consolidate the data set. This method provided the mathematical convenience of working with the eigenvalues and eigenvectors to determine the number of factors to retain and at the same time compute factor scores (Mulaik, 2010).

Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy and Bartlett's Test of Sphericity (Hutcheson and Sofroniou, 1999; Kaiser, 1974) were used to test the data set for its suitability for factor analysis. The KMO test indicates the proportion of variance in the variables and a high value close to 1.00 is a strong indication that factor analysis may be useful with the data. Lower values usually below 0.50 is an indication that the results of the factor analysis will not be very useful (IBM SPSS Case Studies, Version 27.0). A further test using Bartlett's Test tests the correlation in the variables and indicates whether they are related or unrelated. Small values of significance level usually less than 0.05 is an indication that factor analysis may be useful with the data (Hutcheson and Sofroniou, 1999; Kaiser, 1974).

3.6.5.2 Correlation Analysis

Correlation is a statistical test that measures the relationship or association between two or more variables in a data set (George and Mallery, 2019; Morgan *et al.*, 2019; Aldrich, 2018). This test is important for this research because there is a need to measure the relationship that exists between the variables in the study. There are different forms of correlation but the Spearman's rank-order correlation was chosen for this research carried out with the aid of SPSS Statistics Version 27.0.

The Spearman rank-order correlation (Spearman's correlation) is a non-parametric measure of the strength and direction of association that exists between two or more variables normally measured on an ordinal scale (George and Mallery, 2019; Morgan *et al.*, 2019; Aldrich, 2018). It is denoted by the symbol r_s (the Greek letter ρ, called rho). The non-parametric Spearman correlation as used in this research is based on ranking the scores and it is excellent for ordinal data (Morgan *et al.*, 2019; Aldrich, 2018). It offers a better option to report correlations on survey instruments or Likert-type survey responses as used in this research (George and Mallery, 2019; Morgan *et al.*, 2019). The results are presented in a matrix form which shows Spearman's correlation, the significance value and the sample size for the calculation.

Spearman's correlation coefficients range from -1 to +1. The coefficient sign indicates whether it is a positive or negative relationship (Morgan *et al.*, 2019;

Aldrich, 2018). A positive correlation means that as one variable increases, the other variable tends to increase. A negative correlation means that as one variable increases, the other variable tends to decrease (George and Mallery, 2019; Morgan *et al.*, 2019; Aldrich, 2018). Values close to -1 or +1 represent stronger relationships than values closer to zero (George and Mallery, 2019; Morgan *et al.*, 2019).

For Likert scale items using the Strongly Agree to Strongly Disagree scale as used in this research, Spearman's correlations interpretations indicate that: strongly positive coefficients mean strongly agree values tend to occur together (Morgan *et al.*, 2019; Aldrich, 2018). Strongly negative coefficients mean strongly agree for one item tends to coincide with strongly disagree for the other. Near zero coefficients means the value of one Likert item does not predict the value of the other hence there is no relationship between them (George and Mallery, 2019; Morgan *et al.*, 2019).

In interpreting the results, a *p*-value less than 0.05, indicates evidence of a statistically significant bivariate association between the variables. A *p*-value of more than 0.05, is evidence that there is no statistically significant association between the variables (Morgan *et al.*, 2019; Aldrich, 2018). In addition, higher rho values indicate a stronger magnitude of the relationship between the variables while smaller values indicate weaker relationships (George and Mallery, 2019; Morgan *et al.*, 2019). In testing the hypothesis; the null hypothesis; H_0: ρ (rho) = 0, means there is no relationship between the variables. For the alternative hypothesis; H_1: ρ (rho) $\neq$ 0, means there is a relationship between the variables.

3.6.5.3 Regression Analysis

Regression is a statistical technique that is used to formulate a model and analyze the relationship between two or more variables in use. It analyses the relationship between the dependent and independent variables (George and Mallery, 2019; Morgan *et al.*, 2019; Aldrich, 2018). The independent variables are the predictors that are very significant in a regression analysis (IBM SPSS Case Studies, Version 27.0).

There are various forms of regression analysis but multiple regression is used in this research because it is best suited to model the value of a dependent variable based on

its relationship to two or more independent variables (predictors) (George and Mallery, 2019; Morgan *et al.*, 2019; Aldrich, 2018). Multiple regression also enables the determination of the overall fit (variance explained) of the model and the relative contribution of each of the predictors to the total variance explained (George and Mallery, 2019; Aldrich, 2018). The degree of relationship between the variables is best determined with the help of testing the hypotheses (George and Mallery, 2019; Morgan *et al.,* 2019). Therefore, the research-specific hypotheses served as the basis for the regression analysis. The various regression tests that are carried out in this research include; descriptive statistics; Model summary; Analysis of Variance (ANOVA) and Coefficients of regression. These tests were conducted to further check the degree of relationship between the research variables. The next section presents the validity, reliability and generalizability of the study.

3.7 Validity, Reliability, and Generalizability

Reliability, validity, and generalizability are very important in ensuring the quality of a research outcome (Saunders *et al.,* 2019; Dudwick *et al.*, 2006). Therefore, it is important to explain them and how they were applied in this research.

3.7.1 Validity

Validity is "the extent to which data collection methods accurately measure what they were intended to measure" (Saunders *et al.*, 2016, *p. 730*). It deals with the appropriateness of the research methods, tools, and data used and ensures that research outcomes are what they admit to being. It includes the accuracy of the analyzed results, and the possibility of generalizing the findings (Saunders *et al.*, 2019; Leung, 2015; Dudwick *et al.*, 2006). *Validation* on the other hand according to Saunders *et al.* (2016, *p. 206*) "is the process of verifying research data, analysis, and interpretation to establish their validity/credibility/authenticity". Two main validation techniques can be used to establish research quality, these are; *triangulation,* and *participant or member validation*. These techniques were used in this research to enhance the validity of the research and validated the research outcome.

Triangulation involves the use of two or more data sources and methods during the collection, analysis and interpretation (Saunders *et al.,* 2019). Therefore, this research employed the mixed-method approach by combining both quantitative and qualitative research methods. This approach is believed to have added depth, breadth, complexity, and richness to this research (Denzin, 2012; Denzin and Lincoln, 2011).

Participant or member validation involves "taking or sending research data back to participants to allow them to confirm its accuracy, by permitting them to comment on and correct it to validate it" (Saunders *et al.,* 2016, *p. 207*). Therefore, the draft framework to improve design documentation quality which is the aim of this research was sent to interview participants' who are experts in the industry to confirm its accuracy and to comment on it (Saunders *et al.,* 2019; Cayla and Arnould, 2013). This helped improve the framework as presented in this research report.

3.7.2 Reliability

Reliability denotes the replicability of the processes, the outcome, and the consistency of research (Leung, 2015). This explains the ease at which a research design can be replicated to achieve the same results as an earlier study (Saunders *et al.,* 2019). The researcher must carefully report the entire research more transparently to enable readers to be able to replicate the study if there is a need. It is on this premise that each process involved in this research is presented. Data collection and analysis techniques are duly presented to enhance the research's reliability.

3.7.3 Generalizability

Generalizability refers to the applicability of specific research findings to other settings (Saunders *et al.,* 2019; Opoku *et al.,* 2016) and different approaches may be used to enhance it. It can be enhanced "based on the ability of qualitative research to be used to test an existing theory, or for an emergent theory to be subsequently discussed in relation to a pre-existing theory" (Saunders *et al.*, 2016, *p. 400*).

However, the proposed framework for improving design documentation quality can be generalized as the processes involved in producing design documentation are similar in the construction industry across the world. It is also based on the fact that

appropriate literature was reviewed in consonance with the aim of this research. To pragmatically assess the generalizability of studies, there is a need to adopt the same criteria for validity (i.e. use of systematic sampling, triangulation, constant comparison, and documentation) (Leung, 2015; Fellows, 2009). Therefore, the use of mixed-method research and the selection of a representative sample of the population enhanced the generalizability of this research outcome. Cronbach's alpha is also used to further check the validity, reliability and generalizability of the variables.

3.7.3.1 Cronbach's Alpha

Cronbach's alpha, α (or *coefficient alpha*) provides a measure of internal consistency or reliability of a test or scale (Bonett and Wright, 2015; Tavakol and Dennick, 2011; Santos, 1999). It provided a test to determine the reliability of the Likert scale survey used in this research since these questions measure latent variables (Bonett and Wright, 2015; Tavakol and Dennick, 2011). It is expressed as a number between 0 and 1, where high reliability means excellent, and extremely low reliability means unacceptable (Bonett and Wright, 2015; Tavakol and Dennick, 2011).

The formula for calculating Cronbach's alpha is $\alpha = \frac{\mathrm{N}.\bar{c}}{\bar{v}+(N-1).\bar{c}}$

Where: N = number of items, $\bar{c}$ = average covariance between item pairs, and $\bar{v}$ = average variance. The Statistical Package for Social Sciences (IBM SPSS) Statistics for Windows, Version 27.0 software was used to calculate the Cronbach's alpha values for this research without the need to calculate it manually. Table 3.9 indicates the rule of thumb for interpreting alpha for dichotomous questions (i.e., questions with two possible answers) or Likert-scale questions as used in this research.

Table 3.9: Cronbach's Alpha Values

Cronbach's Alpha	**Internal Consistency**
$\alpha \geq 0.9$	Excellent
$0.9 > \alpha \geq 0.8$	Good
$0.8 > \alpha \geq 0.7$	Acceptable
$0.7 > \alpha \geq 0.6$	Questionable
$0.6 > \alpha \geq 0.5$	Poor
$0.5 > \alpha$	Unacceptable

` *Source: (Tavakol and Dennick, 2011)*

A score of more than 0.7 is usually acceptable, however; preference is usually given to higher values of 0.90 to 0.95. It is often argued that a high level of alpha is an indication that the items in the test are highly correlated (Bonett and Wright, 2015; Tavakol and Dennick, 2011).

However, in ensuring validity, reliability, and generalizability in this research, the following measures were employed:

i. *Triangulation:* mixed-method research was used where both quantitative and qualitative methods were combined (Mohajan, 2017) for a more independent data collection and methods (Saunders *et al.,* 2019). This added depth, breadth, and richness to the research (Denzin, 2012; Denzin and Lincoln, 2011).
ii. The questionnaire survey is composed of questions adapted from the literature.
iii. A pilot study was carried out before eliciting information with the survey tool for this research. All ambiguity and anomalies in data collection were cleared during the pilot study to enhance the quality of the instrument.
iv. Cronbach's alpha values were used.
v. *Participant or member validation:* this was achieved by sending the draft framework back to interview participants to allow them to confirm its accuracy and comment on it and correct it to validate it (Saunders *et al.,* 2019; Cayla and Arnould, 2013). This resulted in 13 validations.

In addition, semi-structured interviews for this research were carefully and well-conducted to enhance high levels of validity and credibility of the data that was collected (Saunders *et al.,* 2019). However, research involving human participants requires ethical considerations hence important in this research.

3.8 Ethical Considerations

Research ethics is one of the most critical parts of research, and formulating the research design (Saunders *et al.,* 2019). According to Saunders *et al.* (2016, *p. 201*), "it is a matter of judgment as to whether the strategy and data collection method(s) suggested will yield data that are valid". In ensuring ethics in research, the design

must not expose participants to the risk of embarrassment, pain, harm or any other disadvantage (Saunders *et al.,* 2019; Knight and Ruddock, 2009; Fellows, 2009).

In research on ethics: an exploratory content analysis by Bell and Bryman (2007), the following ethical considerations were argued: research participants should not be subjected to harm; participants' dignity should be respected; full consent should be obtained from the participants before the study; participants privacy and confidentiality must be protected. The anonymity of individuals and organizations participating in the research must be ensured; and any type of misleading information, as well as representation of primary data findings in a biased way, must be avoided.

In pursuant to these, all human ethics were duly observed in carrying out this research and consideration was given to the sensitive nature of all private, public, and government institutions, especially in this democratic dispensation. It was also required to obtain an ethics clearance certificate as presented in appendix "A" before starting any data collection hence achieved in this research. In addition;

i. All ethical issues in the Human Research Ethics policy of the University of the Witwatersrand were strictly adhered to in carrying out this research.
ii. The privacy, anonymity, and confidentiality of all respondents are paramount and were duly assured and implemented.
iii. The use of offensive, discriminatory, or other unacceptable language was avoided in the formulation of questionnaires and in carrying out interviews.
iv. Respondents and participants were duly informed of their voluntary participation in the research and the right to withdraw from the research at any stage if they wished to do so during survey and interviews.
v. Sufficient information was provided to all participants and respondents including consent forms to enable individuals to understand the implications of participation and to reach a fully informed, considered, and freely given decision on whether or not to do so, without any pressure or coercion.
vi. In reporting the responses, all projects and participants were made anonymous and all data protection acts and regulations in the research area were adhered to.

3.9 Chapter Summary

This chapter presents the research design, methods employed, data gathering, and analysis techniques that were used. The research-specific objectives with their corresponding research methods, data collection strategies, data analysis and presentation techniques are presented. Both objective and subjective views of research respondents and participants were considered very important in achieving the research aim. Therefore, the analysis and presentation of the data were done in their very true state or form to prevent bias and the researcher's influence.

The philosophical basis for this mixed-method research was consistent with the philosophy of pragmatism based on a deductive approach. The mixed methods design was employed to enable the combination of both quantitative and qualitative features to vigorously tackle the specific research problem rather than using just one of the two approaches. It provided a premise for a better understanding of the research problem and allowed for in-depth exploration, data collection and analysis to be carried out. A combination of exploratory and evaluative research designs was employed to achieve the research aim.

As a strategy, a review of the literature was followed by a questionnaire survey and subsequently, semi-structured interviews were conducted. The research was carried out on construction clients and professionals in consulting and construction firms in the industry. These experts include architects, quantity surveyors, project managers, contractors, and other relevant professionals. They provided data that helped achieve the aim of this research. Qualitative data analysis was done using QSR Nvivo 12 to bring order and structure to the data collected while quantitative data was analysed using IBM SPSS Statistics for Windows, Version 27.0. Ethical issues were considered since the research involved human participants.

Data presentation and analysis are a very important part of the research. This is dependent on the research methods adopted. This determines whether it is quantitative or qualitative data analysis or a combination of the two for mixed-method research as used in this research.

CHAPTER 4

QUANTITATIVE DATA PRESENTATION AND ANALYSIS

4.1 Introduction

This chapter presents the quantitative data collected including the analysis. This data was collected using a questionnaire survey distributed to construction sector experts who are; project supervisors, engineers, quantity surveyors, architects, project managers, managing directors and clients. A total of 235 responses were received. The analysis and presentation include descriptive and inferential statistics with the aid of IBM SPSS Statistics for Windows, Version 27.0.

The chapter begins with the presentation of information from the pilot study that was conducted with the instrument before data collection. It further presents the data from the survey by first presenting respondents' background information. The validity, reliability and generalisability of the research data are presented. There was a need to determine the significance of each variable in the survey based on the RII of each variable and this is presented as a preliminary analysis of survey data. After further analysis of the data using a factor, correlation and regression analyses, the research hypotheses were tested and presented in this chapter.

4.2 Pilot Survey

A pilot study was carried out before eliciting information with the survey instrument for this research. This provided for all ambiguity and anomalies in the instrument to be cleared to ensure that responses are the true reflections of the views of respondents. The pilot survey was carried out online via google form with purposefully selected construction industry professionals. These experts include project supervisors, engineers, quantity surveyors, architects, and construction managers. The pilot survey received a total of 34 responses from these experts. Analysis of the pilot study indicated that the variables under the various categories in the survey should be numbered and this was appropriately done. It also indicated that a short description of each section in the survey should be provided to enhance

clarity. This resulted in a brief explanation of each category of variables in the survey. There were indications from the pilot survey that respondents' outfits of work should be collected which resulted in the addition of a question in the background information on whether respondents work in consultants' or contractors' outfits. It was also indicated that the questions were adequate and appropriate for the research aim. Therefore, the pilot survey helped enhance the validity and reliability of the research instrument.

4.3 Respondents' Background Information

Respondents' background information includes their role in the construction sector; the highest level of education; years of experience in the sector; and their sector and outfit of work. Figure 4.1 presents the research respondents with their corresponding frequencies and percentages. Project or construction managers accounted for 27%, followed by quantity surveyors representing 22%, engineers and foreman or project supervisors accounted for 15% respectively, while architects represented 13%.

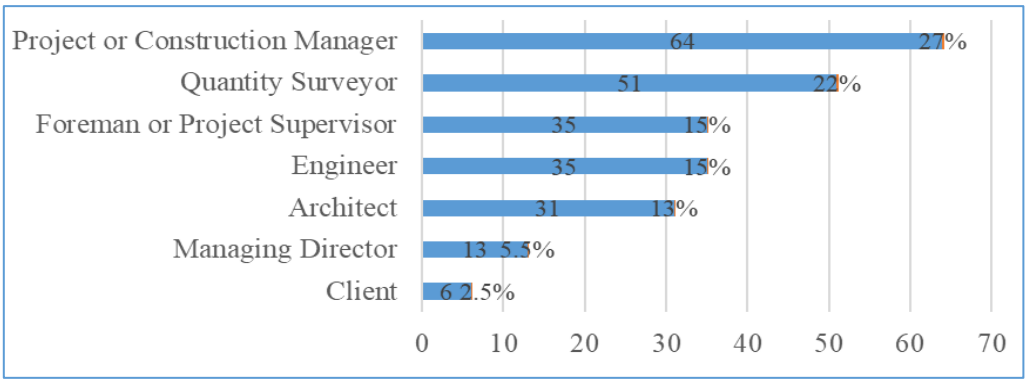

Figure 4.1: Respondent's role in the construction sector

This is indicative that the groups of respondents are experts in the construction industry and are involved in the production of design documentation, therefore, provided appropriate and reliable data for this research. Respondents' level of education is significant since it influences their responses; therefore, their major qualifications are presented in Figure 4.2.

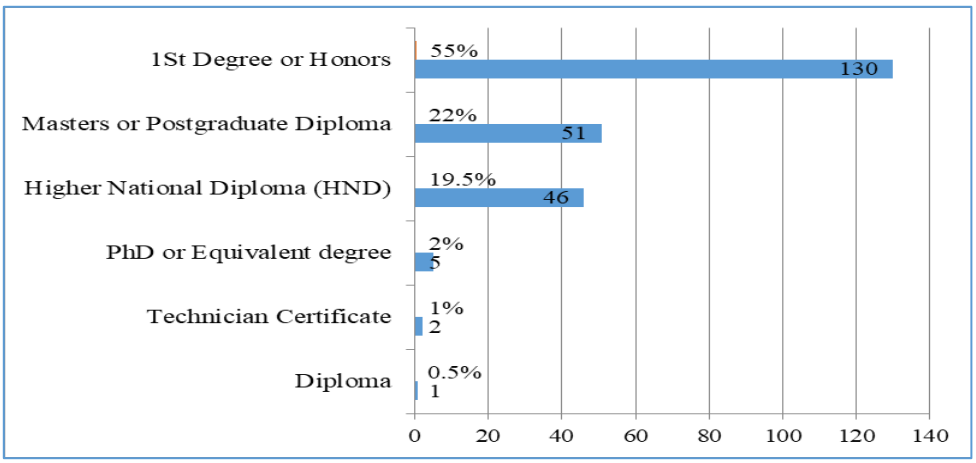

Figure 4.2: Respondent's level of education

A majority who are 1st-degree graduates accounted for 55%, followed by Master's degree holders 22%, Higher National Diploma (HND) holders 19.5%, and 2% PhD holders. This means respondents have attained good levels of education and hence provided adequate data. Respondents' years of experience are very significant in this research since it is believed to have influenced their reasoning and judgement, therefore, presented in Figure 4.3.

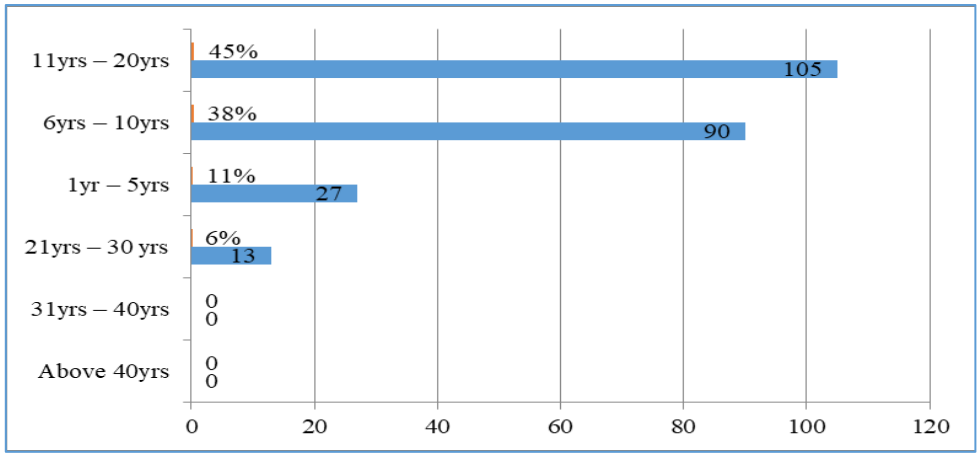

Figure 4.3: Respondent's years of experience in the construction sector

A majority of 45% have between 11 to 20 years of experience, followed by 38% having between 6 to 10 years of experience while 11% have 1 to 5 years of experience in the industry. This is indicative that respondents have significant experience in the construction sector with in-depth knowledge and provided relevant responses.

In determining whether respondents work within the private or the public sector, a majority of 50.21% work within the public sector while 49.79% work within the private sector. This data represents nearly a fair balance between the private and the public sector within the industry. This provided reliable data for the research because a majority of projects that are delivered using the conventional project delivery are within the public sector while a majority of projects that are delivered using IPD or some level of integration happens within the private sector.

It was also important to know whether respondents work within consultants' or contractors' outfits. A majority of 65% work within consultants' outfits while 35% work within contractors' outfits. This provided data from both consultants' and contractors' points of view which is believed to offer fair data for the research.

4.4 Validity, Reliability and Generalizability of Research Data

To achieve validity, reliability and generalizability of the quantitative data by enhancing the extent to which the data collection instrument yielded consistent findings that can be replicated transparently, Cronbach's alpha values were used. This was done with the aid of IBM SPSS Statistics for Windows, Version 27.0 software.

4.4.1 Quantitative data on the state of design documentation quality in practice

Table 4.1 presents the reliability statistics of data on 15 items that seek to determine the state of design documentation quality in practice. It provides the actual value for Cronbach's alpha of all the data in this category.

Table 4.1: Reliability Statistics for Design documentation quality

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	Number of Items
0.993	0.993	15

The actual Cronbach's alpha value of the data is 0.993 which is greater than 0.9 ($\alpha > 0.9$) indicating an ***excellent*** level of internal consistency hence valid and acceptable.

4.4.2 Quantitative data on Weaknesses associated with the conventional approach

Table 4.2 presents the reliability statistics of data on 24 items on weaknesses associated with the conventional project delivery approach. It provides the actual value for Cronbach's alpha of all the data in this category.

Table 4.2: Reliability Statistics for Weaknesses in Conventional project delivery

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	Number of Items
0.996	0.997	24

The actual Cronbach's alpha value of the data is 0.997 which is greater than 0.9 ($\alpha > 0.9$) indicating an ***excellent*** level of internal consistency hence valid and acceptable.

4.4.3 Data on Capabilities required in the production of design documentation

Table 4.3 presents the reliability statistics of data on 20 items on capabilities required in the production of design documentation. It provides the actual value for Cronbach's alpha of all the data in this category.

Table 4.3: Reliability Statistics for Capabilities Required

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	Number of Items
0.993	0.994	20

The actual Cronbach's alpha value of the data is 0.994 which is greater than 0.9 ($\alpha > 0.9$) indicating an ***excellent*** level of internal consistency hence valid and acceptable.

4.4.4 Quantitative data on enablers inherent in IPD

There are three categories of data on enablers inherent in IPD that can be adapted to improve design documentation quality; *Contractual Principles, Behavioural Principles* and *Early Involvement and Collaboration of Key Participants.* Table 4.4 presents the reliability statistics of data on 12 items on IPD Contractual Principles. It provides the actual value for Cronbach's alpha of all the data in this category.

Table 4.4: Reliability Statistics for IPD Contractual Principles

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	Number of Items
0.983	0.986	12

The actual Cronbach's alpha value of the data is 0.986 which is greater than 0.9 ($\alpha > 0.9$) indicating an ***excellent*** level of internal consistency hence valid and acceptable.

Table 4.5 presents the reliability statistics of data on six items on Behavioural principles and provides the actual value for Cronbach's alpha of all the data.

Table 4.5: Reliability Statistics for IPD Behavioural Principles

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	Number of Items
0.974	0.975	6

The actual Cronbach's alpha value of the data is 0.975 which is greater than 0.9 ($\alpha > 0.9$) indicating an ***excellent*** level of internal consistency hence valid and acceptable.

Table 4.6 presents the reliability statistics of data on seven items on early involvement and collaboration of key participants in a project. It provides the actual value for Cronbach's alpha of all the data in this category.

Table 4.6: Reliability Statistics for Early Involvement and Collaboration

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	Number of Items
0.966	0.972	7

The actual Cronbach's alpha value of the data is 0.972 which is greater than 0.9 ($\alpha > 0.9$) indicating an ***excellent*** level of internal consistency hence valid and acceptable.

4.5 Preliminary Analysis of Questionnaire Survey Data

A preliminary analysis of the data collected from the survey is presented in this section. The analysis was done based on the RII to rank the factors used in the survey. The RII values presented in Table 3.8 were used to rank all the factors in the survey. Where the RII values are the same, the mean score is used to determine the ranking. The following sub-sections present the preliminary analysis.

4.5.1 The State of Design Documentation Quality in Practice

The ranking of factors on the state of design documentation quality in practice under the conventional project delivery approach is presented in appendix "D" based on the RII values of the factors. The ranking involves a total of 15 factors and all had RII values between 0.82 - 0.89 which falls within $0.8 \leq RII \leq 1$ indicating high importance level. These factors are an indication that design documentation quality in practice under the conventional project delivery approach comes with a lot of challenges. Some of the top-ranked factors include; design drawings, bills of quantities and

specifications containing errors and omissions; lack of coordination among design documents; discrepancies between bill of quantities, drawings and specifications; lack of accuracy in design documentation; issuance of un-amended standard specifications; documents lacking clarity; and issuance of incomplete drawings.

4.5.2 Weaknesses associated with the conventional project delivery approach

The ranking of factors on weaknesses associated with the conventional project delivery approach is presented in appendix "E". The ranking involves a total of 24 factors and all had RII values between 0.83 - 0.88 which falls within $0.8 \leq RII \leq 1$ indicating high importance level. These factors indicate significant weaknesses that are associated with the conventional project delivery approach in practice. Some of the top-ranked factors include; lack of coordination among design consultants and design documents; continuous escalation of project cost, shoddy workmanship, and project abandonment; discrepancies between bill of quantities, drawings and specifications; project team members exploiting loopholes in contract documents; and contracts deliberately let at an excessively low price and hiking the price later.

4.5.3 Capabilities required in the production of design documentation

The ranking of factors on capabilities required in the production of design documentation under the conventional project delivery approach is presented in appendix "F". The ranking involves a total of 20 factors and all had RII values between 0.85 - 0.89 which falls within $0.8 \leq RII \leq 1$ indicating high importance level. These factors indicate significant capabilities that are required in the production of design documentation under the conventional project delivery approach. Some of the top-ranked factors include; preparation of detailed design; improving collaboration between consultants; paying appropriate fees to consultants; involving specialists' in design planning and processing; holding consultants accountable for producing poor design documentation quality, and designers partnering with other designers.

4.5.4 Enablers inherent in IPD that can be adapted

The ranking of factors on enablers inherent in IPD that can be adapted to improve design documentation quality within the conventional project delivery approach is presented in appendix "G". The ranking involves a total of 25 factors categorized into three groups which are; IPD contractual principles; IPD behavioural principles; and early involvement and collaboration of key participants. The group ranking based on the mean RII of factors is presented in Table 4.7. This placed behavioural principles in the first place with a mean RII of 0.90; contractual principles ranked second with a mean RII of 0.88, and early involvement and collaboration of key participants ranked third with a mean RII of 0.88 but with the least group mean value of 4.39.

Table 4.7: Ranking of groups of enablers in IPD

S/N	Group Ranking of Enablers in IPD	SD	D	U	A	SA	Average Group		Ranking
							RII	Mean	
1	IPD Behavioural Principles	0.84	2.33	3.33	105.17	123.33	0.90	4.48	1
2	IPD Contractual Principles	0.92	4.42	2.67	119.91	107.08	0.88	4.40	2
3	Early Involvement and Collaboration of Key Participants	0.71	4.3	3.29	121.7	105	0.88	4.39	3

However, all three groups had mean RII values within $0.8 \leq RII \leq 1$ which indicates high importance level of all the factors on enablers inherent in IPD that can be adapted to improve design documentation quality.

The overall ranking of all the 25 factors on enablers in IPD had RII values between 0.86 - 0.92 which falls within $0.8 \leq RII \leq 1$ indicating high importance level. These factors indicate the significant enablers inherent in IPD that can be adapted to improve design documentation quality within the conventional project delivery. Some of the top-ranked factors include; ensuring transparent processes throughout the project; key participants having mutual respect and trust for each other; open information sharing among key participants; participants making collaborative value-based decisions; involving key participants early in the project; tying the success of key participants to project success; and opportunity for adequate pre-design, design, and documentation planning.

4.5.5 Summary of Preliminary Data Analysis

Respondents' background information includes their role in the construction sector; their highest level of education; years of experience; their sector and their outfit of work. Analysis of the data using RII to rank the factors was necessary to determine the significance of each variable. The ranking of factors on the state of design documentation quality in practice under the conventional project delivery approach involves a total of 15 factors. The ranking of factors on weaknesses associated with the conventional project delivery approach involved a total of 24 factors. The ranking of factors on capabilities required in the production of design documentation involved a total of 20 factors. The ranking of factors on enablers inherent in IPD that can be adapted to improve design documentation quality involved a total of 25 factors.

4.6 Factor Analysis

Further analysis of the data in this research involves Factor Analysis. This analysis helped in determining the main variables for developing the framework. The test was executed with the aid of IBM SPSS Statistics for Windows, Version 27.0. The following sub-sections present the Factor Analysis of the data for this research.

4.6.1 Factor Analysis of the state of design documentation quality in practice

There were 15 factors on the state of design documentation quality in practice with a data sample size of 235 representing an acceptable ratio of 16 and an adequate sample size of more than 200 (Mundfrom, Shaw and Ke, 2005).

Testing Data Suitability for Factor Analysis

The KMO measure of sampling adequacy for the data is 0.940 as presented in Table 4.8. This value is very close to 1.00 indicating data suitability for factor analysis.

Table 4.8: KMO and Bartlett's Test of Sphericity for Design Documentation

Kaiser-Meyer-Olkin (KMO) Measure of Sampling Adequacy		0.940
Bartlett's Test of Sphericity	Approx. Chi-Square	10266.612
	df	105
	Sig.	0.000

A further test using Bartlett's Test of Sphericity produced an approximate Chi-Square value of 10266.612 with a 105 degree of freedom. The Sig. level for all the variables

is $p = 0.00$ which is far less than 0.05 indicating the suitability of the data for factor analysis. Therefore, both the KMO and Bartlett's Test indicate data suitability.

Initial and Extraction communalities

Table 4.9 presents the values of the Initial and the Extraction communalities of all the 15 variables. It is observed that the initial communalities of all the components were 1.000. This represents the proportion of variance that is accounted for in each variable by the others. Small values indicate that the variables do not fit well. All the values in this research are high indicating their fitness with the factor solution.

Table 4.9: Initial and Extraction Communalities variable for the state of Design Documentation Quality

Component	The state of design documentation quality Variables	Initial Communalities	Extraction Communalities
1	Design drawings usually contain errors and omissions.	1.000	0.834
2	Specifications usually contain errors and omissions.	1.000	0.903
3	Bills of quantities usually contain errors and omissions.	1.000	0.863
4	There is lack of coordination among design documents.	1.000	0.873
5	There are discrepancies between bill of quantities, drawings and specifications.	1.000	0.906
6	There are disparities between drawings and specifications only.	1.000	0.938
7	Documents are often issued with conflicting, inaccurate, and ambiguous information.	1.000	0.957
8	Documents lacking clarity.	1.000	0.951
9	Documents are often issued with insufficient details.	1.000	0.896
10	Issuance of un-amended standard specifications.	1.000	0.936
11	Issuance of incomplete design drawings.	1.000	0.958
12	Issuance of incomplete specifications.	1.000	0.900
13	Issuance of incomplete bills of quantities.	1.000	0.945
14	Issuance of bulky documents containing irrelevant information.	1.000	0.952
15	There is often lack of accuracy in design documentation.	1.000	0.923

From Table 4.9, the value of component 1 is comparably the smallest (0.834) hence has been dropped from the set of factors. Therefore, the extraction communalities for this solution are acceptable since they all fit well together except component 1.

Total Variance Explained

Table 4.10 presents the total variance explained by the initial solution of the PCA test. Under the *Initial Eigenvalues*, it is only one factor in the initial solution that has an eigenvalue of 13.736 which is more than one. This however accounted for 91.572% of the variability in the original variables. This suggests that there is one latent influence associated with the state of design documentation quality in practice.

Table 4.10: Total Variance Explained for Design Documentation Quality

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	13.736	91.572	91.572	13.736	91.572	91.572
2	0.644	4.293	95.865			
3	0.208	1.387	97.252			
4	0.104	0.691	97.943			
5	0.081	0.538	98.481			
6	0.062	0.416	98.897			
7	0.041	0.274	99.170			
8	0.031	0.207	99.378			
9	0.027	0.177	99.555			
10	0.018	0.119	99.674			
11	0.014	0.095	99.768			
12	0.013	0.085	99.853			
13	0.011	0.074	99.927			
14	0.008	0.052	99.979			
15	0.003	0.021	100.000			

From Table 4.10, the *Extraction Sums of Squared Loadings* show that it is only one factor in the solution with a cumulative variability of 91.572% and a total value of 13.736 extraction sums of squared loadings. Therefore, this factor was dropped from the set of factors on the state of design documentation quality in practice.

Factor Rotation and Remaining Factors after PCA Test

The outcome of the PCA test resulted in the extraction of only one factor therefore, the solution cannot be rotated hence a total of 14 factors are considered.

4.6.2 Factor Analysis of the Weaknesses associated with the Conventional Project Delivery Approach

There were 24 factors on the Weaknesses associated with the conventional project delivery with a data sample size of 235 representing an acceptable ratio of 10 and an adequate sample size of more than 200 (Guadagnoli and Velicer, 1988).

Testing Data Suitability for Factor Analysis

The KMO measure of sampling adequacy for the data is 0.950 as presented in Table 4.11. This value is very close to 1.00 indicating the suitability of the data.

Table 4.11: KMO and Bartlett's Test of Sphericity for Weaknesses

Kaiser-Meyer-Olkin Measure of Sampling Adequacy		0.950
Bartlett's Test of Sphericity	Approx. Chi-Square	18512.119
	df	276
	Sig.	0.000

A further test using Bartlett's Test of Sphericity as presented in Table 4.11 produced an approximate Chi-Square value of 18512.119 with a 276 degree of freedom. The associated Significance level for all the variables is $p = 0.00$. This value is far less than 0.05 which indicates the suitability of the data. Therefore, both the KMO and Bartlett's Test indicate the suitability of the data.

Initial and Extraction communalities

Table 4.12 presents the values of the Initial and the Extraction communalities of the 24 variables used. The values of all the 24 components were 1.000 representing the proportion of variance that is accounted for in each variable by the others. From Table 4.12, the extraction communalities values are all high which indicates their fitness with the factor solution. However, the values of components 1 and 2 are comparably small (0.769 and 0.766 respectively). Therefore, the values for this solution are acceptable since they all fit well together except for components 1 and 2.

Table 4.12: Initial and Extraction Communalities variables of Weaknesses

Component	Weaknesses associated with the conventional project delivery approach	Communalities	
		Initial	Extraction
1	Lack of coordination among design consultants.	1.000	0.769
2	Lack of cooperation and collaboration among project participants.	1.000	0.766
3	Lack of coordination among design documents.	1.000	0.872
4	Discrepancies between bill of quantities, drawings and specifications.	1.000	0.918
5	Reliance on specification notes only when drawings are required.	1.000	0.954
6	Projects always experience cost escalation, shoddy workmanship, project abandonment and other manifestations of project failure.	1.000	0.908
7	There is high inflation or escalation of final contract cost.	1.000	0.971
8	No guarantee of certainty of project final cost, only initial cost.	1.000	0.966
9	It encourages claim consciousness among project participants.	1.000	0.952
10	There is too much focus on lowest price instead of best price.	1.000	0.961
11	It encourages participants to be more profit conscious instead of project quality conscious.	1.000	0.936
12	Individual team members exploits loopholes in contract documents.	1.000	0.949
13	Letting contracts at excessively low price and hiking the price later to claim for reward.	1.000	0.953
14	Adversarial relationships among project participants threaten project goals; party spirit instead of team spirit.	1.000	0.954
15	It does not encourage commitment to project objectives rather individual participants' objectives and gain.	1.000	0.899
16	Each party has its own agenda based on its singular interest.	1.000	0.969
17	Lack of contractors' input at the design stage and not taking advantage of their experience.	1.000	0.949
18	It does not encourage commitment of all participants to total quality right from project design.	1.000	0.930
19	The rigid definition of roles and responsibilities provides no basis for shared vision or goals.	1.000	0.965
20	Hierarchical relationships making communication and transfer of useful knowledge among project participants difficult.	1.000	0.955
21	Compartmentalization of project participants around functional and professional lines leads to poor communication, poor relationships and leads to poor design documentation.	1.000	0.940
22	Uneven, unclear and unfair allocation of risks to some participants.	1.000	0.951
23	It does not create a win-win situation among project participants.	1.000	0.951
24	Relationships among project participants encourage professional mistrust and rivalry.	1.000	0.916

Total Variance Explained

From Table 4.13, the *Initial Eigenvalues* show that one factor in the initial solution has an eigenvalue of 22.253 which is more than one. This accounted for 92.721% of the variability in the original variables. This suggests that there is one latent influence associated with the components hence component 1 has been dropped.

Table 4.13: Total Variance Explained for Weaknesses

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	22.253	92.721	92.721	22.253	92.721	92.721
2	0.566	2.357	95.079			
3	0.418	1.740	96.818			
4	0.170	0.709	97.528			
5	0.123	0.514	98.042			
6	0.094	0.393	98.434			
7	0.073	0.303	98.737			
8	0.059	0.244	98.981			
9	0.048	0.201	99.183			
10	0.032	0.134	99.316			
11	0.029	0.120	99.437			
12	0.025	0.102	99.539			
13	0.020	0.083	99.622			
14	0.018	0.073	99.695			
15	0.013	0.056	99.752			
16	0.012	0.050	99.802			
17	0.010	0.043	99.845			
18	0.008	0.035	99.879			
19	0.007	0.030	99.909			
20	0.006	0.025	99.934			
21	0.005	0.022	99.956			
22	0.005	0.020	99.975			
23	0.004	0.016	99.992			
24	0.002	0.008	100.000			

From Table 4.13, the *Extraction Sums of Squared Loadings* show that there is only one factor in the extracted solution with a cumulative variability of 92.721% and a total value of 22.253. Therefore, this factor was dropped from the set of factors used.

Factor Rotation and Remaining Factors after PCA Test

The outcome of the PCA test on the data resulted in the extraction of one factor therefore, the solution cannot be rotated. This considered a total of 23 factors on the weaknesses associated with the conventional project delivery approach.

4.6.3 Factor Analysis of the Capabilities required in the production of design documentation under the conventional project delivery approach

There were 20 factors on the Capabilities required in the production of design documentation with a data set sample size of 235. This represents an acceptable ratio of 12 and an adequate sample size of more than 200 (Mundfrom *et al.,* 2005; Guadagnoli and Velicer, 1988).

Testing Data Suitability for Factor Analysis

The KMO measure of sampling adequacy for the data in this research is 0.954 as presented in Table 4.14. This value is very close to 1.00 indicating data suitability.

Table 4.14: KMO and Bartlett's Test of Sphericity for Capabilities

Kaiser-Meyer-Olkin Measure of Sampling Adequacy		0.954
Bartlett's Test of Sphericity	Approx. Chi-Square	13696.720
	df	190
	Sig.	0.000

Bartlett's Test of Sphericity for the research data as presented in Table 4.14 produced an approximate Chi-Square value of 13696.720 with a 190 degree of freedom. The associated Significance level from the test for all the variables is $p = 0.00$. This value is far less than 0.05 which is an indication of the suitability of the data. Therefore, both the KMO and Bartlett's Test indicates the suitability of the data.

Initial and Extraction communalities

Table 4.15 presents the values of the Initial and the Extraction communalities of the 20 variables used. It is observed from Table 4.15 that the initial communalities of all the 20 components were 1.000. This represents the proportion of variance that is accounted for in each variable by the others.

From Table 4.15, the extraction communalities values in this research are all high which indicates their fitness with the factor solution. However, the values of components 1, 2 and 20 are comparably small (0.822, 0.671 and 0.789 respectively). Therefore, the extraction communalities for this solution are acceptable since they all fit well together except for components 1, 2 and 20.

Table 4.15: Initial and Extraction Communalities variables on Capabilities required

Component	Capabilities required in the production of design documentation	Initial	Extraction
1	Holding Consultants accountable for producing poor design documentation quality (penalty).	1.000	0.822
2	Incentives for producing good design documentation quality.	1.000	0.671
3	Paying appropriate fees to consultants.	1.000	0.851
4	Improving consultants working conditions and procedures.	1.000	0.940
5	Clients allowing adequate time for the preparation of design documents.	1.000	0.951
6	Mandatory coordination of design documentation by a supervisor with requisite skills and knowledge.	1.000	0.923
7	Independent review of design documentation by a supervisor with requisite skills and knowledge.	1.000	0.945
8	Encouraging self-check practice and independent verification.	1.000	0.956
9	Re-checking design documentation for accuracy.	1.000	0.964
10	Use of checklists.	1.000	0.911
11	Setting up quality control departments.	1.000	0.935
12	Setting up minimum quality and service standards.	1.000	0.933
13	Designers partnering with others while preparing design documents.	1.000	0.950
14	Improving collaboration between consultants.	1.000	0.830
15	Specialists' involvement in design planning and processing.	1.000	0.844
16	Use of computer programs such as BIM.	1.000	0.905
17	Job-relevant training and practice.	1.000	0.909
18	Provision of elaborate and improved project brief.	1.000	0.903
19	Systematic audit to ensure the quality of briefs.	1.000	0.908
20	Preparation of detailed design.	1.000	0.789

Total Variance Explained

Table 4.16 presents the total variance explained by the initial solution of the PCA test. Under the *Initial Eigenvalues,* it is only one factor in the initial solution that has an eigenvalue of 17.838 which is more than one. This accounted for 89.188% of the variability in the variables and suggests that there is one latent influence associated with the components. Therefore, component 1 has been dropped. From Table 4.16, the *Extraction Sums of Squared Loadings* show that there is only one factor in the extracted solution with a cumulative variability of 89.188% and a total value of 17.838. Therefore, this factor was dropped from the set of factors.

Factor Rotation and Remaining Factors after PCA Test

The outcome of the PCA test resulted in the extraction of one factor (i.e. holding consultants' accountable for producing poor design documentation quality (penalty)); therefore, the solution cannot be rotated and a total of 19 factors are considered.

Table 4.16: Total Variance Explained for Capabilities

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	17.838	89.188	89.188	17.838	89.188	89.188
2	0.841	4.204	93.391			
3	0.446	2.229	95.621			
4	0.263	1.315	96.935			
5	0.174	0.871	97.806			
6	0.105	0.524	98.330			
7	0.088	0.439	98.769			
8	0.042	0.212	98.981			
9	0.041	0.203	99.184			
10	0.032	0.160	99.344			
11	0.025	0.127	99.471			
12	0.021	0.107	99.577			
13	0.018	0.090	99.667			
14	0.016	0.080	99.747			
15	0.013	0.064	99.811			
16	0.011	0.055	99.867			
17	0.009	0.045	99.912			
18	0.007	0.037	99.950			
19	0.006	0.032	99.982			
20	0.004	0.018	100.000			

4.6.4 Factor Analysis of the Enablers inherent in IPD

There were three categories of data sets for the Enablers inherent in IPD that can be adapted. These include Contractual Principles; Behavioural Principles; and Early Involvement and Collaboration of Key Participants.

a. Contractual Principles inherent in IPD

There were 12 factors on the Contractual Principles in IPD with a data set sample size of 235. This represents an acceptable ratio of 20 and an adequate sample size of more than 200 (Mundfrom *et al.*, 2005; Guadagnoli and Velicer, 1988).

Testing Data Suitability for Factor Analysis

The KMO measure of sampling adequacy is 0.885 as presented in Table 4.17. This value is very close to 1.00 which indicates the suitability of the data.

Table 4.17: KMO and Bartlett's Test of Sphericity for CP

Kaiser-Meyer-Olkin Measure of Sampling Adequacy		0.885
Bartlett's Test of Sphericity	Approx. Chi-Square	6888.039
	df	66
	Sig.	0.000

A further test using Bartlett's Test of Sphericity as presented in Table 4.17 produced an approximate Chi-Square value of 6888.039 with a 66 degree of freedom. The associated Sig. level from the test for all the variables is $p = 0.00$. This value is far less than 0.05 which is an indication of the suitability of the data for factor analysis. Therefore, both the KMO test and Bartlett's Test indicate data suitability.

Initial and Extraction communalities

Table 4.18 presents the values of the Initial and the Extraction communalities of the 12 variables used. It is observed from the table that the initial communalities of all the 12 components were 1.000. This represents the proportion of variance that is accounted for in each variable by the other variables.

Table 4.18: Initial and Extraction Communalities variables of Contractual Principles

Component	Contractual Principles inherent in IPD	Initial	Extraction
1	Involving Key participants early in the project.	1.000	0.896
2	Early contributions of knowledge and expertise by key participants.	1.000	0.828
3	Making collaborative value-based decisions by all participants.	1.000	0.859
4	Key participants bound together as equals.	1.000	0.908
5	Jointly and early developed project target criteria.	1.000	0.926
6	Tying the success of key participants to the success of the project.	1.000	0.902
7	Key participants jointly accountable for any errors in design.	1.000	0.890
8	Key participants sharing financial reward (compensation) based on project outcome.	1.000	0.912
9	Sharing financial risk among key participants.	1.000	0.886
10	Utilization of new technologies and approaches during design and construction.	1.000	0.864
11	Waiving liabilities between key participants.	1.000	0.833
12	Encourage fiscal transparency between key participants.	1.000	0.746

From Table 4.18, the extraction communalities show that the values in this research are all high which indicates their fitness with the factor solution. However, the values of components 2, 11 and 12 are comparably small (0.828, 0.833 and 0.746 respectively). Therefore, the extraction communalities for this solution are acceptable since they all fit well together except for components 2, 11 and 12.

Total Variance Explained

Table 4.19 presents the total variance explained by the initial solution of the PCA test. Under the *Initial Eigenvalues*, it is only one factor in the initial solution that has an eigenvalue of 10.452 which is more than one. This accounted for 87.097% of the variability in the variables. This suggests that there is one latent influence associated with the components. Therefore, component 1 has been dropped.

Table 4.19: Total Variance Explained for Contractual Principles

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	10.452	87.097	87.097	10.452	87.097	87.097
2	0.666	5.553	92.650			
3	0.464	3.865	96.515			
4	0.136	1.133	97.648			
5	0.093	0.776	98.424			
6	0.051	0.429	98.853			
7	0.042	0.347	99.199			
8	0.033	0.278	99.477			
9	0.026	0.219	99.697			
10	0.018	0.147	99.844			
11	0.014	0.118	99.962			
12	0.005	0.038	100.000			

From Table 4.19, the *Extraction Sums of Squared Loadings* show that there is only one factor in the solution with a cumulative variability of 87.097% and a total value of 10.452. Therefore, this factor was dropped from the set of factors.

Factor Rotation and Remaining Factors after PCA Test

The outcome of the PCA test resulted in the extraction of one factor therefore, the solution cannot be rotated hence a total of 11 factors are considered.

b. Behavioural Principles inherent in IPD

There were six factors on the Behavioural Principles (BP) with a data set sample size of 235. This represents an acceptable ratio of 39 and an adequate sample size of more than 200 (Mundfrom *et al.*, 2005; Guadagnoli and Velicer, 1988).

Testing Data Suitability for Factor Analysis

The KMO measure of sampling adequacy for the data on the Behavioural Principles inherent in IPD in this research is 0.884 as presented in Table 4.20. This value is very close to 1.00 which indicates the suitability of the data for factor analysis.

Table 4.20: KMO and Bartlett's Test of Sphericity for BP

Kaiser-Meyer-Olkin Measure of Sampling Adequacy		0.884
Bartlett's Test of Sphericity	Approx. Chi-Square	2313.669
	df	15
	Sig.	0.000

A further test using Bartlett's Test of Sphericity as presented in Table 4.20 produced an approximate Chi-Square value of 2313.669 with a 15 degree of freedom. The associated Significance level from the test for all the variables is $p = 0.00$. This value is far less than 0.05 which is an indication of the suitability of the data. Therefore, both the KMO and Bartlett's Tests indicate the suitability of the data.

Initial and Extraction communalities

Table 4.21 presents the values of the Initial and the Extraction communalities of the six variables used. It is observed that the initial values are all 1.000. This represents the proportion of variance that is accounted for in each variable by the others.

Table 4.21: Initial and Extraction Communalities variables of Behavioural Principles

Component	Behavioural Principles inherent in IPD	Initial	Extraction
1	Key participants having mutual respect for each other.	1.000	0.911
2	Key participants having mutual trust for each other.	1.000	0.867
3	Willingness to collaborate as key participants.	1.000	0.909
4	Open communication among key participants.	1.000	0.941
5	Open information sharing among key participants.	1.000	0.905
6	Ensuring transparent processes throughout the project.	1.000	0.804

From Table 4.21, extraction communalities represent an estimation of the variance in each variable accounted for by the factors in the factor solution. The values in Table 4.21 are all high indicating their fitness with the solution. However, the value of component 6 is comparatively small (0.804). Therefore, the extraction communalities for this solution are acceptable since they all fit well together except for component 6.

Total Variance Explained

Table 4.22 presents the total variance explained by the initial solution of the PCA test. Under the *Initial Eigenvalues*, it is only one factor in the initial solution that has an eigenvalue of 5.337 which is more than one. This however accounted for 88.942% of the variability in the original variables. This suggests that there is one latent influence associated with the components. Therefore, component 1 has been dropped.

Table 4.22: Total Variance Explained for Behavioural Principles

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	5.337	88.942	88.942	5.337	88.942	88.942
2	0.352	5.869	94.812			
3	0.142	2.362	97.174			
4	0.069	1.149	98.323			
5	0.059	0.989	99.311			
6	0.041	0.689	100.000			

From Table 4.22, the *Extraction Sums of Squared Loadings* show that there is only one factor in the extracted solution with a cumulative variability of 88.942% and a total value of 5.337 extraction sums of squared loadings. Therefore, this factor was dropped from the set of factors on the Behavioural Principles inherent in IPD.

Factor Rotation and Remaining Factors after PCA Test

The outcome of the PCA test resulted in the extraction of one factor therefore, the solution cannot be rotated hence a total of five factors are considered.

c. Early Involvement and Collaboration of Key Participants in IPD

There were seven factors on the early involvement and collaboration of key participants with a data sample size of 235. This represents an acceptable ratio of 34 and an adequate sample size of more than 200 (Guadagnoli and Velicer, 1988).

Testing Data Suitability for Factor Analysis

The KMO measure of sampling adequacy for the data in this research is 0.836 as presented in Table 4.23. This value is very close to 1.00 which indicates the suitability of the data for factor analysis.

Table 4.23: KMO and Bartlett's Test of Sphericity for EICKP

Kaiser-Meyer-Olkin Measure of Sampling Adequacy		0.836
Bartlett's Test of Sphericity	Approx. Chi-Square	2864.497
	df	21
	Sig.	0.000

A further test using Bartlett's Test of Sphericity as presented in Table 4.23 produced an approximate Chi-Square value of 2864.497 with a 21 degree of freedom. The associated Significance level from the test for all the variables is $p = 0.00$. This value is far less than 0.05 indicating the suitability of the data for factor analysis. Therefore, both the KMO and Bartlett's Tests indicate the suitability of the data.

Initial and Extraction Communalities

Table 4.24 presents the values of the Initial and the Extraction communalities of the variables. It shows that the initial values of all the components are 1.000 representing the proportion of variance that is accounted for in each variable by the others.

Table 4.24: Initial and Extraction Communalities variables of EICKP

Component	Early Involvement and Collaboration of Key Participants in IPD	Initial	Extraction
1	It enhances and strengthens key participants' understanding of the owner's desired outcome.	1.000	0.898
2	Effective collaboration by all participants improves design documentation quality.	1.000	0.805
3	There is a more timely and informed understanding of the design.	1.000	0.864
4	Provides an opportunity for adequate pre-design, design, and documentation planning.	1.000	0.912
5	Provides an opportunity for strong pre-construction planning.	1.000	0.909
6	Early visualization of construction sequencing prior to commencing project.	1.000	0.842
7	An increase in the level of effort by key participants during design documentation results in better documentation quality.	1.000	0.764

From Table 4.24, the extraction communalities are all high indicating their fitness with the solution. However, the values of components 2, 6, and 7 are comparatively small (0.805, 0.842, and 0.764 respectively). Therefore, the values for this solution are acceptable since they all fit well together except for components 2, 6, and 7.

Total Variance Explained

Table 4.25 presents the total variance explained by the initial solution of the PCA test. Under the *Initial Eigenvalues*, it is only one factor in the initial solution that has an eigenvalue of 5.993 which is more than one. This however accounted for 85.617% of the variability in the original variables. This suggests that there is one latent influence associated with components. Therefore, component 1 has been dropped.

Table 4.25: Total Variance Explained for EICKP

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	5.993	85.617	85.617	5.993	85.617	85.617
2	0.508	7.261	92.878			
3	0.246	3.519	96.397			
4	0.133	1.897	98.294			
5	0.071	1.019	99.313			
6	0.026	0.372	99.685			
7	0.022	0.315	100.000			

From Table 4.25, the *Extraction Sums of Squared Loadings* show that it is only one factor in the solution with a cumulative variability of 85.617% and a total value of 5.993. Therefore, this factor was dropped from the set of factors.

Factor Rotation and Remaining Factors after PCA Test

The outcome of the PCA test resulted in the extraction of one factor therefore, the solution cannot be rotated hence a total of six factors are considered.

4.7 Spearman's Rank-order Correlation Analysis

This non-parametric Correlation analysis involves the determination of the degree of correlation (*Spearman's correlation)*, the significance level and testing of the correlation coefficients hypotheses. The statistical hypothesis test for the ρ – values is: H_0: ρ (rho) = 0 (there is no relationship between the variables); while H_1: ρ (rho) ≠ 0 (there is a relationship between the variables).

4.7.1 Correlation Analysis of the state of design documentation quality in practice

There were 15 variables on the state of design documentation quality in practice with a sample size (N) of 235 with no missing data as presented in Table 4.26.

Table 4.26: Correlation Descriptive Statistics of data on design documentation quality

Labels	Variables	Mean	Std. Deviation	N
S1	Design drawings usually contain errors and omissions.	4.43	0.697	235
S2	Specifications usually contain errors and omissions.	4.27	0.775	235
S3	Bills of quantities usually contain errors and omissions.	4.38	0.683	235
S4	There is lack of coordination among design documents.	4.37	0.725	235
S5	There are discrepancies between bill of quantities, drawings and specifications.	4.36	0.692	235
S6	There are disparities between drawings and specifications only.	4.34	0.782	235
S7	Documents are often issued with conflicting, inaccurate, and ambiguous information.	4.19	0.896	235
S8	Documents lacking clarity.	4.20	0.937	235
S9	Documents are often issued with insufficient details.	4.15	0.843	235
S10	Issuance of un-amended standard specifications.	4.23	0.783	235
S11	Issuance of incomplete design drawings.	4.20	0.920	235
S12	Issuance of incomplete specifications.	4.11	0.952	235
S13	Issuance of incomplete bills of quantities.	4.17	0.915	235
S14	Issuance of bulky documents containing irrelevant information.	4.19	0.911	235
S15	There is often lack of accuracy in design documentation.	4.29	0.924	235

The variable labels are used to represent the variables in Table 4.27.

The Correlation Analysis (r_s)

The results of Spearman's correlation are presented in a matrix form in Table 4.27 with the correlations replicated. The Spearman's correlation and its significance values are presented in Table 4.27 while the sample size on which the calculation is based is presented in Table 4.26. The standard value for ρ is 0.05 or smaller but the correlation is considered highly significant statistically for smaller values at the 0.01 level (2-tailed). The least Spearman's correlation coefficient (r_s) value from the data set is +0.748 and the highest is +0.983 which are all very close to +1 (strong, positive correlation). The ρ –value for all the 15 variables is 0.000 which is far less than the 0.01 level (2-tailed) which is the set standard for a statistically significant relationship. Since all the *p*-values are far less than 0.05, there is evidence of a statistically significant bivariate association between the variables.

Table 4.27: Spearman's Correlation Matrix for the state of design documentation quality in practice (N = 235)

Variables	Values	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11	S12	S13	S14	S15
S1	r_s	1.000	.818**	.905**	.921**	.896**	.931**	.817**	.855**	.748**	.795**	.849**	.776**	.816**	.832**	.947**
	Sig.		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
S2	r_s	.818**	1.000	.893**	.883**	.906**	.863**	.971**	.924**	.890**	.955**	.931**	.914**	.969**	.950**	.840**
	Sig.	0.000		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
S3	r_s	.905**	.893**	1.000	.983**	.980**	.945**	.879**	.922**	.803**	.859**	.916**	.831**	.878**	.897**	.919**
	Sig.	0.000	0.000		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
S4	r_s	.921**	.883**	.983**	1.000	.968**	.962**	.871**	.913**	.797**	.851**	.907**	.824**	.870**	.888**	.935**
	Sig.	0.000	0.000	0.000		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
S5	r_s	.896**	.906**	.980**	.968**	1.000	.951**	.900**	.941**	.828**	.882**	.936**	.852**	.899**	.917**	.927**
	Sig.	0.000	0.000	0.000	0.000		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
S6	r_s	.931**	.863**	.945**	.962**	.951**	1.000	.878**	.917**	.812**	.860**	.911**	.835**	.878**	.895**	.975**
	Sig.	0.000	0.000	0.000	0.000	0.000		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
S7	r_s	.817**	.971**	.879**	.871**	.900**	.878**	1.000	.958**	.911**	.961**	.964**	.950**	1.000**	.982**	.872**
	Sig.	0.000	0.000	0.000	0.000	0.000	0.000		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
S8	r_s	.855**	.924**	.922**	.913**	.941**	.917**	.958**	1.000	.874**	.920**	.994**	.912**	.958**	.976**	.909**
	Sig.	0.000	0.000	0.000	0.000	0.000	0.000	0.000		0.000	0.000	0.000	0.000	0.000	0.000	0.000
S9	r_s	.748**	.890**	.803**	.797**	.828**	.812**	.911**	.874**	1.000	.937**	.879**	.955**	.911**	.895**	.806**
	Sig.	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000		0.000	0.000	0.000	0.000	0.000	0.000
S10	r_s	.795**	.955**	.859**	.851**	.882**	.860**	.961**	.920**	.937**	1.000	.925**	.957**	.961**	.943**	.843**
	Sig.	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000		0.000	0.000	0.000	0.000	0.000
S11	r_s	.849**	.931**	.916**	.907**	.936**	.911**	.964**	.994**	.879**	.925**	1.000	.917**	.964**	.982**	.903**
	Sig.	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000		0.000	0.000	0.000	0.000
S12	r_s	.776**	.914**	.831**	.824**	.852**	.835**	.950**	.912**	.955**	.957**	.917**	1.000	.950**	.933**	.833**
	Sig.	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000		0.000	0.000	0.000
S13	r_s	.816**	.969**	.878**	.870**	.899**	.878**	1.000**	.958**	.911**	.961**	.964**	.950**	1.000	.982**	.872**
	Sig.	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000		0.000	0.000
S14	r_s	.832**	.950**	.897**	.888**	.917**	.895**	.982**	.976**	.895**	.943**	.982**	.933**	.982**	1.000	.887**
	Sig.	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000		0.000
S15	r_s	.947**	.840**	.919**	.935**	.927**	.975**	.872**	.909**	.806**	.843**	.903**	.833**	.872**	.887**	1.000
	Sig.	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	

**Correlation is Significant at the 0.01 level (2-tailed)

The ρ – values are not technically zero but SPSS does not give these values to more than three decimal places. In testing the population hypothesis; since all the ρ – values are less than 0.01 but not equal to zero, H_1: ρ (rho) $\neq 0$, the null hypothesis is rejected and the alternative hypothesis accepted that the relationship between the variables is statistically significant. Therefore, Spearman's correlation coefficient, r_s of +0.748 is statistically significant ($p = 0.000$).

Summary of the Spearman's Rank-order Correlation

A Spearman's rank-order correlation was conducted to determine the relationship between 15 variables on the state of design documentation quality in practice. The results in Table 4.27 shows that there is a strong, positive correlation between the variables, which is statistically significant ($r_s(15) = +0.748$, $p = 0.000$).

4.7.2 Correlation Analysis of Weaknesses in the conventional project delivery

There were 24 variables on Weaknesses associated with the conventional project delivery with a sample size of 235 as presented in Table 4.28.

The Correlation Analysis (r_s)

The results of Spearman's correlation are presented in a matrix form in Table 4.29 with the correlations replicated. The Spearman's correlation and its significance values are presented in Table 4.29 while the sample size on which the calculation is based is presented in Table 4.28. The standard value for ρ is 0.05 or smaller but the correlation is considered highly significant statistically for smaller values at the 0.01 level (2-tailed). The least Spearman's correlation coefficient (r_s) value from the data set is +0.726 and the highest is +0.993 which are all very close to +1 (strong, positive correlation). The ρ –values for all 24 variables is 0.000 which is far less than the 0.01 level (2-tailed) and 0.05, therefore, there is evidence of a statistically significant bivariate association between the variables.

In testing the population hypothesis; since all the ρ – values are less than 0.01 but not equal to zero, H_1: ρ (rho) $\neq 0$, the null hypothesis is rejected and the alternative hypothesis accepted that the relationship between the variables is statistically

significant. Therefore, Spearman's correlation coefficient, r_s of +0.726 is statistically significant (p = 0.000).

Table 4.28: Correlation Descriptive Statistics of data on Weaknesses

Label	Variables	Mean	Std. Deviation	N
W1	Lack of coordination among design consultants.	4.38	0.708	235
W2	Lack of cooperation and collaboration among project participants.	4.19	0.642	235
W3	Lack of coordination among design documents.	4.33	0.698	235
W4	Discrepancies between bill of quantities, drawings and specifications.	4.32	0.707	235
W5	Reliance on specification notes only when drawings are required.	4.22	0.775	235
W6	Projects always experience cost escalation, shoddy workmanship, project abandonment and other manifestations of project failure.	4.34	0.764	235
W7	There is high inflation or escalation of final contract cost.	4.23	0.830	235
W8	No guarantee of certainty of project final cost, only initial cost.	4.24	0.792	235
W9	It encourages claim consciousness among project participants.	4.28	0.814	235
W10	There is too much focus on lowest price instead of best price.	4.25	0.827	235
W11	It encourages participants to be more profit conscious instead of project quality conscious.	4.19	0.800	235
W12	Individual team members exploits loopholes in contract documents.	4.30	0.814	235
W13	Letting contracts at excessively low price and hiking the price later to claim for reward.	4.29	0.827	235
W14	Adversarial relationships among project participants threatening project goals; party spirit instead of team spirit.	4.24	0.854	235
W15	It does not encourage commitment to project objectives rather individual participant's objectives and gain.	4.13	0.832	235
W16	Each party has its own agenda based on its singular interest.	4.25	0.806	235
W17	Lack of contractors input at the design stage and not taking advantage of their experience.	4.25	0.750	235
W18	It does not encourage commitment of all participants to total quality right from project design.	4.19	0.807	235
W19	The rigid definition of roles and responsibilities provides no basis for shared vision or goals.	4.22	0.852	235
W20	Hierarchical relationships making communication and transfer of useful knowledge among project participants difficult.	4.24	0.855	235
W21	Compartmentalization of project participants around functional and professional lines leads to poor communication, poor relationships and leads to poor design documentation.	4.17	0.864	235
W22	Uneven, unclear and unfair allocation of risks to some participants.	4.18	0.873	235
W23	It does not create a win-win situation among project participants.	4.20	0.796	235
W24	Relationships among project participants encourage professional mistrust and rivalry.	4.26	0.891	235

The variable labels are used to represent the variables in Table 4.29.

Table 4.29: Spearman's Correlation Matrix for Weaknesses associated with the conventional project delivery (N = 235)

Variables	Values	W1	W2	W3	W4	W5	W6	W7	W8	W9	W10	W11	W12	W13	W14	W15	W16	W17	W18	W19	W20	W21	W22	W23	W24
W1	**rho**	1.000	.727**	.933**	.929**	.843**	.985**	.879**	.869**	.944**	.908**	.812**	.969**	.960**	.920**	.788**	.895**	.858**	.814**	.884**	.927**	.829**	.857**	.841**	.952**
	Sig.		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
W2	**rho**	.727**	1.000	.784**	.791**	.845**	.751**	.809**	.826**	.759**	.792**	.875**	.749**	.751**	.768**	.878**	.804**	.839**	.879**	.801**	.764**	.848**	.816**	.840**	.726**
	Sig.	0.000		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
W3	**rho**	.933**	.784**	1.000	.993**	.901**	.938**	.937**	.929**	.951**	.969**	.868**	.935**	.939**	.965**	.836**	.956**	.918**	.871**	.942**	.958**	.882**	.910**	.897**	.906**
	Sig.	0.000	0.000		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
W4	**rho**	.929**	.791**	.993**	1.000	.909**	.945**	.946**	.938**	.959**	.976**	.879**	.943**	.948**	.973**	.846**	.964**	.926**	.881**	.950**	.966**	.891**	.919**	.906**	.914**
	Sig.	0.000	0.000	0.000		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
W5	**rho**	.843**	.845**	.901**	.909**	1.000	.864**	.959**	.968**	.900**	.931**	.964**	.883**	.891**	.912**	.926**	.943**	.979**	.958**	.951**	.905**	.980**	.967**	.995**	.863**
	Sig.	0.000	0.000	0.000	0.000		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
W6	**rho**	.985**	.751**	.938**	.945**	.864**	1.000	.899**	.890**	.961**	.926**	.836**	.984**	.976**	.937**	.811**	.914**	.879**	.837**	.903**	.943**	.850**	.876**	.863**	.967**
	Sig.	0.000	0.000	0.000	0.000	0.000		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
W7	**rho**	.879**	.809**	.937**	.946**	.959**	.899**	1.000	.980**	.938**	.968**	.925**	.916**	.924**	.950**	.897**	.980**	.964**	.919**	.991**	.943**	.946**	.971**	.960**	.898**
	Sig.	0.000	0.000	0.000	0.000	0.000	0.000		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
W8	**rho**	.869**	.826**	.929**	.938**	.968**	.890**	.980**	1.000	.918**	.960**	.938**	.904**	.908**	.931**	.899**	.973**	.984**	.937**	.972**	.923**	.950**	.976**	.964**	.879**
	Sig.	0.000	0.000	0.000	0.000	0.000	0.000	0.000		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
W9	**rho**	.944**	.759**	.951**	.959**	.900**	.961**	.938**	.918**	1.000	.955**	.869**	.977**	.985**	.976**	.849**	.943**	.903**	.862**	.943**	.980**	.890**	.914**	.902**	.956**
	Sig.	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
W10	**rho**	.908**	.792**	.969**	.976**	.931**	.926**	.968**	.960**	.955**	1.000	.903**	.940**	.945**	.969**	.869**	.987**	.945**	.901**	.972**	.961**	.915**	.941**	.928**	.914**
	Sig.	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
W11	**rho**	.812**	.875**	.868**	.879**	.964**	.836**	.925**	.938**	.869**	.903**	1.000	.856**	.860**	.880**	.952**	.914**	.948**	.995**	.917**	.873**	.970**	.933**	.959**	.833**
	Sig.	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
W12	**rho**	.969**	.749**	.935**	.943**	.883**	.984**	.916**	.904**	.977**	.940**	.856**	1.000	.992**	.954**	.831**	.928**	.889**	.849**	.921**	.959**	.869**	.894**	.881**	.971**
	Sig.	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
W13	**rho**	.960**	.751**	.939**	.948**	.891**	.976**	.924**	.908**	.985**	.945**	.860**	.992**	1.000	.962**	.838**	.932**	.893**	.853**	.929**	.966**	.877**	.902**	.889**	.967**
	Sig.	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
W14	**rho**	.920**	.768**	.965**	.973**	.912**	.937**	.950**	.931**	.976**	.969**	.880**	.954**	.962**	1.000	.871**	.956**	.916**	.874**	.959**	.992**	.909**	.937**	.918**	.945**
	Sig.	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
W15	**rho**	.788**	.878**	.836**	.846**	.926**	.811**	.897**	.899**	.849**	.869**	.952**	.831**	.838**	.871**	1.000	.879**	.907**	.947**	.895**	.869**	.945**	.926**	.931**	.833**
	Sig.	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

**Correlation is significant at the 0.01 level (2-tailed)

Table 4.29: Continued

Variables	Values	W1	W2	W3	W4	W5	W6	W7	W8	W9	W10	W11	W12	W13	W14	W15	W16	W17	W18	W19	W20	W21	W22	W23	W24
W16	**rho**	.895**	.804**	.956**	.964**	.943**	.914**	.980**	.973**	.943**	.987**	.914**	.928**	.932**	.956**	.879**	1.000	.957**	.913**	.985**	.948**	.927**	.952**	.940**	.902**
	Sig.	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
W17	**rho**	.858**	.839**	.918**	.926**	.979**	.879**	.964**	.984**	.903**	.945**	.948**	.889**	.893**	.916**	.907**	.957**	1.000	.952**	.956**	.908**	.959**	.974**	.975**	.864**
	Sig.	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000		0.000	0.000	0.000	0.000	0.000	0.000	0.000
W18	**rho**	.814**	.879**	.871**	.881**	.958**	.837**	.919**	.937**	.862**	.901**	.995**	.849**	.853**	.874**	.947**	.913**	.952**	1.000	.911**	.867**	.964**	.928**	.954**	.825**
	Sig.	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000		0.000	0.000	0.000	0.000	0.000	0.000
W19	**rho**	.884**	.801**	.942**	.950**	.951**	.903**	.991**	.972**	.943**	.972**	.917**	.921**	.929**	.959**	.895**	.985**	.956**	.911**	1.000	.951**	.942**	.967**	.956**	.906**
	Sig.	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000		0.000	0.000	0.000	0.000	0.000
W20	**rho**	.927**	.764**	.958**	.966**	.905**	.943**	.943**	.923**	.980**	.961**	.873**	.959**	.966**	.992**	.869**	.948**	.908**	.867**	.951**	1.000	.902**	.934**	.910**	.953**
	Sig.	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000		0.000	0.000	0.000	0.000
W21	**rho**	.829**	.848**	.882**	.891**	.980**	.850**	.946**	.950**	.890**	.915**	.970**	.869**	.877**	.909**	.945**	.927**	.959**	.964**	.942**	.902**	1.000	.962**	.984**	.862**
	Sig.	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000		0.000	0.000	0.000
W22	**rho**	.857**	.816**	.910**	.919**	.967**	.876**	.971**	.976**	.914**	.941**	.933**	.894**	.902**	.937**	.926**	.952**	.974**	.928**	.967**	.934**	.962**	1.000	.972**	.892**
	Sig.	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000		0.000	0.000
W23	**rho**	.841**	.840**	.897**	.906**	.995**	.863**	.960**	.964**	.902**	.928**	.959**	.881**	.889**	.918**	.931**	.940**	.975**	.954**	.956**	.910**	.984**	.972**	1.000	.869**
	Sig.	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000		0.000
W24	**rho**	.952**	.726**	.906**	.914**	.863**	.967**	.898**	.879**	.956**	.914**	.833**	.971**	.967**	.945**	.833**	.902**	.864**	.825**	.906**	.953**	.862**	.892**	.869**	1.000
	Sig.	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	

***Correlation is significant at the 0.01 level (2-tailed)*

Summary of the Spearman's Rank-order Correlation

A Spearman's rank-order correlation was conducted to determine the relationship between 24 weaknesses associated with the conventional project delivery approach. The results in Table 4.29 shows that there is a strong, positive correlation between the variables, which is statistically significant ($r_s(24) = +0.726$, $p = 0.000$).

4.7.3 Correlation Analysis of the Capabilities required in the production of design documentation under the conventional project delivery approach

There were 20 variables with a sample size (N) of 235 with no missing data as presented in Table 4.30.

Table 4.30: Correlation Descriptive Statistics of data on Capabilities

Labels	Variables	Mean	Std. Deviation	N
C1	Holding Consultants accountable for producing poor design documentation quality (penalty).	4.39	0.627	235
C2	Incentives for producing good design documentation quality.	4.30	0.567	235
C3	Paying appropriate fees to consultants.	4.43	0.659	235
C4	Improving consultants working conditions and procedures.	4.31	0.730	235
C5	Clients allowing adequate time for the preparation of design documents.	4.34	0.688	235
C6	Mandatory coordination of design documentation by a supervisor with requisite skills and knowledge.	4.33	0.686	235
C7	Independent review of design documentation by a supervisor with requisite skills and knowledge.	4.35	0.744	235
C8	Encouraging self-check practice and independent verification.	4.31	0.728	235
C9	Re-checking design documentation for accuracy.	4.33	0.721	235
C10	Use of checklists.	4.24	0.786	235
C11	Setting up quality control departments.	4.26	0.789	235
C12	Setting up minimum quality and service standards.	4.32	0.798	235
C13	Designers partnering with others while preparing design documents.	4.34	0.758	235
C14	Improving collaboration between consultants.	4.44	0.613	235
C15	Specialists' involvement in design planning and processing.	4.43	0.626	235
C16	Use of computer programs such as BIM.	4.25	0.862	235
C17	Job relevant training and practice.	4.23	0.812	235
C18	Provision of elaborate and improved project brief.	4.24	0.749	235
C19	Systematic audit to ensure the quality of briefs.	4.29	0.833	235
C20	Preparation of detailed design.	4.46	0.791	235

The variable labels are used to represent the variables in Table 4.31.

The Correlation Analysis (r_s)

The results of Spearman's correlation are presented in a matrix form in Table 4.31 with the correlations replicated. The Spearman's correlation and its significance values are presented in Table 4.31 while the sample size on which the calculation is based is presented in Table 4.30. The standard value for ρ is 0.05 or smaller but the correlation is considered highly significant statistically for smaller values at the 0.01 level (2-tailed). The least Spearman's correlation coefficient (r_s) value from the data set is +0.715 and the highest is +0.995 which are all very close to +1 (strong, positive correlation). The ρ –values for all the 20 variables are 0.000 which is far less than the 0.01 level (2-tailed) and 0.05, therefore, there is evidence of a statistically significant bivariate association between the variables.

In testing the population hypothesis; since all the ρ – values are less than 0.01 but not equal to zero, H_1: ρ (rho) $\neq$ 0, the null hypothesis is rejected and the alternative hypothesis accepted that the relationship between the variables is statistically significant. Therefore, Spearman's correlation coefficient, r_s of +0.715 is statistically significant (p = 0.000).

Summary of the Spearman's Rank-order Correlation

A Spearman's rank-order correlation was conducted to determine the relationship between the 20 capabilities required in the production of design documentation. The results in Table 4.31 shows that there is a strong, positive correlation between the variables, which is statistically significant ($r_s(20)$ = +0.715, p = 0.000).

Table 4.31: Spearman's Correlation Matrix for capabilities required in the production of design documentation (N = 235)

Variables	Values	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	C12	C13	C14	C15	C16	C17	C18	C19	C20
C1	**rho**	1.000	.817**	.886**	.943**	.965**	.946**	.941**	.939**	.969**	.886**	.923**	.925**	.946**	.904**	.918**	.957**	.903**	.862**	.926**	.737**
	Sig.		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
C2	**rho**	.817**	1.000	.725**	.833**	.813**	.837**	.769**	.828**	.803**	.855**	.825**	.756**	.773**	.739**	.751**	.781**	.831**	.889**	.756**	.606**
	Sig.	0.000		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
C3	**rho**	.886**	.725**	1.000	.862**	.881**	.863**	.926**	.860**	.886**	.820**	.850**	.927**	.918**	.981**	.965**	.883**	.837**	.798**	.916**	.836**
	Sig.	0.000	0.000		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
C4	**rho**	.943**	.833**	.862**	1.000	.978**	.995**	.928**	.995**	.967**	.940**	.977**	.912**	.933**	.868**	.881**	.939**	.955**	.919**	.912**	.745**
	Sig.	0.000	0.000	0.000		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
C5	**rho**	.965**	.813**	.881**	.978**	1.000	.973**	.948**	.974**	.988**	.922**	.957**	.932**	.953**	.888**	.901**	.960**	.937**	.901**	.932**	.760**
	Sig.	0.000	0.000	0.000	0.000		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
C6	**rho**	.946**	.837**	.863**	.995**	.973**	1.000	.922**	.991**	.962**	.934**	.971**	.906**	.926**	.870**	.883**	.933**	.950**	.913**	.906**	.736**
	Sig.	0.000	0.000	0.000	0.000	0.000		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
C7	**rho**	.941**	.769**	.926**	.928**	.948**	.922**	1.000	.929**	.956**	.883**	.916**	.983**	.991**	.935**	.949**	.945**	.898**	.862**	.983**	.801**
	Sig.	0.000	0.000	0.000	0.000	0.000	0.000		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
C8	**rho**	.939**	.828**	.860**	.995**	.974**	.991**	.929**	1.000	.972**	.946**	.982**	.918**	.938**	.866**	.878**	.944**	.961**	.925**	.918**	.754**
	Sig.	0.000	0.000	0.000	0.000	0.000	0.000	0.000		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
C9	**rho**	.969**	.803**	.886**	.967**	.988**	.962**	.956**	.972**	1.000	.922**	.956**	.945**	.965**	.893**	.906**	.971**	.936**	.900**	.944**	.774**
	Sig.	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
C10	**rho**	.886**	.855**	.820**	.940**	.922**	.934**	.883**	.946**	.922**	1.000	.965**	.891**	.892**	.825**	.835**	.922**	.974**	.965**	.898**	.737**
	Sig.	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
C11	**rho**	.923**	.825**	.850**	.977**	.957**	.971**	.916**	.982**	.956**	.965**	1.000	.921**	.924**	.856**	.867**	.950**	.978**	.935**	.925**	.758**
	Sig.	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
C12	**rho**	.925**	.756**	.927**	.912**	.932**	.906**	.983**	.918**	.945**	.891**	.921**	1.000	.979**	.935**	.948**	.951**	.905**	.866**	.987**	.815**
	Sig.	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
C13	**rho**	.946**	.773**	.918**	.933**	.953**	.926**	.991**	.938**	.965**	.892**	.924**	.979**	1.000	.927**	.940**	.954**	.907**	.871**	.978**	.799**
	Sig.	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000		0.000	0.000	0.000	0.000	0.000	0.000	0.000
C14	**rho**	.904**	.739**	.981**	.868**	.888**	.870**	.935**	.866**	.893**	.825**	.856**	.935**	.927**	1.000	.984**	.889**	.841**	.802**	.924**	.818**
	Sig.	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000		0.000	0.000	0.000	0.000	0.000	0.000
C15	**rho**	.918**	.751**	.965**	.881**	.901**	.883**	.949**	.878**	.906**	.835**	.867**	.948**	.940**	.984**	1.000	.901**	.852**	.812**	.936**	.805**
	Sig.	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000		0.000	0.000	0.000	0.000	0.000
	Sig.	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	

**Correlation is significant at the 0.01 level (2-tailed).

Table 4.31: Continued

Variables	Values	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	C12	C13	C14	C15	C16	C17	C18	C19	C20
C16	**rho**	.957**	.781**	.883**	.939**	.960**	.933**	.945**	.944**	.971**	.922**	.950**	.951**	.954**	.889**	.901**	1.000	.947**	.890**	.964**	.791**
	Sig.	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000		0.000	0.000	0.000	0.000
C17	**rho**	.903**	.831**	.837**	.955**	.937**	.950**	.898**	.961**	.936**	.974**	.978**	.905**	.907**	.841**	.852**	.947**	1.000	.940**	.920**	.754**
	Sig.	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000		0.000	0.000	0.000
C18	**rho**	.862**	.889**	.798**	.919**	.901**	.913**	.862**	.925**	.900**	.965**	.935**	.866**	.871**	.802**	.812**	.890**	.940**	1.000	.866**	.715**
	Sig.	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000		0.000	0.000
C19	**rho**	.926**	.756**	.916**	.912**	.932**	.906**	.983**	.918**	.944**	.898**	.925**	.987**	.978**	.924**	.936**	.964**	.920**	.866**	1.000	.812**
	Sig.	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000		0.000
C20	**rho**	.737**	.606**	.836**	.745**	.760**	.736**	.801**	.754**	.774**	.737**	.758**	.815**	.799**	.818**	.805**	.791**	.754**	.715**	.812**	1.000
	Sig.	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	

**Correlation is significant at the 0.01 level (2-tailed).

4.7.4 Correlation Analysis of Enablers inherent in IPD

The three categories of data set for Enablers inherent in IPD that can be adapted to improve design documentation quality are; Contractual Principles; Behavioural Principles; and Early Involvement and Collaboration of Key Participants.

a. Contractual Principles inherent in IPD

There were 12 variables on Contractual Principles inherent in IPD with a sample size (N) of 235 with no missing data in the data set as presented in Table 4.32. The results of the Spearman's correlation and its significance values are presented in a matrix form in Table 4.32 with the correlations replicated. The standard value for ρ is 0.05 or less but the correlation is considered highly significant statistically for smaller values at the 0.01 level (2-tailed). The least Spearman's correlation coefficient (r_s) value from the data set is +0.747 and the highest is +0.997 which are all very close to +1 (strong, positive correlation). The ρ –values for all the 12 variables are 0.000 which is far less than the 0.01 level (2-tailed) and 0.05, therefore, there is evidence of a statistically significant bivariate association between the variables.

In testing the population hypothesis; since all the ρ – values are less than 0.01 but not equal to zero, H_1: ρ (rho) $\neq$ 0, the null hypothesis is rejected and the alternative hypothesis accepted that the relationship between the variables is statistically significant. Therefore, Spearman's correlation coefficient, r_s of +0.747 is statistically significant (ρ = 0.000).

Summary of the Spearman's Rank-order Correlation

A Spearman's rank-order correlation was conducted to determine the relationship between the 12 Contractual Principles inherent in IPD. The results in Table 4.32 shows that there is a strong, positive correlation between the variables, which is statistically significant ($r_s(12) = +0.747$, $\rho = 0.000$).

Table 4.32: Spearman's Correlation Matrix for IPD Contractual Principles (N = 235)

S/N	Variables	Mean	Std. Deviation	Values	Spearman's Correlation Values											
					CP1	CP2	CP3	CP4	CP5	CP6	CP7	CP8	CP9	CP10	CP11	CP12
1	Key participants involved early in the project.	4.46	0.541	rho	1.000	.862**	.944**	.882**	.919**	1.000**	.884**	.968**	.860**	.796**	.797**	.867**
				Sig.		0.000	0.000	0.000	0.000		0.000	0.000	0.000	0.000	0.000	0.000
2	Key participants early contributions of knowledge and expertise.	4.40	0.540	rho	.862**	1.000	.813**	.975**	.916**	.862**	.977**	.834**	.973**	.804**	.738**	.747**
				Sig.	0.000		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
3	Making collaborative value based decisions by all participants.	4.49	0.565	rho	.944**	.813**	1.000	.834**	.871**	.944**	.835**	.961**	.817**	.774**	.774**	.918**
				Sig.	0.000	0.000		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
4	Key participants bound together as equals.	4.39	0.576	rho	.882**	.975**	.834**	1.000	.941**	.882**	.997**	.859**	.966**	.855**	.810**	.771**
				Sig.	0.000	0.000	0.000		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
5	Jointly and early developed project target criteria.	4.38	0.651	rho	.919**	.916**	.871**	.941**	1.000	.919**	.938**	.909**	.937**	.907**	.901**	.826**
				Sig.	0.000	0.000	0.000	0.000		0.000	0.000	0.000	0.000	0.000	0.000	0.000
6	Tying the success of key participants to the success of the project.	4.45	0.593	rho	1.000**	.862**	.944**	.882**	.919**	1.000	.884**	.968**	.860**	.800**	.812**	.867**
				Sig.		0.000	0.000	0.000	0.000		0.000	0.000	0.000	0.000	0.000	0.000
7	Key participants jointly accountable for any errors in design.	4.40	0.533	rho	.884**	.977**	.835**	.997**	.938**	.884**	1.000	.856**	.963**	.843**	.793**	.767**
				Sig.	0.000	0.000	0.000	0.000	0.000	0.000		0.000	0.000	0.000	0.000	0.000
8	Key participants sharing financial reward based on project outcome.	4.45	0.607	rho	.968**	.834**	.961**	.859**	.909**	.968**	.856**	1.000	.853**	.836**	.834**	.898**
				Sig.	0.000	0.000	0.000	0.000	0.000	0.000	0.000		0.000	0.000	0.000	0.000
9	Sharing financial risk among key participants.	4.34	0.649	rho	.860**	.973**	.817**	.966**	.937**	.860**	.963**	.853**	1.000	.935**	.888**	.787**
				Sig.	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000		0.000	0.000	0.000
10	Utilization of new technologies and approaches during design.	4.29	0.769	rho	.874**	.935**	.834**	.959**	.946**	.874**	.956**	.867**	.963**	1.000	.968**	.823**
				Sig.	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000		0.000	0.000
11	Waiving liabilities between key participants.	4.29	0.842	rho	.908**	.899**	.866**	.924**	.980**	.908**	.921**	.898**	.928**	.968**	1.000	.850**
				Sig.	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000		0.000
12	Encourage fiscal transparency between key participants.	4.41	0.803	rho	.867**	.747**	.918**	.771**	.826**	.867**	.767**	.898**	.787**	.899**	.918**	1.000
				Sig.	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	

**Correlation is significant at the 0.01 level (2-tailed).

b. Behavioural Principles inherent in IPD

There were six variables on Behavioural Principles inherent in IPD with a sample size (N) of 235 with no missing data in the data set as presented in Table 4.33. The results of Spearman's correlation and its significance values are presented in a matrix form in Table 4.33 with the correlations replicated. The standard value for ρ is 0.05 or smaller but the correlation is considered highly significant statistically for smaller values at the 0.01 level (2-tailed). The least Spearman's correlation coefficient (r_s) value from the data set is +0.695 and the highest is +0.952 which are all very close to +1 (strong, positive correlation). The ρ –values for all the six variables are 0.000 which is far less than the 0.01 level (2-tailed) and 0.05, therefore, there is evidence of a statistically significant bivariate association between the variables.

Table 4.33: Spearman's Correlation Matrix for IPD Behavioural Principles (N = 235)

S/N	Variables	Mean	Std. Deviation	Values	Spearman's Correlation Values					
					BP1	BP2	BP3	BP4	BP5	BP6
1	Key participants having mutual respect for each other.	4.50	0.587	rho	1.000	.849**	.891**	.947**	.925**	.796**
				Sig.		0.000	0.000	0.000	0.000	0.000
2	Key participants having mutual trust for each other.	4.41	0.565	rho	.849**	1.000	.952**	.896**	.800**	.695**
				Sig.	0.000		0.000	0.000	0.000	0.000
3	Willingness to collaborate as key participants.	4.43	0.584	rho	.891**	.952**	1.000	.935**	.834**	.722**
				Sig.	0.000	0.000		0.000	0.000	0.000
4	Open communication among key participants.	4.45	0.621	rho	.947**	.896**	.935**	1.000	.889**	.771**
				Sig.	0.000	0.000	0.000		0.000	0.000
5	Open information sharing among key participants.	4.50	0.682	rho	.925**	.800**	.834**	.889**	1.000	.863**
				Sig.	0.000	0.000	0.000	0.000		0.000
6	Ensuring transparent processes throughout the project.	4.59	0.644	rho	.796**	.695**	.722**	.771**	.863**	1.000
				Sig.	0.000	0.000	0.000	0.000	0.000	

**Correlation is significant at the 0.01 level (2-tailed).

In testing the population hypothesis; since all the ρ – values are less than 0.01 but not equal to zero, H_1: ρ (rho) $\neq$ 0, the null hypothesis is rejected and the alternative hypothesis accepted that the relationship between the variables is statistically significant. Therefore, Spearman's correlation coefficient, r_s of +0.695 is statistically significant (ρ = 0.000).

Summary of the Spearman's Rank-order Correlation

A Spearman's rank-order correlation was conducted to determine the relationship between six Behavioural Principles inherent in IPD. The results in Table 4.33 shows

that there is a strong, positive correlation between the variables, which is statistically significant ($r_s(6) = +0.695$, $\rho = 0.000$).

c. Early Involvement and Collaboration of Key Participants in IPD

There were seven variables on early involvement and collaboration of key participants in IPD with a sample size (N) of 235 with no missing data in the data set as presented in Table 4.34. The results of Spearman's correlation and its significance values are presented in a matrix form in Table 4.34.

Table 4.34: Spearman's Correlation Matrix for Early Involvement and Collaboration of Key Participants (N = 235)

S/N	Variables	Mean	Std. Deviation	Values	Spearman's Correlation Values						
					EI1	EI2	EI3	EI4	EI5	EI6	EI7
1	It enhances and strengthens key participants' understanding of the owner's desired outcome.	4.39	0.555	rho	1.000	.892**	.825**	.975**	.892**	.948**	.776**
				Sig.		0.000	0.000	0.000	0.000	0.000	0.000
2	Effective collaboration by all participants improves design documentation quality.	4.33	0.547	rho	.892**	1.000	.744**	.871**	.803**	.852**	.700**
				Sig.	0.000		0.000	0.000	0.000	0.000	0.000
3	There is a more timely and informed understanding of the design.	4.49	0.557	rho	.825**	.744**	1.000	.846**	.922**	.839**	.941**
				Sig.	0.000	0.000		0.000	0.000	0.000	0.000
4	Provides an opportunity for adequate pre-design, design, and documentation planning.	4.40	0.571	rho	.975**	.871**	.846**	1.000	.915**	.957**	.795**
				Sig.	0.000	0.000	0.000		0.000	0.000	0.000
5	An opportunity for strong pre-construction planning.	4.43	0.590	rho	.892**	.803**	.922**	.915**	1.000	.899**	.872**
				Sig.	0.000	0.000	0.000	0.000		0.000	0.000
6	Early visualization of construction sequencing prior to commencing project.	4.28	0.788	rho	.948**	.852**	.839**	.957**	.899**	1.000	.842**
				Sig.	0.000	0.000	0.000	0.000	0.000		0.000
7	An increase in the level of effort by key participants during design documentation results in better documentation quality.	4.39	0.806	rho	.776**	.700**	.941**	.795**	.872**	.842**	1.000
				Sig.	0.000	0.000	0.000	0.000	0.000	0.000	

**Correlation is significant at the 0.01 level (2-tailed).

The standard value for ρ is 0.05 or smaller but the correlation is considered highly significant statistically for smaller values at the 0.01 level (2-tailed). The least Spearman's correlation coefficient (r_s) value from the data set is +0.700 and the highest is +0.975 which are all very close to +1 (strong, positive correlation). The ρ – values for all the seven variables are 0.000 which is far less than the 0.01 level (2-

tailed) and 0.05, therefore, there is evidence of a statistically significant bivariate association between the variables.

In testing the population hypothesis; since all the ρ – values are less than 0.01 but not equal to zero, H_1: ρ (rho) $\neq$ 0, the null hypothesis is rejected and the alternative hypothesis accepted that the relationship between the variables is statistically significant. Therefore, Spearman's correlation coefficient, r_s of +0.700 is statistically significant (ρ = 0.000).

Summary of the Spearman's Rank-order Correlation

A Spearman's rank-order correlation was conducted to determine the relationship between seven early involvement and collaboration of key participants in IPD. The results in Table 4.34 shows that there is a strong, positive correlation between the variables, which is statistically significant ($r_s(7) = +0.700$, $\rho = 0.000$).

4.8 Regression Analysis

Multiple regression is used in this research to determine the degree of relationship between the variables with the help of testing the hypotheses for the study which are;

- H_{01} *Poor design documentation quality has no relationship to the conventional project delivery approach.*
- H_{A1} *Poor design documentation quality has a relationship to the conventional project delivery approach.*
- H_{02} *Design documentation quality will not improve when the weaknesses associated with the conventional project delivery approach are minimized using identified capabilities.*
- H_{A2} *Design documentation quality will improve when the weaknesses associated with the conventional project delivery approach are minimized using identified capabilities.*
- H_{03} *Adaptation of inherent enablers in IPD will not improve design documentation quality under the conventional project delivery approach.*
- H_{A3} *Adaptation of inherent enablers in IPD will improve design documentation quality under the conventional project delivery approach.*

The various tests that are produced in the regression are; Model summary; Analysis of Variance (ANOVA) and Coefficients of regression. These tests are carried out in the following sub-sections.

4.8.1 Regression Analysis of the state of design documentation quality in practice

There were 15 independent variables (predictors) as presented in Table 4.35 on the state of design documentation quality in practice that was entered for the Regression analysis with a sample size (N) of 235 because there is no missing score in the variables. Table 4.35 shows the descriptive statistics for all the variables in the test.

Table 4.35: Descriptive Statistics of Design documentation quality

Independent Variables	Mean	Std. Deviation	N
State of Design Documentation Quality in Practice (DV)**	60.00	28.345	235
Design drawings usually contain errors and omissions.	4.43	0.697	235
Specifications usually contain errors and omissions.	4.27	0.775	235
Bills of quantities usually contain errors and omissions.	4.38	0.683	235
There is lack of coordination among design documents.	4.37	0.725	235
Discrepancies between bill of quantities, drawings and specifications.	4.36	0.692	235
There are disparities between drawings and specifications only.	4.34	0.782	235
Documents issued with conflicting, inaccurate, and ambiguous information.	4.19	0.896	235
Documents lacking clarity.	4.20	0.937	235
Documents are often issued with insufficient details.	4.15	0.843	235
Issuance of un-amended standard specifications.	4.23	0.783	235
Issuance of incomplete design drawings.	4.20	0.920	235
Issuance of incomplete specifications.	4.11	0.952	235
Issuance of incomplete bills of quantities.	4.17	0.915	235
Issuance of bulky documents containing irrelevant information.	4.19	0.911	235
There is often lack of accuracy in design documentation.	4.29	0.924	235

**DV: Dependent Variable

The mean values and the standard deviation of the variables are presented in Table 4.35. All these values are relatively high indicating statistical significance.

The Model Summary Analysis

Table 4.36 provides the various values for the model summary analysis. This table provides the *R*, R^2, adjusted R^2, and the standard error of the estimate, which can be used to determine how well a regression model fits the data. The value for R *(multiple correlation coefficient)* is a measure of the quality of the prediction of the dependent variable (State of design documentation quality in practice). This value indicates the correlation between the dependent and the independent variables. The *R-Square* (R^2)

value also known as the *coefficient of determination*, is the proportion of variance in the dependent variable that can be explained by the independent variables.

Table 4.36: Regression Analysis Model Summary of Design documentation quality

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	0.846[a]	0.715	0.696	15.638

Table 4.36 shows that the multiple correlation coefficient (*R*), using all the predictors simultaneously is 0.846 and the Adjusted R-square (*adj*. R^2) is 0.696. This means that 69.6% of the variance in the state of design documentation quality in practice can be predicted from the combination of all the independent variables.

Analysis of Variance (ANOVA)

Table 4.37 provides the various values for the ANOVA. The Sig. value (also known as P-value) and the F-ratio are very important for ANOVA. The F-ratio tests whether the overall regression model is a good fit for the data. It represents an improvement in the prediction of the variables by fitting the model after considering the inaccuracy present in the model statistically. An F-ratio of 36.653 in this case which is greater than 1 will yield an efficient model therefore, the model is efficient and acceptable. A 95% confidence level representing 5% or 0.05 level of significance was set for the analysis hence, a sig. value of 0.001 in this case less than 0.05 is acceptable.

Table 4.37: Regression Analysis ANOVA of Design documentation quality

Model	Sum of Squares	df	Mean Square	F	Sig.
Regression	134446.234	15	8963.082	36.653	<.001[b]
Residual	53553.766	219	244.538		
Total	188000.000	234			

Table 4.37 shows that the independent variables statistically significantly predict the dependent variable, $F(15, 219) = 244.538$, $p < 0.05$ hence the regression model is a good fit for the data. The ANOVA table shows that F = 36.653 which is statistically significant and indicates that the predictors significantly combine to predict the state of design documentation quality in practice.

Regression Analysis Coefficients

Table 4.38 provides the coefficients from the analysis. It shows the standardized and unstandardized beta coefficients. Unstandardized coefficients indicate how much the dependent variable varies with an independent variable when all other independent variables are held constant. The statistical significance (sig.) and the t-value of each predictor variable are very important in determining the variables that are significantly contributing to predicting the state of design documentation quality in practice. This tests whether the unstandardized or standardized coefficients are equal to zero. However, the sig. value is very important in testing the hypothesis and should be less than the tolerable level of significance which is 0.05 for a 95% confidence level. This determines whether the null hypothesis should be rejected or not. Therefore, if the sig. value is $p < 0.05$, it can be concluded that the coefficients are statistically significantly different to zero hence the null hypothesis can be rejected.

From Table 4.38, in considering the sig. values, it is only three variables that are significantly adding to the prediction when the other predictors are considered. These variables have $p < 0.05$ and include: *design drawings usually contain errors and omissions; there are discrepancies between bill of quantities, drawings and specifications; and there is often lack of accuracy in design documentation*. However, all the predictors need to be included to obtain this result, because the overall F value was computed with all the variables. This is because if any of the predictors are considered insignificant and deleted, it can affect the levels of significance for other predictors. Therefore, these three variables reject the null hypothesis (H_{01}) and accept the alternative hypothesis (H_{A1}) that; poor design documentation quality has a relationship to conventional project delivery.

Table 4.38: Regression Analysis Coefficients of Design documentation quality

Model	Unstandardized Coefficients		Standardized Coefficients		Sig.
	B	Std. Error	Beta	t	
Constant	-88.693	8.037		-11.036	<.001
Design drawings usually contain errors and omissions.	22.852	5.640	.562	4.052	<.001
Specifications usually contain errors and omissions.	-8.648	7.336	-.236	-1.179	.240
Bills of quantities usually contain errors and omissions.	6.179	9.637	.149	.641	.522
There is lack of coordination among design documents.	-16.254	9.579	-.416	-1.697	.091
There are discrepancies between bill of quantities, drawings and specifications.	24.518	7.020	.598	3.493	<.001
Disparities between drawings and specifications only.	-2.095	8.762	-.058	-.239	.811
Documents are often issued with conflicting, inaccurate, and ambiguous information.	-13.466	10.904	-.426	-1.235	.218
Documents lacking clarity.	-11.787	11.670	-.390	-1.010	.314
Documents are often issued with insufficient details.	-1.785	5.227	-.053	-.342	.733
Issuance of un-amended standard specifications.	-.974	7.544	-.027	-.129	.897
Issuance of incomplete design drawings.	.964	12.815	.031	.075	.940
Issuance of incomplete specifications.	10.215	5.533	.343	1.846	.066
Issuance of incomplete bills of quantities.	24.501	12.652	.791	1.937	.054
Issuance of bulky documents with irrelevant information.	14.324	10.883	.461	1.316	.190
There is often lack of accuracy in design documentation.	-14.062	6.684	-.459	-2.104	.037

Summary of regression results on the state of design documentation quality

Multiple regression was carried out to investigate the best predictors of the state of design documentation quality in practice. The combination of variables to predict the dependent variable from the predictor variables is statistically significant, $F(15, 219) = 244.538, p < 0.05$. The results of the beta coefficients indicate that three independent variables significantly predict the dependent variable when all 15 variables are included. These variables are; *design drawings usually contain errors and omissions; there are discrepancies between bill of quantities, drawings and specifications; and there is often lack of accuracy in design documentation*. The adjusted R^2 value is 0.696. This indicates that 69.6% of the variance in the state of design documentation quality in practice was explained by the model.

4.8.2 Regression Analysis of Weaknesses in the conventional project delivery

There were 24 independent variables as presented in Table 4.39 on weaknesses associated with the conventional project delivery that was entered for the Regression Analysis with a sample size (N) of 235 because there is no missing score in the variables. Table 4.39 shows the descriptive statistics for all the variables in the test.

Table 4.39: Descriptive Statistics of Weaknesses

Independent Variables	Mean	Std. Deviation	N
Weaknesses associated with the conventional project delivery. (DV)*	60.00	28.345	235
Lack of coordination among design consultants.	4.38	0.708	235
Lack of cooperation and collaboration among project participants.	4.19	0.642	235
Lack of coordination among design documents.	4.33	0.698	235
Discrepancies between bill of quantities, drawings and specifications.	4.32	0.707	235
Reliance on specification notes only when drawings are required.	4.22	0.775	235
Projects always experience cost escalation, shoddy workmanship, project abandonment and other manifestations of project failure.	4.34	0.764	235
There is high inflation or escalation of final contract cost.	4.23	0.830	235
No guarantee of certainty of project final cost, only initial cost.	4.24	0.792	235
It encourages claim consciousness among project participants.	4.28	0.814	235
There is too much focus on lowest price instead of best price.	4.25	0.827	235
It encourages participants to be more profit conscious instead of project quality conscious.	4.19	0.800	235
Individual team members exploits loopholes in contract documents.	4.30	0.814	235
Letting contracts at excessively low price and hiking the price later to claim for reward.	4.29	0.827	235
Adversarial relationships among project participants threatening project goals; party spirit instead of team spirit.	4.24	0.854	235
It does not encourage commitment to project objectives rather individual participant's objectives and gain.	4.13	0.832	235
Each party has its own agenda based on its singular interest.	4.25	0.806	235
Lack of contractors input at the design stage and not taking advantage of their experience.	4.25	0.750	235
It does not encourage commitment of all participants to total quality right from project design.	4.19	0.807	235
The rigid definition of roles and responsibilities provides no basis for shared vision or goals.	4.22	0.852	235
Hierarchical relationships making communication and transfer of useful knowledge among project participants difficult.	4.24	0.855	235
Compartmentalization of project participants around functional and professional lines leads to poor communication, poor relationships and leads to poor design documentation.	4.17	0.864	235
Uneven, unclear and unfair allocation of risks to some participants.	4.18	0.873	235
It does not create a win-win situation among project participants.	4.20	0.796	235
Relationships among project participants encourage professional mistrust and rivalry.	4.26	0.891	235

*DV: Dependent Variable

The mean values and the standard deviation of the variables are presented in Table 4.39. All these values are relatively high indicating statistical significance.

The Model Summary Analysis

Table 4.40 provides the *R*, R^2, adjusted R^2, and the standard error of the estimate, which can be used to determine how well a regression model fits the data.

Table 4.40: Regression Analysis Model Summary of Weaknesses

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	0.865[a]	0.748	0.719	15.014

Table 4.40 shows that the multiple correlation coefficient (*R*), using all the predictors simultaneously is 0.865 and the Adjusted R-square (*adj.* R^2) is 0.719. This means that 71.9% of the variance in the weaknesses associated with the conventional project delivery can be predicted from the combination of all the independent variables.

Analysis of Variance (ANOVA)

Table 4.41 provides the values for the ANOVA. The F-ratio tests whether the overall regression model is a good fit for the data. An F-ratio of 26.000 in this case greater than 1 will yield an efficient model hence the model is efficient and acceptable. A 95% confidence level representing a 5% (0.05) level of significance was set for the analysis hence, a sig. value of 0.001 in this case less than 0.05 is acceptable.

Table 4.41: Regression Analysis ANOVA of Weaknesses

Model	Sum of Squares	df	Mean Square	F	Sig.
Regression	140662.010	24	5860.917	26.000	<0.001[b]
Residual	47337.990	210	225.419		
Total	188000.000	234			

Table 4.41 shows that the independent variables statistically significantly predict the dependent variable, $F(24, 210) = 225.419$, $p < 0.05$ hence the regression model is a good fit for the data. The ANOVA table shows that F = 26.000 which is statistically significant and indicates that the predictors significantly combine to predict the weaknesses associated with the conventional project delivery.

Regression Analysis Coefficients

Table 4.42 provides the coefficients from the analysis. The t-value and the Sig. values of each independent variable indicate whether a variable is significantly contributing to predicting the weaknesses associated with the conventional project delivery. However, the sig. value is very important in testing the hypothesis and should be less than 0.05 for a 95% confidence level. This determines whether the null hypothesis should be rejected or not. Therefore, if the sig. value is $p < 0.05$, it can be concluded that the coefficients are statistically significantly different to zero hence the null hypothesis can be rejected.

From Table 4.42, in considering the sig. values, it is only four variables that are significantly adding to the prediction when the other predictors are considered. These variables have $p < 0.05$ and include: *lack of coordination among design consultants; it does not encourage commitment to project objectives rather individual participant's objectives and gain; it does not encourage commitment of all participants to total quality right from project design; and compartmentalization of project participants around functional and professional lines leads to poor communication, poor relationships and leads to poor design documentation.* However, all the predictors need to be included to obtain this result, because the overall F value was computed with all the variables. This is because if any of the predictors are considered insignificant and deleted, it can affect the levels of significance for other predictors. Therefore, these four variables reject the null hypothesis (H_{02}) and accept the alternative hypothesis (H_{A2}) that; design documentation quality will improve when the weaknesses associated with the conventional project delivery approach are minimized using identified capabilities.

Table 4.42: Regression Analysis Coefficients of Weaknesses

Model	Unstandardized Coefficients		Standardized Coefficients		Sig.
	B	Std. Error	Beta	t	
Constant	-94.418	7.782		-12.133	<0.001
Lack of coordination among design consultants.	16.238	6.499	0.406	2.499	0.013
Lack of cooperation and collaboration among project participants.	3.099	4.333	0.070	0.715	0.475
Lack of coordination among design documents.	-4.156	13.177	-0.102	-0.315	0.753
Discrepancies between bill of quantities, drawings and specifications.	13.657	11.439	0.341	1.194	0.234
Reliance on specification notes only when drawings are required.	-12.164	12.115	-0.333	-1.004	0.317
Projects always experience cost escalation, shoddy workmanship, project abandonment and other manifestations of project failure.	-7.509	11.193	-0.202	-0.671	0.503
There is high inflation or escalation of final contract cost.	-6.302	12.525	-0.184	-0.503	0.615
No guarantee of certainty of project final cost, only initial cost.	1.732	11.599	0.048	0.149	0.881
It encourages claim consciousness among project participants.	5.233	11.449	0.150	0.457	0.648
There is too much focus on lowest price instead of best price.	-5.720	12.247	-0.167	-0.467	0.641
It encourages participants to be more profit conscious instead of project quality conscious.	31.155	16.090	0.879	1.936	0.054
Individual team members exploits loopholes in contract documents.	-16.486	15.769	-0.474	-1.045	0.297
Letting contracts at excessively low price and hiking the price later to claim for reward.	-3.210	13.503	-0.094	-0.238	0.812
Adversarial relationships among project participants threatening project goals; party spirit instead of team spirit.	4.283	11.359	0.129	0.377	0.707
It does not encourage commitment to project objectives rather individual participant's objectives and gain.	19.881	6.006	0.584	3.310	0.001
Each party has its own agenda based on its singular interest.	4.710	12.941	0.134	0.364	0.716
Lack of contractors input at the design stage and not taking advantage of their experience.	19.825	11.631	0.525	1.704	0.090
It does not encourage commitment of all participants to total quality right from project design.	-41.132	13.757	-1.171	-2.990	0.003
The rigid definition of roles and responsibilities provides no basis for shared vision or goals.	11.519	11.992	0.346	0.960	0.338
Hierarchical relationships making communication and transfer of knowledge among project participants difficult.	-3.934	11.153	-0.119	-0.353	0.725
Compartmentalization of project participants around functional and professional lines leads to poor communication, poor relationships and leads to poor design documentation.	-19.848	8.641	-0.605	-2.297	0.023
Uneven, unclear and unfair allocation of risks to some participants.	-7.409	9.720	-0.228	-0.762	0.447
It does not create a win-win situation among project participants.	18.180	11.049	0.510	1.645	0.101
Relationships among project participants encourage professional mistrust and rivalry.	14.523	7.672	0.456	1.893	0.060

Summary of regression results on weaknesses associated with the conventional project delivery approach

Multiple regression was carried out to investigate the best predictors of the weaknesses associated with conventional project delivery. The combination of variables to predict the weaknesses associated with the conventional project delivery from the predictor variables is statistically significant, $F(24, 210) = 225.419, p < 0.05$. The results indicate that four independent variables significantly predict the weaknesses associated with conventional project delivery when all 24 variables are included. These variables are; *lack of coordination among design consultants; it does not encourage commitment to project objectives rather individual participant's objectives and gain; does not encourage commitment of all participants to total quality right from project design; and compartmentalization of project participants around functional and professional lines leads to poor communication, poor relationships and leads to poor design documentation.* The adjusted R^2 value is 0.719. This indicates that 71.9% of the variance in the weaknesses associated with the conventional project delivery was explained by the model.

4.8.3 Regression Analysis of the Capabilities required in the production of design documentation

There were 20 independent variables as presented in Table 4.43 on capabilities required in the production of design documentation for the Regression Analysis with a sample size (N) of 235 because there is no missing score in the variables. Table 4.43 shows the descriptive statistics for all the variables in the test and presented the mean values and the standard deviation of the variables. All these values are relatively high indicating statistical significance.

Table 4.43: Descriptive Statistics of Capabilities

Independent Variables	Mean	Std. Deviation	N
Capabilities required in the production of design documentation. (DV)*	60.00	28.345	235
Holding Consultants accountable for producing poor design documentation quality (penalty).	4.39	0.627	235
Incentives for producing good design documentation quality.	4.30	0.567	235
Paying appropriate fees to consultants.	4.43	0.659	235
Improving consultants working conditions and procedures.	4.31	0.730	235
Clients allowing adequate time for the preparation of design documents.	4.34	0.688	235
Mandatory coordination of design documentation by a supervisor with requisite skills and knowledge.	4.33	0.686	235
Independent review of design documentation by a supervisor with requisite skills and knowledge.	4.35	0.744	235
Encouraging self-check practice and independent verification.	4.31	0.728	235
Re-checking design documentation for accuracy.	4.33	0.721	235
Use of checklists.	4.24	0.786	235
Setting up quality control departments.	4.26	0.789	235
Setting up minimum quality and service standards.	4.32	0.798	235
Designers partnering with others while preparing design documents.	4.34	0.758	235
Improving collaboration between consultants.	4.44	0.613	235
Specialists' involvement in design planning and processing.	4.43	0.626	235
Use of computer programs such as BIM.	4.25	0.862	235
Job relevant training and practice.	4.23	0.812	235
Provision of elaborate and improved project brief.	4.24	0.749	235
Systematic audit to ensure the quality of briefs.	4.29	0.833	235
Preparation of detailed design.	4.46	0.791	235

*DV: Dependent Variable

The Model Summary Analysis

Table 4.44 provides the R, R^2, adjusted R^2, and the standard error of the estimate, which can be used to determine how well a regression model fits the data.

Table 4.44: Regression Analysis Model Summary of Capabilities

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	0.886[a]	0.786	0.766	13.722

Table 4.44 shows that the multiple correlation coefficient (R), using all the predictors simultaneously is 0.886 and the adjusted R-square is 0.766. This means that 76.6% of the variance in the capabilities required in the production of design documentation can be predicted from the combination of all the independent variables.

Analysis of Variance (ANOVA)

Table 4.45 provides the various values for the ANOVA. The F-ratio tests whether the overall regression model is a good fit for the data. An F-ratio value of 39.220 in this case which is greater than 1 will yield an efficient model therefore, the model is efficient and acceptable. A 95% confidence level representing a 5% (0.05) level of significance was set for the analysis therefore, a sig. value of 0.001 in this case which is less than 0.05 is acceptable.

Table 4.45: Regression Analysis ANOVA of Capabilities

Model	Sum of Squares	df	Mean Square	F	Sig.
Regression	147703.782	20	7385.189	39.220	<0.001[b]
Residual	40296.218	214	188.300		
Total	188000.000	234			

Table 4.45 shows that the independent variables statistically significantly predict the dependent variable, $F(20, 214) = 188.300$, $p < 0.05$ hence the regression model is a good fit for the data. The ANOVA table shows that F = 39.220 which is statistically significant and indicates that the predictors significantly combine to predict the capabilities required in the production of design documentation.

Regression Analysis Coefficients

Table 4.46 provides the coefficients from the analysis. The statistical significance (sig.) and the t-value of each predictor variable are very important in determining the variables that are significantly contributing to predicting the capabilities required in the production of design documentation. However, the sig. value is very important in testing the hypothesis and should be less than 0.05 for a 95% confidence level. This determines whether the null hypothesis should be rejected or not. Therefore, if the sig. value is $p < 0.05$, it can be concluded that the coefficients are statistically significantly different to zero hence the null hypothesis can be rejected.

Table 4.46: Regression Analysis Coefficients of Capabilities

Model	Unstandardized Coefficients		Standardized Coefficients		Sig.
	B	Std. Error	Beta	t	
Constant	-130.323	8.380		-15.552	<0.001
Holding Consultants accountable for producing poor design documentation quality (penalty).	9.617	6.639	0.213	1.448	0.149
Incentives for producing good design documentation quality.	12.816	4.420	0.256	2.899	0.004
Paying appropriate fees to consultants.	-13.425	7.476	-0.312	-1.796	0.074
Improving consultants working conditions and procedures.	-49.342	9.843	-1.271	-5.013	<0.001
Clients allowing adequate time for the preparation of design documents.	9.590	9.826	0.233	0.976	0.330
Mandatory coordination of design documentation by a supervisor with requisite skills and knowledge.	52.952	13.295	1.281	3.983	<0.001
Independent review of design documentation by a supervisor with requisite skills and knowledge.	-1.318	10.175	-0.035	-0.129	0.897
Encouraging self-check practice and independent verification.	-18.847	15.362	-0.484	-1.227	0.221
Re-checking design documentation for accuracy.	-19.028	10.279	-0.484	-1.851	0.066
Use of checklists.	.959	7.886	0.027	0.122	0.903
Setting up quality control departments.	9.249	10.181	0.257	0.908	0.365
Setting up minimum quality and service standards.	-8.083	9.794	-0.228	-0.825	0.410
Designers partnering with others while preparing design documents.	14.049	11.644	0.376	1.207	0.229
Improving collaboration between consultants.	26.493	9.591	0.573	2.762	0.006
Specialists' involvement in design planning and processing.	-9.670	9.868	-0.213	-0.980	0.328
Use of computer programs such as BIM.	7.189	6.410	0.218	1.121	0.263
Job-relevant training and practice.	16.524	7.831	0.473	2.110	0.036
Provision of elaborate and improved project brief.	-4.298	6.351	-0.114	-0.677	0.499
Systematic audit to ensure the quality of briefs.	-7.619	8.765	-0.224	-0.869	0.386
Preparation of detailed design.	15.620	3.155	0.436	4.951	<0.001

From Table 4.46, it is only six variables that are significantly adding to the prediction when the other predictors are considered. These variables have $p < 0.05$ and include: *incentives for producing good design documentation quality; improving consultants' working conditions and procedures; mandatory coordination of design documentation by a supervisor with requisite skills and knowledge; improving collaboration between consultants; job-relevant training and practice; and preparation of detailed design.* However, all the predictors need to be included to obtain this result, because the overall F value was computed with all the variables. This is because if any of the predictors are considered insignificant and deleted, it can

affect the levels of significance for other predictors. Therefore, these six variables reject the null hypothesis (H_{02}) and accept the alternative hypothesis (H_{A2}) that; design documentation quality will improve when the weaknesses associated with the conventional project delivery approach are minimized using identified capabilities.

Summary of regression results on capabilities required

Multiple regression was carried out to investigate the best predictors of the capabilities required in the production of design documentation. The combination of variables to predict the capabilities required in the production of design documentation from the predictor variables is statistically significant, $F(20, 214) = 188.300, p < 0.05$. The results indicate that six independent variables significantly predict the capabilities required in the production of design documentation when all 20 variables are included. These variables are; *incentives for producing good design documentation quality; improving consultants working conditions and procedures; mandatory coordination of design documentation by a supervisor with requisite skills and knowledge; improving collaboration between consultants; job-relevant training and practice; and preparation of detailed design.* The adjusted R^2 value is 0.766. This indicates that 76.6% of the variance in the capabilities required in the production of design documentation was explained by the model.

4.8.4 Regression Analysis of Enablers inherent in IPD

The regression involves the three categories of data set for Enablers inherent in IPD that can be adapted to improve design documentation quality. These include Contractual Principles; Behavioural Principles; and Early Involvement and Collaboration of Key Participants.

a. Contractual Principles inherent in IPD

There were 12 independent variables (predictors) as presented in Table 4.47 on IPD Contractual Principles that were entered for the Regression Analysis with a sample size (N) of 235 because there is no missing score in the variables. Table 4.47 shows the descriptive statistics for all the variables in the test.

Table 4.47: Descriptive Statistics of Contractual Principles

Independent Variables	Mean	Std. Deviation	N
IPD Contractual Principles. (DV)*	60.00	28.345	235
Key participants involved early in the project.	4.46	0.541	235
Key participants' early contributions of knowledge and expertise.	4.40	0.540	235
Making collaborative value-based decisions by all participants.	4.49	0.565	235
Key participants bound together as equals.	4.39	0.576	235
Jointly and early developed project target criteria.	4.38	0.651	235
Tying the success of key participants to the success of the project.	4.45	0.593	235
Key participants jointly accountable for any errors in design.	4.40	0.533	235
Key participants sharing financial reward based on project outcome.	4.45	0.607	235
Sharing financial risk among key participants.	4.34	0.649	235
Utilization of new technologies and approaches during design.	4.29	0.769	235
Waiving liabilities between key participants.	4.29	0.842	235
Encourage fiscal transparency between key participants.	4.41	0.803	235

*DV: Dependent Variable

The mean values and the standard deviation of the variables are presented in Table 4.47. All these values are relatively high indicating statistical significance.

The Model Summary Analysis

Table 4.48 provides the *R*, R^2, adjusted R^2, and the standard error of the estimate, which can be used to determine how well a regression model fits the data.

Table 4.48: Regression Analysis Model Summary of Contractual Principles

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	0.914[a]	0.836	0.827	11.779

Table 4.48 shows that *R*, using all the predictors simultaneously is 0.914 and the Adjusted R^2 is 0.827. This means that 82.7% of the variance in the IPD Contractual Principles can be predicted from the combination of all the independent variables.

Analysis of Variance (ANOVA)

Table 4.49 provides the values for the ANOVA. The F-ratio tests whether the overall regression model is a good fit for the data. An F-ratio of 94.426 in this case which is greater than 1 will yield an efficient and acceptable model. A 95% confidence level which represents a 5% or 0.05 level of significance was set for the analysis therefore, a sig. value of 0.001 in this case which is less than 0.05 is acceptable.

Table 4.49: Regression Analysis ANOVA of Contractual Principles

Model	Sum of Squares	df	Mean Square	F	Sig.
Regression	157201.018	12	13100.085	94.426	<0.001[b]
Residual	30798.982	222	138.734		
Total	188000.000	234			

Table 4.49 shows that the independent variables statistically significantly predict the dependent variable, $F(12, 222) = 138.734$, $p < 0.05$ hence the regression model is a good fit for the data. The ANOVA table shows that F = 94.426 which is statistically significant and indicates that the predictors significantly combine to predict IPD Contractual Principles.

Regression Analysis Coefficients

Table 4.50 provides the coefficients from the analysis. The t-value and the Sig. values of each independent variable indicate whether a variable is significantly contributing to predicting IPD Contractual Principles. However, the sig. value is very important in testing the hypothesis and should be less than 0.05 for a 95% confidence level. This determines whether the null hypothesis should be rejected or not. Therefore, if the sig. value is $p < 0.05$, it can be concluded that the coefficients are statistically significantly different to zero hence the null hypothesis can be rejected.

From Table 4.50, in considering the sig. values, it is only six variables that are significantly adding to the prediction when the other predictors are considered. These variables have $p < 0.05$ and include: *key participants involved early in the project; tying the success of key participants to the success of the project; key participants jointly accountable for any errors in design; sharing financial risk among key participants; utilization of new technologies and approaches during design; and encourage fiscal transparency between key participants.* However, all the predictors need to be included to obtain this result, because the overall F value was computed with all the variables. This is because if any of the predictors are considered insignificant and deleted, it can affect the levels of significance for other predictors. Therefore, these six variables reject the null hypothesis *(H_{03})* and accept the alternative hypothesis *(H_{A3})* that; the adaptation of inherent enablers in IPD will

improve design documentation quality under the conventional project delivery approach.

Table 4.50: Regression Analysis Coefficients of Contractual Principles

Model	Unstandardized Coefficients		Standardized Coefficients		Sig.
	B	Std. Error	Beta	t	
Constant	-168.344	7.725		-21.792	<0.001
Key participants involved early in the project.	66.844	12.140	1.275	5.506	<0.001
Key participants' early contributions of knowledge and expertise.	-3.190	6.018	-0.061	-0.530	0.597
Making collaborative value-based decisions by all participants.	8.409	6.408	0.168	1.312	0.191
Key participants bound together as equals.	-6.380	11.123	-0.130	-0.574	0.567
Jointly and early developed project target criteria.	-9.403	5.331	-0.216	-1.764	0.079
Tying the success of key participants to the success of the project.	-60.792	10.847	-1.271	-5.605	<0.001
Key participants jointly accountable for any errors in design.	37.981	12.255	0.714	3.099	0.002
Key participants sharing financial reward based on project outcome.	-4.020	6.811	-0.086	-0.590	0.556
Sharing financial risk among key participants.	16.374	5.440	0.375	3.010	0.003
Utilization of new technologies and approaches during design.	-16.360	6.197	-0.444	-2.640	0.009
Waiving liabilities between key participants.	8.351	5.113	0.248	1.633	0.104
Encourage fiscal transparency between key participants.	13.632	3.618	0.386	3.767	<0.001

Summary of regression results on IPD Contractual Principles

Multiple regression was carried out to investigate the best predictors of IPD Contractual Principles. The combination of variables to predict IPD Contractual Principles from the predictor variables is statistically significant, $F(12, 222) = 138.734, p < 0.05$. The results indicate that six independent variables significantly predict IPD Contractual Principles when all 12 variables are included. These variables are; *key participants involved early in the project; tying the success of key participants to the success of the project; key participants jointly accountable for any errors in design; sharing financial risk among key participants; utilization of new technologies and approaches during design; and encourage fiscal transparency between key participants.* The adjusted R^2 value is 0.827. This indicates that 82.7% of the variance in IPD Contractual Principles was explained by the model.

b. Behavioural Principles inherent in IPD

There were six independent variables (predictors) as presented in Table 4.51 on IPD Behavioural Principles that were entered for the Regression Analysis with a sample size (N) of 235 because there is no missing score in the variables. Table 4.51 shows the descriptive statistics for all the variables in the test.

Table 4.51: Descriptive Statistics of Behavioural Principles

Independent Variables	Mean	Std. Deviation	N
IPD Behavioural Principles (DV)*	60.00	28.345	235
Key participants having mutual respect for each other.	4.50	0.587	235
Key participants having mutual trust for each other.	4.41	0.565	235
Willingness to collaborate as key participants.	4.43	0.584	235
Open communication among key participants.	4.45	0.621	235
Open information sharing among key participants.	4.50	0.682	235
Ensuring transparent processes throughout the project.	4.59	0.644	235

*DV: Dependent Variable

The mean values and the standard deviation of the variables are presented in Table 4.51. All these values are relatively high indicating statistical significance.

The Model Summary Analysis

Table 4.52 provides the *R*, R^2, adjusted R^2, and the standard error of the estimate, which can be used to determine how well a regression model fits the data.

Table 4.52: Regression Analysis Model Summary of Behavioural Principles

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	0.861[a]	0.741	0.735	14.601

Table 4.52 shows that *R*, using all the predictors simultaneously is 0.861 and the Adjusted R^2 is 0.735. This means that 73.5% of the variance in the IPD Behavioural Principles can be predicted from the combination of all the independent variables.

Analysis of Variance (ANOVA)

Table 4.53 provides the various values for the ANOVA. An F-ratio value of 108.978 which is greater than 1 will yield an efficient and acceptable model. A 95% confidence level representing a 5% or 0.05 level of significance was set for the analysis therefore, a sig. value of 0.001 in this case which is less than 0.05 is acceptable.

Table 4.53: Regression Analysis ANOVA of Behavioural Principles

Model	Sum of Squares	df	Mean Square	F	Sig.
Regression	139394.081	6	23232.347	108.978	<0.001[b]
Residual	48605.919	228	213.184		
Total	188000.000	234			

Table 4.53 shows that the independent variables statistically significantly predict the dependent variable, $F(6, 228) = 213.184$, $p < 0.05$ hence the regression model is a good fit for the data. The ANOVA table shows that F = 108.978 which is statistically significant and indicates that the predictors significantly combine to predict IPD Behavioural Principles.

Regression Analysis Coefficients

Table 4.54 provides the coefficients from the analysis. The sig. value is very important in testing the hypothesis and should be less than 0.05 for a 95% confidence level. This determines whether the null hypothesis should be rejected or not. Therefore, if the sig. value is $p < 0.05$, it can be concluded that the coefficients are statistically significantly different to zero hence the null hypothesis can be rejected.

Table 4.54: Regression Analysis Coefficients of Behavioural Principles

Model	Unstandardized Coefficients		Standardized Coefficients		Sig.
	B	Std. Error	Beta	t	
Constant	-142.526	8.320		-17.130	<0.001
Key participants having mutual respect for each other.	15.876	5.022	0.329	3.161	0.002
Key participants having mutual trust for each other.	34.839	5.581	0.695	6.242	<0.001
Willingness to collaborate as key participants.	-8.825	6.369	-0.182	-1.386	0.167
Open communication among key participants.	-.782	5.446	-0.017	-0.144	0.886
Open information sharing among key participants.	-8.016	4.737	-0.193	-1.692	0.092
Ensuring transparent processes throughout the project.	12.259	3.632	0.278	3.376	<0.001

From Table 4.54, in considering the sig. values, it is only three variables that are significantly adding to the prediction when the other predictors are considered. These variables have $p < 0.05$ and include: *key participants having mutual respect for each other; key participants having mutual trust for each other; and ensuring transparent processes throughout the project.* However, all the predictors need to be included to obtain this result, because the overall F value was computed with all the variables. This is because if any of the predictors are considered insignificant and deleted, it can

affect the levels of significance for other predictors. Therefore, these three variables reject the null hypothesis *(H_{03})* and accept the alternative hypothesis *(H_{A3})* that; the adaptation of inherent enablers in IPD will improve design documentation quality under the conventional project delivery approach.

Summary of regression results on IPD Behavioural Principles

Multiple regression was carried out to investigate the best predictors of IPD Behavioural Principles. The combination of variables to predict IPD Behavioural Principles from the predictor variables is statistically significant, $F(6, 228) = 213.184, p < 0.05$. The results indicate that three independent variables significantly predict IPD Behavioural Principles when all the six variables are included. These variables are; *key participants having mutual respect for each other; key participants having mutual trust for each other, and ensuring transparent processes throughout the project.* The adjusted R^2 value is 0.735. This indicates that 73.5% of the variance in IPD Contractual Principles was explained by the model.

c. Early Involvement and Collaboration of Key Participants in IPD (EICKP)

There were seven independent variables as presented in Table 4.55 on early involvement and collaboration of key participants that were entered for the analysis with a sample size (N) of 235 because there is no missing score in the variables. Table 4.55 shows the descriptive statistics for all the variables in the test.

Table 4.55: Descriptive Statistics of EICKP in IPD

Independent Variables	Mean	Std. Deviation	N
Early Involvement and Collaboration of Key Participants. (DV)*	60.00	28.345	235
It enhances and strengthens key participants' understanding of the owner's desired outcome.	4.39	0.555	235
Effective collaboration by all participants improves design documentation quality.	4.33	0.547	235
More timely and informed understanding of the design.	4.49	0.557	235
Provides an opportunity for adequate pre-design, design, and documentation planning.	4.40	0.571	235
Provides an opportunity for strong pre-construction planning.	4.43	0.590	235
Early visualization of construction sequencing prior to commencing project.	4.28	0.788	235
An increase in the level of effort by key participants during design documentation results in better documentation quality.	4.39	0.806	235

*DV: Dependent Variable

The mean values and the standard deviation of the variables are presented in Table 4.55. All these values are relatively high indicating statistical significance.

The Model Summary Analysis

Table 4.56 provides the *R*, R^2, adjusted R^2, and the standard error of the estimate, which can be used to determine how well a regression model fits the data.

Table 4.56: Regression Analysis Model Summary of EICKP in IPD

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	0.877[a]	0.769	0.762	13.824

Table 4.56 shows that *R*, using all the predictors simultaneously is 0.877 and the Adjusted R-square is 0.762. This means that 76.2% of the variance in the early involvement and collaboration of key participants in IPD can be predicted from the combination of all the independent variables.

Analysis of Variance (ANOVA)

Table 4.57 provides the various values for the ANOVA. The F-ratio tests whether the overall regression model is a good fit for the data. An F-ratio value of 108.111 in this case which is greater than 1 will yield an efficient and acceptable model. A 95% confidence level representing a 5% or 0.05 level of significance was set for the analysis therefore, a sig. value of 0.001 in this case which is less than 0.05 is acceptable.

Table 4.57: Regression Analysis ANOVA of EICKP in IPD

Model	Sum of Squares	df	Mean Square	F	Sig.
Regression	144620.205	7	20660.029	108.111	<0.001[b]
Residual	43379.795	227	191.100		
Total	188000.000	234			

Table 4.57 shows that the independent variables statistically significantly predict the dependent variable, $F(7, 227) = 191.100$, $p < 0.05$ hence the regression model is a good fit for the data. The ANOVA table shows that F = 108.111 which is statistically significant and indicates that the predictors significantly combine to predict the early involvement and collaboration of key participants in IPD.

Regression Analysis Coefficients

Table 4.58 provides the coefficients from the analysis. The sig. value is very important in testing the hypothesis and should be less than 0.05 for a 95% confidence level. This determines whether the null hypothesis should be rejected or not. Therefore, if the sig. value is $p < 0.05$, it can be concluded that the coefficients are statistically significantly different to zero hence the null hypothesis can be rejected.

Table 4.58: Regression Analysis Coefficients of EICKP in IPD

Model	Unstandardized Coefficients		Standardized Coefficients		Sig.
	B	Std. Error	Beta	t	
Constant	-137.243	8.194		-16.750	<0.001
It enhances and strengthens key participants' understanding of the owner's desired outcome.	22.021	8.163	0.431	2.698	0.008
Effective collaboration by all participants improves design documentation quality.	9.734	3.945	0.188	2.467	0.014
There is a more timely and informed understanding of the design.	17.042	5.820	0.335	2.928	0.004
Provides an opportunity for adequate pre-design, design, and documentation planning.	-12.389	7.932	-0.250	-1.562	0.120
Provides an opportunity for strong pre-construction planning.	-1.250	5.099	-0.026	-0.245	0.807
Early visualization of construction sequencing prior to commencing project.	4.155	4.552	0.116	0.913	0.362
An increase in the level of effort by key participants during design documentation results in better documentation quality.	5.510	4.457	0.157	1.236	0.218

From Table 4.58, in considering the sig. values, it is only three variables that are significantly adding to the prediction when the other predictors are considered. These variables have $p < 0.05$ and include: *it enhances and strengthens key participants' understanding of the owner's desired outcome; effective collaboration by all participants improves design documentation quality, and there is a timely and informed understanding of the design.* However, all the predictors need to be included to obtain this result, because the overall F value was computed with all the variables. This is because if any of the predictors are considered insignificant and deleted, it can affect the levels of significance for other predictors. Therefore, these three variables reject the null hypothesis *(H_{03})* and accept the alternative hypothesis *(H_{A3})* that; the

adaptation of inherent enablers in IPD will improve design documentation quality under the conventional project delivery approach.

Summary of regression results on EICKP in IPD

Multiple regression was carried out to investigate the best predictors of the early involvement and collaboration of key participants in IPD. The combination of variables to predict the early involvement and collaboration of key participants in IPD from the predictor variables is statistically significant, $F(7, 227) = 191.100, p < 0.05$. The results indicate that three independent variables significantly predict the early involvement and collaboration of key participants in IPD when all seven variables are included. These variables are; *it enhances and strengthens key participants' understanding of the owner's desired outcome; effective collaboration by all participants improves design documentation quality; and there is a timely and informed understanding of the design.* The adjusted R^2 value is 0.762. This indicates that 76.2% of the variance in IPD Contractual Principles was explained by the model.

4.9 Summary of Factor, Correlation and Regression Analysis

After further analyses of the research data using factor analysis, correlation and regression, the research hypotheses were tested. These tests helped determine the main variables for developing the framework to improve design documentation quality within the conventional project delivery approach. The results present three main variables on the state of design documentation quality in practice. These variables are responsible for poor design documentation quality under the conventional project delivery. They include: *design drawings usually contain errors and omissions; there are discrepancies between bill of quantities, drawings and specifications; and there is often lack of accuracy in design documentation.*

There are four main weaknesses associated with the conventional project delivery approach from the research results which include: *lack of coordination among design consultants; it does not encourage commitment to project objectives rather individual participant's objectives and gain; it does not encourage commitment of all participants to total quality right from project design; and compartmentalization of*

project participants around functional and professional lines leads to poor communication, poor relationships and leads to poor design documentation.

The results present six capabilities that are required of the conventional project delivery approach particularly, during the production of design documentation. These are; *incentives for producing good design documentation quality; improving consultants working conditions and procedures; mandatory coordination of design documentation by a supervisor with requisite skills and knowledge; improving collaboration between consultants; job-relevant training and practice; and preparation of detailed design.*

The results on enablers inherent in IPD to improve design documentation quality are in three main categories. There are six contractual principles, three behavioural principles, and three variables on early involvement and collaboration of key participants. Contractual principles include; *key participants involved early in the project; tying the success of key participants to the success of the project; key participants jointly accountable for any errors in design; sharing financial risk among key participants; utilization of new technologies and approaches during design; and encourage fiscal transparency between key participants.*

Behavioural principles include; *key participants having mutual respect for each other; key participants having mutual trust for each other; and ensuring transparent processes throughout the project.* Variables on early involvement and collaboration of key participants include; *it enhances and strengthens key participants' understanding of the owner's desired outcome; effective collaboration by all participants improves design documentation quality; and there is a timely and informed understanding of the design.*

4.10 Chapter Summary

This chapter presents the quantitative data that was collected for this research and the analysis. The questionnaire survey was the medium through which quantitative data was collected. The survey instrument was disseminated online via google form to

construction sector experts and a total of 235 responses were recorded for analysis. However, validity and reliability of the quantitative data were ensured by calculating Cronbach's alpha, α (or *coefficient alpha*) values. The quantitative data were analyzed using descriptive statistics, factor analysis, correlation, and regression calculations with the aid of the Statistical Package for Social Sciences (SPSS). The analyses rejected the three null hypotheses (H_{01}, H_{02}, *and* H_{03}) for the research and accepted the alternative hypotheses. However, to make a conclusive argument for the research, there is a need to consider the qualitative data that was collected. Therefore, the next stage is the presentation and analysis of the qualitative data after concluding the quantitative data presentation and analysis.

CHAPTER 5

QUALITATIVE DATA PRESENTATION AND ANALYSIS

5.1 Introduction

This chapter presents the qualitative data that was collected and the analysis. Semi-structured interviews were used to collect the qualitative data. The data was analysed based on content analysis employing descriptive and pattern coding with the aid of QSR Nvivo 12 Pro. The chapter presents how the data from the interviews in audio formats were transcribed and analyzed. There were 15 interview participants involved as presented in Table 5.1. The individual transcripts were cleaned to correct all forms of transcribing errors and to bring order into the data. This helped in correcting grammatical errors and structuring the interview transcripts based on paragraph style in Microsoft word in preparation for export into QSR Nvivo 12 Pro to aid in the analysis of the data. The data cleaning was helpful in auto coding where relevant information was assigned to specific nodes automatically as shown in Figure 5.1. It helped to re-organize the data for further analysis.

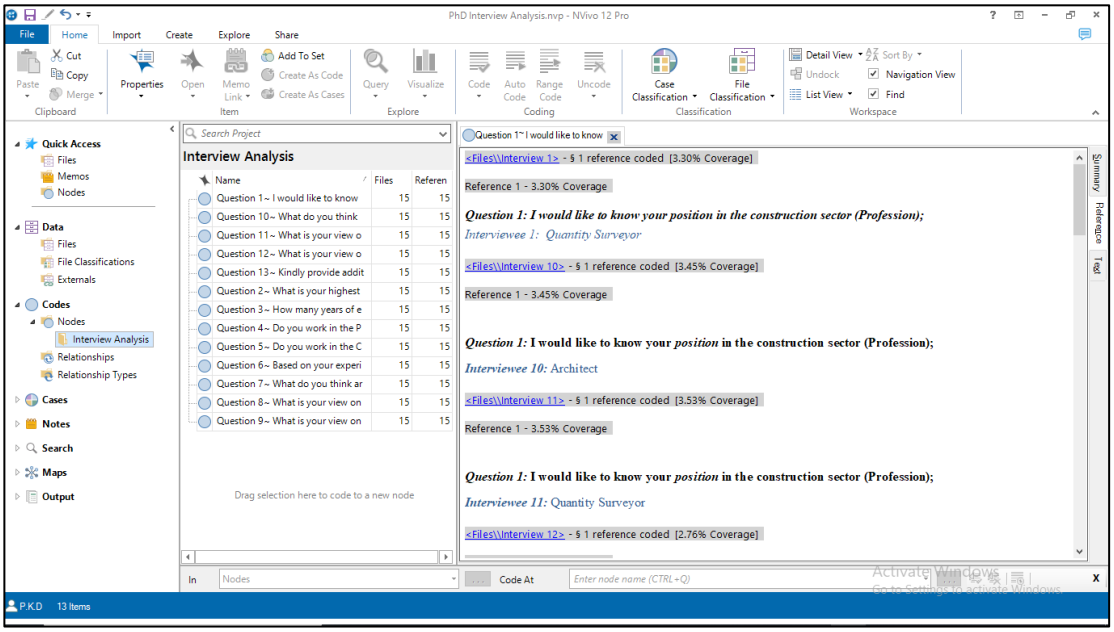

Figure 5.1: Auto coding of interview transcripts in QSR Nvivo 12 Pro

The interviews aimed to collect relevant data on the second and third objectives of this research which are; to identify the inherent *weaknesses* associated with the conventional project delivery approach and *capabilities* required in the production of design documentation; and to identify *enablers* inherent in IPD that can be adapted to improve design documentation quality. The interview participants are identified with codes to prevent the direct use of names. The codes are; P1, P2, P3, P4, P5, P6, P7, P8, P9, P10, P11, P12, P13, P14, and P15 representing each participant as presented in Table 5.1. Participants' background information is necessary and hence presented.

5.2 Interview Participants Background Information

Interview participants' background information includes their position in the construction sector; their highest level of education; their years of experience in the construction sector; their sector of work (public or private); and the outfit in which they work (Consultants or contractors outfit). Table 5.1 presents their responses.

Table 5.1: Participants background information

Participants	Position	Level of Education	Years of Experience	Sector of Work	Outfit of Work
P1	QS	Master's D.	13	Public	Consultancy
P2	C/P Man.	Master's D.	17	Public	Consultancy
P3	Architect	Master's D.	13	Private	Consultancy
P4	QS	Master's D.	21	Public	Consultancy
P5	Architect	Master's D.	19	Private	Contractor
P6	QS	BSc. Hons	11	Public	Consultancy
P7	C/P Man.	Master's D.	14	Private	Contractor
P8	QS	BSc. Hons	11	Public	Consultancy
P9	C/P Man.	Master's D.	19	Public	Consultancy
P10	Architect	Master's D.	15	Private	Consultancy
P11	QS	Master's D.	21	Public	Consultancy
P12	Architect	Master's D.	13	Private	Contractor
P13	C/P Man.	BSc. Hons	8	Public	Consultancy
P14	Architect	Master's D.	11	Private	Contractor
P15	C/P Man.	BSc. Hons	9	Private	Contractor

*QS: Quantity Surveyor
*C/P Man.: Construction/ Project Manager
*Master's D.: Master's Degree

The background information on participants gives an overview of their qualifications as construction professionals as well as their experience in the construction sector. This is important to collect data that is relevant and reliable to achieve the aim of this

research. The participants with their corresponding frequencies as presented in Figure 5.2 include; quantity surveyors, architects, and construction or project managers.

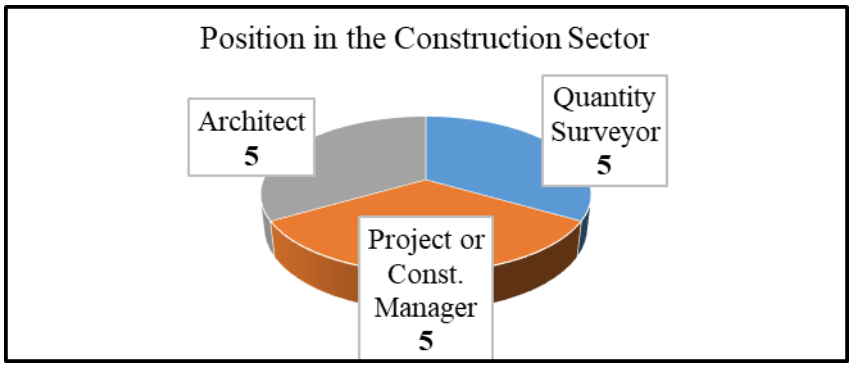

Figure 5.2: Participant's position in the construction sector

Participants' professions are in three main categories which are quantity surveyors, architects and construction or project managers. Therefore, interview data were collected from five of each profession. The category of professionals interviewed is indicative that the groups of participants are experts in the construction industry and are involved in the production of design documentation, therefore, provided appropriate and reliable data for this research. Participants' level of education is significant in this research since it has the tendency to influence their responses. From Table 5.1, a majority who are Master's degree graduates accounted for 11 representing 73%, and the remaining four representing 27% are 1st degree or BSc. Honours graduates. Therefore, it is indicative that participants have attained good levels of education and hence provided adequate data.

The years of experience of participants as presented in Table 5.1 is very significant in this research since it is believed to influence their sense of reasoning and judgement. The highest number of years of participants' experience in the construction sector is 21 while the least is eight. However, the average years of experience in the construction sector for the 15 participants is 14. This is indicative that respondents have significant experience in the construction sector and hence had in-depth knowledge and provided relevant responses for this research.

It was necessary to know whether participants work within the private or the public sector in the construction industry. As presented in Table 5.1, eight participants representing 53% work within the public sector while seven representing 47% work within the private sector. Participants' sector of work represents nearly a balance between the private sector and the public sector of work within the construction industry. This however provided fair and nearly balanced data from the private and the public sector. This also provided reliable data for the research because a majority of projects that are delivered using the conventional project delivery approach are in the public sector while a majority of projects that are delivered using IPD or some level of integration happen within the private sector.

It was also important to know whether participants work within consultants' outfits or contractors' outfits as presented in Table 5.1. Ten representing 67% of participants work within consultants' outfits while five representing 33% work within contractors' outfits in the construction industry. This provided data from both consultants' and contractors' points of view which is believed to offer fair data for the research.

5.3 Weaknesses associated with the Conventional Project Delivery Approach

Participants were asked to indicate some weaknesses that they deemed associated with the conventional project delivery approach during the production of design documentation based on their experience in the construction sector. This question is linked to the second research objective which seeks to identify the inherent *weaknesses* associated with the conventional project delivery approach, particularly in the production of design documentation. Responses from all 15 interview participants are presented in Table 5.2.

Table 5.2: Participants' responses on the Weaknesses associated with the conventional project delivery approach

Question: Based on your experience in the construction sector; what do you think are some weaknesses that are associated with the conventional project delivery approach during the production of design documentation;	
Participants	**Response**
P1	*"I think the conventional approach is so fragmented and leaves all stakeholders to operate on their own. There is no formalized collaboration among the professionals when preparing design documentation and this often results in errors in the documents that are used on-site".*
P2	*"I think the conventional method lacks collaboration and coordination among design consultants or team members. This results in significant discrepancies between design drawings, specifications and bills of quantities".*
P3	*"Design consultants do not collaborate effectively to enhance quality. They are left on their own individually and work individually without any collaboration. Each professional prepares their documents individually which is only assembled by the project or design team leader".*
P4	*"The conventional method gives the various project professionals and some stakeholders the room to be more conscious about the profits that they will make. They are not necessarily concerned about the quality of the project. This project delivery approach is also characterized with fragmentation where various professionals and stakeholders do not properly collaborate".*
P5	*"Conventional project delivery lacks cooperation and collaboration among project team members or professionals. It lacks contractors' input and experience during the design stage. This delivery method often results in inconsistencies between design drawings, bill of quantities, specifications and other documents. Most projects often results in unnecessary cost overruns, shoddy works, and project abandonment".*
P6	*"There is lack of collaboration among project team members. This method lacks contractors' input even with their worth of experience particularly at the design and documentation stage. Under the conventional method, most Contracts are deliberately awarded at excessively low price, with the intention of applying for claims later by deliberately exploiting errors or inefficiencies in contract documents. This method creates room for individual project team members to deliberately exploit loopholes in contract documents".*
P7	*"Project or design team members do not cooperate and collaborate appropriately to ensure quality delivery. It does not provide the opportunity for contractors to make inputs at the design stage and does not make use of their experience. There are always discrepancies between contract documents. Most projects end up experiencing cost overruns, poor work, and even project abandonment. The final project cost is always very high compared to the initial cost of the project. The focus on lowest price instead of best price is so much and often results in high amounts of claims".*
P8	*"The conventional method is fragmented whereby team members individually work on their own without collaboration. It does not promote collaboration among the project team members particularly during the preparation of design documentation. It often results in claims whereby escalating the project final price astronomically".*

Table 5.2: Continued

Participants	Response
P9	*"I think the conventional method lacks collaboration and there is no coordination among design team members. It is a highly fragmented approach to project delivery. It often results in discrepancies between drawings, bills of quantities and specifications".*
P10	*"There is lack of collaboration among design consultants and other stakeholders. Most design team members do not have the interest of the project at heart; instead, they are more concerned about their pay".*
P11	*"Project team members are more profit conscious instead of having the success of the project at heart. The conventional project delivery approach is more fragmented and lacks the needed collaboration among the team members".*
P12	*"The conventional project delivery approach is fragmented and lacks collaboration among team members. It does not give contractors the opportunity to make inputs based on their experience during the design and documentation stage. Most projects executed under the conventional method often results in project cost overruns, poor quality delivery of works, and subsequent project abandonment".*
P13	*"The conventional approach lacks contractors input during the production of design and documentation. It does not harness the experience of contractors particularly during the design and documentation stage. This approach is fragmented and lacks collaboration among project team members. Under the conventional approach, most Contracts are deliberately awarded at very low price, and later apply for claims intentionally by exploiting loopholes in the documentation".*
P14	*"Lack of collaboration and cooperation among project or design team members. Contract documents are often characterized with discrepancies.* *There is always cost escalation on most of the projects. Higher final project cost as compared to the initial cost of the project. High amount of claims".*
P15	*"The conventional method lacks collaboration and coordination among design team members. This approach to project delivery is fragmented.* *It produces documents that are often loaded with errors and discrepancies".*

The interview data from all 15 transcripts were auto-coded in QSR Nvivo 12 Pro software. The auto coding categorized the transcribed data based on the interview question. All the 15 participants' responses are brought together into one node labelled *Weaknesses* as presented in Figure 5.3. This is further presented in Table 5.3 by stating the responses of each interview participant verbatim.

After further classification of the data, various themes were coded and subsequently categorized. The *weaknesses* associated with the conventional project delivery approach were coded as W. The coding resulted in 16 categories of weaknesses as presented in Table 5.3. The frequency of occurrence of the various categories in the

data was very important in determining the significance of such categories. All 15 participants indicated; a lack of cooperation and collaboration among project participants as a major weakness.

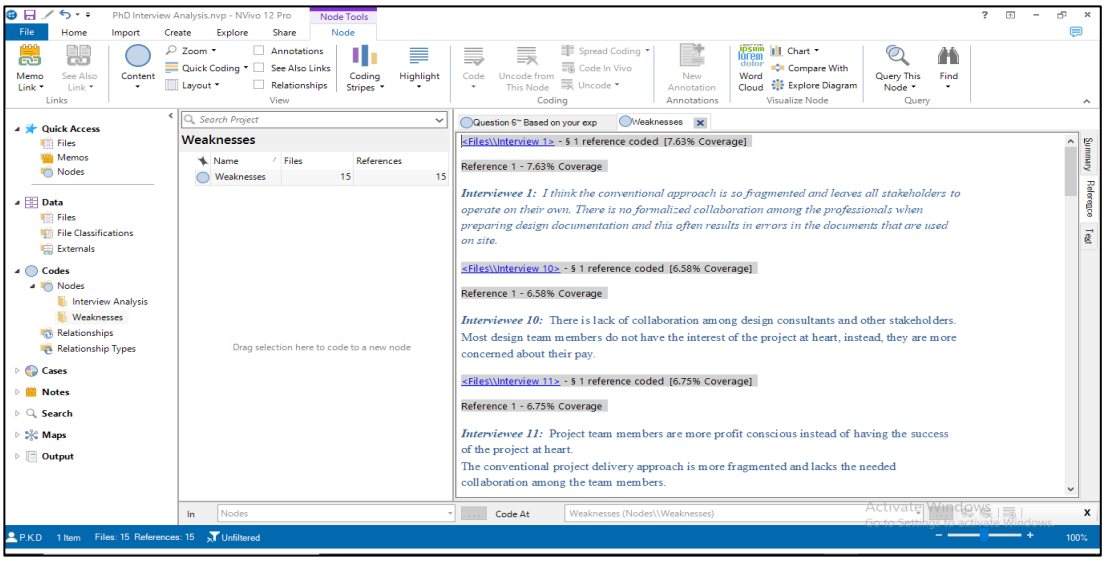

Figure 5.3: Weaknesses as categorized in QSR Nvivo 12 Pro

Eight participants were of the view that; lack of coordination among design consultants; discrepancies between bill of quantities, drawings and specifications (errors); and finally, the method is a fragmented approach to project delivery as weaknesses associated with the conventional approach. However, five participants also indicated; lack of contractors' input at the design stage and not taking advantage of their experience as weaknesses. Another four participants also stated that; projects always experience cost escalation, shoddy workmanship, project abandonment and other manifestations of project failure including lack of coordination among design documents as weaknesses of the conventional method. However, there are other important weaknesses of the conventional project delivery as presented in Table 5.3.

Table 5.3: Weaknesses associated with the conventional project delivery approach

Code	Categories	Participants Responses															Frequency	Ranking
		P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12	P13	P14	P15		
W12	Lack of cooperation and collaboration among project participants.	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	**15**	**1**
W1	Lack of coordination among design consultants.	✓	✓	✓		✓	✓	✓		✓						✓	**8**	**2**
W4	Discrepancies between bill of quantities, drawings and specifications (errors).	✓	✓			✓	✓	✓		✓					✓	✓	**8**	**3**
W16	It is a fragmented approach to project delivery.	✓			✓				✓	✓		✓	✓	✓		✓	**8**	**4**
W9	Lack of contractors' input at the design stage and not taking advantage of their experience.					✓	✓	✓					✓	✓			**5**	**5**
W2	Projects always experience cost escalation, shoddy workmanship, project abandonment and other manifestations of project failure.					✓		✓					✓		✓		**4**	**6**
W3	Lack of coordination among design documents.	✓	✓			✓									✓		**4**	**7**
W7	It encourages claim consciousness among project participants.						✓		✓						✓		**3**	**8**
W11	There is high inflation or escalation of final contract cost.							✓	✓						✓		**3**	**9**

Table 5.3: Continued

Code	Categories	Participants Responses															Frequency	Ranking
		P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12	P13	P14	P15		
W13	It encourages participants to be more profit conscious instead of project quality conscious.				✓						✓	✓					**3**	**10**
W14	It does not encourage commitment of all participants to total quality right from project design.			✓	✓												**2**	**11**
W6	Letting contracts at excessively low price and hiking the price later to claim for reward.						✓							✓			**2**	**12**
W5	Individual team members exploits loopholes in contract documents.						✓										**1**	**13**
W8	Too much focus on lowest price instead of best price.							✓									**1**	**14**
W10	No guarantee of certainty of project final cost, only initial cost.							✓									**1**	**15**
W15	It does not encourage commitment to project objectives rather individual participants' objectives and gain.										✓						**1**	**16**

From Table 5.3, the ranking of interview responses on weaknesses associated with the conventional project delivery based on the frequency of response is presented. The top five factors are; lack of cooperation and collaboration among project participants; lack of coordination among design consultants; discrepancies between bill of quantities, drawings and specifications (errors); it is a fragmented approach to project delivery; and lack of contractors' input at the design stage and not taking advantage of their experience.

5.4 Capabilities required in the production of design documentation under the conventional project delivery approach

Participants were asked to indicate some potential capabilities required of the conventional project delivery approach during design to improve design documentation quality. This question is also linked to the second research objective which seeks to identify potential capabilities required of the conventional project delivery approach during design to improve design documentation quality. Responses from all 15 interview participants are presented in Table 5.4.

Table 5.4: Participants' responses on the Capabilities required in the production of design documentation under the conventional project delivery approach

Question: What do you think are some potential capabilities required of the conventional project delivery approach during design to improve design documentation quality?	
Participants	**Response**
P1	*"With my experience in the industry, I think there is a need for the various professionals in the project team to collaborate and work together as a team".*
P2	*"There should be an improvement in the level of collaboration between all professional consultants involved in a specific project. There could be the room for the various professionals to partner each other during the preparation of design documents. If possible, coordination of design consultants should be made mandatory with an appointed supervisor".*
P3	*"The project stakeholders should collaborate more during the design documentation stage. Design consultants should be held accountable for deficiencies in design documentation".*
P4	*"I think incentives should be provided to design professionals for producing good quality design documentation. They should also be well remunerated of paid for work done. If the level or amount of collaboration between the various design professionals is improved, it will also translate into better quality design and documentation preparation".*
P5	*"There should be cooperation and collaboration among project team members or professionals. Contractors should be allowed to make input and bring their experience to bear particularly during the design stage. There should be the use of computer programs such as Building Information Modelling during the production of design documentation. Various professionals should be given regular job relevant training and practice to enhance the preparation of quality documentation".*
P6	*"If design and documentation consultants can be held accountable for producing poor design and documentation, there will be a significant improvement in quality. The same way, there should be incentives for producing good design and documentation. Clients should ensure a good and appropriate remuneration or payment to consultants.* *There should be an improvement in the level of collaboration between architects, engineers, surveyors and other professionals during the design and documentation process. Consultants should ensure that they receive more elaborate and improved project brief from clients. Designers should also ensure the preparation of detailed design to enhance the preparation of improved quality documentation".*
P7	*"There should be incentives to project team members for producing good design documentation quality. Appropriate fees should be paid to project team members or consultants. Clients should allow adequate time for project team members to prepare design documents. Clients should provide a more elaborate and improved project brief. Design team should always ensure that detailed design and documentation is prepared. Design team members of project consultants should be held accountable for producing poor design documentation. There should be an improved collaboration between design team members or consultants. Re-checking design documentation for accuracy should always be ensured. The use of computer programs such as BIM should be encouraged".*

Table 5.4: Continued

Participants	Response
P8	*"I think there is a need for the various professionals in the project team to effectively collaborate and work together as a team. Design consultants should be paid their appropriate fees by clients to enable them deliver their best".*
P9	*"Collaboration among all professionals involved in a project should be enhanced. Design team members should always partner each other during the preparation of design documents. There should be an appointed supervisor to coordinate all design team members effectively to enhance collaboration".*
P10	*"There should be more collaboration among the design professionals and other stakeholders during the design documentation stage. There should be a provision in the contract that will cause clients to hold design team professionals or consultants accountable for errors in design documentation".*
P11	*"Project professionals should encourage collaboration among each other. There should be award of bonuses to design team members when they produce good quality design documentation. Payments to design consultants should be commensurate with output".*
P12	*"Designers must collaborate and bring their expertise to bare during the design and documentation stage. Designers need to collaborate with contractors to harness the experience of contractors on projects. There is the need for designers to collaborate with all stakeholders during the preparation of design and documentation. If necessary, computer programs such as Building Information Modelling should be used during the production of design and documentation".*
P13	*"Architects, engineers, surveyors and other professionals should collaborate during the design and documentation process. Designers or Consultants should ensure that they ask questions and receive more elaborate and improved project brief from clients. They should also ensure that they prepare a more detailed design and documentation. Designers or consultants should be held accountable for producing poor design and documentation. Clients should also formulate appropriate incentives for producing good design and documentation. Clients should ensure that designers or consultants are paid appropriate fees".*
P14	*"Project team members should be awarded or compensated for producing good design documentation. Design team members should also be held accountable for producing poor design documentation. There should be an improved collaboration between design team members or consultants. Consultants' should be paid appropriate fees for services rendered. Adequate time should be given for consultants to prepare design documents. Consultants should ensure they receive a more elaborate and improved project brief from clients".*
P15	*"There should be collaboration and coordination among design team members. There should be enough effort towards reducing the level of fragmentation that is associated with the conventional approach".*

After auto-coding all the 15 interview transcripts with the aid of QSR Nvivo 12 Pro software, the data were categorized based on the interview question. All the 15 participants' responses are brought together into one node labelled *Capabilities* as presented in Figure 5.4. This is further presented in Table 5.4 by stating the responses of each interview participant verbatim.

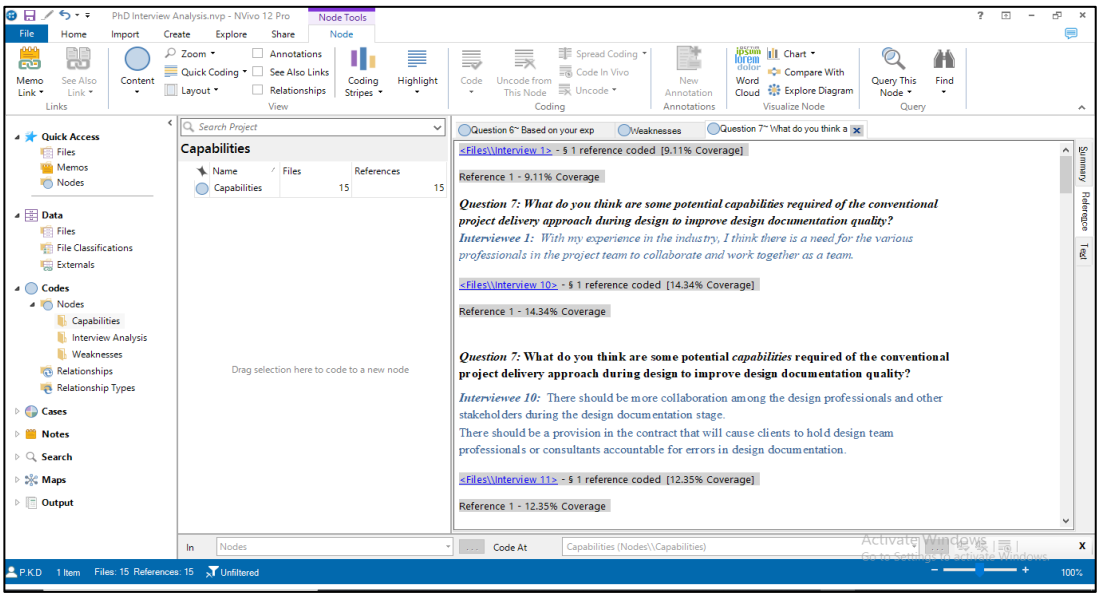

Figure 5.4: Capabilities as categorized in QSR Nvivo 12 Pro

After further classification of the data, various themes were coded and subsequently categorized. The potential capabilities required of the conventional project delivery approach during design to improve design documentation quality were coded as C. The coding resulted in 16 different categories of Capabilities identified from the data as presented in Table 5.5.

The frequency of occurrence of the various categories in the data was very important in determining the significance of such categories. All 15 participants indicated; an improvement in collaboration between architectural and engineering design disciplines (consultants) as a major capability. Seven participants were of the view that; payment of appropriate fees to design consultants is also a major capability to consider. However, six participants also indicated that; holding consultants accountable for producing poor design documentation quality (penalty), and providing incentives for producing good design documentation quality are some potential capabilities. This notwithstanding, other equally important capabilities are required of the conventional project delivery approach as presented in Table 5.5.

Table 5.5: Capabilities required in the production of design documentation

Code	Categories	Participants Responses															Frequency	Ranking
		P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12	P13	P14	P15		
C2	Improving collaboration between consultants.	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	**15**	**1**
C4	Paying appropriate fees to consultants.				✓		✓	✓	✓			✓		✓	✓		**7**	**2**
C7	Holding Consultants accountable for producing poor design documentation quality (penalty).			✓			✓	✓			✓			✓	✓		**6**	**3**
C12	Incentives for producing good design documentation quality.				✓		✓	✓				✓		✓	✓		**6**	**4**
C14	Provision of elaborate and improved project brief.						✓	✓						✓	✓		**4**	**5**
C1	Preparation of detailed design and documentation.						✓	✓						✓			**3**	**6**
C8	Designers partnering with others while preparing design documents.	✓	✓							✓							**3**	**7**
C13	Use of computer programs such as BIM.					✓		✓					✓				**3**	**8**
C6	Allowing Contractors to make input during the design stage.					✓							✓				**2**	**9**
C9	Clients allowing adequate time for the preparation of design documents.							✓							✓		**2**	**10**

Table 5.5: Continued

Code	Categories	Participants Responses															Frequency	Ranking
		P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12	P13	P14	P15		
C10	Mandatory coordination of design documentation by a supervisor with requisite skills and knowledge.		✓							✓							**2**	**11**
C5	Specialists' involvement in design planning and processing.					✓											**1**	**12**
C3	Designers collaborating with all stakeholders during design and documentation.												✓				**1**	**13**
C11	Re-checking design documentation for accuracy.							✓									**1**	**14**
C15	Job-relevant training and practice.					✓											**1**	**15**
C16	Appropriate efforts towards reducing the level of fragmentation.															✓	**1**	**16**

From Table 5.5, the ranking of interview responses on capabilities required based on the frequency of response is presented. The top five factors are: improving collaboration among consultants; paying appropriate fees to consultants; holding consultants accountable for producing poor design documentation quality (penalty); incentives for producing good design documentation quality; and provision of an elaborate and improved project brief.

5.5 Possibility of using the required capabilities towards improving design documentation quality within the conventional project delivery

Participants were asked to indicate the possibility of using the required capabilities towards improving design documentation quality within the conventional project delivery. This question is linked to the second research objective. After auto-coding all 15 transcripts, the data were categorized. All the 15 participants' responses are brought together into one node as presented in Table 5.6 by stating the responses of each interview participant verbatim.

This question provided information on how possible the required capabilities identified can be integrated into the conventional project delivery approach towards improving design documentation quality within the conventional project delivery. Participants indicated that there is a need for an improvement in the conventional project delivery method and all stakeholders must make efforts towards improving the approach. This desired improvement in the quality of design documentation within the conventional project delivery will occur if professionals and stakeholders in the industry make conscious efforts and are ready to change their approach. They further indicated that there is a need for more capabilities to be considered and introduced into the conventional method because it will help enhance the quality of design documentation that will be produced.

Table 5.6: Participants' responses on the possibility of using the required capabilities toward improving design documentation quality

Question: What is your view on the possibility of these required capabilities towards improving design documentation quality within the conventional project delivery?	
Participants	**Response**
P1	*"If we as industry professionals make conscious efforts and also in a way change our approach in the conventional method, there will be a significant improvement in the quality of design documentation".*
P2	*"There is the need for an improvement in the conventional method therefore; all efforts should be directed towards the required capabilities by all stakeholders to ensure an improvement. These required capabilities are very significant and should be duly considered if we want an improvement".*
P3	*"These capabilities will help improve on the traditional approach".*
P4	*"I am confident that when these capabilities are introduced or improved upon in the conventional method, the quality of design documentation will increase".*
P5	*"These capabilities can be easily adapted into the conventional method if the professionals and stakeholders are ready to accept change".*
P6	*"It is possible and needs to be done if we expect to see improvement".*
P7	*"Very possible since it will help improve on the conventional approach".*
P8	*"There is a need for conscious efforts towards improving the conventional method. This will result in significant improvement in design documentation quality. So yes, it is possible for these capabilities to be worked on within the conventional approach to enhance delivery".*
P9	*"There is the need for more capabilities to be introduced into the conventional method to enhance it. These capabilities if introduced will help improve the quality of design documentation".*
P10	*"The capabilities should be considered because it will help improve on the traditional method".*
P11	*"The conventional project delivery approach needs to be improved and therefore, there is a need for capabilities that will help improve the current approach be introduced. So, it is possible to introduce these capabilities into the conventional method".*
P12	*"I think it is possible for these capabilities to be introduced into the conventional method to help improve the quality of design documentation that is produced".*
P13	*"There is the need for these capabilities to be introduced in the conventional approach if we are expecting an improvement".*
P14	*"It is possible and will help improve the conventional approach".*
P15	*"It is possible to improve the conventional approach even though it will be faced with a lot of challenges due to the changes that may likely be resisted by some industry players who are comfortable with the conventional approach".*

Participant 4 emphatically stated that; *"I am confident that when these capabilities are introduced or improved upon in the conventional method, the quality of design documentation will increase".* Therefore, the responses positively posited that the identified capabilities can be adapted to the conventional project delivery method. This notwithstanding, participant 15 indicated that; *"It is possible to improve the conventional approach even though it will be faced with a lot of challenges due to the*

changes that may likely be resisted by some industry players who are comfortable with the conventional approach".

5.6 Enablers inherent in IPD that can be adapted to improve design documentation quality

Participants were asked to indicate enablers that are inherent in IPD that can be adapted and used within the conventional project delivery approach during the production of design to improve design documentation quality. This question is linked to the third research objective. Responses from all 15 participants are presented in Table 5.7.

After auto-coding all 15 transcripts, the data were categorized. All the 15 participants' responses on enablers are brought together into one node labelled *Enablers* as presented in Figure 5.5. This is further presented in Table 5.7 by stating the responses of each interview participant verbatim. After further classification of the data, various themes were coded and subsequently categorized.

Table 5.7: Participants' responses on Enablers inherent in IPD

Question: What do you think are enablers that are inherent in IPD that can be adapted and used within the conventional project delivery approach during the production of design to improve design documentation quality?	
Participants	**Response**
P1	*"I think the level of collaboration in IPD is deep and if this can be introduced into the conventional approach, there will be an improvement. The project professionals must all have the success of the project at heart and join forces together to achieving that as it is the case with IPD projects".*
P2	*"There should be the early involvement of key project stakeholders to enhance early contributions of knowledge and expertise. This will ensure an early and jointly developed project target since all team members will make collaborative decisions. Project team members should be willing to collaborate and share pieces of information openly. The early collaboration will provide the opportunity for better pre-construction planning".*
P3	*"IPD as a project delivery approach is an embodiment of both contractual and behavioural principles. It is these principles that give IPD better and more efficient project delivery over other project delivery methods. I believe most of the principles, both contractual and behavioural can be adapted into the conventional approach. Project professionals should be assembled early enough to take critical decisions and they must respect each other's opinion and knowledge".*
P4	*"The involvement of project participants or stakeholders at an early stage of the project and their early contributions of knowledge and their expertise will help improve design documentation quality. The collaborative and early developed project target criteria that exist in IPD can help improve design documentation in the conventional approach. The principle of holding project participants or professionals accountable for any errors in design documentation will be very helpful in the conventional method. The principle of willingness to collaborate as project professionals of stakeholders in IPD can help improve design document quality in the convention method".*
P5	*"Key project participants are involved at an early stage in the project and this ensures early contributions of knowledge and expertise by all. These professionals are jointly accountable for any inefficiencies or errors in design documentation. There is the use of new technologies and approaches such as BIM. The project professionals have mutual respect for each other and are willing to collaborate. IPD ensures open information sharing among key project team members. It enables an early and adequate pre-design, design, and documentation planning of projects".*
P6	*"Involvement of key participants at an early stage of the project. The project participants must have mutual respect for each other, be willing to collaborate and ensure open information sharing as well as communication among each other. The success or effectiveness of the project should be tied to the success or effectiveness of the project participants. Holding project participants jointly accountable for any inconsistencies and or errors in design and documentation. Financial rewards or compensation should be shared among project participants based on the outcome of the project.* *New technologies and approaches during design should be used".*
P7	*"Involvement of Key participants early in the project. They ensure early contributions of knowledge and expertise. They make collaborative value-based decisions that are helpful for the success of the project. Project key participants jointly and early develop project target criteria to ensure smooth progress. The key participants are jointly accountable for any errors or inefficiencies in design. Sharing of financial reward or compensation among key participants based on the outcome of the project. There is willingness to collaborate as key participants and it enhances open communication among key participants. Key participants promote open information sharing among themselves. The early involvement of key participants enhances and strengthens key participants' understanding of the owner's desired project outcome. There is a more timely and informed understanding of the design and provides an opportunity for adequate pre-design, design, and documentation planning".*

Table 5.7: Continued

Participants	Response
P8	*"The level of collaboration or integration in IPD is awesome and this needs to be introduced into the conventional approach. The success of the project is tied to the success of the project participants and this need to be introduced into the conventional approach of project delivery".*
P9	*"Project team members should be involved early enough to ensure early contribution of knowledge and expertise. There is a collaborative and early decision-making on the project. Project team members are willing to collaborate and communicate openly".*
P10	*"I have always been of the view that most of the principles, both contractual and behavioural in IPD can be adapted into the conventional project delivery approach. This will help improve on the effectiveness of the conventional project delivery approach".*
P11	*"The principle of willingness to collaborate as professionals in IPD will help improve the conventional method. The early involvement of project participants or stakeholders and the early contribution of their knowledge and expertise will help improve design documentation quality within the conventional project delivery approach. Project participants or professionals should be held accountable for any errors in design documentation".*
P12	*"The IPD principle that promotes open information sharing among project team members can be adapted. The involvement of key project participants at an early stage in the project where they contribute their knowledge and expertise in IPD can be adapted. An early and adequate pre-design, design, and documentation planning of the project in IPD can be adapted. The principle of holding professionals jointly accountable for any inefficiencies or errors in design documentation in IPD can be adapted. The principle of willingness to collaborate and having mutual respect for each other in IPD can be adapted".*
P13	*"IPD operates on two main groups of principles which are contractual and behavioural. Some of these principles can be adapted into the conventional project delivery approach to help improve it. The principle of early involvement of key participants can be adapted. Holding project participants jointly accountable for any errors in design and documentation can be adapted. Sharing of financial rewards or compensation among project participants based on the outcome of the project can be adapted. Project participants having mutual respect for each other, willingness to collaborate and open information sharing as well as open communication among each other can be adapted".*
P14	*"The early involvement of key participants in the project that helps to ensure early contribution of knowledge and expertise can be adapted. Collaborative value-based decision-making that are helpful for the success of the project can be adapted. The principle of holding key participants jointly accountable for any errors or inefficiencies in design can be adapted. Sharing of financial reward among key participants based on the project outcome can be adapted".*
P15	*"The principle of early involvement of team members to ensure early contribution of knowledge and expertise can be adapted. The principle of collaboration and early decision-making on the project in IPD can be adapted. The willingness of project team members to collaborate and communicates openly in IPD can be adapted".*

The enablers inherent in IPD were coded as E. The coding resulted in 17 different categories of Enablers identified from the data as presented in Table 5.8. There were

eight enablers on *IPD Contractual Principles (CP);* four enablers on *IPD Behavioural Principles (BP);* and five enablers on *Early Involvement and Collaboration of Key Participants (EICKP).*

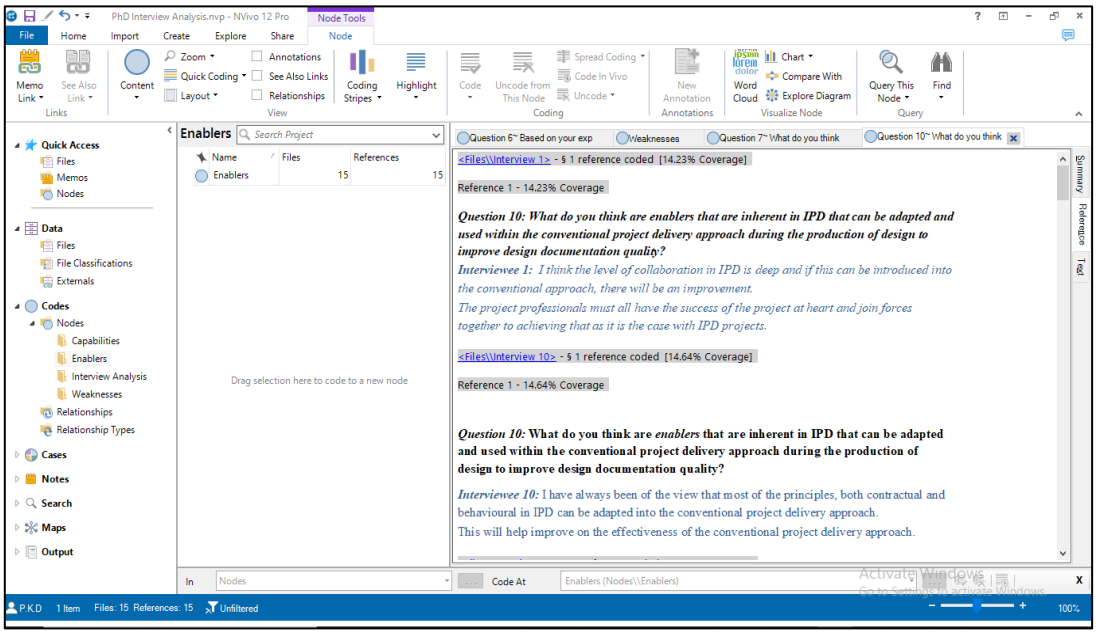

Figure 5.5: Enablers as categorized in QSR Nvivo 12 Pro

The frequency of occurrence of the various categories in the data was very important in determining the significance of such categories. Twelve participants were of the view that; involving key participants early in the project is an enabler that can be used within the conventional project delivery approach. Ten participants were of the view that; willingness to collaborate as key participants is also an important enabler to consider. Nine participants indicated that; key participants ensuring early contributions of knowledge and expertise is another important enabler. However, eight participants also indicated that; making collaborative value-based decisions by all participants, and key participants jointly accountable for any errors in design are enablers that must be considered. This notwithstanding, other equally important enablers inherent in IPD that can be adapted are presented in Table 5.8. It includes a ranking of the interview responses based on the frequency of responses.

Table 5.8: Enablers inherent in IPD that can be adapted to improve design documentation quality

Code	Categories	Participants Responses															Frequency	Ranking
		P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12	P13	P14	P15		
CP2	Key participants involved early in the project.		✓	✓	✓	✓	✓	✓		✓		✓	✓	✓	✓	✓	**12**	**1**
BP4	Willingness to collaborate as key participants.		✓		✓	✓	✓	✓		✓		✓	✓	✓		✓	**10**	**2**
CP5	Key participants' early contributions of knowledge and expertise.	✓	✓		✓	✓		✓				✓	✓		✓	✓	**9**	**3**
CP1	Making collaborative value-based decisions by all participants.	✓	✓	✓	✓			✓		✓					✓	✓	**8**	**4**
CP6	Key participants jointly accountable for any errors in design.				✓	✓	✓	✓				✓	✓	✓	✓		**8**	**5**
BP2	Open information sharing among key participants.		✓			✓	✓	✓					✓	✓			**6**	**6**
BP1	Key participants having mutual respect for each other.			✓		✓	✓						✓	✓			**5**	**7**
BP3	Open communication among key participants.						✓	✓		✓				✓		✓	**5**	**8**
CP4	Key participants sharing financial reward (compensation) based on project outcome.						✓	✓						✓	✓		**4**	**9**
CP3	Tying the success of key participants to the success of the project.	✓					✓		✓								**3**	**10**
EICK P3	Provides an opportunity for adequate pre-design, design, and documentation planning.					✓		✓					✓				**3**	**11**

Table 5.8: Continued

Code	Categories	Participants Responses															Frequency	Ranking
		P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12	P13	P14	P15		
CP7	Jointly and early developed project target criteria.		✓					✓									**2**	**12**
CP8	Utilization of new technologies and approaches during design.					✓	✓										**2**	**13**
EICK P5	Most of the principles in IPD can be adapted into the conventional project delivery.										✓			✓			**2**	**14**
EICK P1	A more timely and informed understanding of the design.							✓									**1**	**15**
EICK P2	Opportunity for strong pre-construction planning.		✓														**1**	**16**
EICK P4	Enhances and strengthens key participants' understanding of the owner's desired outcome.							✓									**1**	**17**

5.7 Possibility of adapting some Contractual Principles in IPD

Participants were asked to indicate the possibility of adapting some contractual principles in IPD towards improving design documentation quality within the conventional project delivery. All the 15 participants' responses are brought together into one node as presented in Table 5.9 with each participant's response verbatim.

Table 5.9: Participants' responses to the Possibility of adapting contractual principles in IPD

Question: What is your view on the possibility of adapting some contractual principles in IPD towards improving design documentation quality within the conventional project delivery?	
Participants	**Response**
P1	*"Yes, it is possible, it is highly possible. If the contract is such that project professionals are entreated to work together, it will improve the conventional approach".*
P2	*"Contractual principles are very important in the effective delivery of a project. Therefore, in order to improve design documentation quality, there is the need for the contract to specify certain principles that must guide the project team members. So, it is possible to adapt some principles in IPD into the conventional method that will help improve the traditional method".*
P3	*"Yes, it is possible to adapt contractual principles in IPD. If some of these principles are brought into the conventional approach, it will help improve performance. It will make it easy to hold professionals accountable for errors that they often commit".*
P4	*"It is possible and must be done if we want to salvage the conventional approach from the devastating situation it is in currently".*
P5	*"This will help improve the conventional method and eliminate most of the weaknesses".*
P6	*"It is possible and should be done if only we are expectant of an improvement in the conventional method".*
P7	*"This should be done to improve the conventional approach to project delivery".*
P8	*"Yes, it is possible, it is highly possible".*
P9	*"Contractual principles are very necessary if we want to deliver projects on time, to quality and within budget. Therefore some of these principles in IPD should be adapted into the conventional method to help improve it".*
P10	*"My view is that, it is highly possible to adapt contractual principles in IPD into the conventional project delivery approach".*
P11	*"It is possible and should be considered as early as possible".*
P12	*"It is possible to adapt some contractual principles in IPD into the conventional project delivery approach to help improve the quality of design and documentation".*
P13	*"It is possible and should be done to help improve the conventional project delivery approach".*
P14	*"It is possible and it will help improve the conventional project delivery approach".*
P15	*"It is possible and needs to be done".*

This question is linked to the third research objective which seeks to identify *enablers* inherent in IPD that can be adapted. After auto-coding all 15 transcripts with the aid of QSR Nvivo 12 Pro software, the data were categorized based on the interview question. This research is aimed at adapting some principles of IPD into the conventional project delivery approach to improve design documentation quality. Therefore, determining the possibility of adapting some contractual principles in IPD towards improving design documentation quality within the conventional project delivery is paramount. The majority of the participants are of the view that it is possible to adapt some contractual principles in IPD into the conventional project delivery. Participant 9 stated that; *"Contractual principles are very necessary if we want to deliver projects on time, to quality and within budget. Therefore some of these principles in IPD should be adapted into the conventional method to help improve it".*

The data indicates that adapting some contractual principles in IPD to the conventional project delivery approach is important in the effective delivery of a project and will result in holding professionals accountable for any errors committed. Participants 15, 6 and 4 are of the view that;

P15: "It is possible to adapt some principles in IPD into the conventional method that will help improve the traditional method".

P6: "It is possible and should be done if only we are expectant of an improvement in the conventional method".

P4: "It is possible and must be done if we want to salvage the conventional approach from the devastating situation it is in currently".

Therefore, it is indicative from the data that it is possible to adapt some contractual principles in IPD into the conventional project delivery approach to improve design documentation quality.

5.8 Possibility of adapting some Behavioural Principles in IPD

Participants were asked to indicate the possibility of adapting behavioural principles in IPD towards improving design documentation quality within the conventional

project delivery. All 15 participants' responses are brought together into one node as presented in Table 5.10 with the responses of each interview participant verbatim.

Table 5.10: Participants' responses to the Possibility of adapting behavioural principles in IPD

Question: What is your view on the possibility of adapting behavioural principles in IPD towards improving design documentation quality within the conventional project delivery?	
Participants	**Response**
P1	*"This is also possible and it is highly important because our behaviour influences our output a lot. Therefore I think there should be a behavioural and attitudinal change under the conventional or traditional approach in delivering a project. So if we really expect an improvement in the conventional approach, then we should be prepared to adopt some of those principles from IPD".*
P2	*"Behavioural principles are highly needed within the traditional project delivery method. This is because the behaviour of project team members' influences the final delivery. So it is very possible to adapt some behavioural principles in IPD into the traditional method".*
P3	*"I strongly think IPD behavioural principles are required within the conventional project delivery method. This will help improve the approach to the preparation of design documentation".*
P4	*"This should be done early enough since the behaviour of project professionals is having a devastating effect on the delivery of the conventional method".*
P5	*"This will also help improve the conventional method particularly the behaviour of project professionals".*
P6	*"It is possible and should be done if only we are expectant of an improvement in the conventional method".*
P7	*"This is very important since the behaviour of project professionals greatly affects project output. It is a major concern in the conventional project delivery approach".*
P8	*"This is also possible and it is very necessary based on the fact that the behaviour of project professionals highly influences their output. There is the need for behavioural and attitudinal change within the conventional method".*
P9	*"It is possible to adapt some behavioural principles in IPD into the traditional project delivery approach".*
P10	*"I am strongly of the view that it is possible to adapt some behavioural principles in IPD into the conventional project delivery method".*
P11	*"This is also possible and should be considered as early as possible".*
P12	*"It is possible to adapt some behavioural principles in IPD into the conventional project delivery approach to help improve the quality of design and documentation".*
P13	*"It is possible and should be done to help improve the conventional project delivery approach".*
P14	*"It is possible and it will help improve the conventional project delivery approach".*
P15	*"It is possible and needs to be done".*

This question is linked to the third research objective. After auto-coding all the 15 interview transcripts with the aid of QSR Nvivo 12 Pro software, the data were categorized based on the interview question. Data on the possibility of adapting

behavioural principles in IPD towards improving design documentation quality within the conventional project delivery was important in the research. The data indicate that behavioural principles in IPD are highly needed within the conventional project delivery because the behaviour of project professionals highly influences their output. Therefore, it is important to consider adapting some of these principles into the conventional approach to improve the quality of design documentation.

5.9 Key Findings from the Qualitative Study

The key findings from the interviews are presented in the following sub-sections and categorised according to the specific research objectives.

5.9.1 Weaknesses associated with the conventional project delivery approach

The top ten key findings on weaknesses of the conventional project delivery approach particularly during the production of design documentation are:

- Lack of cooperation and collaboration among project participants.
- Lack of coordination among design consultants.
- Discrepancies between bill of quantities, drawings and specifications (errors).
- It is a fragmented approach to project delivery.
- Lack of contractors' input and experience at the design stage.
- Continuous rise in project cost, shoddy workmanship, and project failure.
- Lack of coordination among design documents.
- It encourages claim consciousness among project participants.
- There is high inflation or escalation of final contract costs.
- Project participants are more profit conscious than project quality conscious.

5.9.2 Potential capabilities required of the conventional project delivery

The top ten key findings from the interviews on potential capabilities required of the conventional project delivery approach particularly during the production of design documentation to improve quality are:

- Improving collaboration between consultants.
- Paying appropriate fees to consultants.

- Holding consultants accountable for producing poor design documentation.
- Incentives for producing good design documentation quality.
- Provision of an elaborate and improved project brief.
- Preparation of detailed design and documentation.
- Designers partnering with others while preparing design documents.
- Use of computer programs such as BIM.
- Allowing Contractors to make input during the design stage.
- Clients allowing adequate time for the preparation of design documents.

5.9.3 Possibility of using the required capabilities toward improving quality

The key findings on the possibility of using the identified capabilities towards improving design documentation quality are:

- Participants positively posited that the identified capabilities can be easily adapted to the conventional project delivery method and needs to be done.
- They further indicated that there is a need for more capabilities to be considered and introduced into the conventional method because it will help enhance the quality of design documentation that will be produced.
- There must be conscious efforts and readiness to change by all professionals and stakeholders in the industry towards improving the approach.
- This notwithstanding, a participant indicated that even though it is possible to improve the conventional project delivery approach, it will likely be faced with a lot of challenges due to the changes that may likely be resisted by some industry players who are comfortable with the conventional approach.

5.9.4 Enablers inherent in IPD that can be adapted

The key findings on enablers inherent in IPD that can be adapted and used within the conventional project delivery approach to improve design documentation quality are:

IPD Contractual Principles

- Key participants involved early in the project.
- Making collaborative value-based decisions by all participants.

- Key participants' early contributions of knowledge and expertise.
- Key participants jointly accountable for any errors in design.
- Key participants sharing financial reward based on project outcome.
- Tying the success of key participants to the success of the project.
- Jointly and early developed project target criteria.
- Utilization of new technologies and approaches during design.

IPD Behavioural Principles

- Willingness to collaborate as key participants.
- Open information sharing among key participants.
- Key participants having mutual respect for each other.
- Open communication among key participants.

Early Involvement and Collaboration of Key Participants

- An opportunity for adequate pre-design, design, and documentation planning.
- There is a more timely and informed understanding of the design.
- Provides an opportunity for strong pre-construction planning.
- Key participants' understanding of the owner's desired outcome is enhanced.

5.9.5 Participants' views on the possibility of adapting Enablers in IPD

The key findings from the interviews on participant's views on the possibility of adapting some contractual and behavioural principles in IPD towards improving design documentation quality within the conventional project delivery are:

Contractual Principles

- The data indicates that it is possible to adapt some contractual principles in IPD into the conventional project delivery to improve design documentation quality.
- These principles if adapted into the conventional project delivery approach will ensure project delivery on time, to quality and within budget.
- It will result in holding construction professionals accountable for any errors they may commit leading to a more efficient, effective and better project delivery.

Behavioural Principles

- It is possible to adapt some behavioural principles in IPD into the conventional method to improve the approach to the preparation of design documentation.
- These principles are highly needed within the conventional approach based on the fact that the behaviour of project professionals highly influences their output.
- There is a need for behavioural and attitudinal change under the conventional project delivery approach.
- An improvement in the approach to the preparation of design documentation will result in an improvement in the quality of design documentation that is produced.

5.10 Chapter Summary

The interviews were conducted as a sequel to the survey to further collect qualitative data and this resulted in both objective and subjective views of participants. The coding of *weaknesses* associated with the conventional project delivery resulted in 16 categories. It also resulted in 16 categories of potential *capabilities* required of the conventional approach. The data indicates that there is a need for an improvement in the conventional project delivery method. There is also a need for more capabilities to be considered and introduced to enhance design documentation quality.

After further classification of the data, the coding of enablers inherent in IPD that can be adapted and used within the conventional project delivery to improve design documentation quality resulted in 17 categories. There were eight enablers on *Contractual Principles;* Four enablers on *Behavioural Principles;* and Five enablers on *Early Involvement and Collaboration of Key Participants.* Determining the possibility of adapting principles in IPD towards improving design documentation quality within the conventional project delivery approach is paramount since it is the aim of this research. The data indicates that it is possible to adapt enablers in IPD into the conventional project delivery to improve design documentation quality.

After an extensive data presentation and analysis, it is important to present the research findings and subsequently provide a discussion of the findings.

CHAPTER 6

FINDINGS, DISCUSSION AND FRAMEWORK DEVELOPMENT

6.1 Introduction

This research adapted some principles associated with IPD to develop a framework within the conventional project delivery approach to improve design documentation quality. The outcome of the literature review, questionnaire survey and semi-structured interviews that were conducted demonstrates that design documentation quality in practice under the conventional project delivery is bedevilled with a lot of challenges. These challenges make design documentation quality poor in the construction industry and often results in project inefficiencies. The results demonstrate that poor design documentation quality is due to the weaknesses that are associated with the conventional project delivery approach. It was ascertained that there will be a major improvement in design documentation quality when the weaknesses associated with the conventional project delivery approach are minimized by adapting some principles in IPD. This fulfilled the aim that was set for the research which is to develop a framework to improve design documentation quality by adapting IPD approach.

Therefore, this chapter presents the research findings, and discussion of the findings to each research question and provides a link to the conclusions of the overall research problem. However, the research questions that framed the arguments are;

- *What is the current state of design documentation quality in practice under the conventional project delivery approach?*
- *What are the inherent weaknesses and capabilities associated with the conventional project delivery approach in producing design documentation?*
- *What are the enablers inherent in IPD that can be adapted to improve design documentation quality?*
- *Can a framework be developed within the conventional project delivery approach to improve design documentation quality?*

This chapter is structured in line with the specific research questions. It presents the key findings, a discussion of the findings and finally the framework development which is the aim of the research. However, the results and findings provide enough information and substantial evidence to reject the three null hypotheses (*H_{01}, H_{02}, and H_{03})* for the research and accepted the alternative hypotheses that;

H_{A1} Poor design documentation quality has a relationship to the conventional project delivery approach.

H_{A2} Design documentation quality will improve when the weaknesses associated with the conventional project delivery approach are minimized using identified capabilities.

H_{A3} Adaptation of inherent enablers in IPD will improve design documentation quality under the conventional project delivery approach.

6.2 Findings and Discussion

The outcomes of the research-specific questions are presented and discussed here.

6.2.1 Research Question One

What is the current state of design documentation quality in practice under the conventional project delivery approach?

H_{A1} *Poor design documentation quality has a relationship to the conventional project delivery approach.*

This question refers to the quality of design documentation in practice in the construction industry. It seeks to ascertain the state of design documentation quality under the conventional project delivery approach. Analysis of the data collected on this provides enough information and evidence to reject the null hypothesis and to conclude on the alternative hypothesis that poor design documentation quality has a relationship to the conventional project delivery approach. In other words, the results indicate that design documentation quality under the conventional project delivery approach is poor due to many underlining factors which offer a significant implication for this research.

The main findings from the research on the state of design documentation quality in practice under the conventional project delivery approach are presented in Table 6.1.

Table 6.1: Findings on the State of design documentation quality in practice

S/N	Variables
1	Design drawings usually contain errors and omissions.
2	There are discrepancies between bill of quantities, drawings and specifications.
3	There is often lack of accuracy in design documentation.

These findings are the main factors responsible for poor design documentation quality under the conventional project delivery and are discussed in the subsequent sections.

6.2.1.1 Discussion of findings on the state of design documentation quality in practice

The three main findings on the state of design documentation quality in practice under the conventional project delivery approach as presented in Table 6.1 are discussed:

- *Design drawings usually contain errors and omissions*

The research results identified design drawings usually containing errors and omissions as a major factor on the state of design documentation quality. It is an indication that drawings that are produced under the conventional project delivery approach often come with errors that are likely to influence the efficiency of the project. This finding is similar to a study by Agbaxode *et al.* (2021*b*) on design documentation quality in the construction industry. Their study reported that a major cause of inefficiency in the construction industry is due to the "existence of inadequate, dubious, deficient and errors or omissions in design documentation" (Agbaxode *et al.,* 2021*b, p. 21*).

This finding resonates with that of Dosumu and Aigbavboa (2018) where an assessment of the causes and effects of design error ranked high omissions in design and omission of details in documentation as factors that influence design documentation quality. Their study also ranked high design error and error in design calculation as critical factors on design documentation quality. Another study reported that there are often errors and omissions in dimensions which includes missing dimensions, dimensions not summing up and or discrepancies between the dimensions for the various designs (Assaf, Hassanain and Abdallah, 2017) under the conventional project delivery.

Furthermore, Agbaxode *et al.* (2021*a*) in a study on quality influential variables of design documentation in the construction sector ranked omissions, ambiguities and errors high as major quality influencing factors. Therefore, this finding aligns with studies by Zaneldin (2020); Yap and Skitmore (2018); and Dosumu *et al.* (2017) that design drawings under the conventional project delivery are characterized by enormous errors and omissions.

- *There are discrepancies between the bill of quantities, drawings and specifications*

Another very important factor on the state of design documentation quality under the conventional project delivery approach is discrepancies between bills of quantities, drawings and specifications. These documents are the fundamental set of documentation for the execution of construction projects. The structure of the conventional project delivery is such that its delivery depends on the drawings, specifications and bill of quantities. Therefore, if there are discrepancies in these documents, there are bound to be correspondent consequences that often result in project inefficiencies. A study by Yap and Skitmore (2018) that investigated design changes in Malaysian building projects confirmed that there are often discrepancies among design documentation under the conventional project delivery approach.

This resonates with a systematic review by Agbaxode *et al.* (2021*b*) on design documentation quality which indicated that there are disparities between construction documents. The study was emphatic that the disparities exist between bills of quantities, drawings and specifications. This was also confirmed by Assaf *et al.* (2017) that there is often a lack of coordination among different drawings which results in conflicts and contradictions among drawings and other documentation provided.

In another study by Agbaxode *et al.* (2021*a*) in ranking design documentation quality influential variables ranked disparities between bill of quantities, drawings and specifications very high as a quality influencing factor. This aligns with findings by Dosumu and Aigbavboa (2018) that design documentation contains poor working drawings and mistakes. Therefore, there is a lack of consistency and or discrepancies between drawings and specifications (Dosumu *et al.,* 2017; Philips-Ryder *et al.,* 2013).

- *There is often lack of accuracy in design documentation*

Lack of accuracy in design documentation is another very important factor on the state of design documentation quality under the conventional project delivery approach. If design documentation that is supposed to be the engine to drive the construction process lacks accuracy, then there are bound to be significant challenges in the execution of the project. Agbaxode *et al.* (2021*b*) on design documentation quality indicated design documentation lacks accuracy and is often incomplete and inexplicit. This finding aligns with that of Akampurira and Windapo (2019) who asserted that design documents in practice are deficient with respect to completeness, accuracy and certainty. They indicated that accuracy is the most important quality criterion of design documentation.

Furthermore, a study by Agbaxode *et al.* (2021*a*) ranked the accuracy of design documentation very high under quality attributes of design documentation. This is consistent with the finding that there exist wrong and inadequate descriptions in design documentation especially the specifications (Dosumu and Aigbavboa, 2018) and design documentation lacks clarity and legibility (Dosumu *et al.*, 2017).

6.2.2 Research Question Two

What are the inherent weaknesses and capabilities associated with the conventional project delivery approach in producing design documentation?

H_{A2} *Design documentation quality will improve when the weaknesses associated with the conventional project delivery approach are minimized using identified capabilities.*

This question has two main parts; firstly, weaknesses of the conventional project delivery and secondly, capabilities required to improve the approach. A questionnaire survey and semi-structured interviews were the strategies employed to collect data on this second research question. Therefore, the discussion entails both quantitative and qualitative data. The question seeks to ascertain the weaknesses that are associated with the conventional project delivery approach, particularly in the production of design

documentation; and capabilities that are required to improve upon the weaknesses to improve design documentation quality.

Analysis of the data collected on this provides enough information and evidence to reject the null hypothesis and to conclude on the alternative hypothesis that design documentation quality will improve when the weaknesses associated with the conventional project delivery approach are minimized using identified capabilities. In other words, the results indicate that design documentation quality under the conventional project delivery approach will improve when the weaknesses associated with the approach are improved using the identified capabilities. However, this result offers a significant implication for the research and is therefore discussed in the subsequent sections based on both quantitative and qualitative data.

6.2.2.1 Data on Weaknesses associated with the conventional project delivery

This refers to the weaknesses associated with the conventional project delivery approach particularly in producing design documentation in the construction industry. The aim here is to identify shortfalls or challenges that the conventional project delivery is confronted with in practice, particularly during the production of design documentation. The questionnaire survey identified 24 factors presented in Appendix "E" that are weaknesses associated with the conventional project delivery approach. The preliminary research results consider all these factors as very important, particularly during the production of design documentation.

The interview responses agree with the outcome of the preliminary questionnaire survey analyses that there are significant weaknesses associated with the conventional project delivery approach. The interviews identified 16 weaknesses associated with the conventional project delivery approach as presented in Table 5.3. However, 15 of these weaknesses align with the outcome of the questionnaire survey. Nonetheless, there was one additional weakness identified through the interviews which was not part of the questionnaire survey. Interview participants were of the view that; *the conventional project delivery is a fragmented approach to project delivery*. The main findings from

the research on the Weaknesses of the conventional project delivery approach particularly in the production of design documentation are presented in Table 6.2.

Table 6.2: Findings on Weaknesses associated with the conventional project delivery

S/N	Variables
1	Lack of coordination among design consultants.
2	It does not encourage commitment to project objectives but rather individual participants' objectives and gain.
3	It does not encourage the commitment of all participants to total quality right from project design.
4	Compartmentalization of project participants around functional and professional lines leads to poor communication, poor relationships and leads to poor design documentation.
5	It is a fragmented approach to project delivery.

These are the findings from the research on the main weaknesses associated with the conventional project delivery approach as presented in the subsequent section.

6.2.2.2 Data on Capabilities required in the production of design documentation

This refers to the capabilities required in the production of design documentation under the conventional project delivery approach. The aim here is to identify some competencies that the conventional project delivery approach will require in practice particularly during the production of design documentation to improve design documentation quality. The questionnaire survey identified 20 factors presented in appendix "F" that are potential capabilities required in the production of design documentation under the conventional project delivery approach. The preliminary research results consider all these factors as very important capabilities in the production of design documentation under the conventional project delivery approach in the construction industry.

The interview responses agree with the outcome of the questionnaire survey that significant capabilities are required in the production of design documentation under the conventional project delivery approach. The interviews identified 16 Capabilities that are required of the conventional project delivery approach, particularly during the production of design documentation as presented in Table 5.5. However, 13 of these capabilities align with the outcome of the preliminary questionnaire survey. Nonetheless, there were three additional capabilities identified through the interviews

which were not part of the questionnaire survey. Interview participants were of the view that; *Contractors should be allowed to make input during the design stage; designers should collaborate with all stakeholders during design and documentation, and there should be enough effort towards reducing the level of fragmentation.* The main findings from the research on the Capabilities required in the production of design documentation are presented in Table 6.3.

Table 6.3: Findings on Capabilities required in the production of design documentation

S/N	Variables
1	Incentives for producing good design documentation quality.
2	Improving consultants working conditions and procedures.
3	Mandatory coordination of design documentation by a supervisor with requisite skills and knowledge.
4	Improving collaboration between consultants.
5	Job-relevant training and practice.
6	Preparation of detailed design.
7	Allowing Contractors to make input during the design stage.
8	Designers collaborating with all stakeholders during design and documentation.
9	Appropriate efforts towards reducing the level of fragmentation.

These are the main capabilities required of the conventional project delivery based on the research findings and are discussed in the subsequent sections.

6.2.2.3 Discussion of the Weaknesses in the conventional project delivery approach

This sub-section discusses the findings (quantitatively and qualitatively) on the weaknesses associated with the conventional project delivery approach. From Table 6.2, there are five findings including one additional weakness identified through the interviews which were not part of the questionnaire survey. Participants were of the view that the conventional project delivery is a fragmented approach to project delivery.

- *Lack of coordination among design consultants*

The research findings indicate lack of coordination among design consultants as a significant weakness associated with the conventional project delivery approach. It is an indication that the conventional project delivery leaves the various design consultants to be on their own and work independently. This, therefore, results in a lot of inaccuracies,

errors and inconsistencies in the design documentation that is produced for a specific project. This aligns with findings by Yap and Skitmore (2018); Dosumu *et al.* (2017) and Philips-Ryder *et al.* (2013) that the conventional project delivery lacks coordination between design consultants. As a consequence, there are often deficiencies in the design documentation that is produced under the conventional project delivery (Assaf, *et al.*, 2017).

Furthermore, Dosumu and Aigbavboa (2018) in a study that assessed the causes and effects of design error in building construction indicated that lack of coordination among design consultants during design is a major weakness of the conventional project delivery. However, Akampurira and Windapo (2019) on key quality attributes of design documentation asserted that coordinated design information is very paramount as a quality attribute of design documentation. This is seen as a reflection of the multi-disciplines that are characterized by the engineering or construction design process. Durdyev *et al.* (2019) also affirmed that project team members or professionals and firms involved in a project under the conventional project delivery work in isolation and are only responsible for their portion of work within the entire project life cycle. This often results in the pursuance of their vested interest and not the success of the project.

- *It does not encourage commitment to project objectives and, lacks commitment of all participants to total quality right from project design*

Another very important weakness of the conventional project delivery approach is that it does not encourage commitment to project objectives but rather individual participants' objectives and gain. It also lacks the commitment of all participants to total quality right from the project design stage. This aligns with a study by Durdyev *et al.* (2019) which indicated that project team members are left to work in isolation and are only responsible for their portion of work therefore, do not pursue project objectives. It further stated that they are not wholly committed to total project quality right from the planning and design stages. Therefore, Heravi *et al.* (2015) indicated that it is important to ensure quality right from the start of the project planning stage to enhance the quality of the project delivery.

- *Compartmentalization of participants around functional and professional lines*

One other major weakness of the conventional project delivery is how project team members are left to work in isolation. This does not enhance collaboration and often results in poor communication which translates into poor quality design documentation. It is purported that improved collaboration among the design team members or project participants will result in good communication among the team and eventually enhance design documentation quality (Assaf *et al.,* 2017). Coordination among the design team is very significant in achieving effective delivery of a project (Akampurira and Windapo, 2019).

- *It is a fragmented approach to project delivery*

The findings indicate that the conventional project delivery is a fragmented approach to project delivery. That the conventional approach does not carry along the various project team members and stakeholders throughout the project cycle thereby resulting in a fragmentation of the approach. This aligns with a study by Dosumu *et al.* (2017) on the causes of errors in construction contract documents which asserted that the conventional project delivery approach is characterized by fragmentation. According to Ebrahimi and Dowlatabadi (2019), project professionals and firms enter the project at different phases of the project under the conventional project delivery approach. Therefore, the processes of delivering a project under this project delivery are fragmented due to the complexity and specialized nature of the construction industry and this often results in poor project outcomes.

According to Viana *et al.* (2020), the existence of multiple cultures and over-reliance on these cultures results in the fragmentation of the conventional project delivery. The fragmentation is also due to the lack of integration that is associated with the conventional approach (Durdyev *et al.,* 2019). The consequences of fragmentation include low productivity, schedule delays, cost overruns and poor quality project delivery (Zhang *et al.,* 2018).

6.2.2.4 Discussion of Capabilities required in the production of design documentation

This sub-section discusses the findings (quantitatively and qualitatively) on the capabilities required in the production of design documentation under the conventional project delivery. From Table 6.3, there are six findings from the survey and three additional findings from the interviews which were not part of the questionnaire survey. Participants were of the view that; *allowing contractors to make input during the design stage; designers collaborating with all stakeholders during design and documentation; and appropriate efforts towards reducing the level of fragmentation.*

- *Incentives for producing good design documentation quality*

One of the major findings on capabilities required of the conventional project delivery approach is the introduction of incentives for producing good design documentation quality. The formulation of incentives will help professionals to concentrate on the project. It will also result in unnecessary negligence on the part of designers (Dosumu and Aigbavboa, 2018). When there is no motivation, productivity is low. Therefore, to improve on the conventional project delivery approach, there is a need for incentives to be introduced for producing better quality design documentation (Dosumu *et al.,* 2017). Designers should also be paid adequately for tasks assigned as a motivation to be more productive (Dosumu and Aigbavboa, 2018).

- *Improving consultants working conditions and procedures*

One of the major findings on capabilities required of the conventional project delivery approach is an improvement in the working conditions and procedures of consultants. Some of these improvements include involving consultants early in the project especially at the design stage to enhance better planning and understanding of the project (Ling *et al.,* 2020; Agbaxode *et al.,* 2020; Ma *et al.,* 2018). They should be encouraged to work as a team rather than as individuals (Maskil-Leitan and Reychav, 2018). They should be held jointly accountable for errors and deficiencies in design and documentation (Agbaxode *et al.,* 2020). Behaviourally, consultants should have mutual trust and respect for each other to improve better team coordination (Durdyev *et al.,* 2019). Therefore, consultants should promote effective collaboration which will result

in better quality project delivery with enhanced project efficiency (Pishdad-Bozorgi, 2017).

- *Mandatory coordination of design documentation by a supervisor with requisite skills and knowledge*

Mandatory coordination of design documentation by a supervisor with requisite skills and knowledge is another important capability required in the production of design documentation under the conventional project delivery approach. Participants were of the view that when coordination of the design process by a supervisor with the requisite expertise is mandatory, there will be an improvement in the quality of design documentation that is produced. Coordination of design documentation will help reduce if not prevent conflicts and contradictions among drawings and other documentation provided (Assaf *et al.,* 2017).

Furthermore, due to the multi-disciplinary nature of the design team, there is a need to coordinate the activities of the various professionals to achieve an improvement in the quality of design documentation (Akampurira and Windapo, 2019).

- *Improving collaboration between consultants*

The research identified an improvement in collaboration between architectural and engineering design disciplines as one of the major capabilities that are required in the production of design documentation. The research participants were of the view that there is a need for a vast or major improvement in their collaboration. Architectural and engineering designs and drawings serve as the basis for the other documents under the conventional project delivery approach. Therefore, any improvement in collaboration between these professionals will result in a better understanding of each other and subsequently improve the quality of documentation that will be produced. Therefore, the lack of collaboration among design consultants during design that is associated with the conventional project delivery needs to be improved to enhance design documentation quality (Dosumu and Aigbavboa, 2018).

A good collaboration between the design professionals will enhance knowledge sharing on the project which will result in improved design documentation quality (Dosumu and

Aigbavboa, 2018). This will also help prevent deficiencies in the design documentation produced (Assaf *et al.,* 2017). This is consistent with Yap and Skitmore (2018); Philips-Ryder *et al.* (2013) that the conventional project delivery lacks coordination between the design team members. Therefore, there is a need to ensure that they are coordinated to enhance project quality.

- *Job-relevant training and practice*

Another significant capability that is required of the conventional project delivery is the training of design team members. The specific duties or tasks that need to be performed by each professional must be clear and there must be a better understanding of the project to be executed (Dosumu and Aigbavboa, 2018). This can be achieved by holding job-specific training for the various project professionals. The training would help in knowledge sharing on their experiences (Dosumu and Aigbavboa, 2018). Furthermore, it will result in the transfer of knowledge and experience between designers (Dosumu *et al.,* 2017). Therefore, designers' professional education must be carried out to equip them with the requisite knowledge (Dosumu *et al.,* 2017).

- *Preparation of detailed design*

Another very important capability identified is the preparation of detailed design during the production of design documentation under the conventional project delivery approach. Design consultants are required to take their time and produce detailed designs. Detailing designs under the conventional project delivery will enhance the quality of design documentation and subsequently improve project efficiency. It gives other professionals a clear understanding of what is to be done and results in better quality design documentation from all the other team members. The preparation of a detailed design will help improve the quality of design documentation. It will reduce oversight problems and negligence on the side of some designers (Dosumu and Aigbavboa, 2018). It will also help reduce design deficiencies since the design documents will portray adequate details (Assaf *et al.,* 2017).

- *Allowing Contractors to make input during the design stage*

One of the major findings on capabilities required of the conventional project delivery approach is to encourage contractors' input during the design stage of a project. This enhances the quality of the design and documentation that is produced (Viana *et al.,* 2020; Agbaxode *et al.,* 2020).

- *Designers collaborating with all stakeholders during design and documentation*

One of the major findings on capabilities required of the conventional project delivery approach is that designers should collaborate with all stakeholders during design and documentation production. Collaboration among all stakeholders during design documentation production will prevent deficiencies in design documentation (Assaf *et al.,* 2017). This will prevent project team members from working in isolation but rather work as a team to pursue the interest of the project rather than individual interests (Durdyev *et al.,* 2019). Heravi *et al.* (2015) after evaluating the level of stakeholder involvement during the project planning processes of building projects indicated that most project designers contribute less during the planning stage while the contractor is not involved in most cases.

- *Appropriate efforts toward reducing the level of fragmentation*

Reduction in the level of fragmentation is another major finding on capabilities required of the conventional project delivery approach. The research affirms that the conventional project delivery is characterised by fragmentation leaving the various project team members and firms on their own. This aligns with Dosumu *et al.* (2017) that the construction industry is fragmented particularly under the conventional project delivery approach. Durdyev *et al.* (2019) asserted that this is a result of a lack of integration that is associated with the conventional approach to project delivery. Consequently, there are low productivity, schedule delays, cost overruns and poor quality project delivery due to the level of fragmentation under the conventional project delivery (Zhang *et al.,* 2018).

6.2.2.5 Possibility of using the required capabilities towards improving design documentation quality within the conventional project delivery

The aim here was to collect expert views of participants on how possible the capabilities identified would be used within the conventional project delivery. This question also aims to determine the validity of the second hypothesis. The results indicate that there are significant weaknesses associated with the conventional approach. Therefore, there is a need for the identified capabilities to help improve the approach.

Participants were of the view that the identified capabilities can be easily adapted to the conventional project delivery approach and needs to be done for improvement. It was indicated that there is a need for more capabilities to be considered and introduced into the conventional method to enhance design documentation quality. Professionals and stakeholders in the industry must make conscious efforts to change their approach toward improving the conventional project delivery. It was indicated that even though it is possible to improve the conventional project delivery approach, it will likely be faced with a lot of challenges. This will be due to the changes that may likely be resisted by some industry players who are comfortable with the conventional approach.

6.2.3 Research Question Three

What are the enablers inherent in IPD that can be adapted to improve design documentation quality?

H_{A3} *Adaptation of inherent enablers in IPD will improve design documentation quality under the conventional project delivery approach.*

This question refers to the enablers inherent in IPD that can be adapted to improve design documentation quality within the conventional project delivery approach. The discussion entails both quantitative and qualitative data. Analysis of the data provides enough information to reject the null hypothesis and to conclude on the alternative hypothesis. In other words, the results indicate that design documentation quality under the conventional project delivery approach will improve when significant enablers inherent in IPD are adapted into the approach. However, this result offers a significant implication for the research and is therefore discussed in the subsequent sections.

6.2.3.1 Data on enablers inherent in IPD that can be adapted to improve design documentation quality

The aim here is to identify enablers inherent in IPD that can be adapted. The survey identified 25 enablers, categorized into three groups which are; contractual principles; behavioural principles; and early involvement and collaboration of key participants as presented in appendix "G". The preliminary research results consider all these enablers as very important to improving design documentation quality. The interview responses agree with the outcome of the questionnaire survey and identified 17 different categories of Enablers inherent in IPD that can be adapted as presented in Table 5.8. However, 16 of these enablers align with the enablers used in the survey. Nonetheless, there was one additional enabler identified through the interviews which was not part of the questionnaire survey. Participants were of the view that; *most of the principles in IPD can be adapted into the conventional project delivery approach.* The main findings from the research on enablers inherent in IPD that can be adapted to improve the quality of design documentation under the conventional project delivery are presented in Table 6.4 and are discussed in the subsequent sections.

Table 6.4: Research Findings on Enablers inherent in IPD

S/N	Variables
1.0	***Contractual Principles***
1.1	Key participants involved early in the project.
1.2	Tying the success of key participants to the success of the project.
1.3	Key participants jointly accountable for any errors in design.
1.4	Sharing financial risk among key participants.
1.5	Utilization of new technologies and approaches during design.
1.6	Encourage fiscal transparency between key participants.
2.0	***Behavioural Principles***
2.1	Key participants having mutual respect for each other.
2.2	Key participants having mutual trust for each other.
2.3	Ensuring transparent processes throughout the project.
3.0	***Early Involvement and Collaboration of Key Participants***
3.1	It enhances and strengthens key participants' understanding of the owner's desired outcome.
3.2	Effective collaboration by all participants improves design documentation quality.
3.3	There is a more timely and informed understanding of the design.
4.0	**Others**
4.1	Most of the principles in IPD can be adapted into the conventional project delivery.

6.2.3.2 Discussion of enablers inherent in IPD

The findings on enablers inherent in IPD that can be adapted to improve design documentation quality within the conventional project delivery are discussed here. From Table 6.4, there are 13 findings including one additional enabler identified through the interviews which was not part of the questionnaire survey captioned as others. It was indicated that; *most of the principles in IPD can be adapted into the conventional project delivery approach.* This aligns with a study by Ling *et al.* (2020) on the adoption of IPD practices for superior project performance which asserted that conventional project delivery do adopt IPD-related practices to a large extent to enhance project performance. Therefore, IPD has the potential to reduce the weaknesses associated with the conventional project delivery and can enhance project performance (Agbaxode *et al.*, 2020).

Furthermore, Ling *et al.* (2020) indicated that the adoption of IPD-related practices into the conventional project delivery results in more efficient and better project delivery. Their study further reported that the improvement in project performance is due to the deeper level of collaboration among team members and their willingness to collaboratively achieve the project goals (Ling *et al.*, 2020).

IPD Contractual Principles

Contractual principles are very important in the successful delivery of an IPD project and it involves the appropriation of tasks by the project manager (Kahvandi *et al.*, 2018). One of such principles identified in the findings of this research is the early involvement of key project participants in a project. In IPD, the key project participants such as the owner, the consultants and contractors are involved early in the project (Jadidoleslami *et al.*, 2019).

The early involvement of key participants is a very critical and significant element in project delivery (Agbaxode *et al.*, 2020). It helps in fostering collaboration among the participants at the earliest possible stage of the project which results in numerous benefits to the project (Viana *et al.*, 2020). Some of these benefits include an early contribution and sharing of knowledge and expertise during the project planning and

design phases which results in a more effective, feasible and constructible design of better quality (Viana *et al.,* 2020; Jadidoleslami *et al.,* 2019). It also helps in reducing possible reworks at the construction stage (Viana *et al.*, 2020).

The early involvement of key project participants also results in the early and jointly development of project target criteria that subsequently results in better project design. It provides the opportunity for all participants to be involved with the project from the design phase (Maskil-Leitan and Reychav, 2018). This results in making value-based decisions since key project participants will have an understanding of what is to be done from the very beginning of the project.

Furthermore, the early involvement of key project participants especially at the design stage ensures better planning and understanding of the project which enhances the quality of design documentation (Ling *et al.,* 2020; Agbaxode *et al.,* 2020; Ma *et al.,* 2018). It also helps in reducing claims and consequently minimizes design changes throughout the project life (Kahvandi *et al.*, 2016).

Another important principle in IPD which was identified in this research is tying the success of key participants to the success of the project. The key participants are always determined to deliver better project quality. They consider their success on the project to be the success of the project. Therefore, when the project fails, they consider themselves to have failed (Jadidoleslami *et al.*, 2019). This drives the key participants to always pursue the success of the project by giving in their best at all times (Viana *et al.*, 2020). Furthermore, the success in IPD is dependent on the success of each other. Therefore, every project participant benefits from the success of the project and this enhances team spirit and boosts productivity (Viana *et al.,* 2020; Jadidoleslami *et al.,* 2019).

Tying the success of key participants to the success of the project ensures that key participants are duly paid for work done (Ling *et al.*, 2020). This encourages teamwork and promotes project success rather than individual success (Maskil-Leitan and Reychav, 2018). According to Agbaxode *et al.* (2020) in a study on the potential of IPD projecting a common good, it was indicated that the common good is achieved when the success of the participants is tied to the success of the project.

IPD promotes holding project participants jointly accountable for errors in design. This ensures that key participants put in their best to reduce to the minimum errors that may occur. Furthermore, a common good is achieved when project key participants are jointly accountable for any errors in design and documentation (Agbaxode *et al.,* 2020). This enhances the quality of services that are offered by the key participants under the IPD approach. They become conscious of errors and anomalies and are ready and willing to offer their best (Viana *et al.,* 2020).

Key participants share any financial risk that may accrue based on the outcome of the project (Elghaish *et al.,* 2020). The various professionals and even contractors including clients share the risk and reward among themselves. This is due to the availability of mutual trust and respect for each other (Jadidoleslami *et al.,* 2019; Kahvandi *et al.,* 2018). Furthermore, the sharing of risk and reward by the key participants serves as a motivation that drives them to deliver their best to ensure an efficient project delivery (Adamtey, 2021; Agbaxode *et al.,* 2020; Viana *et al.*, 2020; Kahvandi *et al.*, 2016). This motivation leads the key participants to achieve the project goals (Adamtey, 2021; Marco and Karzouna, 2018; Maskil-Leitan and Reychav, 2018).

IPD implementation on a project is characterised by the utilization of new technologies and approaches during both design and construction. The use of technologies such as BIM is identical to IPD projects. This often results in better project delivery and enhances the quality of design documentation that is produced. Another very important enabler in IPD is that it encourages fiscal transparency between key participants. The willingness on the part of project participants to collaborate and relate with each other encourages fiscal transparency throughout the project (Ling *et al.,* 2020). Furthermore, open information sharing and continuous owner involvement enhance more transparent processes throughout the project (Ling *et al.,* 2020). Therefore, these contractual principles are important enablers to improve on the weaknesses in the conventional project delivery approach. The adaption of these principles will enhance the quality of design documentation that is produced.

IPD Behavioural Principles

Behavioural principles are very important in achieving project success in IPD (Agbaxode *et al.,* 2020). However, it is important to carefully select key participants who will be willing to relate with each other (Ling *et al.,* 2020). This encourages fiscal transparency throughout the project between key participants and promotes mutual respect and trust for each other (Ling *et al.,* 2020; Kahvandi *et al.,* 2016).

Project owners are often concerned about mutual trust, respect and integrity of the key participants including better team coordination (Durdyev *et al.,* 2019). Zhang *et al.* (2018) indicated that trust is the main ingredient that can strengthen collaboration and successful relationships in IPD. Trust has the potential to enhance project performance and improve communication. Mutual respect and trust also enhance a good relationships and conduct among project participants (Agbaxode *et al.,* 2020).

Furthermore, the principle of risk-sharing and rewards in IPD ensures a balance of a win or fail for all key participants (Pishdad-Bozorgi, 2017). The sharing of risks and rewards is usually based on the availability of mutual trust and respect for each other (Viana *et al.,* 2020; Kahvandi *et al.,* 2018). Therefore, stakeholders do not abuse the terms of the contract but accept common risks due to the availability of mutual trust and respect for each other (Jadidoleslami *et al.,* 2019; Kahvandi *et al.,* 2018; Pishdad-Bozorgi, 2017).

IPD promotes transparent processes throughout the project. Project key participants share information openly and communicate openly among themselves. There is no hoarding of information under IPD. Every project participant freely and openly communicates whatever they deem fit in the interest of the project. These principles enhance better project delivery and result in project efficiency. However, regular meetings and in some cases face to face meetings, discussions, and video conferences result in a more transparent process (Ma *et al.,* 2018).

Therefore, these behavioural principles are important enablers to improve on the weaknesses in the conventional project delivery approach towards enhancing the quality of design documentation that is produced.

Early Involvement and Collaboration of Key Participants

In IPD, the key project participants such as the owner, the consultants and contractors are involved early in the project (Jadidoleslami *et al.*, 2019). It provides the opportunity for all participants to be involved with the project from the design phase (Maskil-Leitan and Reychav, 2018). The early involvement of key participants is a very critical and significant element in project delivery. It helps in fostering collaboration among the participants at the earliest possible stage of the project which results in numerous benefits to the project (Viana *et al.*, 2020). Some of these benefits include an increase in knowledge sharing during the project planning and design phases which results in a more effective, feasible and constructible design of better quality (Elghaish *et al.*, 2020). It also helps in reducing possible reworks at the construction stage (Viana *et al.*, 2020; Kahvandi *et al.*, 2016).

Early involvement of key participants provides an opportunity for adequate pre-design, design, documentation and strong pre-construction planning and enhances critical decision making. This is because it gives the project participants a more timely and informed understanding of the design. It enhances their understanding of the owner's desired outcome of the project and promotes the common good of the participants (Agbaxode *et al.*, 2020). It gives a better understanding of the project which helps in reducing claims and consequently minimizes changes (Kahvandi *et al.*, 2016).

However, an effective collaboration by all participants improves design documentation quality. This, therefore, results in better quality project delivery with enhanced project efficiency (Pishdad-Bozorgi, 2017). It results in better quality project design documentation which is the backbone of the project. The early involvement of project participants especially at the design stage ensures better planning and understanding of the project which enhances the quality of design documentation (Ling *et al.*, 2020; Jadidoleslami *et al.*, 2019; Ma *et al.*, 2018; Kahvandi *et al.*, 2016).

One significant aspect of collaboration in IPD is that the project owner is also involved early in the project and therefore, takes part in decision-making on the project (Adamtey, 2021; Ling *et al.*, 2020). Even though IPD is characterized by collaboration,

the level of collaboration at the design stage is deeper compared to the other stages of the project. This enhances a better understanding of the project by all participants and ensures a good review of the design prior to construction (Ling *et al.*, 2020; Ma *et al.*, 2018). Nonetheless, the findings of this research indicate that there is the production of better quality design documentation in IPD projects. Therefore, early involvement and collaboration of key participants are important enablers to improve on the weaknesses in the conventional project delivery approach towards enhancing the quality of design documentation. However, the research outcome discovered that most of the principles in IPD can be adapted into the conventional project delivery approach to improve the processes involved in executing projects.

6.2.3.3 Participants' views on the possibility of adapting enablers in IPD towards improving design documentation quality within the conventional project delivery

The aim here was to collect expert views of participants on how possible the potential enablers identified in IPD could be used within the conventional project delivery. This question also aims to determine the validity of the third hypothesis. The results indicate that there are significant enablers in IPD to be adapted towards improving design documentation quality within the conventional project delivery approach.

- *Contractual Principles*

Contractual principles in IPD serve as one of the strong engines on which the entire project delivery runs. These principles have resulted in project efficiencies under IPD across the world. Therefore, if these principles are adapted into the conventional project delivery, there will be improvements in the outcome of projects that will be executed under the approach. The question with regards to the possibility of adapting some of these principles into the conventional project delivery became paramount for the successful execution of this research. However, the results indicate that it is possible to adapt some contractual principles in IPD into the conventional project delivery approach, particularly during the production of design documentation. It will enhance project delivery on time, to quality and within budget. It will also result in holding construction professionals accountable for any errors they may commit which may lead

to better project delivery. There will be a more efficient and effective delivery of construction projects. It will help reduce and if possible eliminate most of the weaknesses associated with the conventional project delivery and will result in better quality design documentation.

- *Behavioural Principles*

Behavioural principles are also very important in the successful implementation and delivery of projects based on an IPD approach. The question of whether or not these principles can be adapted into the conventional project delivery became paramount for this research. It was emphatic from the results that it is possible to adapt some behavioural principles in IPD into the conventional project delivery approach. These principles are highly needed within the conventional project delivery approach based on the fact that the behaviour of project professionals highly influences their output. Therefore, there is a need for behavioural and attitudinal change under the conventional project delivery approach towards improvement particularly, during the production of design documentation. It was indicated that an improvement in the approach to the preparation of design documentation will result in a quality improvement.

6.3 Summary of Findings and Discussions

The findings after both quantitative and qualitative approaches to data collection and analyses demonstrate that the state of design documentation quality in practice under the conventional project delivery is poor. It further finds out that this is due to the weaknesses that are associated with the conventional project delivery approach. It was also ascertained that there will be a major improvement in design documentation quality when these weaknesses are minimized by adapting some principles in IPD. Nonetheless, this is the aim that was set for this research to develop a framework to improve design documentation quality by adapting IPD approach.

The first research objective was; to ascertain the current state of design documentation quality in practice under the conventional project delivery approach. The main findings on this objective are presented in Table 6.1. The results rejected the first null hypothesis

(H_{01}) and accepted the alternative hypothesis (H_{A1}) that; Poor design documentation quality has a relationship to the conventional project delivery approach.

The second research objective was; to identify the inherent weaknesses associated with the conventional project delivery approach and capabilities required in the production of design documentation. The main findings of this second objective are presented in Table 6.2 and Table 6.3. The results rejected the second null hypothesis (H_{02}) and accepted the alternative hypothesis (H_{A2}) that; design documentation quality will improve when the weaknesses associated with the conventional project delivery approach are minimized using the identified capabilities.

The third research objective was; to identify enablers inherent in IPD that can be adapted to improve design documentation quality. The main findings on this objective are presented in Table 6.4. The results rejected the null hypothesis (H_{03}) and accepted the alternative hypothesis (H_{A3}) that; Adaptation of inherent enablers in IPD will improve design documentation quality under the conventional project delivery approach. Therefore, these findings provided adequate data for the development of the framework to improve design documentation quality within the conventional project delivery approach. The framework development is presented in the next section.

6.4 Framework Development

The development of the framework to improve design documentation quality within the conventional project delivery by adapting some enablers in IPD as the aim of this research was carried out based on the research findings. To achieve the research aim and objectives, an elaborate research approach was carried out as presented in Figure 6.1. This involves the systematic stages in the development of the framework.

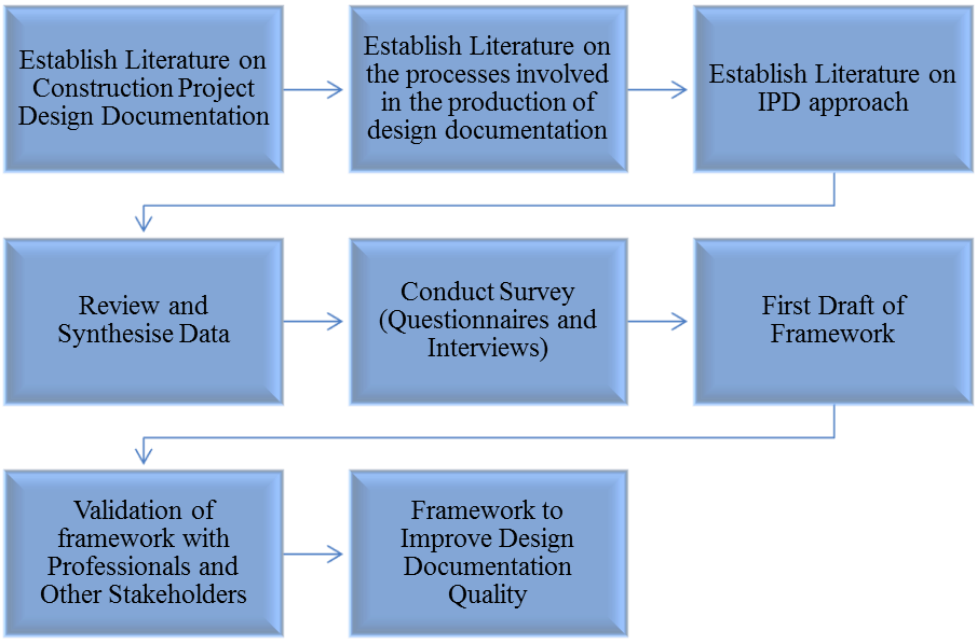

Figure 6.1: Development Stages of the Proposed Framework

Throughout the research process, the focus was on the processes involved during the pre-design (planning or programming) and design phases of a construction project. However, after establishing, reviewing and synthesizing the literature on design documentation including the processes involved in the production of design documentation, the next step was to do the same for the IPD approach. The information gathered from this initial phase set the stage for a quantitative study to be carried out using questionnaires. After an initial analysis of the results from the questionnaire survey, interviews were conducted with professionals in the industry to ascertain credible and reliable data for the research. However, the research's major findings after both quantitative and qualitative data collection and analysis that served as the basis for the development of the framework for this research are presented in Table 6.2, Table 6.3, and Table 6.4. However, the next sub-section gives a matrix of all the variables that were extracted from the research for the development of the framework.

6.4.1 Matrix of all Variables extracted from the research for the framework development

After an elaborate mixed method of data collection and analysis, findings were arrived at in line with the aim and objectives of this research. These findings serve as the major variables for the development of the framework as presented in a matrix in Table 6.5. This includes five variables on the Weaknesses associated with the Conventional Project delivery approach, nine variables on Capabilities required in the production of design documentation, and 12 variables on Enablers inherent in IPD to improve design documentation quality.

Table 6.5: Matrix of Variables extracted from the research for the framework development

S/N	*Weaknesses associated with the Conventional Project delivery approach*	*Capabilities Required in the production of design documentation*	*Enablers inherent in IPD to improve design documentation quality*
1	Lack of coordination among design consultants.	1. Mandatory coordination of design documentation by a supervisor with requisite skills and knowledge. 2. Improving consultants working conditions and procedures.	1. Effective collaboration by all participants improves design documentation quality (EI). 2. It enhances and strengthens key participants understanding of the owner's desired outcome (EI). 3. There is a more timely and informed understanding of the design (EI).
2	It does not encourage commitment to project objectives but rather individual participants' objectives and gain.	3. Allowing Contractors to make input during the design stage.	4. Tying the success of key participants to the success of the project (CP). 5. Ensuring transparent processes throughout the project (BP). 6. Key participants should be involved early in the project (CP).
3	It does not encourage the commitment of all participants to total quality right from project design.	4. Incentives for producing good design documentation quality. 5. Preparation of detailed design.	7. Key participants jointly accountable for any errors in design (CP). 8. Sharing financial risk among key participants (CP).
4	Compartmentalization of project participants around functional and professional lines leads to poor communication, poor relationships and leads to poor design documentation.	6. Job-relevant training and practice. 7. Improving collaboration between consultants. 8. Designers collaborating with all stakeholders during design and documentation.	9. Encourage fiscal transparency between key participants (CP). 10. Key participants having mutual respect for each other (BP). 11. Key participants having mutual trust for each other (BP).
5	It is a fragmented approach to project delivery.	9. Appropriate efforts towards reducing the level of fragmentation.	12. Utilization of new technologies and approaches during design and construction (CP).

**CP = Contractual Principles, BP = Behavioural Principles, EI = Early Involvement and Collaboration of Key Participants*

The variables in Table 6.5 are further simplified as shown in Table 6.6, Table 6.7, and Table 6.8. The simplification was carefully done to reduce the number of words in each variable without changing the meaning. This was necessary to help in the development of the framework with shorter and succinct sentences of variables.

Table 6.6: Variables on Weaknesses associated with the Conventional approach

	Original Variables	***Simplified Variables***
1.	Lack of coordination among design consultants (W, 1).	1. Lack of coordination (W, 1).
2.	It does not encourage commitment to project objectives rather individual participants' objectives and gain (W, 2).	2. Lack of commitment to project objectives (W, 2).
3.	It does not encourage the commitment of all participants to total quality right from project design (W, 3).	3. Lack of participants' commitment to total quality (W, 3).
4.	Compartmentalization of project participants around functional and professional lines leads to poor communication, poor relationships and leads to poor design documentation (W, 4).	4. Fragmented approach (W, 4).
5.	It is a fragmented approach to project delivery (W, 5).	5. Fragmented approach (W, 5).

Therefore, the five variables on the Weaknesses associated with the Conventional Project delivery approach are presented in Table 6.6 in their original sentence structures vis a vis their simplified forms by carefully maintaining the meanings.

Table 6.7 presents the variables on the Capabilities required in the production of design documentation in their original form vis a vis their simplified sentence forms.

Table 6.7: Variables on Capabilities required in the production of design documentation

Original Variables	***Simplified Variables***
1. Mandatory coordination of design documentation by a supervisor with requisite skills and knowledge (C, 1). 2. Improving consultants working conditions and procedures (C, 2).	1. Mandatory coordination (C, 1). 2. Improvement in Consultants working conditions (C, 2).
3. Allowing Contractors to make input during the design stage (C, 3).	3. Contractors' input during design (C, 3).
4. Incentives for producing good design documentation quality (C, 4). 5. Preparation of detailed design (C, 5).	4. Formulate incentives (C, 4). 5. Preparation of detailed design (C, 5).
6. Job-relevant training and practice (C, 6). 7. Improving collaboration between consultants (C, 7). 8. Designers collaborating with all stakeholders during design and documentation (C, 8).	6. Job training and practice (C, 6). 7. Improvement in Collaboration (C, 7). 8. Designers & Stakeholders Collaboration (C, 8).
9. Appropriate efforts towards reducing the level of fragmentation (C, 9).	9. Reduction in fragmentation (C, 9).

The variables on Enablers inherent in IPD that can be adapted to improve design documentation are presented in Table 6.8 in their original sentence structure vis a vis their simplified sentence forms.

Table 6.8: Variables on Enablers inherent in IPD

Original Variables	***Simplified Variables***
1. Effective collaboration by all participants improves design documentation quality (EI, 1). 2. It enhances and strengthens key participants' understanding of the owner's desired outcome (EI, 2). 3. There is a more timely and informed understanding of the design (EI, 3).	1. Effective collaboration (EI, 1). 2. Enhancement in understanding of the owner's desire (EI, 2). 3. Better understanding of the design (EI, 3).
4. Tying the success of key participants to the success of the project (CP, 1). 5. Ensuring transparent processes throughout the project (BP, 1). 6. Key participants should be involved early in the project (CP, 2).	4. Key participants' success equals project success (CP, 1). 5. Transparent processes (BP, 1). 6. Early involvement of Key participants (CP, 2).
7. Key participants jointly accountable for any errors in design (CP, 3). 8. Sharing financial risk among key participants (CP, 4).	7. Accountability for errors in design (CP, 3). 8. Sharing financial risk (CP, 4).
9. Encourage fiscal transparency between key participants (CP, 5). 10. Key participants having mutual respect for each other (BP, 2). 11. Key participants having mutual trust for each other (BP, 3).	9. Fiscal transparency (CP, 5). 10. Mutual respect for each other (BP, 2). 11. Mutual trust for each other (BP, 3).
12. Utilization of new technologies and approaches during design and construction (CP, 6).	12. New technologies and approaches (CP, 6).

Table 6.9 presents a combined simplified matrix of variables collected from Table 6.6, Table 6.7, and Table 6.8 respectively on Weaknesses associated with the conventional project delivery, Capabilities required in the production of design documentation and Enablers inherent in IPD that can be adapted to improve design documentation quality. The matrix provides the Weaknesses with their corresponding Capabilities required and the requisite Enablers in IPD that can be adapted.

A framework of these variables is presented in Figure 6.2 indicating the Weaknesses, Capabilities required and Enablers in IPD that can be adapted. These variables are further classified into appropriate categories to aid the development of the framework to improve the quality of design documentation. The categories include the Design Team, Operational Principles, Rewards, and Accountability.

The *Design Team* involves the Client, the Architect and other relevant consultants as well as a Specialist General Contractor. This category includes end-users as well.

Operational Principles include Collaboration, Fiscal Transparency, Mutual Respect and Trust among the design team.

Rewards refer to incentives for producing an enhanced quality of design documentation.

Accountability involves holding the design team responsible for errors and deficiencies in the design documentation.

Table 6.9: Combined Simplified Matrix of Variables for framework development

Weaknesses	***Capabilities Required***	***Enablers in IPD***	***Framework Development***
1. Lack of coordination (W, 1).	1. Mandatory coordination (C, 1). 2. Improvement in Consultants working conditions (C, 2).	1. Effective collaboration (EI, 1). 2. Enhancement in understanding of the owner's desire (EI, 2). 3. Better understanding of the design (EI, 3).	1. Design Team 2. Operational Principles
2. Lack of commitment to project objectives (W, 2).	3. Contractors' input during design (C, 3).	4. Key participants' success equals project success (CP, 1). 5. Transparent processes (BP, 1). 6. Early involvement of Key participants (CP, 2).	3. Operational Principles
3. Lack of participants' commitment to total quality (W, 3).	4. Formulate incentives (C, 4). 5. Preparation of detailed design (C, 5).	7. Accountability for errors in design (CP, 3). 8. Sharing financial risk (CP, 4).	4. Rewards 5. Accountability
4. Fragmented approach one (W, 4).	6. Job training and practice (C, 6). 7. Improvement in Collaboration (C, 7). 8. Designers and Stakeholders Collaboration (C, 8).	9. Fiscal transparency (CP, 5). 10. Mutual respect for each other (BP, 2). 11. Mutual trust for each other (BP, 3).	6. Operational Principles
5. Fragmented approach two (W, 5).	9. Reduction in fragmentation (C, 9).	12. New technologies and approaches (CP, 6).	7. Operational Principles

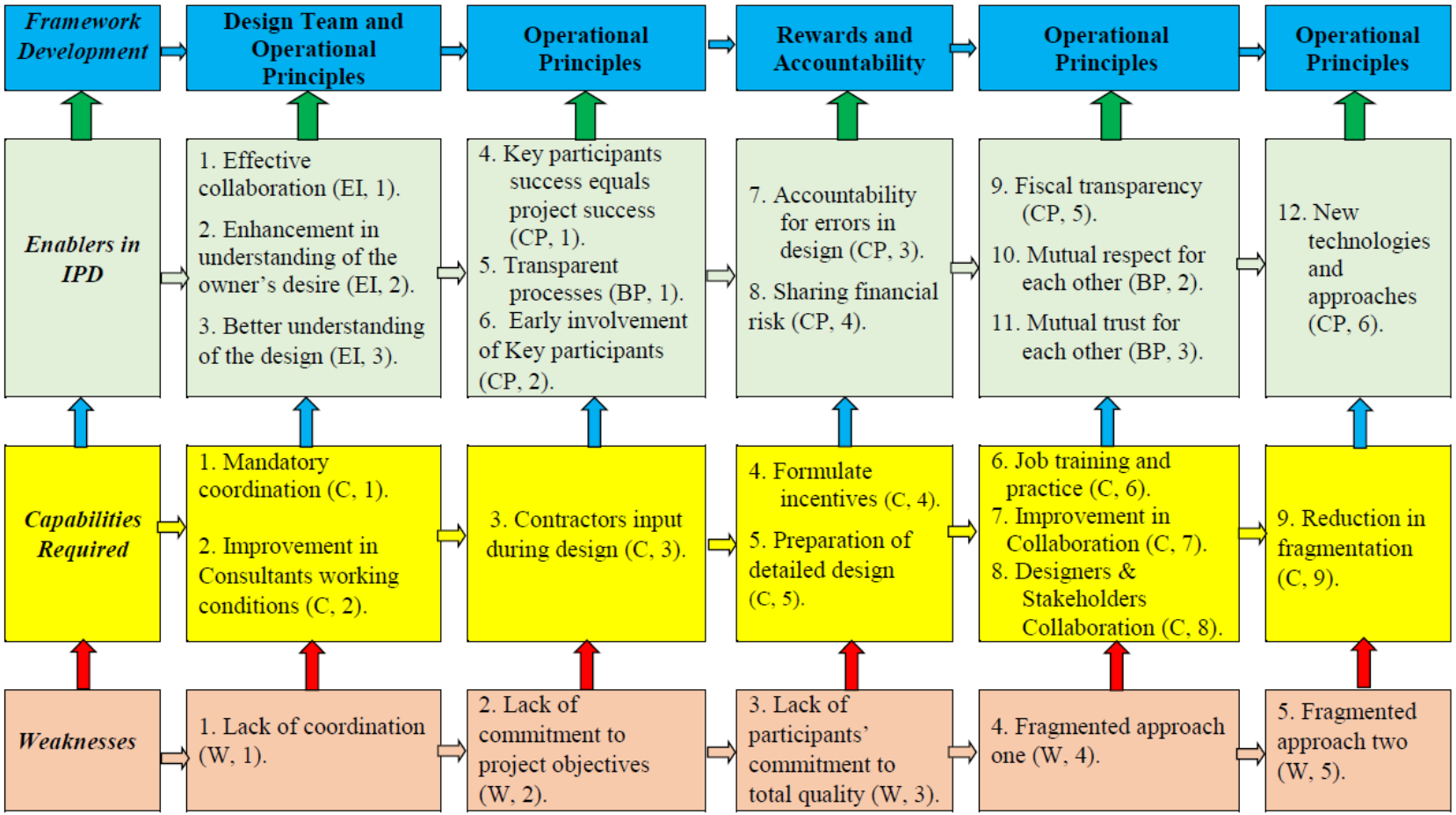

Figure 6.2: A framework of variables on Weaknesses, Capabilities and Enablers in IPD
Source: Researcher

6.5 Framework Validation

Analysis of the findings from both quantitative and qualitative data resulted in the development of the draft framework. However, to achieve better results, it became necessary for the draft framework to be sent to industry professionals for validation. Therefore, the validation of the framework was done with professionals in the construction industry (Architects, Quantity Surveyors and Construction Project Managers). This was done to ensure that the framework is developed with the capability to improve the quality of design documentation within the conventional project delivery approach. The validation was achieved by sending the draft framework to research participants who participated in the interview session of this research for their comments and this resulted in fine-tuning the draft framework.

During the validation, the question that was asked is:

> *"Please find attached the draft framework to improve the quality of design documentation by adapting IPD. This draft framework is based on the findings from the mixed-method research that was earlier conducted.*
>
> *Kindly peruse the draft framework and provide your comments to enhance the structure of the draft framework".*

The validation ensured that the final framework takes into consideration the comments by the industry professionals based on the draft framework. This was also necessary to eliminate any form of bias that may exist in the draft framework.

6.5.1 Responses on Validation of Framework

The validation process received 13 participants' comments on the draft framework as presented verbatim in Table 6.10.

Table 6.10: Framework Validation Comments Reported Verbatim

Validator	Comments
1	*"Framework looks appropriate for addressing the issue of poor quality design documentation. However, it will be more appropriate if the provision of awards or incentives to team members for producing better quality design documentation is separated from the operational principles. The same should apply to accountability for errors. These will make the two (incentives and penalty) emphatic in the project delivery process and will enhance the services of the design team members".*
2	*"The draft framework is appropriate in addressing design documentation quality problems since it is a worrying trend in the industry. I will advise that academics and practitioners should do a further research to outline the specific incentives and penalties that can be formulated to enhance the process".*
3	*"State specifically in the framework that the services of the specialist general contractor will only be during the design stage and may serve as an advisor during construction but will not take part in the tendering to prevent conflict of interest and bias".*
4	*"There should be policy by stakeholders in the construction industry to ensure the implementation of the framework since it will improve on the existing traditional or conventional approach".*
5	*"The Framework looks good for the intended purpose. I feel rewards for good work and penalty for errors should not be under operational principles as in the draft framework. Rewards and penalties should be on their own".*
6	*"The framework is needed in the industry but you have to be clear on whether the services of the specialist or general contractor during the pre-design and design phases will extend into construction. Is this specialist or general contractor the one that will do the construction? I feel the answer to this is yes and no because it may be optional. The services of these specialist contractors can be hired at the pre-design and design stages only so as to improve the quality of design and documentation. Thereafter, a substantive contractor can be selected during tendering".*
7	*"The draft Framework is good since the focus is only on the processes during design and not construction. But the incentives and penalties are important if we really want to improve the quality of design documentation".*
8	*"Clients should be advised to adopt this framework in executing their projects if they want to achieve value for money".*
9	*"It should be specific under the big room discussions that team members should formulate incentives and penalties that will be appropriate for each project".*
10	*"The operational principles should focus more on collaboration, transparency, respect and trust for each other as team members. Issues on incentives and penalties should not fall under operational principles. The team member that will be responsible for orienting the entire team on the operational principles should be specified. I think these things will make a more robust framework to help improve design documentation quality".*
11	*"I think the framework is good. The main challenge I foresee is its implementation in the construction industry since most professionals are reluctant when it is about new changes or modifications to their old and existing ways of executing their tasks".*
12	*"It should be clear in the framework who will be the head or leader of the design team. Aside that, the draft framework looks good".*
13	*"I think the framework is good to improve the quality of design documentation. It can be implemented in the building construction sector".*

The content of the validation comments was analysed and summarized in the next section.

6.5.2 Summary of Validation Comments

The comments received from participants are summarized as follows:

- The draft framework is appropriate for addressing poor design documentation quality problems since it is a worrying trend in the industry.
- Incentives (rewards) and Accountability (penalties) should be separated from the operational principles to be on their own.
- The services of the specialist or general contractor should be hired during the pre-design and design phases and may serve as an advisor during the construction phase, but should not take part in the tendering to prevent conflict of interest and bias. Thereafter, a substantive contractor can be selected during tendering.
- Design team members must formulate incentives and penalties that will be appropriate for each project during the big room discussions.
- The operational principles should focus more on collaboration, transparency, respect and trust for each other as team members.
- The head or leader of the design team should be indicated in the framework.
- The implementation of the framework in the construction industry is highly possible but will likely be faced with reluctance on the side of professionals to change from their old and existing ways of executing their tasks.
- Academics and practitioners should do further research to outline the specific incentives and penalties that can be formulated to enhance the process.
- There should be policy by stakeholders in the construction industry to ensure the implementation of this framework since it will improve on the existing traditional or conventional approach to project delivery.
- Clients should be advised to adopt this framework in executing their projects if they want to achieve value for money.

6.5.3 Implementation of framework Validation Comments

The validation resulted in the removal of incentives or rewards to design team members for producing better quality design documentation from the operational principles. Therefore, validation results indicate that incentives or rewards and accountability by design team members should be separated from the operational principles. The separation will further enhance the approach and make it incumbent on the design team members to be fully aware of the appropriate incentives and accountability or penalty.

The validation also resulted in the removal of accountability for errors or deficiencies in design documentation by design team members from the operational principles. The comments from validators have been very useful in fine-tuning the final framework to improve design documentation quality as presented in Figure 6.3.

However, the development of the framework is based on the two main phases of a construction project that precedes the pre-construction phase as shown in the framework in Figure 6.3. These include the pre-design phase (planning or programming) and the design phase of a construction project because these are the stages where major and critical decisions are made which translates into the design documentation.

As presented in Figure 6.3, the *Pre-Design Phase* of the framework involves the planning or programming of the project. It is at this stage that the client (the project owner) consults an architect with his/her intention and gives a brief. The architect together with the client brings together a team of designers and end-users if possible. The formation of the design team would be a combined effort between the architect and the client. This team will consist of the client (owner), the architect and other relevant professionals or consultants, a specialist general contractor and end-users depending on the type of project. The team will collaboratively formulate rewards or incentives for producing better quality design documentation as well as penalties or accountability based on the type of project for any errors or deficiencies that may arise in the design documentation. The team will consistently update themselves on

operational principles that ensure collaboration, fiscal transparency, mutual respect and trust among all and finally the use of any new technology or approach. As a requirement, the design team may converge to have a big room discussion or hold combined discussions online via any appropriate online meeting platform.

The *Design Phase* involves the entire design team, particularly during the schematic and design development stages. The client (owner) and the end-users may not be required during the construction documentation stage as indicated in the framework. However, the architect together with the other appropriate consultants and the specialist general contractor is required to collaborate during the design documentation or construction documentation stage. The team is required to work willingly and abide by the operational principles. At this stage, the design team will be abreast with the kind of project at hand and the necessary information gathered at the pre-design phase. This is because the scope and content of the project will be well understood by the design team at this stage. While this phase involves the preparation of schematic design, the design development, and the preparation of construction documentation, the design development stage is where detailed design is required to be prepared by the project design team after the schematic design. The detailed preparation of the design will aid in the preparation of better quality design documentation or construction documentation for the project.

The *Pre-Construction, Construction and post-construction phases* follow the same processes as the existing conventional project delivery approach. Therefore, the final framework to improve design documentation quality is presented in Figure 6.3.

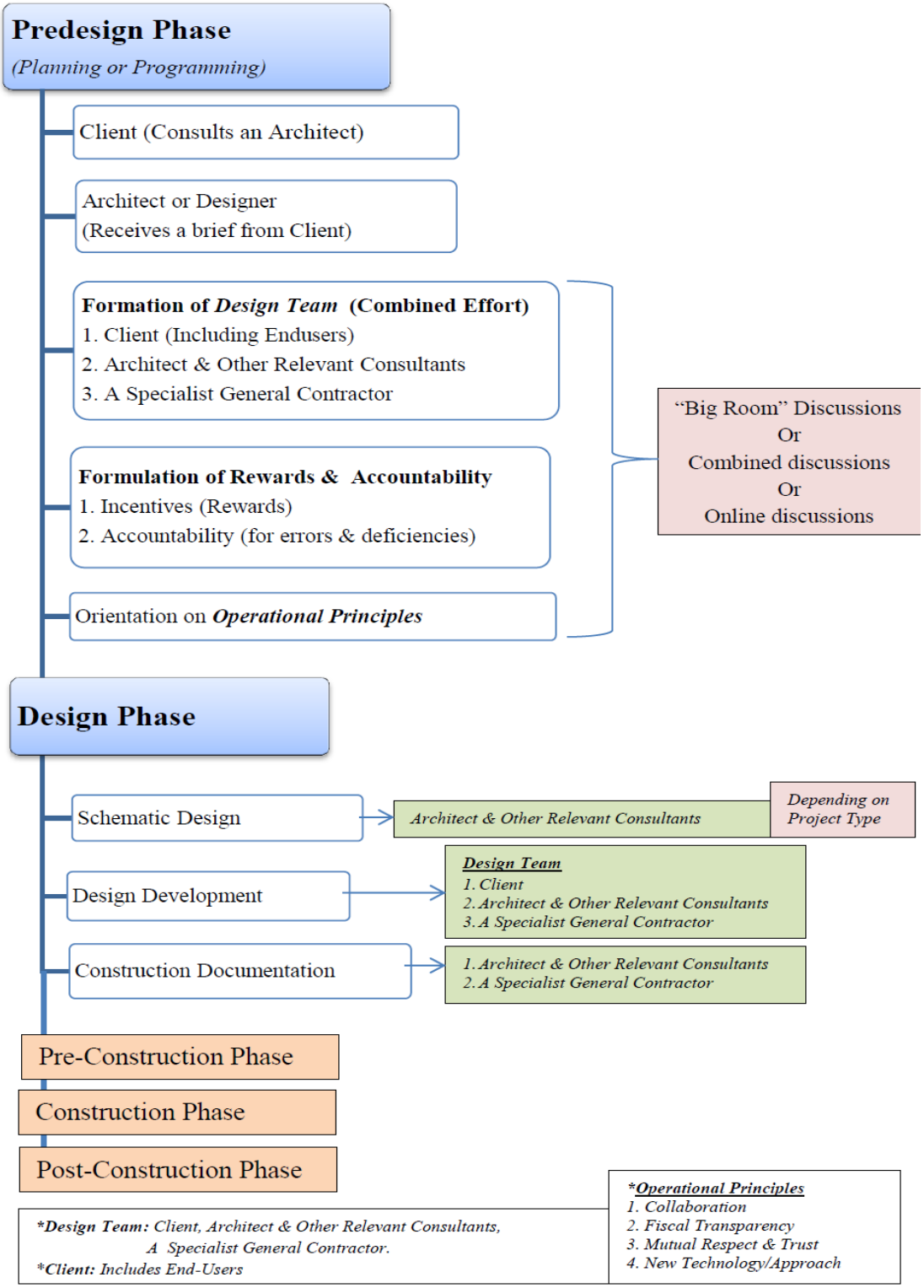

Figure 6.3: Framework for improving design documentation quality

6.6 Chapter Summary

This chapter discussed the findings of this research. This was done based on the aim of the research which is to develop a framework to improve design documentation quality by adapting the enablers in IPD. The discussions included data on; the current state of design documentation quality in practice under the conventional project delivery approach; the inherent weaknesses associated with the conventional project delivery approach and capabilities required in the production of design documentation; and finally enablers inherent in IPD that can be adapted to improve design documentation quality. These findings and discussions resulted in the development of the framework to improve design documentation quality.

The research aim is achieved in this chapter including the processes involved in the development of the framework. The framework development was based on both qualitative and quantitative research processes. The draft framework was validated by construction industry professionals to ensure that the framework is developed with the capability to improve the quality of design documentation within the conventional project delivery approach. Comments from the validation were taken into account which resulted in the final framework as presented in this chapter.

Therefore, this research contributes to improving design documentation quality under the conventional project delivery approach and significantly enhance value for money. The outcome will pragmatically inform industry players on appropriate measures for improving design documentation quality. It is expected that the implementation of the research results will help position the construction industry on the path of using IPD shortly. As a contribution to knowledge, the research offers a solution to bridge the gap in the literature on the processes within the conventional project delivery approach that often produces poor design documentation quality.

It is important to conclude research and provide recommendations based on the outcome. Therefore, having fulfilled the aim of this research, it is necessary to conclude the research, state limitations and propose appropriate recommendations.

CHAPTER 7

CONCLUSION AND RECOMMENDATIONS

7.1 Introduction

Overall, this research achieved its aim by developing a framework to improve design documentation quality within the conventional project delivery approach by adapting enablers in IPD. It is important to conclude the research report after presenting appropriate information in the preceding chapters. Therefore, this chapter presents the conclusion to the research; a summary of research findings; limitations during the research period; contributions of the research to both theory and practice; and finally, appropriate recommendations for policy and future research.

7.2 Conclusion

To set this research in motion, it was established from the literature that there are weaknesses associated with the processes involved in the conventional project delivery approach which results in poor design documentation quality. Consequences are; undesirable high cost of projects, delays, and poor project quality. Researchers and practitioners have all argued for efforts to improve design documentation quality. Some have recommended the development of an instrument for evaluating design documentation quality. There is also the existence of various tools developed and used over the years in the industry for evaluating design documentation quality. Yet, poor quality design documentation is still rampant in the industry. However, research to improve design documentation quality within the conventional project delivery approach by adapting enablers in IPD does not exist. Therefore, this research developed a framework to improve design documentation quality within the conventional project delivery approach by adapting enablers in IPD.

The research identified the weaknesses and capabilities required of the conventional project delivery approach and adapted some enablers associated with IPD to develop the framework. The research outcome demonstrates that design documentation

quality in practice under the conventional project delivery approach is poor and often results in project inefficiencies. This is due to the weaknesses that are associated with the conventional project delivery approach. Therefore, any effort aimed at reducing the weaknesses will result in a major improvement in design documentation quality. This however fulfilled the aim of this research and provided answers to the hypotheses that were set. However, the specific objectives that framed the argument for this research and helped in achieving the aim are:

i. To ascertain the current state of design documentation quality in practice under the conventional project delivery approach.
ii. To identify the inherent weaknesses associated with the conventional project delivery approach and capabilities required in the production of design documentation.
iii. To identify enablers inherent in IPD that can be adapted to improve design documentation quality.
iv. To develop a framework within the conventional project delivery approach to improve design documentation quality.

The major findings of this research on the first objective revealed that; design drawings usually contain enormous errors and omissions; there are often discrepancies between project documents such as bills of quantities, drawings and specifications; and there is often lack of accuracy in design documentation that is produced. Therefore, it is ascertained on this premise that the current state of design documentation quality in practice is unsatisfactory and bedevilled with challenges.

The second research objective identified inherent weaknesses and capabilities under the conventional project delivery approach. The major weaknesses identified include; lack of coordination among design consultants; it is a fragmented approach to project delivery; and it does not encourage the commitment of all participants to total quality right from project design. However, the major capabilities that are required in the production of design documentation include; designers' collaboration with all stakeholders during design and documentation; and an improvement in the

collaboration between various design disciplines. Other capabilities include; the formulation of incentives for producing good design documentation quality; and allowing contractors to make input during the design stage.

The third objective was; to identify enablers in IPD that can be adapted to improve design documentation quality. The research identified three categories of enablers which are; contractual, behavioural, and early involvement and collaboration of key participants. This fulfilled the focus of the third research objective. Contractually, some enablers are; key participants' early involvement in the project; key participants jointly accountable for any errors in design; key participants' success tied to the success of the project; and encouraging fiscal transparency among key participants. Behaviourally, key participants having mutual respect and trust for each other and ensuring transparent processes throughout the project. The early involvement and collaboration of key participants enhance and strengthen their understanding of the owner's desired outcome; it promotes a more timely and informed understanding of the design thereby improving design documentation quality.

These findings provided adequate data in achieving the aim of this research by developing a framework within the conventional project delivery approach to improve design documentation quality.

7.3 Summary of Findings

The literature review indicated that the project delivery method adopted significantly impacts the efficiency of the project and determines the quality of design documentation. The literature also purports that, while there are numerous project delivery methods in use, the conventional approach is the most widely used method across the world and its usage will continue for a long time since the industry is not yet positioned to adopt new delivery methods. However, practitioners and researchers have argued that there are significant weaknesses in the processes involved with the conventional project delivery approach particularly in producing design documentation, which often leads to poor design documentation quality. It is

indicative in the literature that design documentation in practice is generally poor and contains incomplete and conflicting information. The literature indicates that industry changes and initiatives to resolve the problems of design documentation quality are required. This, therefore, justifies the aim of this research to develop a framework to improve design documentation quality by adapting IPD approach.

The first objective which seeks to ascertain the current state of design documentation quality in practice under the conventional project delivery approach at the end concluded that design documentation quality is bedevilled with challenges. The major findings on the weaknesses associated with the conventional project delivery approach and capabilities required in the production of design documentation which was the second objective of this research identified certain weaknesses and capabilities. These weaknesses are associated with the processes involved in the production of design documentation. There were specific findings on capabilities that are required of the conventional project delivery approach particularly during the production of design documentation to improve the quality of design documentation.

The major findings on Enablers inherent in IPD that can be adapted to improve design documentation quality which was the third objective indicated that most of the principles in IPD can be adapted into the conventional project delivery approach. The identified enablers are grouped into Contractual, Behavioural, and Early Involvement and collaboration of key participants.

The research findings from both quantitative and qualitative data sources resulted in the development of the draft framework to improve design documentation quality. However, to ensure that the framework is developed to achieve the research aim, the draft framework was sent to industry professionals for validation. This was achieved by sending the draft framework to research participants who participated in the interview session of this research for their comments. This resulted in fine-tuning the draft framework into the finalised framework as presented in this research.

7.4 Research Limitations

Despite the significant contributions of this research, there are certain limitations. One such limitation is that qualitative data from semi-structured interviews were collected from 15 participants due to the research time constraints. A larger number of participants should be considered in future studies to collect more diverse subjective views of many participants.

The research focused only on the pre-design and design phases of a project since it is at this stage that design documentation is produced. Therefore, the project construction and post-construction stages were not considered.

The insurgence of the COVID-19 pandemic was also a major limitation in carrying out this research, particularly during data collection. This brought about restrictions on people's movements, public gatherings and even physical meetings across the globe. Therefore, it was difficult and in some instances practically impossible to physically meet with research participants, particularly for interviews. However, online tools were designed and used for data collection together with voice calls to mitigate the impact of the pandemic on the research.

Another limitation was during the validation of the draft framework. There were efforts to physically meet with the research participants to thoroughly discuss the draft framework but it was practically impossible in some cases. Therefore, most of the validation had to be done via voice calls and recorded.

7.5 Research Contributions

This research aims to develop a framework to improve design documentation quality that is produced under the conventional project delivery approach. The majority of succeeding research on design documentation quality identified the problems and causes that are associated with the quality. However, this research identified the required capabilities and adapted some enablers in IPD to develop a framework within the conventional project delivery approach to improve the quality of design documentation in practice. This is a valuable contribution to knowledge by this

research, particularly within the infrastructure construction industry. Therefore, this research contributes theoretically and practically to both industry and academia at large.

7.5.1 Theoretical Contributions

This research offers significant theoretical contributions in the construction sector research space among which include:

- The statistics from this research on the state of design documentation quality, weaknesses associated with the conventional project delivery approach, capabilities required of the conventional approach, enablers to improve design documentation quality and the developed framework provide relevant information for academic research in the field of design documentation.
- It offers a theoretical understanding of the poor quality state of design documentation in the construction industry, particularly under the conventional project delivery approach.
- It brings to light the weaknesses associated with the conventional project delivery approach during the production of design documentation which includes: lack of coordination; lack of commitment to project objectives; lack of participants' commitment to total quality; and a fragmented approach.
- It also discovers the capabilities required of the conventional project delivery approach to mitigate the impacts of the weaknesses which include: contractors' input during design; mandatory coordination; formulation of incentives; improvement in collaboration; and reduction in fragmentation.
- This research provides a solution to bridge the gap in the literature on the existence of poor quality design documentation as a result of the weaknesses in the processes involved in producing design documentation under the conventional project delivery.

- It provides pragmatic data on enablers in IPD to improve design documentation quality, particularly under the conventional project delivery approach.

7.5.2 Contributions to Industry

The outcome of this research makes significant practical contributions to the construction industry among which are:

- The statistics from this research and the developed framework will help construction owners achieve value for money since design documentation quality will improve with corresponding efficient project delivery.
- The research will inform professionals and practitioners in the construction industry on appropriate measures to take in the production of design documentation to help improve the quality.
- The implementation of the developed framework and results of this research will help in positioning the construction industry in most countries across the globe on the path of using IPD in the near future.
- It provides a guide on the implementation of the conventional project delivery approach that seeks to improve design documentation quality.
- It seeks to enhance the amount of collaboration among project design team members and the involvement of the project owner, a general contractor and end-users with an ultimate goal of improving the quality of documentation.

7.6 Recommendations

This research developed a framework to improve design documentation quality by adapting some principles in IPD. However, some recommendations are born out of the findings of this research for policy and future research.

7.6.1 Recommendations for Policy

The research established that there are numerous project delivery methods in the construction industry but the conventional project delivery approach is the most widely used across the globe. Therefore, it is recommended that appropriate

regulatory bodies in various countries should formulate or amend existing policies to boost the implementation of this framework in the construction industry since most professionals and practitioners are reluctant about change. There should be policies that will aim to reduce or prevent the production of incomplete and inexplicit drawings, disparities between bill of quantities, drawings, and specifications, and lack of coordination and collaboration among design team members to improve design documentation quality.

The research findings identified that incentives (rewards) play a major role in consultants' commitment to effective project delivery. Therefore, there should be policies that will provide the environment for appropriate incentives to be offered to consultants and other key project participants within the conventional project delivery approach to improve project efficiency and subsequently enhance design documentation quality. The policies should also make way for appropriate punishments (accountability for errors and deficiencies) to consultants and other key project participants for producing poor quality design documentation to be introduced.

7.6.2 Recommendations for future research

Despite the achievement of the aim of this research and the useful contribution to knowledge, there is still more room for further research in the area of design documentation. Therefore, the following are recommended for future research:

- Research on appropriate incentives or rewards for design team members for producing better quality design documentation that will fit into the conventional project delivery approach. This will serve as a motivation for improving on services to be rendered particularly towards improving the quality of design documentation.
- Research on appropriate penalties or accountability for design team members for errors and deficiencies in design documentation produced which often results in

poor quality design documentation. These penalties should be such that they can fit into the conventional project delivery approach.

- Research on how to improve project efficiency and performance during the pre-construction and construction phases of construction projects under the conventional project delivery approach since this research focused on the planning and design phases. Weaknesses associated with this delivery approach during construction should be identified including potential capabilities to improve productivity and quality of completed projects.

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APPENDICES

Appendix A: Ethical Clearance Certificate and Turn-it-in Report

Appendix A1: Ethical Clearance Certificate

UNIVERSITY OF THE WITWATERSRAND, JOHANNESBURG

Research Office

HUMAN RESEARCH ETHICS COMMITTEE (NON-MEDICAL)
R14/49 Agbaxode

CLEARANCE CERTIFICATE	**PROTOCOL NUMBER: H20/08/02**
PROJECT TITLE	A Framework to Improve Design Documentation Quality Using Integrated Project Delivery (IPD) Approach
INVESTIGATOR(S)	Mr P Agbaxode
SCHOOL/DEPARTMENT	Construction Economics and Management /
DATE CONSIDERED	21 August 2020
DECISION OF THE COMMITTEE	Approved Risk Level: Minimal
EXPIRY DATE	02 September 2023

DATE 03 September 2020 **CHAIRPERSON** (Professor J Knight)

cc: Supervisor : Dr S Dlamini and Prof E Saghatforoush

DECLARATION OF INVESTIGATOR(S)

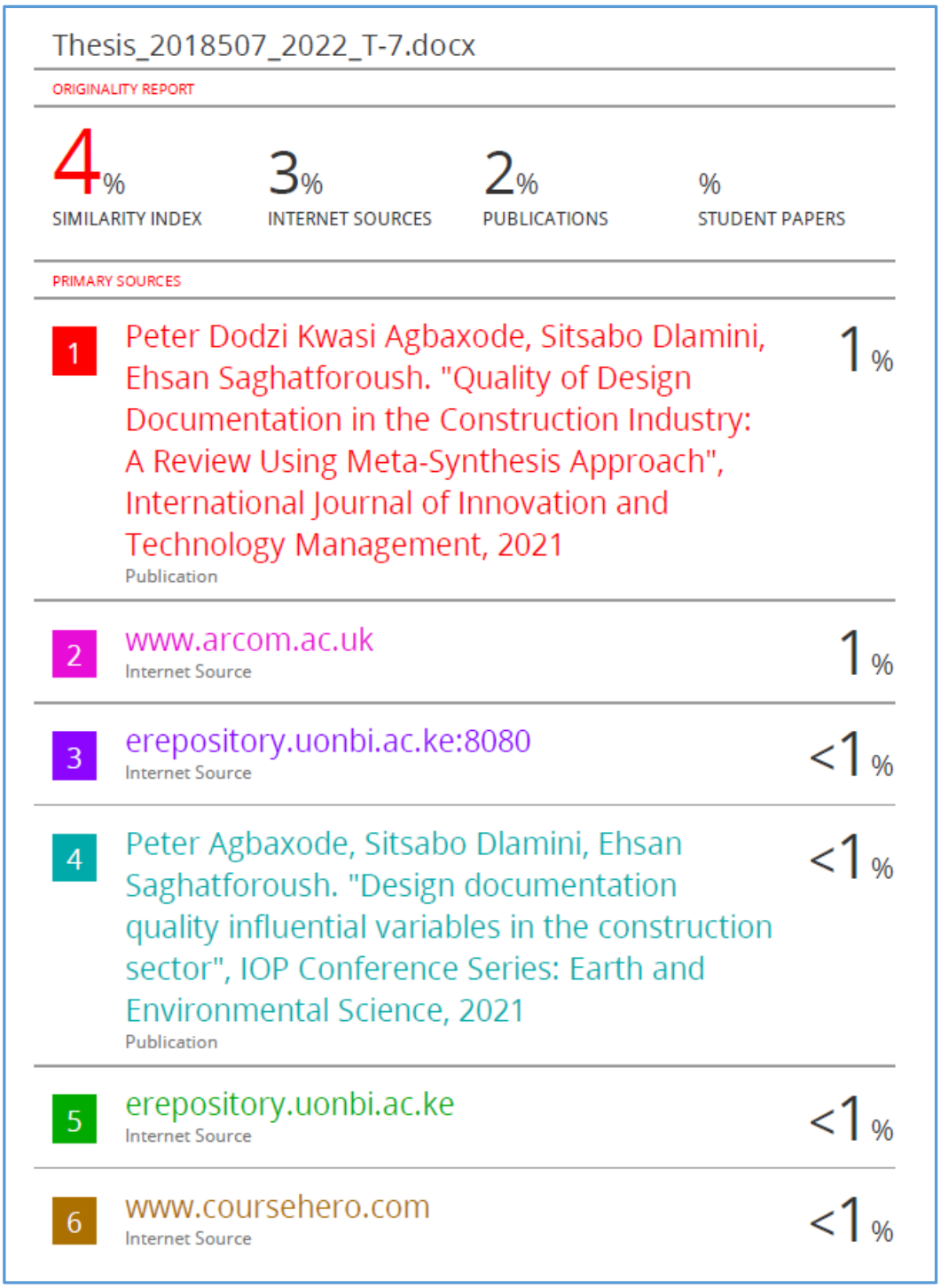
To be completed in duplicate and **ONE COPY** returned to the Secretary at Room 10004, 10th Floor, Senate House, University. Unreported changes to the application may invalidate the clearance given by the HREC (Non-Medical)

I/We fully understand the conditions under which I am/we are authorized to carry out the abovementioned research and I/we guarantee to ensure compliance with these conditions. Should any departure to be contemplated from the research procedure as approved I/we undertake to resubmit the protocol to the Committee. **I agree to completion of a yearly progress report.**

Signature **Date** 03/09/2020

PLEASE QUOTE THE PROTOCOL NUMBER ON ALL ENQUIRIES

Appendix A2: Turn-it-in (Originality) Report



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ORIGINALITY REPORT

4%	3%	2%	%
SIMILARITY INDEX	INTERNET SOURCES	PUBLICATIONS	STUDENT PAPERS

PRIMARY SOURCES

1	Peter Dodzi Kwasi Agbaxode, Sitsabo Dlamini, Ehsan Saghatforoush. "Quality of Design Documentation in the Construction Industry: A Review Using Meta-Synthesis Approach", International Journal of Innovation and Technology Management, 2021 Publication	1%
2	www.arcom.ac.uk Internet Source	1%
3	erepository.uonbi.ac.ke:8080 Internet Source	<1%
4	Peter Agbaxode, Sitsabo Dlamini, Ehsan Saghatforoush. "Design documentation quality influential variables in the construction sector", IOP Conference Series: Earth and Environmental Science, 2021 Publication	<1%
5	erepository.uonbi.ac.ke Internet Source	<1%
6	www.coursehero.com Internet Source	<1%

Appendix B: Critical Appraisal Skills Program (CASP)

Appendix B1: CASP Screening Template

Template adapted from Public Health Resource Unit, England (2006); 10 questions to help you make sense of qualitative research; CASP (CASP, 2006)

Question No.	**CASP Screening Questions**	Yes	Partial	No
1	**Is there a clear statement of the aims of the research?** *Consideration: Research goal; Research importance; and Its relevance.*			
2	**Is a qualitative methodology appropriate?** *Consideration: if the research seeks to interpret the actions or subjective experiences of research participants.*			
3	**Research design appropriate to address the research aim?** *Consideration: is the research design justified?*			
4	**Is the recruitment strategy appropriate to the research aim** *(Sampling)***?** *Consideration: how participants were selected; if selected participants provided the most appropriate knowledge for the study.*			
5	**Does the data collected addressed the research issue?** *Consideration:* ▪ *Justification for data collection setting and method chosen provided.* ▪ *Clarity of data collection methods (e.g. focus group, semi-structured interview etc).*			
6	**Is the relationship between researcher and participants adequately considered?** *Consideration: Researcher critically examined their own role, potential bias and influence during: formulation of research questions, data collection, including sample recruitment and choice of location.*			
7	**Are ethical issues taken into consideration?**			
8	**Is the data analysis sufficiently rigorous?** *Consideration: an in-depth description of the analysis process and if sufficient data are presented to support the findings.*			
9	**Is there a clear statement of the findings?** *Consideration:* ▪ *Findings are explicit.* ▪ *Discussed credibility of findings (e.g. triangulation, respondent validation, more than one analyst).* ▪ *Findings discussed in relation to the original research questions.*			
10	**Is the research considered valuable** *(Value)***?** *Consideration: Discusses contribution to existing knowledge or understanding.*			

Yes: Means "Fully achieved"
Partial: Means "Not fully achieved"
No: Means "Not achieved"

Appendix B2: Articles Screened using the CASP Template

Articles Screened	CASP Screening Questions (Refer to Template in Appendix B1)									
	Question 1	**Question 2**	**Question 3**	**Question 4**	**Question 5**	**Question 6**	**Question 7**	**Question 8**	**Question 9**	**Question 10**
Article 1	Yes	Yes	Yes	Yes	Partial	Yes	Yes	Yes	Yes	Yes
Article 2	Yes	Yes	Yes	Yes	Yes	Yes	Partial	Yes	Yes	Yes
Article 3	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Partial	Yes	Yes
Article 4	Yes	Yes	Yes	Yes	Yes	Partial	Yes	Yes	Yes	Yes
Article 5	Yes	Yes	Yes	Yes	Yes	Yes	Partial	Partial	Partial	Yes
Article 6	Yes	Yes	Yes	Yes	Partial	Yes	Yes	Yes	Yes	Yes
Article 7	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Partial	Yes	Yes
Article 8	Yes	Yes	Yes	Yes	Yes	Partial	Yes	Yes	Yes	Yes
Article 9	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Article 10	Yes	Yes	Yes	Yes	Partial	Yes	Yes	Yes	Yes	Yes
Article 11	Yes	Yes	Yes	Partial	Yes	Yes	Yes	Partial	Yes	Yes
Article 12	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Article 13	Yes	Yes	Yes	Yes	Yes	Yes	Partial	Yes	Yes	Yes
Article 14	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Partial	Yes	Yes
Article 15	Yes	Yes	Yes	Yes	Partial	Yes	Yes	Yes	Yes	Yes
Article 16	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Article 17	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Partial	Yes	Yes
Article 18	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Article 19	Yes	Yes	Yes	Yes	Yes	Yes	Partial	Yes	Partial	Yes
Article 20	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Article 21	Yes	Yes	Yes	Yes	Partial	Yes	Yes	Yes	Yes	Yes
Article 22	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Partial	Yes	Yes
Article 23	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Article 24	Yes	Yes	Yes	Yes	Yes	Partial	Yes	Yes	Yes	Yes
Article 25	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Article 26	Yes	Yes	Yes	Yes	Yes	Yes	Partial	Partial	Yes	Yes
Article 27	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Appendix B2 Continued

Articles Screened	CASP Screening Questions (Refer to Template in Appendix B1)									
	Question 1	**Question 2**	**Question 3**	**Question 4**	**Question 5**	**Question 6**	**Question 7**	**Question 8**	**Question 9**	**Question 10**
Article 28	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Article 29	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Article 30	Yes	Yes	Yes	Yes	Partial	Yes	Yes	Yes	Yes	Yes
Article 31	Yes	Yes	Yes	Yes	Yes	Yes	Partial	Yes	Yes	Yes
Article 32	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Article 33	Yes	Yes	Yes	Yes	Yes	Partial	Yes	Partial	Yes	Yes
Article 34	Yes	Yes	Yes	Yes	Partial	Yes	Yes	Yes	Yes	Yes
Article 35	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Article 36	Yes	Yes	Yes	Yes	Yes	Yes	Partial	Yes	Yes	Yes
Article 37	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Article 38	Yes	Yes	Yes	Partial	Yes	Partial	Yes	Yes	Yes	Yes
Article 39	Yes	Yes	Yes	Yes	Yes	Partial	Yes	Yes	Yes	Yes
Article 40	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Article 41	Yes	Yes	Yes	Yes	Yes	Partial	Yes	Partial	Partial	Yes
Article 42	Yes	Yes	Yes	Yes	Partial	Yes	Yes	Yes	Yes	Yes
Article 43	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Article 44	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Article 45	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Partial	Yes	Yes
Article 46	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Article 47	Yes	Yes	Yes	Yes	Yes	Partial	Yes	Yes	Yes	Yes
Article 48	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Article 49	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Partial	Yes	Yes
Article 50	Yes	Yes	Yes	Yes	Partial	Yes	Yes	Yes	Yes	Yes
Article 51	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Article 52	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Article 53	Yes	Yes	Yes	Yes	Yes	Partial	Yes	Yes	Yes	Yes
Article 54	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Partial	Yes	Yes

Appendix B2 Continued

Articles Screened	CASP Screening Questions (Refer to Template in Appendix B1)									
	Question 1	**Question 2**	**Question 3**	**Question 4**	**Question 5**	**Question 6**	**Question 7**	**Question 8**	**Question 9**	**Question 10**
Article 55	Yes	Yes	Yes	Yes	Partial	Yes	Yes	Yes	Yes	Yes
Article 56	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Article 57	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Article 58	Yes	Yes	Yes	Yes	Yes	Partial	Yes	Yes	Yes	Yes
Article 59	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Article 60	Yes	Yes	Yes	Yes	Yes	Yes	Partial	Yes	Yes	Yes
Article 61	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Article 62	Yes	Yes	Yes	Partial	Yes	Yes	Yes	Yes	Yes	Yes
Article 63	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Article 64	Yes	Yes	Yes	Yes	Partial	Yes	Yes	Yes	Yes	Yes
Article 65	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Article 66	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Partial	Yes	Yes
Article 67	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Article 68	Yes	Yes	Yes	Yes	Yes	Partial	Yes	Yes	Yes	Yes
Article 69	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Article 70	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Article 71	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Article 72	Yes	Yes	Yes	Yes	Partial	Yes	Yes	Yes	Yes	Yes
Article 73	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Article 74	Yes	Yes	Yes	Yes	Yes	Yes	Partial	Yes	Yes	Yes
Article 75	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Article 76	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Article 77	Yes	Yes	Yes	Yes	Partial	Yes	Yes	Yes	Yes	Yes
Article 78	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Article 79	Yes	Yes	Yes	Yes	Yes	Yes	Partial	Yes	Yes	Yes

Appendix C: Questionnaire Survey Sample

QUESTIONNAIRE

Research Title: **Improving design documentation quality using Integrated Project Delivery (IPD) approach**

Invitation for Research Survey

Dear Sir / Madam,
My name is Peter Dodzi Kwasi Agbaxode and I am a PhD student in the school of Construction economics and management at the University of the Witwatersrand, Johannesburg in South Africa. As part of my studies, I have to undertake a research project, and the title is *A Framework to Improve Design Documentation Quality Using Integrated Project Delivery (IPD) Approach.* The aim of this research project is to develop a framework to improve design documentation quality in the construction industry by adapting IPD approach.

As part of this project, I would like to kindly invite you to take part in a questionnaire survey. The questionnaire will take about twenty (20) minutes to complete. Kindly note that this is purely an academic exercise and you will not receive any direct benefits from participating in this research, and there are no disadvantages or penalties for not participating.

Kindly note that completion of this questionnaire indicates your consent to participate in this research. You may withdraw at any time or not answer any question if you do not want to. The questionnaire will be completely confidential and anonymous as I will not be asking for your name or any identifying information, and your responses will be held securely and not disclosed to anyone else. However, the information (data) that you will provide may be used anonymously by other researchers after this project has ended.

If you have any questions during or afterwards about this research, feel free to contact me on the details listed below. This study will be written up as a research report which will be available online through the university library website. If you have any concerns or complaints regarding the ethical procedures of this study, you are welcome to contact the University Human Research Ethics Committee (Non-Medical);
Telephone +27(0) 11 717 1408, email hrec-medical.researchoffice@wits.ac.za
Yours sincerely,
Peter D.K. Agbaxode

Researcher:	*Supervisor 1:*	*Supervisor 2:*
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This Survey is in Five sections; A, B, C, D, and E.
SECTION A: Background Information; SECTION B: The state of design documentation quality in practice under the conventional project delivery approach; SECTION C: Weaknesses associated with the conventional project delivery approach and capabilities required in the production of design documentation; SECTION D: Enablers inherent in IPD that can be adapted to improve design documentation quality; SECTION E: Your Comments and additional factors.

Please tick the appropriate variable in order of the scale.

Interpretation of Scale

SA	Strongly Agree	5
A	Agree	4
U	Undecided	3
D	Disagree	2
SD	Strongly Disagree	1

SECTION A: ***Background Information***

Please *tick* the appropriate information that best describes you.

S/N	*Information's*	*Tick*	*S/N*	*Information's*	*Tick*
1	***What is your Role in the Construction Sector?***		***3***	***What is your Years of Experience in the Construction Sector***	
1.1	Foreman or Project Supervisor		3.1	1yr – 5yrs	
1.2	Engineer		3.2	6yrs – 10yrs	
1.3	Quantity Surveyor		3.3	11yrs – 20yrs	
1.4	Architect		3.4	21yrs – 30 yrs	
1.5	Project or Construction Manager		3.5	31yrs – 40yrs	
1.6	Managing Director		3.6	Above 40yrs	
1.7	Client				
1.8	Others: ……..				
2	***What is your Highest Level of Education***		***4***	***Which Sector do you work in?***	
2.1	Diploma		4.1	Private sector	
2.2	Technician Certificate		4.2	Public sector	
2.3	Higher National Diploma (HND)				
2.4	1St Degree or Honors		***5***	***Which of the following Outfits do you work in?***	
2.5	Masters or Postgraduate Diploma				
2.6	PhD or Equivalent degree		5.1	Consultants Outfit	
2.7	Others: ……..		5.2	Contractors Outfit	

SECTION B: The state of design documentation quality in practice under the conventional project delivery approach;

Design documentation quality for the purpose of this research refers to *how clear, adequate, comprehensive, precise, accurate, unambiguous and effective a document is to serve the purpose for which it is intended and be constructible with the best possible economy and safety.*

This section is aimed at ascertaining the current state of design documentation quality in practice under the conventional project delivery approach.

Please tick the *appropriate Scale* to indicate your level of agreement to each variable.

***SD**=Strongly Disagree, **D**=Disagree, **U**=Undecided, **A**=Agree, **SA**=Strongly Agree*						
S/N	**Variables**	**SD**	**D**	**U**	**A**	**SA**
1	Design drawings usually contain errors and omissions.					
2	Specifications usually contain errors and omissions.					
3	Bills of quantities usually contain errors and omissions.					
4	There is lack of coordination among design documents.					
5	There are discrepancies between bill of quantities, drawings and specifications.					
6	There are disparities between drawings and specifications only.					
7	Documents are often issued with conflicting, inaccurate, and ambiguous information.					
8	Documents lacking clarity.					
9	Documents are often issued with insufficient details.					
10	Issuance of un-amended standard specifications.					
11	Issuance of incomplete design drawings.					
12	Issuance of incomplete specifications.					
13	Issuance of incomplete bills of quantities.					
14	Issuance of bulky documents containing irrelevant information.					
15	There is often lack of accuracy in design documentation.					

<u>SECTION C:</u> Weaknesses associated with the conventional project delivery approach and capabilities required in the production of design documentation;

This section is aimed at identifying the inherent weaknesses associated with the conventional project delivery approach and capabilities required in the production of design documentation.

Please tick the *appropriate Scale* to indicate your level of agreement to each variable.

***SD**=Strongly Disagree, **D**=Disagree, **U**=Undecided, **A**=Agree, **SA**=Strongly Agree*						
S/N	**Variables**	**SD**	**D**	**U**	**A**	**SA**
1	***Weaknesses***					
1.1	Lack of coordination among design consultants.					
1.2	Lack of cooperation and collaboration among project participants.					
1.3	Lack of coordination among design documents.					
1.4	Discrepancies between bill of quantities, drawings and specifications.					
1.5	Reliance on specification notes only when drawings are required.					
1.6	Projects always experience cost escalation, shoddy workmanship, project abandonment and other manifestations of project failure.					
1.7	There is high inflation or escalation of final contract cost.					
1.8	No guarantee of certainty of project final cost, only initial cost.					
1.9	It encourages claim consciousness among project participants.					
1.10	There is too much focus on lowest price instead of best price.					
1.11	It encourages participants to be more profit conscious instead of project quality conscious.					
1.12	Individual project participants are exploitative of loopholes in contract documents.					
1.13	Contracts are deliberately let at excessively low price, with the intention of hiking the price (claim for reward) later through deliberate manipulation or exploitation of loopholes in the contract documents.					
1.14	Adversarial relationships among project participants threatening project goals; party spirit instead of team spirit.					
1.15	It does not encourage commitment to project objectives rather individual participant's objectives and gain.					
1.16	Each party has its own agenda based on its singular interest.					

1.17	Lack of contractors input at the design stage and not taking advantage of their experience.					
1.18	It does not encourage commitment of all participants to total quality right from project design.					
1.19	The rigid definition of roles and responsibilities provides no basis for shared vision or goals.					
1.20	Hierarchical relationships making communication and transfer of useful knowledge among project participants difficult.					
1.21	Compartmentalization of project participants around functional and professional lines is seen to lead to poor communication, undermine relationships among team members and leads to poor design documentation.					
1.22	There is uneven, unclear and unfair allocation of risks to some participants.					
1.23	It does not create a win-win situation among project participants.					
1.24	Relationships among project participants encourage professional mistrust and rivalry.					
2	***Capabilities Required***					
2.1	Consultants should be held accountable for producing poor design documentation quality (penalty).					
2.2	There should be incentives for producing good design documentation quality.					
2.3	Appropriate fees should be paid to consultants.					
2.4	Consultants working conditions and procedures should be improved.					
2.5	Clients should allow adequate time for the preparation of design documents.					
2.6	Mandatory coordination of design documentation by a supervisor with requisite skills and knowledge.					
2.7	Independent review of design documentation by a supervisor with requisite skills and knowledge.					
2.8	Encourage self-check practice and independent verification.					
2.9	Design documentation should be re-checked for accuracy.					
2.10	Use of checklists.					
2.11	Quality control departments should be set-up.					
2.12	Increased quality control by setting minimum quality and service standards.					
2.13	Designers should partner with other designers while preparing design documents.					
2.14	Collaboration between architectural and engineering design disciplines should be vastly improved.					
2.15	Specialists' involvement in design planning and processing.					
2.16	Use of computer programs such as BIM.					
2.17	Job relevant training and practice.					
2.18	Provision of elaborate and improved project brief.					
2.19	Systematic audit to ensure the quality of briefs.					
2.20	Preparation of detailed design.					

SECTION D:* *Enablers inherent in IPD that can be adapted to improve design documentation quality;

This section is aimed at identifying enablers inherent in IPD that can be adapted to improve design documentation quality. *Key Participants* as used in this section refers to consultants (designers), contractors, client, end-users etc.

Please tick the *appropriate Scale* to indicate your level of agreement to each variable.

***SD**=Strongly Disagree, **D**=Disagree, **U**=Undecided, **A**=Agree, **SA**=Strongly Agree*						
S/N	**Variables**	**SD**	**D**	**U**	**A**	**SA**
1	***IPD Contractual Principles***					
1.1	Key participants should be involved early in the project.					
1.2	Key participants should ensure early contributions of knowledge and expertise.					
1.3	Making collaborative value based decisions by all participants.					
1.4	Key participants bound together as equals.					
1.5	Jointly and early developed project target criteria.					
1.6	Tying the success of key participants to the success of the project.					
1.7	Key participants jointly accountable for any errors in design.					
1.8	Key participants sharing financial reward (compensation) based on project outcome.					
1.9	Sharing financial risk among key participants.					
1.10	Utilization of new technologies and approaches during design and construction.					
1.11	Waiving liabilities between key participants.					
1.12	Encourage fiscal transparency between key participants.					
2	***IPD Behavioural Principles***					
2.1	Key participants having mutual respect for each other.					
2.2	Key participants having mutual trust for each other.					
2.3	Willingness to collaborate as key participants.					
2.4	Open communication among key participants.					
2.5	Open information sharing among key participants.					
2.6	Ensuring transparent processes throughout the project.					
3	***Early Involvement and Collaboration of Key Participants***					
3.1	It enhances and strengthens key participants understanding of the owner's desired outcome.					
3.2	Effective collaboration by all participants improves design documentation quality.					
3.3	There is a more timely and informed understanding of the design.					
3.4	Provides an opportunity for adequate pre-design, design, and documentation planning.					
3.5	Provides an opportunity for strong pre-construction planning.					
3.6	Early visualization of construction sequencing prior to commencing project.					
3.7	An increase in the level of effort by key participants during design documentation results in better documentation quality.					

SECTION E: ***Your Comments and Additional Factors;***

Kindly list additional factors you deemed important in improving design documentation quality in construction:

……

Appendix D: Ranking of factors on the state of design documentation quality

S/N	Variables	SD	D	U	A	SA	RII	Mean	Ranking	Importance Level
1	Design drawings usually contain errors and omissions.	2	4	4	106	119	0.89	4.43	1	H
2	Bills of quantities usually contain errors and omissions.	2	4	3	120	106	0.88	4.38	2	H
3	There is lack of coordination among design documents.	4	2	4	117	108	0.87	4.37	3	H
4	There are discrepancies between bill of quantities, drawings and specifications.	2	2	11	115	105	0.87	4.36	4	H
5	There are disparities between drawings and specifications only.	4	3	12	105	111	0.87	4.34	5	H
6	There is often lack of accuracy in design documentation.	5	14	4	98	114	0.86	4.29	6	H
7	Specifications usually contain errors and omissions.	4	7	2	130	92	0.85	4.27	7	H
8	Issuance of un-amended standard specifications.	3	8	9	127	88	0.85	4.23	8	H
9	Documents lacking clarity.	6	14	6	110	99	0.84	4.2	9	H
10	Issuance of incomplete design drawings.	6	12	8	111	98	0.84	4.2	9	H
11	Issuance of bulky documents containing irrelevant information.	5	14	7	114	95	0.84	4.19	10	H
12	Documents are often issued with conflicting, inaccurate, and ambiguous information.	6	10	10	117	92	0.84	4.19	10	H
13	Issuance of incomplete bills of quantities.	5	15	6	117	92	0.83	4.17	11	H
14	Documents are often issued with insufficient details.	4	13	5	134	79	0.83	4.15	12	H
15	Issuance of incomplete specifications.	7	16	4	124	84	0.82	4.11	13	H

Appendix E: Ranking of factors on Weaknesses associated with the conventional project delivery approach

S/N	Variables	SD	D	U	A	SA	RII	Mean	Ranking	Importance Level
1	Lack of coordination among design consultants.	3	4	1	120	107	0.88	4.38	1	H
2	Projects always experience cost escalation, shoddy workmanship, project abandonment and other manifestations of project failure.	1	11	3	113	107	0.87	4.34	2	H
3	Lack of coordination among design documents.	1	7	4	124	99	0.87	4.33	3	H
4	Discrepancies between bill of quantities, drawings and specifications.		9	6	121	99	0.86	4.32	4	H
5	Individual project participants are exploitative of loopholes in contract documents.	1	14	5	109	106	0.86	4.3	5	H
6	Contracts are deliberately let at excessively low price, with the intention of hiking the price (claim for reward) later through deliberate manipulation or exploitation of loopholes in the contract documents.	1	15	5	109	105	0.86	4.29	6	H
7	It encourages claim consciousness among project participants.		16	6	110	103	0.86	4.28	7	H
8	Relationships among project participants encourage professional mistrust and rivalry.	2	17	7	100	109	0.85	4.26	8	H
9	There is too much focus on lowest price instead of best price.	1	17	1	119	97	0.85	4.25	9	H
10	Each party has its own agenda based on its singular interest.	1	15	3	121	95	0.85	4.25	9	H
11	Lack of contractors input at the design stage and not taking advantage of their experience.		13	5	128	89	0.85	4.25	9	H
12	No guarantee of certainty of project final cost, only initial cost.	1	14	4	125	91	0.85	4.24	10	H
13	Adversarial relationships among project participants threatening project goals; party spirit instead of team spirit.	1	17	7	110	100	0.85	4.24	10	H

14	Hierarchical relationships making communication and transfer of useful knowledge among project participants difficult.	2	14	10	108	101	0.85	4.24	10	H
15	There is high inflation or escalation of final contract cost.	2	14	6	120	93	0.85	4.23	11	H
16	Reliance on specification notes only when drawings are required.	1	12	8	127	87	0.84	4.22	12	H
17	The rigid definition of roles and responsibilities provides no basis for shared vision or goals.	2	16	5	118	94	0.84	4.22	12	H
18	It does not create a win-win situation among project participants.		16	7	125	87	0.84	4.2	13	H
19	Lack of cooperation and collaboration among project participants.		8	6	154	67	0.84	4.19	14	H
20	It encourages participants to be more profit conscious instead of project quality conscious.	1	16	3	133	82	0.84	4.19	14	H
21	It does not encourage commitment of all participants to total quality right from project design.	2	15	1	135	82	0.84	4.19	14	H
22	There is uneven, unclear and unfair allocation of risks to some participants.	3	15	9	118	90	0.84	4.18	15	H
23	Compartmentalization of project participants around functional and professional lines is seen to lead to poor communication, undermine relationships among team members and leads to poor design documentation.	3	16	5	126	85	0.83	4.17	16	H
24	It does not encourage commitment to project objectives rather individual participant’s objectives and gain.	1	17	11	128	78	0.83	4.13	17	H

Appendix F: Ranking of factors on Capabilities required in the production of design documentation under the conventional project delivery approach

S/N	Variables	SD	D	U	A	SA	RII	Mean	Ranking	Importance Level
1	Preparation of detailed design.	1	12	2	82	138	0.89	4.46	1	H
2	Collaboration between architectural and engineering design disciplines should be vastly improved.	1	2	3	115	114	0.89	4.44	2	H
3	Appropriate fees should be paid to consultants.	2	2	4	111	116	0.89	4.43	3	H
4	Specialists' involvement in design planning and processing.	1	3	2	117	112	0.89	4.43	3	H
5	Consultants should be held accountable for producing poor design documentation quality (penalty).	2	2		129	102	0.88	4.39	4	H
6	Independent review of design documentation by a supervisor with requisite skills and knowledge.	1	10	2	115	107	0.87	4.35	5	H
7	Designers should partner with other designers while preparing design documents.	1	11	2	115	106	0.87	4.34	6	H
8	Clients should allow adequate time for the preparation of design documents.	1	6	5	123	100	0.87	4.34	6	H
9	Mandatory coordination of design documentation by a supervisor with requisite skills and knowledge.	1	7	2	128	97	0.87	4.33	7	H
10	Design documentation should be re-checked for accuracy.	1	8	5	120	101	0.87	4.33	7	H
11	Increased quality control by setting minimum quality and service standards.	1	13	4	109	108	0.86	4.32	8	H
12	Consultants working conditions and procedures should be improved.	3	5	4	126	97	0.86	4.31	9	H
13	Encourage self-check practice and independent verification.	1	9	4	124	97	0.86	4.31	9	H

14	There should be incentives for producing good design documentation quality.	1	2	1	153	78	0.86	4.3	10	H
15	Systematic audit to ensure the quality of briefs.	1	15	6	106	107	0.86	4.29	11	H
16	Quality control departments should be set-up.	1	13	5	120	96	0.85	4.26	12	H
17	Use of computer programs such as BIM.	2	15	8	108	102	0.85	4.25	13	H
18	Use of checklists.	1	13	6	124	91	0.85	4.24	14	H
19	Provision of elaborate and improved project brief.	1	11	5	131	87	0.85	4.24	14	H
20	Job relevant training and practice.	1	14	8	118	94	0.85	4.23	15	H

Appendix G: Ranking of Enablers inherent in IPD

G1: Ranking of factors on IPD Contractual Principles

S/N	Variables	SD	D	U	A	SA	RII	Mean	Ranking by Category	Overall Ranking	Importance Level
1	Making collaborative value based decisions by all participants.	1		2	112	120	0.90	4.49	1	3	H
2	Key participants should be involved early in the project.		1	2	119	113	0.89	4.46	2	4	H
3	Tying the success of key participants to the success of the project.	1	2		119	113	0.89	4.45	3	5	H
4	Key participants sharing financial reward (compensation) based on project outcome.	1	1	5	112	116	0.89	4.45	3	5	H
5	Encourage fiscal transparency between key participants.	1	13	2	91	128	0.88	4.41	4	7	H
6	Key participants should ensure early contributions of knowledge and expertise.	1			138	96	0.88	4.4	5	8	H
7	Key participants jointly accountable for any errors in design.		1	2	134	98	0.88	4.4	5	8	H
8	Key participants bound together as equals.	1	1	2	133	98	0.88	4.39	6	9	H
9	Jointly and early developed project target criteria.	1	4	4	122	104	0.88	4.38	7	10	H
10	Sharing financial risk among key participants.		6	5	128	96	0.87	4.34	8	11	H
11	Utilization of new technologies and approaches during design and construction.	1	11	6	118	99	0.86	4.29	9	13	H
12	Waiving liabilities between key participants.	3	13	2	113	104	0.86	4.29	9	13	H
	Group Average	**0.92**	**4.42**	**2.67**	**119.91**	**107.08**	**0.88**	**4.40**			

G2: Ranking of factors on IPD Behavioural Principles

S/N	Variables	SD	D	U	A	SA	RII	Mean	Ranking by Category	Overall Ranking	Importance Level
1	Ensuring transparent processes throughout the project.	1	4	2	77	151	0.92	4.59	1	1	H
2	Key participants having mutual respect for each other.	1	1	2	107	124	0.90	4.5	2	2	H
3	Open information sharing among key participants.	2	4	1	95	133	0.90	4.5	2	2	H
4	Open communication among key participants.		4	4	109	118	0.89	4.45	3	5	H
5	Willingness to collaborate as key participants.	1		5	119	110	0.89	4.43	4	6	H
6	Key participants having mutual trust for each other.		1	6	124	104	0.88	4.41	5	7	H
	Group Average	**0.84**	**2.33**	**3.33**	**105.17**	**123.33**	**0.90**	**4.48**			

G3: Ranking of factors on Early Involvement and Collaboration of Key Participants

S/N	Variables	SD	D	U	A	SA	RII	Mean	Ranking by Category	Overall Ranking	Importance Level
1	There is a more timely and informed understanding of the design.		1	4	110	120	0.90	4.49	1	3	H
2	Provides an opportunity for strong pre-construction planning.		3	3	119	110	0.89	4.43	2	6	H
3	Provides an opportunity for adequate pre-design, design, and documentation planning.	1	1	1	132	100	0.88	4.4	3	8	H
4	It enhances and strengthens key participants understanding of the owner's desired outcome.	1		2	135	97	0.88	4.39	4	9	H
5	An increase in the level of effort by key participants during design documentation results in better documentation quality.	1	12	6	91	125	0.88	4.39	4	9	H
6	Effective collaboration by all participants improves design documentation quality.	1		3	147	84	0.87	4.33	5	12	H
7	Early visualization of construction sequencing prior to commencing project.	1	13	4	118	99	0.86	4.28	6	14	H
	Group Average	**0.71**	**4.3**	**3.29**	**121.7**	**105**	**0.88**	**4.39**			

Appendix H: Sample of Semi-Structured Interview Questions

INTERVIEW QUESTIONS

Dear Participant;

My name is Peter and thank you for consenting to be part of this interview.

As indicated in the consent, the aim of this interview is towards the *development of a framework to improve design documentation quality within the conventional project delivery by adapting Integrated Project Delivery (IPD) approach.*

1. I would like to know your ***position*** in the construction sector (Profession);
2. What is your highest level of ***education***?
3. How many years of ***experience*** do you have in the construction sector?
4. Do you work in the ***Private sector*** or the ***Public sector***?
5. Do you work in the ***Consultants Outfit*** or the ***Contractors Outfit***?
6. Based on your experience in the construction sector; what do you think are some ***weaknesses*** that are associated with the conventional project delivery approach during the production of design documentation; ……..
7. What do you think are some potential ***capabilities*** required of the conventional project delivery approach during design to improve design documentation quality;
8. What is your view on the possibility of these required ***capabilities*** towards improving design documentation quality within the conventional project delivery?
9. What is your view on Integrated Project Delivery (IPD) and its use in the construction industry? …….
10. What do you think are ***enablers*** that are inherent in IPD that can be adapted and used within the conventional project delivery approach during the production of design to improve design documentation quality? ……..
11. What is your view on the possibility of adapting some *contractual principles* in IPD towards improving design documentation quality within the conventional project delivery? ……
12. What is your view on the possibility of adapting some *behavioural principles* in IPD towards improving design documentation quality within the conventional project delivery? …….
13. Kindly provide additional factors you deemed important in achieving the aim of this research; ……

Appendix I: Sample Interview Consent

Consent form

Research Title: **A framework to improve design documentation quality using Integrated Project Delivery (IPD) approach**

Researcher

Peter Dodzi Kwasi Agbaxode,

email: 2018507@students.wits.ac.za

Cell: +27(0) 814997608 / 233(0)242152219

I, ……., agree to participate in this research project. The research has been explained to me and I understand what my participation will involve. I agree to the following:

*(Please **circle** the relevant options below):*

1.	I agree that my participation will remain anonymous	YES	NO
2.	I agree that the researcher may use anonymous quotes in his / her research report	YES	NO
3.	I agree that the interview may be audio recorded	YES	NO
4.	I agree that the information I provide may be used anonymously after this project has ended, for academic purposes	YES	NO

…… (signature)

…… (name of participant)

…… (date)

…… (signature)

…… (name of person seeking consent)

…… (date)

Appendix J: Sample Interview Participant Information Sheet



Dear Sir / Madam,

My name is Peter Dodzi Kwasi Agbaxode and I am a PhD student in the school of Construction economics and management at the University of the Witwatersrand, Johannesburg in South Africa. As part of my studies, I have to undertake a research project, and the title is *A Framework to Improve Design Documentation Quality Using Integrated Project Delivery (IPD) Approach.* The aim of this research project is to develop a framework to improve design documentation quality in the construction industry by adapting IPD approach.
As part of this project, I would like to kindly invite you to take part in an interview. The interview will take between twenty (20) to thirty (30) minutes and will be conducted online via Microsoft teams. It will be conducted during the day at a time that will be more convenience to you. With your permission, I would also like to record the interview using a digital device.

Kindly note that this is purely an academic exercise and you will not receive any direct benefits from participating in this research, and there are no disadvantages or penalties for not participating. You may withdraw at any time or not answer any question if you do not want to. The interview will be completely confidential and anonymous as I will not be asking for your name or any identifying information, and your responses will be held securely and not disclosed to anyone else. I will be using a pseudonym (false name) to represent your participation in my final research report. However, the information (data) that you will provide may be used anonymously by other researchers after this project has ended.

If you have any questions during or afterwards about this research, feel free to contact me on the details listed below. This study will be written up as a research report which will be available online through the university library website. If you have any concerns or complaints regarding the ethical procedures of this study, you are welcome to contact the University Human Research Ethics Committee (Non-Medical);
Telephone +27(0) 11 717 1408, email hrec-medical.researchoffice@wits.ac.za

Yours sincerely,
Peter D.K. Agbaxode

Researcher:	*Supervisor 1:*	*Supervisor 2:*
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