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Capabilities required of the conventional project delivery (CPD) approach in producing quality design documentation: the Ghanaian construction industry perspective

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Abstract

Purpose – The conventional project delivery (CPD) approach has been reported in the literature as the most widely used project delivery method in the construction industry globally compared to other delivery methods. However, researchers and practitioners have argued that the approach, specifically during the production of design documentation under the CPD, lacks certain capabilities that ensure quality and enhance project delivery. Therefore, this study aims to use the Ghanaian construction industry to identify the capabilities required of the CPD in practice, particularly during the production of design documentation.

Design/methodology/approach – The study design follows a pragmatist philosophy and uses mixed methods based on a deductive approach. Data collection involved a questionnaire survey, followed by semi-structured interviews. Quantitative data analysis used descriptive and inferential statistics, whereas qualitative data analysis used content analysis with the assistance of IBM SPSS and QSR Nvivo 12 Pro.

Findings – Findings indicate that there should be incentives for producing good design documentation quality; mandatory coordination of design documentation; improving collaboration among designers; and allowing contractors to make input during the design stage.

Practical implications – The results indicate the need for the identified capabilities to be introduced in the CPD approach to improve design documentation quality.

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Originality/value – This study offers a significant insight into the specific capabilities that are required of the CPD approach in practice particularly, in the production of design documentation

Keywords Conventional project delivery, Capabilities, Design documentation

Paper type Research paper

1. Introduction

There are numerous project delivery methods in use in the construction industry globally. However, the conventional project delivery (CPD) approach is the most widely used method across the world (Agbaxode *et al.*, 2021b; Harper *et al.*, 2016; Mesa *et al.*, 2016; Nawi *et al.*, 2014). In this approach, a general contractor undertakes the construction, whereas the design and supervision are carried out by specialist consultants (Masterman, 2003). According to Ebrahimi and Dowlatabadi (2019), the CPD approach engages project professionals and firms at different phases of the project, working in isolation and independently of each other, focusing solely on their respective portions of work (Durdyev *et al.*, 2019). However, according to Viana *et al.* (2020), excessive reliance on multiple cultures by these professionals and firms working in isolation leads to the fragmentation of CPD. This fragmentation is also attributed to a lack of collaboration or integration (Durdyev *et al.*, 2019). These limitations of the CPD approach often result in poor design documentation quality (Agbaxode *et al.*, 2021a, 2021b; Akampurira and Windapo, 2019), leading to low productivity, schedule delays, cost overruns and poor-quality project delivery (Zhang *et al.*, 2018). These findings are consistent with an earlier study by Tilley *et al.* (2002), which indicated a lack of collaboration among project team members, particularly during the design documentation stage, to ensure consistency within the documents produced.

This notwithstanding, the CPD 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 changes and initiatives to address the limitations of the CPD approach in producing quality design documentation (Agbaxode *et al.*, 2021b; Akampurira and Windapo, 2019). This requires certain capabilities, such as the early involvement of consultants in the project, especially during the design stage, to enhance planning and understanding (Ling *et al.*, 2020; Agbaxode *et al.*, 2020; Ma *et al.*, 2018). According to researchers and practitioners, these capabilities will contribute to efforts aimed at improving the quality of design documentation (Agbaxode *et al.*, 2021b; Abdallah *et al.*, 2018; Dosumu and Aigbavboa, 2018; Brown, 2002).

In a broader project management process, there are many factors that can significantly influence project delivery and overall quality. However, this study considers design documentation as one critical aspect of the process and provides the necessary capabilities to enhance quality. Therefore, this study used the Ghanaian construction industry to identify specific capabilities that are required in the CPD approach, particularly during the production of design documentation, to improve quality.

2. Literature review

2.1 Background

Although the construction industry globally has a variety of project delivery methods, the CPD (design-bid-build) approach where the owner hires a consultant to design the project, after which a contractor is procured to execute the works is dominant (Addy *et al.*, 2018; Mesa *et al.*, 2016; Nawi *et al.*, 2014; Fish and Keen, 2012). Comparably, it is the widely used method in the industry globally (Salla, 2020; CMAA, 2012). Its usage in the construction industry in terms of market share is 60% compared to the other existing delivery methods

(Aldossari *et al.*, 2021; CMAA, 2012). This resonates with statistics that over 90% of construction projects in Ghana, particularly in the public sector are delivered using this approach (Buertey *et al.*, 2021; Ameyaw and Oteng-Seifah, 2010). Therefore, Addy *et al.* (2018) posit that the CPD approach will continue to dominate the construction industry due to the industry's lack of readiness to apply new delivery methods.

Some major project delivery methods in use are design-build (DB); construction management (CM); public–private partnerships (PPPs) and integrated project delivery (IPD) (Ashcraft, 2022; Patterson *et al.*, 2021; CMAA, 2012). The DB is where the owner contracts a single entity (design-build contractor) to be responsible for both the project design and construction. The CM is where the owner hires a construction manager to oversee the entire construction process. The PPPs is where based on the collaboration, the private sector takes on the responsibility to deliver the project while the public sector retains ownership. Other project delivery methods exist but they are variations of these four (Patterson *et al.*, 2021; Aldossari *et al.*, 2021). While CPD accounts for about 60% of usage in the industry globally, CM accounts for 25%, DB accounts for 15% and IPD accounts for less than 1% usage (Aldossari *et al.*, 2021; CMAA, 2012). However, the CPD remains the dominant delivery method in the Ghanaian construction industry (Buertey *et al.*, 2021; Ameyaw and Oteng-Seifah, 2010).

Even though the CPD approach is the most widely used method in the industry globally, it is characterised by wide dissatisfaction (Agbaxode *et al.*, 2021b; Viana *et al.*, 2020). It has been widely criticised for its inability to produce quality design documentation (Shoar and Payan, 2021; Agbaxode *et al.*, 2021b; Zaneldin, 2020; Yap and Skitmore, 2018; Harper *et al.*, 2016; Mesa *et al.*, 2016; Nawi *et al.*, 2014). The CPD approach produces poor design documentation quality as a result of the processes involved (Agbaxode *et al.*, 2021b; Akampurira and Windapo, 2018). This often leads to acrimonious conflicts between various project parties (Rowlinson and McDermott, 2005). It has been argued that this approach lacks collaboration and integration, especially during design, which often results in poor design documentation quality (Shoar and Payan, 2021; Agbaxode *et al.*, 2021b; Zaneldin, 2020; Durdyev *et al.*, 2019; Yap and Skitmore, 2018; Harper *et al.*, 2016; Mesa *et al.*, 2016; Nawi *et al.*, 2014).

2.2 Design documentation quality and capabilities required for the conventional project delivery approach

Poor-quality design documentation is predominant and has become a major concern globally (Akampurira and Windapo, 2019). It has consequences of undesirable high cost of construction projects, project delays and poor quality of completed projects (Shoar and Payan, 2021; Tuhacek and Svoboda, 2019; Abdallah *et al.*, 2018; Akampurira and Windapo, 2018; Mesa *et al.*, 2016). It has been argued that large proportion of defects in construction projects often have roots in the defects of the project documentation (Tuhacek and Svoboda, 2019). Therefore, industry changes and initiatives are required to resolve the problems of design documentation quality (Akampurira and Windapo, 2019) particularly under the CPD. This aligns with Nawi *et al.* (2014) that process and team integration, especially during the design stage, are significant enablers for change in the industry to achieve success. Some researchers and practitioners recommend the early involvement of consultants in the project especially during design to enhance better planning and understanding (Ling *et al.*, 2020; Agbaxode *et al.*, 2020; Ma *et al.*, 2018). This will enhance design documentation quality when the consultants are encouraged to work as a team rather than as individuals (Maskil-Leitan and Reychav, 2018). Therefore, effective collaboration should be promoted by consultants to ensure better quality project delivery with enhanced efficiency (Pishdad-Bozorgi, 2017). This is why researchers and practitioners have all called for efforts to improve design documentation quality (Agbaxode *et al.*, 2021b; Abdallah *et al.*, 2018; Dosumu and Aigbavboa, 2018; Brown, 2002).

2.3 Efforts towards improving the quality of design documentation

To cure this canker in the industry globally, some developed countries are advancing in the use of integration and technology. However, various strategies that aimed to improve design documentation quality have been proposed. Some proposed the development of an instrument to measure the quality (Akampurira and Windapo, 2019). Others proposed the use of design checklists, departments for quality control (Abdallah *et al.*, 2018; Brown, 2002) and computer programs like Building Information Modelling (BIM) (Dosumu and Aigbavboa, 2018). Some software vendors and practitioners have also promoted the use of BIM as a panacea to design-related errors (Abdallah *et al.*, 2018; Love *et al.*, 2011). However, Pärn *et al.* (2018), in a study on BIM usage, and Love *et al.* (2011) on effective BIM usage all argue that BIM alone is not a panacea to poor design documentation quality. This notwithstanding, 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, poor-quality design documentation problem still exists (Akampurira and Windapo, 2019). Therefore, the study aims to identify required capabilities to help improve the processes in the CPD approach towards improving design documentation quality using the Ghanaian Construction Industry. It is hypothesised that:

> H_A: The quality of design documentation will improve when the required capabilities are determined.

3. Methodology

A mixed sequential research design (quantitative followed by qualitative methods) was used, which helped provide relevant and reliable results for this study (Saunders *et al.*, 2019; Creswell and Creswell, 2017; Tashakkori and Teddlie, 2010). As a strategy, a two-tier approach was used, which involved a questionnaire survey (composed of questions adapted from the literature) followed by semi-structured interviews to collect relevant data. The questionnaire survey was conducted online via Google Forms, whereas the interviews were conducted both online and in-person. The study involved clients and professionals such as architects, quantity surveyors, project managers and other relevant professionals in consulting and construction firms in the industry. In analysing the data, IBM SPSS Statistics for Windows, Version 27.0 was used to aid in quantitative data analysis, whereas QSR Nvivo 12 Pro software was used to aid in qualitative data analysis. In determining the quantitative data sample size, the following formula by Saunders *et al.* (2016, p. 283) was used:

$$n^a = \frac{n \ x \ 100}{re\%} \text{ therefore, } n^a = \frac{229 \ x \ 100}{53} = 432$$

n^a is the actual sample size required; n is the minimum sample size and $re\%$ is the estimated response rate in percentage. Referring to two different studies conducted in the same geographical area as this study by Agbaxode *et al.* (2021a, 2020), an estimated minimum sample size of 229 with a 53% response rate is calculated for this study. According to the formula, this translates to an estimated actual sample size of 432. However, this study received a total of 235 responses, resulting in a 54% response rate. The sample size for the interviews was determined by conducting additional interviews until data saturation (Saunders *et al.*, 2019) was reached, resulting in 15 interviews.

Descriptive and inferential statistics were used for quantitative data analysis, whereas content analysis was used for qualitative data. However, the main quantitative data analysis methods used were the relative importance index (RII), correlation and regression calculations. In determining the significance of each variable, the ranking was based on the RII of each factor (Holt, 2014; Ribeiro and Fernandes, 2010; Zeng *et al.*, 2005). Correlation and regression analyses were carried out in the study to determine the correlation and significant relationships between the variables. In addition, *correlation analysis* depicts the relationship between the variables and whether or not they relate, whereas *regression analysis* allowed the determination of the relationship between the dependent and the independent variables (George and Mallery, 2019; Morgan *et al.*, 2019; Aldrich, 2018).

Threats to the validity, reliability and generalisability, which are very important in ensuring the quality of a study (Saunders *et al.*, 2019; Dudwick *et al.*, 2006), were mitigated in this study through the triangulation of data. As a result, reliable information was obtained through questionnaires and semi-structured interviews (Mohajan, 2017). This approach added depth, breadth and richness to the study (Denzin, 2012; Denzin and Lincoln, 2011). In addition, a pilot study was conducted with the questionnaire, and subsequently, Cronbach's alpha values were calculated. To address potential research biases, multiple data sources were used to corroborate the findings. Informed consent was obtained from respondents and participants, and anonymity and confidentiality of responses were ensured by using numerical codes to represent responses. Furthermore, the research team comprised individuals from diverse backgrounds to mitigate any potential biases stemming from the researchers' perspectives.

4. Data analysis

Analysis involves data from the questionnaire survey and semi-structured interviews to answer the research question:

RQ. What capabilities are required of the CPD approach in producing quality design documentation?

The questionnaire survey recorded 235 responses, and 15 expert participants were interviewed.

4.1 Quantitative data analysis

The main research question for the study is: *What capabilities are required of the CPD in producing improved quality design documentation?* This provided the premise for the study and helped in finalising the arguments of the study by testing the hypothesis.

4.1.1 Respondents' background information. The study involved 64 (27%) project managers, 51 (22%) quantity surveyors, 35 (15%) engineers and 35 (15%) project supervisors, respectively; 31 (13%) architects; 13 (5%) managing directors; and 6 (3%) clients. The diverse categories of experts in the study, coupled with their involvement in the production of design documentation, indicate that reliable data was provided. In terms of education level, 55% were first-degree or honours graduates, 22% were master's or postgraduate diploma holders, 18% were higher diploma holders and 2% were PhD holders. Therefore, the respondents have attained good levels of education and provided reliable data. A majority of 45% had between 11 and 20 years of experience in the industry, 38% had between 6 and 10 years, 11% had between 1 and 5 years and 6% had between 21 and 30 years of experience. This indicates their significant experience in the industry and, therefore, their provision of relevant responses. In terms of respondents' sector of work, 49.79% work in the private sector, whereas 50.21% work within the public sector. When considering their work outfits, 65% work in consultants' outfits, whereas 35% work in contractors' outfits. Therefore, there is nearly a fair balance between respondents in the private and public sectors of work.

4.1.2 Validity, reliability and generalisability of study data. Cronbach's alpha (α) values were used to determine the extent to which the questionnaire yielded consistent findings that can be replicated transparently. This was achieved by the use of IBM SPSS software and the interpretation is based on the following values according to Tavakol and Dennick (2011); $\alpha \geq 0.9$ (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); and $0.5 > \alpha$ (Unacceptable). A value more than 0.7 is usually acceptable. Most often, higher values of alpha (0.90–0.95) which indicates highly correlated items are preferred. This notwithstanding, Table 1 presents the reliability statistics of data (20 items) on the capabilities required of the CPD approach.

The actual value of alpha is 0.994 which is greater than 0.9 (i.e. $\alpha > 0.9$) indicating an ***excellent*** level of internal consistency. Therefore, the complete data is reliable and acceptable.

4.1.3 Preliminary analysis of questionnaire survey data. A preliminary analysis of the questionnaire data was performed to determine the significance of each factor using RII for the ranking based on values ranging from 0 to 1. The ranking is based on five important levels which are $0.8 \leq \text{RII} \leq 1$ (High, H); $0.6 \leq \text{RII} \leq 0.8$ (High-Medium, H-M); $0.4 \leq \text{RII} \leq 0.6$ (Medium, M); $0.2 \leq \text{RII} \leq 0.4$ (Medium-Low, M-L); and $0 \leq \text{RII} \leq 0.2$ (Low, L). However, where the RII values are the same, the mean score is used for the ranking. A total of 20 factors from the questionnaire survey were ranked and all had RII values between 0.85 and 0.89 (i.e. $0.8 \leq \text{RII} \leq 1$) indicating high importance level. These factors indicate significant capabilities that are required of the CPD approach in producing design documentation. The top five ranked capabilities include preparation of detailed design; improving collaboration between architectural and engineering design disciplines; paying appropriate fees to consultants; specialists' involvement in design planning and processing; and holding consultants accountable for producing poor design documentation quality.

4.1.4 Spearman's rank-order correlation analysis. The Spearman's correlation is a non-parametric correlation analysis that involves determining the degree of correlation, the significance level and testing the correlation coefficient hypotheses. The statistical hypothesis test for the ρ values is H_0: ρ (rho) = 0 (no relationship between the variables). H_1: ρ (rho) $\neq 0$ (relationship exists between the variables). The standard value for ρ is 0.05 or smaller at the 0.01 level (two-tailed) to consider the correlation statistically highly significant. The analysis involves 20 variables with 235 number of cases as presented in Table 2 including their mean and standard deviation values. From Table 2, the least

Table 1. Reliability statistics of data

Cronbach's alpha	Cronbach's alpha based on standardised items	No. of items
0.993	0.994	20

Source: Authors' own work

standard deviation is 0.567 and the highest is 0.862. These values are relatively high which indicates statistical significance.

The codes in Table 2 are used to represent the capabilities in Tables 3 and 5.

4.1.4.1 Correlation analysis (r_s). Table 3 presents the correlation results in a matrix form. 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 (two-tailed) and 0.05, therefore, there is evidence that a statistically significant bivariate association exists between the variables. From Table 3, all the ρ values are less than 0.01 and not equal to zero, therefore, in testing the population hypothesis, H_1: ρ (rho) $\neq 0$; hence, the null hypothesis is rejected and the alternative hypothesis is accepted that the relationship between the variables is statistically significant. Therefore, Spearman's correlation coefficient, r_s of +0.715 is statistically significant ($p = 0.000$).

4.1.4.2 Summary of the Spearman's rank-order correlation. In determining the relationship between the 20 variables on capabilities required in the production of design documentation, a Spearman's rank-order correlation analysis was executed. The results in Table 3 shows that there is a strong, positive correlation between the variables, which is statistically significant [$r_s(20) = +0.715$, $p = 0.000$].

4.1.5 Multiple regression analysis. In determining the degree of relationship between the variables, the multiple regression analysis was carried out which resulted in testing the study hypothesis. The null hypothesis (H_0) is *the quality of design documentation will not improve when the required capabilities are determined.* The alternative hypothesis (H_A) is *the quality of design documentation will improve when the required capabilities are determined.*

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

Source: Authors' own work

Table 2. Descriptive statistics of data ($N = 235$)

Table 3. Spearman's correlation matrix (N = 235); sig. values are all 0.000

Capabilities	Values	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10
C1	rho	1.000	0.817**	0.886**	0.943**	0.965**	0.946**	0.941**	0.939**	0.969**	0.886**
C2	rho	0.817**	1.000	0.725**	0.833**	0.813**	0.837**	0.769**	0.828**	0.803**	0.855**
C3	rho	0.886**	0.725**	1.000	0.862**	0.881**	0.863**	0.926**	0.860**	0.886**	0.820**
C4	rho	0.943**	0.833**	0.862**	1.000	0.978**	0.995**	0.928**	0.995**	0.967**	0.940**
C5	rho	0.965**	0.813**	0.881**	0.978**	1.000	0.973**	0.948**	0.974**	0.988**	0.922**
C6	rho	0.946**	0.837**	0.863**	0.995**	0.973**	1.000	0.922**	0.991**	0.962**	0.934**
C7	rho	0.941**	0.769**	0.926**	0.928**	0.948**	0.922**	1.000	0.929**	0.956**	0.883**
C8	rho	0.939**	0.828**	0.860**	0.995**	0.974**	0.991**	0.929**	1.000	0.972**	0.946**
C9	rho	0.969**	0.803**	0.886**	0.967**	0.988**	0.962**	0.956**	0.972**	1.000	0.922**
C10	rho	0.886**	0.855**	0.820**	0.940**	0.922**	0.934**	0.883**	0.946**	0.922**	1.000
C11	rho	0.923**	0.825**	0.850**	0.977**	0.957**	0.971**	0.916**	0.982**	0.956**	0.965**
C12	rho	0.925**	0.756**	0.927**	0.912**	0.932**	0.906**	0.983**	0.918**	0.945**	0.891**
C13	rho	0.946**	0.773**	0.918**	0.933**	0.953**	0.926**	0.991**	0.938**	0.965**	0.892**
C14	rho	0.904**	0.739**	0.981**	0.868**	0.888**	0.870**	0.935**	0.866**	0.893**	0.825**
C15	rho	0.918**	0.751**	0.965**	0.881**	0.901**	0.883**	0.949**	0.878**	0.906**	0.835**
C16	rho	0.957**	0.781**	0.883**	0.939**	0.960**	0.933**	0.945**	0.944**	0.971**	0.922**
C17	rho	0.903**	0.831**	0.837**	0.955**	0.937**	0.950**	0.898**	0.961**	0.936**	0.974**
C18	rho	0.862**	0.889**	0.798**	0.919**	0.901**	0.913**	0.862**	0.925**	0.900**	0.965**
C19	rho	0.926**	0.756**	0.916**	0.912**	0.932**	0.906**	0.983**	0.918**	0.944**	0.898**
C20	rho	0.737**	0.606**	0.836**	0.745**	0.760**	0.736**	0.801**	0.754**	0.774**	0.737**

Note: **Correlation is significant at the 0.01 level (two-tailed)
Source: Authors' own work

(*continued*)

Capabilities	Values	C11	C12	C13	C14	C15	C16	C17	C18	C19	C20
C1	rho	0.923**	0.925**	0.946**	0.904**	0.918**	0.957**	0.903**	0.862**	0.926**	0.737**
C2	rho	0.825**	0.756**	0.773**	0.739**	0.751**	0.781**	0.831**	0.889**	0.756**	0.606**
C3	rho	0.850**	0.927**	0.918**	0.981**	0.965**	0.883**	0.837**	0.798**	0.916**	0.836**
C4	rho	0.977**	0.912**	0.933**	0.868**	0.881**	0.939**	0.955**	0.919**	0.912**	0.745**
C5	rho	0.957**	0.932**	0.953**	0.888**	0.901**	0.960**	0.937**	0.901**	0.932**	0.760**
C6	rho	0.971**	0.906**	0.926**	0.870**	0.883**	0.933**	0.950**	0.913**	0.906**	0.736**
C7	rho	0.916**	0.983**	0.991**	0.935**	0.949**	0.945**	0.898**	0.862**	0.983**	0.801**
C8	rho	0.982**	0.918**	0.938**	0.866**	0.878**	0.944**	0.961**	0.925**	0.918**	0.754**
C9	rho	0.956**	0.945**	0.965**	0.893**	0.906**	0.971**	0.936**	0.900**	0.944**	0.774**
C10	rho	0.965**	0.891**	0.892**	0.825**	0.835**	0.922**	0.974**	0.965**	0.898**	0.737**
C11	rho	1.000	0.921**	0.924**	0.856**	0.867**	0.950**	0.978**	0.935**	0.925**	0.758**
C12	rho	0.921**	1.000	0.979**	0.935**	0.948**	0.951**	0.905**	0.866**	0.987**	0.815**
C13	rho	0.924**	0.979**	1.000	0.927**	0.940**	0.954**	0.907**	0.871**	0.978**	0.799**
C14	rho	0.856**	0.935**	0.927**	1.000	0.984**	0.889**	0.841**	0.802**	0.924**	0.818**
C15	rho	0.867**	0.948**	0.940**	0.984**	1.000	0.901**	0.852**	0.812**	0.936**	0.805**
C16	rho	0.950**	0.951**	0.954**	0.889**	0.901**	1.000	0.947**	0.890**	0.964**	0.791**
C17	rho	0.978**	0.905**	0.907**	0.841**	0.852**	0.947**	1.000	0.940**	0.920**	0.754**
C18	rho	0.935**	0.866**	0.871**	0.802**	0.812**	0.890**	0.940**	1.000	0.866**	0.715**
C19	rho	0.925**	0.987**	0.978**	0.924**	0.936**	0.964**	0.920**	0.866**	1.000	0.812**
C20	rho	0.758**	0.815**	0.799**	0.818**	0.805**	0.791**	0.754**	0.715**	0.812**	1.000

Table 3.

The regression analysis includes summary analysis: analysis of variance (ANOVA) and coefficients. A total of 20 capabilities were used as presented in Table 5 with a sample size of 235 without any missing score.

4.1.5.1 Summary analysis. The summary analysis provides the *R*, *R-square*, adjusted *R-square* and the standard error of the estimate as presented in Table 4. These values determine how a regression analysis fits the data.

From Table 4, the multiple correlation coefficient (*R*) using all the predictors simultaneously is 0.886. The adjusted *R*-square is 0.766 which 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.

4.1.5.2 Analysis of variance. A 95% confidence level which represents a 5% (0.05) level of significance was set for the regression. Therefore, from Table 4, a sig. value of 0.001 which is less than 0.05 is acceptable. The analysis is considered efficient and acceptable because the *F*-value of 39.220 in this case is greater than 1. From the regression analysis ANOVA in Table 4, there is a good fit for the data because the independent variables statistically significantly predict the dependent variable, $F(20, 214) = 188.300$, $p < 0.05$. This shows that an *F*-value of 39.220 is statistically significant and indicates that the predictors significantly combine to predict the capabilities required in the production of design documentation.

4.1.5.3 Regression analysis coefficients. From Table 5, the statistical significance (sig.) and the *t*-values of each variable are important to determine the variables that significantly contributes to predict the capabilities required in the production of design documentation. For a 95% confidence level, the sig. value should be less than 0.05 ($p < 0.05$) to conclude that the coefficients are statistically significantly different to zero hence the null hypothesis can be rejected.

From Table 5, when all the predictors are considered, six variables have sig. values less than 0.05 ($p < 0.05$) which significantly adds to the prediction. These variables 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.* Therefore, these six variables reject the null hypothesis (H_0) and accept the alternative hypothesis (H_A) that the quality of design documentation will improve when the required capabilities are determined. However, all the predictors inclusively gave this result because the overall *F*-value was computed using all the variables.

4.1.5.4 Summary of regression results. The results of the multiple regression shows that the combination of variables to predict the capabilities required in the production of design documentation from the predictor variables is statistically significant, $F(20, 214) = 188.300$, $p < 0.05$. There are six independent variables that significantly predict the capabilities required in the production of design documentation when all 20 variables are included.

Summary	*R*	*R* square	Adjusted *R* square		Std. error of the estimate	
	0.886	0.786	0.766		13.722	
ANOVA	Model	Sum of squares	df	Mean square	*F*	Sig
	Regression	147,703.782	20	7,385.189	39.220	<0.001
	Residual	40,296.218	214	188.300		
	Total	188,000.000	234			

Source: Authors' own work

Table 4. Regression analysis summary and ANOVA

Capabilities	Unstandardised coefficients B	Std. error	Standardised coefficients Beta	t	Sig.
Constant	−130.323	8.380		−15.552	<0.001
C1	9.617	6.639	0.213	1.448	0.149
C2	12.816	4.420	0.256	2.899	0.004
C3	−13.425	7.476	−0.312	−1.796	0.074
C4	−49.342	9.843	−1.271	−5.013	<0.001
C5	9.590	9.826	0.233	0.976	0.330
C6	52.952	13.295	1.281	3.983	<0.001
C7	−1.318	10.175	−0.035	−0.129	0.897
C8	−18.847	15.362	−0.484	−1.227	0.221
C9	−19.028	10.279	−0.484	−1.851	0.066
C10	0.959	7.886	0.027	0.122	0.903
C11	9.249	10.181	0.257	0.908	0.365
C12	−8.083	9.794	−0.228	−0.825	0.410
C13	14.049	11.644	0.376	1.207	0.229
C14	26.493	9.591	0.573	2.762	0.006
C15	−9.670	9.868	−0.213	−0.980	0.328
C16	7.189	6.410	0.218	1.121	0.263
C17	16.524	7.831	0.473	2.110	0.036
C18	−4.298	6.351	−0.114	−0.677	0.499
C19	−7.619	8.765	−0.224	−0.869	0.386
C20	15.620	3.155	0.436	4.951	<0.001

Source: Authors' own work

Table 5. Regression analysis coefficients

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 of 0.766 presented in Table 4 is an indication that 76.6% of the variance in the capabilities required in producing design documentation was explained.

4.2 Qualitative data analysis

Qualitative data for this study is obtained from 15 interviews with experts in the construction industry. These experts are professional quantity surveyors, architects and project managers. In analysing the data, content analysis was used with focus on descriptive and pattern coding with the aid of QSR Nvivo 12 Pro software. This approach helped to code themes and words in the interview transcripts and provided a systematic analysis of the data. Pseudonyms as used in Table 6 (P1, P2... and P15 which represents Participant 1, Participant 2 in that order up to Participant 15) were assigned to each interview transcript to ensure confidentiality and anonymity of participants.

4.2.1 Research participants background information. Study participants include five quantity surveyors, five architects and five project managers, who provided expert opinions and reliable data. They have good levels of education therefore provided intellectual data for this study. A majority of 73% have master's degrees while 27% are first degree graduates. Participants have rich experiences in the construction industry with in-depth knowledge on the study objective. The highest years of experience recorded is 21 while the least is 8 with an average of 14 years' experience for all. However, eight participants (53%) work within the public sector, whereas seven (47%) works within the private sector. This provided a balance

Table 6. Capabilities required in the production of design documentation under the CPD approach

Code	Capabilities	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12	P13	P14	P15	Frequency	Ranking
		Participants responses																
C14	Improving collaboration between consultants	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	15	1
C3	Paying appropriate fees to consultants				✓		✓	✓	✓			✓		✓	✓		7	2
C1	Holding consultants accountable for producing poor design documentation quality (penalty)			✓			✓	✓			✓			✓	✓		6	3
C2	Incentives for producing good design documentation quality				✓		✓	✓				✓		✓	✓		6	4
C18	Provision of elaborate and improved project brief						✓	✓						✓	✓		4	5
C20	Preparation of detailed design and documentation						✓	✓						✓			3	6
C13	Designers partnering with others while preparing design documents	✓	✓							✓							3	7
C16	Use of computer programs such as BIM					✓		✓					✓				3	8
C21	Allowing contractors to make input during the design stage					✓							✓				2	9
C5	Clients allowing adequate time for the preparation of design documents							✓							✓		2	10
C6	Mandatory coordination of design documentation by a supervisor with requisite skills and knowledge		✓							✓							2	11
C15	Specialists' involvement in design planning and processing					✓											1	12
C22	Designers collaborating with all stakeholders during design and documentation												✓				1	13
C9	Re-checking design documentation for accuracy							✓									1	14
C17	Job-relevant training and practice					✓											1	15
C23	Appropriate efforts towards reducing the level of fragmentation															✓	1	16

Source: Authors' own work

of information from the two sectors of work in the industry. Ten participants (67%) work within consultants' outfit, whereas five (33%) work within contractors' outfit. Therefore, there is a balance of information from both consultants and contractors.

4.2.2 Capabilities required of the conventional project delivery approach. The raw data from the interview transcripts were auto coded with the aid of QSR Nvivo 12 Pro. This helped in coding the data and resulted in the extraction of interview responses verbatim for further analysis. This was followed by the application of content analysis which involves:

- the selection of content to analyse: the interview transcripts;
- definition of units: frequency of phrases and themes in the data; and
- coding: appropriately recording data to determine descriptions and patterns.

The analysis resulted in identifying 16 capabilities as presented in Table 6 with a determination of the significance of each code based on the frequency of occurrence of each code.

The results indicate the following: all participants purported an improvement in collaboration between architectural and engineering design disciplines as a major capability. Seven participants were of the view that payment of appropriate fees to design consultants is a major capability. Six participants indicated that holding consultants accountable for producing poor design documentation quality and providing incentives for producing good design documentation quality are some potential capabilities. The top five factors ranked based on the frequency of response are improving collaboration between architectural and engineering design disciplines; paying appropriate fees to consultants; holding consultants accountable for producing poor design documentation quality; incentives for producing good design documentation quality; and provision of an elaborate and improved project brief.

5. Results and discussion

Identifying capabilities that the CPD approach must acquire in practice, particularly during design documentation production, to improve quality is the aim of this study. The results provide enough information to reject the null hypothesis and conclude that the quality of design documentation will improve when the required capabilities are determined. The questionnaire survey identified 20 capabilities, whereas the interviews identified 16 capabilities. However, 13 of these capabilities align with the questionnaire survey. Results from the interview participants who work in the private sector present three new capabilities that were not part of the questionnaire survey: *contractors should 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.* A majority of 71% of participants who work in the public sector indicated that incentives for producing good design documentation quality must be formulated, whereas 64% believe that there is a need to improve collaboration between consultants. The main findings from the study are presented in Table 7, comprising six findings from the questionnaire survey and three additional findings from the interviews. These findings are discussed as follows.

5.1 Incentives for producing good design documentation quality

One major required capability is the introduction and formulation of incentives for producing good design documentation quality. This will help professionals to concentrate on the project and will result in unnecessary negligence on the part of designers (Dosumu and Aigbavboa, 2018). When there is no motivation, productivity is low. Therefore, there is

Table 7.
Capabilities required in the production of design documentation

No.	Capabilities
Questionnaire and interview capabilities	Incentives for producing good design documentation quality
	Improving consultants working conditions and procedures
	Mandatory coordination of design documentation by a supervisor
	Improving collaboration between consultants
	Job-relevant training and practice
	Preparation of detailed design
New capabilities from interviews	Allowing contractors to make input during the design stage
	Designers collaborating with all stakeholders during design and documentation
	Appropriate efforts towards reducing the level of fragmentation

Source: Authors' own work

the 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).

5.2 Improving consultants' working conditions and procedures

Improvement in the working conditions and procedures of consultants includes involving consultants early in the project especially during design to enhance better planning and project understanding (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, they should have mutual trust and respect for each other to improve better team coordination (Durdyev *et al.*, 2019). They should promote effective collaboration to achieve better quality project delivery with enhanced project efficiency (Pishdad-Bozorgi, 2017).

5.3 Mandatory co-ordination of design documentation by a supervisor

Mandatory coordination of design documentation by a supervisor with requisite skills and knowledge is another important required capability. 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. This will help reduce 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 the need to coordinate the activities of the various professionals to achieve an improvement in the quality of design documentation (Akampurira and Windapo, 2019).

5.4 Improving collaboration between consultants

There is a need for an improvement in collaboration between various design disciplines. Any improvement in collaboration between these professionals will result in a better understanding of each other and subsequently improve documentation quality because designs and drawings serve as the basis for the other documents (Agbaxode *et al.*, 2023; Dosumu and Aigbavboa, 2018). A good collaboration will enhance knowledge sharing on the project which will result in improved design documentation quality (Dosumu and Aigbavboa, 2018) and will prevent deficiencies in design documentation (Assaf *et al.*, 2017). This is consistent with Yap and Skitmore (2018) and Philips-Ryder *et al.* (2013) that the CPD lacks coordination between the design team members. Therefore, there is the need to ensure that they are coordinated to enhance project quality.

5.5 Job-relevant training and practice

The training of design team members is another significant capability. 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 trainings for the various project professionals. The training would help in knowledge sharing on their experiences (Dosumu and Aigbavboa, 2018). Furthermore, it will result in knowledge and experience transfer among designers (Dosumu *et al.*, 2017). Therefore, designers' professional education must be carried out to equip them with the requisite knowledge (Dosumu *et al.*, 2017).

5.6 Preparation of detailed design

Design consultants must take their time and produce detailed designs. Detailing of designs will enhance documentation quality and subsequently improve project efficiency (Agbaxode *et al.*, 2023). It gives other professionals a clear understanding of what is to be done and results in better documentation quality from all the other team members. It will reduce oversight problems and negligence on the side of some designers (Dosumu and Aigbavboa, 2018). Detailed designs have the tendency to ensure an efficient project delivery because the level of uncertainty will be reduced to a minimum. It will also help reduce design deficiencies because the design documents will portray adequate details (Assaf *et al.*, 2017).

5.7 Allowing contractors to make input during the design stage

Encouraging contractors' input during the design stage is considered another major capability that is required of the CPD approach. Interview participant 5 indicated that ". . .. Contractors should be allowed to make input and bring their experience to bear particularly during the design stage. . ..". Their early involvement is a very critical and significant element in project delivery (Agbaxode *et al.*, 2020; Jadidoleslami *et al.*, 2019). It ensures better planning and understanding of the project which enhances the quality of design documentation (Ling *et al.*, 2020; Viana *et al.*, 2020; Agbaxode *et al.*, 2020; Ma *et al.*, 2018). It allows for early contribution and sharing of knowledge and expertise at the project planning and design stages which results in a more effective, feasible and constructible design (Viana *et al.*, 2020; Jadidoleslami *et al.*, 2019). It helps in reducing possible reworks at the construction stage (Viana *et al.*, 2020). It also helps in reducing claims and consequently minimises design changes throughout the project life (Kahvandi *et al.*, 2016).

5.8 Designers collaborating with all stakeholders during design and documentation

Collaboration among all stakeholders during design documentation production will prevent deficiencies (Assaf *et al.*, 2017). It 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 interest (Durdyev *et al.*, 2019). Interview participant 12 indicated that "[. . .] designers must collaborate more with project stakeholders during design and even during the documentation stage [. . .]". This resonates with a research by Heravi *et al.* (2015) which evaluated the level of stakeholder involvement during the project planning stages and indicated that most project designers contribute less during the planning stage while the contractor is not involved in most cases. Therefore, there is a need for collaboration among designers and other stakeholders particularly during the early stages of the project to enhance the quality of design and documentation.

5.9 Appropriate efforts towards reducing the level of fragmentation

The study affirms that the CPD approach is characterised by fragmentation leaving the project team members and firms on their own. Interview participant 15 indicated that "…. there should be enough effort towards reducing the level of fragmentation that is associated with the conventional approach". This aligns with Dosumu *et al.* (2017) that the construction industry is fragmented particularly under the CPD approach. Durdyev *et al.* (2019) asserts that this is a result of a lack of integration with this approach. Project team members are allowed into the project at different stages under this approach (Ebrahimi and Dowlatabadi, 2019). Therefore, design team members should coordinate and collaborate in executing their tasks to achieve effective project delivery (Akampurira and Windapo, 2019). In achieving this, there is a need to overcome the existence of multiple cultures within the CPD approach (Viana *et al.*, 2020). However, the fragmentation with this approach results in poor productivity, delays, upsurges in cost and poor quality of projects (Zhang *et al.*, 2018).

6. Conclusion

The study used the Ghanaian Construction Industry to identify specific capabilities that are required of the CPD in practice, particularly during the production of design documentation. As a result, specific capabilities were identified based on both questionnaire survey and interview data. The questionnaire survey identified 20 potential capabilities, and the interview responses agreed with this outcome, identifying 16 capabilities. However, 13 of these capabilities aligned with the outcome of the questionnaire survey while 3 additional capabilities were identified through the interviews that were not part of the questionnaire survey. After testing the hypothesis and finalising the argument for the study, 9 main required capabilities are presented. The specific findings include providing incentives for producing good design documentation quality; mandatory coordination of design documentation; improving collaboration among designers; and allowing contractors to make input during the design stage. The results indicate the need for the identified capabilities to be introduced in the CPD approach to improve design documentation quality and provide data for future research. The study offers a significant insight into the specific capabilities that are required of the CPD approach in practice, particularly in the production of design documentation. When considering current industry practices and regulations, the findings of this study re-echo the need to enforce compliance with regulations, codes and standards in the production of design documentation. This involves the mandatory co-ordination of design documentation by a supervisor and enhancing the preparation of detailed design. Professional bodies must continuously organise job-relevant training and practice for members, such as the use of various digital tools and technologies to enhance design documentation quality.

7. Limitations and recommendations for future research

This study has certain limitations despite the significant contribution it makes. One such limitation is that only 15 participants were interviewed. In future studies, a larger number of participants should be interviewed to collect a more diverse range of subjective views. Another limitation is that this study is focused on identifying specific capabilities required by the CPD in practice, particularly during the production of design documentation. Further research is recommended based on this study to establish an implementation framework for these capabilities within the CPD approach, aiming to improve the quality of design documentation. However, there is a larger research project underway that aims to develop a framework for improving the quality of design documentation. This study shares a common methodology, research respondents and participants with that larger project.

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