Design documentation quality influential variables in the construction sector

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Abstract

There are numerous studies on design documentation variables without efforts to evaluate their level of importance. Therefore, the aim of this study is to evaluate the significance of these variables towards improving design documentation quality. A questionnaire survey to identify the significance of key quality variables was carried out. A total of 139 variables on design documentation quality were used. The mean score and Standard deviation of each factor were used to determine the level of significance. Based on responses from 112 construction industry players, the significance of each variable is determined. Design documentation is fit for purpose was considered highly important as an attribute while Inadequate and Insufficient documentation was ranked highest for quality influential factors. The findings will provide valuable data to stakeholders, researchers, and academics and will help enhance project performance because professionals will be aware of key factors that can influence design documentation quality. It will also aid in providing solution to sustainable infrastructure design and delivery challenges in the industry. The study offers a pragmatic data and empirical evidence to expand knowledge on design documentation quality. It is the first of its kind that explored the significance of design documentation quality variables based on the outcome of a meta-synthesis.

Keywords: Design documentation, design document quality, quality influential variables, quality improvement, construction sector

1. Introduction

The efficiency of a construction project is underpinned by design documentation quality provided [1], therefore efforts must be gathered during the production of design documentation to improve quality. While it is required of design documentation to be of good quality (precise or accurate, comprehensive and unambiguous) to attain project efficiency, it is rather unfortunate that these documents practically contain erroneous or conflicting information and are often incomplete [1]. However design documentation must ensure fitness for purpose and be effective by communicating the design intent [2,3].

Globally, design documentation quality in the construction sector is poor [2,4]. Tuhacek and Svoboda [4] argued that design documentation in practice is poor hence efforts are required to improve the quality. The consequences of poor documentation quality on project delivery are project delays, poor project quality and upsurges in cost [4–6]. In finding solution to this worrying situation, researchers and practitioners have proposed various means to improve the quality. The use of computer programs such as
Building Information Modelling (BIM) [7], use of design checklists and establishment of quality control departments [6,8]. The development of a measuring instrument for evaluating the quality was proposed by Akampurira and Windapo [2]. This is an indication that poor design documentation quality exists within the construction industry hence efforts must be directed towards improving on the quality.

There are numerous studies on design documentation variables in the construction sector without efforts to evaluate the importance of these variables in improving the quality. However, without identifying the design documentation variables that has high influence on the quality, it will be difficult to improve on the quality. Therefore, the aim of this study is to evaluate each variable that influences design documentation quality and rank the factors on the basis of significance attached. This provides an overview of the factors that highly influence design documentation quality. The following section presents relevant literature regarding design documentation quality in the construction sector.

2. Literature Review

The socio-economic development of nations across the world is largely influenced by the physical infrastructure that is produced by the construction sector [9,10]. The sector contributes about ten percent (10%) of Gross Domestic Product (GDP) and employs about ten percent (10%) of the labor force in countries around the world [7,11,12]. Therefore consideration must be given to factors that may influence inefficiency in the sector. This has necessitated the need for a study on design documentation quality since it influences construction efficiency.

2.1 Design documentation

The accuracy and clarity of design documentation is important in project delivery since it serves as the yardstick for executing the project. It is these documentation that is produced by consultants that contractors use in executing the project [2,13]. Therefore the efficiency of a project is dependent on its clarity and completeness [14]. This notwithstanding, sufficient information and the actual intent of the design should be contained in the documentation provided for a project [2,15]. The client, consultants, contractors and other key stakeholders exchange a variety of design documentation during project delivery [16,17]. These include but not limited to design drawings; specifications; Bill of Quantities; schedule of rates, basic prices; form of tender or contract; conditions of contract [2,16,18–22].

2.2 Design documentation quality

An enhancement in design documentation quality often leads to an achievement in value for money [23]. However, quality can be defined as "the degree to which a set of inherent characteristics fulfills requirements" [24] and this can be categorized into poor, good, and excellent.Completeness, relevance, clarity, timeliness, accuracy, coordination, final checking, certainty, standardization of documentation and conformity are among ten (10) attributes of design documentation quality that McFallan and Tilley [26,27] recommended after a study on design documentation quality. Laryea [20] also stated similar attributes in a study on tender documentation quality in the United Kingdom. Hence a combined assessment of the degree of these quality attributes determines design documentation quality in practice.

Globally, design documentation quality is poor [2] and this calls for concern in the industry across the world [2,4,5,7,19,29–31]. In practice, design documentation is poor and bedeviled with unclear, inconsistent and inadequate information [5,20,32] thereby resulting in inaccurate cost estimates [33] and leads to an increase in project markups [34]. Therefore in a bid to enhance project efficiency, there is the need for an improvement in design documentation quality. This poor quality has been in existence over the past decades [20,25,35,36] and often denies clients from achieving value for money [21].
2.3 Design documentation quality variables
A study by Dosumu and Aigbavboa [7] on evaluating the causes, effects, and solutions of design error posited lack of coordination between design documentation, poor drawings, omissions, and mistakes, as main factors responsible for poor design documentation quality. Poor documentation quality is characterized with conflicting and inaccurate information, lack of clarity, insufficient details, un-amended standard specifications, and documents not clearly projecting project requirements [27]. Others are poor specification writing, discrepancies between bill of quantities, drawings and specifications, and poorly prepared tender documents [20,25]. Therefore there are numerous factors that are responsible for poor design documentation quality.

The delivery of construction projects is highly influenced by poor design documentation quality which often results in claims, rework, shoddy works, disputes, and litigation [11,35,37,38]. It accounts for incorrect cost estimates, higher margins in bids, project costs overruns and project delays [1,20,33,39]. Therefore in a bid to improve the efficiency of the construction process to ensure client satisfaction and project profitability, design documentation quality must be improved [40,41].

2.4 Enhancing design documentation quality
The quality of design documentation produced for most construction projects continue to decrease despite numerous efforts by both researchers and practitioners over the years to improve the quality [25–27,35,36]. Various strategies such as increasing design fees, design and documentation coordination, independent reviews, setting standards for documentation quality control and service, education on constructability, and accountability of design consultants have been proposed to help improve design documentation quality [3]. Other strategies include having design checklists, verifying documents before use, use of BIM or other computer programs, and establishing quality control departments [6–8].

The need for industry changes and initiatives to enhance design documentation quality has been recommended by Tilley et al. [3] in a research on improving design documentation quality. While Akampurira and Windapo [2] after a study on design documentation quality attributes recommends the development of an instrument for assessing design documentation quality, nonetheless, there exist numerous tools for assessing design quality [42,43].

There exist numerous studies on design documentation quality with majority recommending improvement in the quality [5]. However, it will be difficult to improve on the quality without identifying the variables that has high influence on the quality. Therefore, the aim of this study is to evaluate each variable that influences design documentation quality and rank the factors on the basis of significance attached. The methodology is presented in the next section.

3. Methodology
3.1 Study design
The philosophical stance for this research is positivism. Positivism infers “importance of what is posited, and focus strictly on scientific empiricist method designed to yield pure data and facts uninfluenced by human interpretation or bias” [44]. Epistemologically, positivism is a scientific method that observes and measures facts [44] hence the choice for this study since the target is to observe and measure facts with regards to design documentation quality in practice.

The methodological choice for this study is quantitative. The data collection technique is questionnaire and analysis is numerical which is the basis for quantitative research [44]. The study employs deductive approach since this approach emphasizes causality and starts with a theory that is tested to either falsify or verify the theory [44]. The logic is that when the premises are true, the conclusions shall also be true hence propositions are evaluated based on data collected [44].
3.2 Synthesizing data

In order to achieve the aim of this study, an extensive literature review was conducted on design documentation quality in the construction industry using a meta-synthesis approach. Relevant and appropriate research articles were selected through a screening process under the meta-synthesis approach. In achieving this, keywords that are related to the research question were used as the first step to search in appropriate and reliable scientific databases followed by a review of titles and abstracts of articles. The meta-synthesis approach achieved an extraction of a total of 139 variables on design documentation quality within the construction industry. These synthesized factors were classified and categorized to clearly explain the relevance and significance of each factor.

3.3 Survey questionnaire

An online survey questionnaire was developed and distributed to respondents (construction sector professionals). The questionnaire aim to assess the level of significance attached to each factor or variable. The use of questionnaire for this study was because it provides an efficient opportunity to each respondent to respond to the same set of questions [44]. It also ensure that the right information that is needed to achieve the set objective for this study is collected [44]. The assessment of the factors in the survey was based on a five-point Likert scale of importance.

There were four (4) sections of the questionnaire survey; Section A contains demographic information of respondents; Section B contains design documentation quality attributes and indicators; Section C is factors influencing design documentation quality, and Section D makes provision for comments and additional factors from respondents.

Validity and reliability of the instrument was ensured by conducting a pilot study with professionals in the industry with the aim to test the variables; detect ambiguities and to provide opportunity for any overlooked factor to be added. The next section presents results and appropriate discussions.

4. Results and Discussions

A questionnaire survey to identify the significance of the variables was sent to 229 purposefully selected respondents who are construction sector professionals such as site supervisors, engineers, quantity surveyors, architects, project managers and managing directors, in the Ghanaian construction industry as presented in Table 4.1. There were a total of 112 respondents representing 49% response rate. These respondents have significant experiences in the construction sector as presented in Table 4.1, therefore had an in-depth knowledge in responding to the survey.

Table 4.1: Demographic information.

| Role in the Construction Sector                  | Frequency | Percent |
|-------------------------------------------------|-----------|---------|
| Foreman or Supervisor                           | 19        | 16.96   |
| Engineer or Technologist                        | 23        | 20.54   |
| Quantity Surveyor                              | 28        | 25.00   |
| Architect                                       | 14        | 12.50   |
| Project or Construction Manager                 | 18        | 16.07   |
| Managing Director                               | 10        | 8.93    |
| Total                                           | 112       | 100.00  |

| Years of Experience in the Construction Sector  | Frequency | Percent |
|------------------------------------------------|-----------|---------|
| 1yr – 5yrs                                     | 19        | 16.96   |
| 6yrs – 10yrs                                   | 42        | 37.50   |
| 11yrs – 20yrs                                  | 41        | 36.61   |
| 21yrs – 30yrs                                  | 5         | 4.46    |
| 31yrs – 40yrs                                  | 3         | 2.68    |
| Above 40yrs                                    | 2         | 1.79    |
| Total                                           | 112       | 100.00  |

The educational level of respondents is important in this study therefore, presented in figure 4.1 with major qualifications as; Higher National Diploma (HND), 1st degree, Masters and Postgraduate degrees.
A total of 139 variables composed of 19 quality attributes, 109 quality influential factors and 11 indicators of design documentation quality were used. The mean score and Standard deviation of each factor was used to determine their level of importance. The assessment of the factors in the survey was based on a five-point Likert scale of importance with each factor scored on a scale of 1 to 5 where Not Important is rated as 1, Important rated as 2, Not very Important rated as 3, Very Important rated as 4 and, Highly Important rated as 5. The results and their appropriate discussions are presented in the next section.

4.1 Design documentation quality attributes and indicators

Table 4.2 and 4.3 presents the ranking of factors on design documentation quality attributes and assessment indicators respectively. A total of 30 micro factors grouped into 2 appropriate macro factors which are design documentation quality attributes and indicators for measuring the quality were ranked.

![Figure 4.1: Educational level of respondents](image)

| Macro factors | S/N | Micro factor codes | Mean | SD | Ranking |
|---------------|-----|--------------------|------|----|---------|
| 1 Quality attributes of design documentation | 1 | Design documentation is fit for purpose | 4.52 | 0.849 | 1 |
| | 2 | Completeness of design documentation | 4.31 | 0.881 | 2 |
| | 3 | Relevance of design documentation | 4.29 | 0.834 | 3 |
| | 4 | Accuracy of design documentation | 4.29 | 0.845 | 4 |
| | 5 | Clarity of design documentation | 4.29 | 0.885 | 5 |
| | 6 | Easily communicated and constructed | 4.28 | 0.853 | 6 |
| | 7 | Final checking of design documentation | 4.25 | 0.811 | 7 |
| | 8 | Aligned with the owner’s requirements as set out in a project brief | 4.23 | 0.859 | 8 |
| | 9 | Conformity of design documentation | 4.23 | 0.939 | 9 |
| | 10 | Standardization of documentation | 4.22 | 0.887 | 10 |
| | 11 | Coordination of design documentation | 4.21 | 0.864 | 11 |
| | 12 | Design documentation is concise | 4.19 | 0.954 | 12 |
| | 13 | Certainty of design documentation | 4.18 | 0.979 | 13 |
| | 14 | Legibility of design documentation | 4.16 | 0.865 | 14 |
| | 15 | Design documentation is consistent | 4.16 | 0.954 | 15 |
| | 16 | Timeliness of design documentation | 4.15 | 0.942 | 16 |
| | 17 | Topographical representation of design | 4.00 | 0.934 | 17 |
| | 18 | Unambiguous and coherent design documentation | 3.95 | 1.056 | 18 |
| | 19 | Geological representation of design | 3.94 | 1.003 | 19 |

4.1.1 Results of design documentation quality attributes

This category is composed of 19 factors as presented in Table 4.2. Analysis indicates that 17 factors had mean scores range from 4.00 to 4.52 indicating their high level of significance. Design documentation is fit for purpose was ranked highest with a mean score of 4.52 whiles topographical representation of design had a least mean score of 4.00. This is consistent with studies by [2,15, 25–27, 31, 35, 39, 45].
Table 4.3: Ranking of design documentation quality assessment indicators.

| Macro factors | S/N | Micro factor codes                                      | Mean  | SD    | Ranking |
|---------------|-----|--------------------------------------------------------|-------|-------|---------|
| 2 Indicators  | 20  | Revisions to architectural and engineering drawings    | 4.16  | 0.899 | 1       |
| for measuring | 21  | The number and analysis of Requests for Information (RFI)| 4.11  | 1.071 | 2       |
| design        | 22  | Value of rework                                        | 4.07  | 0.877 | 3       |
| documentation | 23  | The submission of field technical queries              | 4.04  | 0.873 | 4       |
| quality       | 24  | The number of variation orders                         | 4.00  | 0.920 | 5       |
|               | 25  | The issuance of new architectural and engineering drawings | 3.99  | 0.925 | 6       |
|               | 26  | Paid delays                                            | 3.98  | 1.039 | 7       |
|               | 27  | The number and analysis of revisions to drawing registers | 3.93  | 0.951 | 8       |
|               | 28  | The submission of early warnings (NEC contract)        | 3.93  | 0.998 | 9       |
|               | 29  | Lost or non-productive time                            | 3.86  | 0.915 | 10      |
|               | 30  | Scope disputes                                         | 3.83  | 0.963 | 11      |

4.1.2 Results of design documentation quality assessment indicators
This category is composed of 11 factors as presented in Table 4.3. Respondents considered revisions to architectural and engineering drawings, the number and analysis of Requests for Information (RFI), Value of rework, submission of field technical queries, and the number of variation orders as most significant factors with mean scores of 4 and above. This is consistent with studies by [3, 15, 29, 35, 38, 46-47].

4.2 Factors influencing design documentation quality in the construction sector
Table 4.4 presents factors that influence design documentation quality in the construction sector. A total of 109 micro factors grouped into 5 appropriate macro factors which are design documentation related; designer’s (consultants) related; owner related; collaboration related; and external related factors.

Table 4.4: Ranking of design documentation quality influential factors.

| Macro Factors | S/N | Micro Factor Codes                                      | Mean  | SD    | Ranking |
|---------------|-----|--------------------------------------------------------|-------|-------|---------|
| 1 Design      | 1   | Inadequate and Insufficient documentation              | 4.45  | 0.994 | 1       |
| Documentation | 2   | Changes to specifications                              | 4.28  | 0.762 | 2       |
| Related       | 3   | Incorrect drawings                                     | 4.26  | 0.937 | 3       |
| Factors       | 4   | Disparities between bil of quantities, drawings and specifications | 4.25  | 0.915 | 4       |
|               | 5   | Design Changes and Frequent Change orders              | 4.22  | 0.975 | 5       |
|               | 6   | Discrepancy and conflict in contract documents         | 4.21  | 0.905 | 6       |
|               | 7   | Poor and Incomplete specification writing              | 4.21  | 0.922 | 7       |
|               | 8   | Lack of clarity and legibility                         | 4.21  | 0.922 | 8       |
|               | 9   | Incomplete and inexplicit drawings                     | 4.20  | 0.976 | 9       |
|               | 10  | Unavailability of detailed information                 | 4.18  | 0.882 | 10      |
|               | 11  | Omissions and Ambiguity in documents                   | 4.17  | 0.879 | 11      |
|               | 12  | Poor working drawings                                  | 4.16  | 0.926 | 12      |
|               | 13  | Deficient or missing information                       | 4.15  | 0.970 | 13      |
|               | 14  | Variations and revisions to design                     | 4.13  | 0.871 | 14      |
|               | 15  | Discrepancies between the specification and the design drawings | 4.13  | 1.006 | 15      |
|               | 16  | Incomplete designs                                     | 4.13  | 0.941 | 16      |
|               | 17  | Wrong/inadequate description in specification          | 4.11  | 0.943 | 17      |
|               | 18  | Outdated and unclear technical specifications          | 4.08  | 0.892 | 18      |
|               | 19  | Design error                                          | 4.07  | 0.908 | 19      |
|               | 20  | Inaccurate details                                     | 4.05  | 0.928 | 20      |
|               | 21  | Unworkable details and unachievable tolerances         | 4.04  | 0.910 | 21      |
|               | 22  | Error in design calculation                            | 4.03  | 0.944 | 22      |
|               | 23  | Documents does not conform to Code and Building Regulation | 3.99  | 0.905 | 23      |
|               | 24  | Quantum of Requests for Information                    | 3.96  | 0.939 | 24      |
|               | 25  | Reliance upon generic specifications documents         | 3.97  | 0.875 | 25      |
|               | 26  | Dimensional errors                                    | 3.89  | 0.894 | 26      |
|               | 27  | Pricing errors                                        | 3.89  | 0.914 | 27      |
|   | Related Factors                                                                 | Mean | Standard Deviation |   |
|---|---------------------------------------------------------------------------------|------|--------------------|---|
| 2 | **Designer’s (Consultants) Related Factors**                                      |      |                    |   |
| 28| Measurement errors                                                               | 3.88 | 0.937              | 28|
| 29| Provision of voluminous and irrelevant documentation                              | 3.86 | 1.130              | 29|
| 30| Symbol and abbreviation errors                                                   | 3.84 | 1.000              | 30|
| 31| Approximation error                                                               | 3.82 | 0.932              | 31|
| 32| Arithmetic errors                                                                 | 3.80 | 0.984              | 32|
| 33| Random errors                                                                    | 3.67 | 0.904              | 33|
| 34| Inadequate design staff                                                          | 4.31 | 0.987              | 1 |
| 35| Failure to provide relevant training to staff                                     | 4.18 | 0.851              | 2 |
| 36| Absence of an experienced overall design manager                                 | 4.17 | 0.837              | 3 |
| 37| Designer’s failure to clearly understand the client’s brief                       | 4.15 | 0.841              | 4 |
| 38| Inadequate experience of designers                                               | 4.13 | 0.829              | 5 |
| 39| Lack of experience on similar projects                                           | 4.13 | 0.875              | 6 |
| 40| Negligence of the Professional                                                   | 4.13 | 0.905              | 7 |
| 41| Reuse of design documents and details from previous projects without effective review by the designer | 4.12 | 0.857              | 8 |
| 42| Insufficient planning of workload                                                | 4.11 | 0.943              | 9 |
| 43| Failure to adopt quality assurance systems e.g. ISO 9001                          | 4.09 | 0.833              | 10|
| 44| Consultant’s Professional experience                                            | 4.09 | 0.865              | 11|
| 45| Inadequate or ineffective use of new technology                                  | 4.05 | 0.858              | 12|
| 46| Designer’s workload                                                              | 4.05 | 0.976              | 13|
| 47| Poor allocation of time with consideration to available workload                 | 4.04 | 0.864              | 14|
| 48| Lack or improper use of modern design software                                   | 4.04 | 0.865              | 15|
| 49| Designer’s lack of experience on similar projects                                | 4.04 | 0.884              | 16|
| 50| Low professional fees                                                            | 4.04 | 0.890              | 17|
| 51| Lack of quality assurance systems and procedures in consultant’s team            | 4.04 | 0.900              | 18|
| 52| Designer’s unfamiliarity with construction techniques and materials.             | 4.04 | 0.929              | 19|
| 53| Lack of time available for checking and correlating information’s on all design documents | 4.04 | 0.929              | 20|
| 54| Leaving design issues to be sorted out in the construction process               | 4.02 | 0.838              | 21|
| 55| Terms of reference not consistent with expected deliverables                      | 4.00 | 0.816              | 22|
| 56| Lack of innovation and design options due to low fees                            | 3.99 | 0.905              | 23|
| 57| Absence of ‘in-house’ design management policies and procedures                 | 3.99 | 0.935              | 24|
| 58| Inadequate supervision of junior design staff                                    | 3.98 | 0.849              | 25|
| 59| Unrealistic contract durations imposed by client                                 | 3.97 | 0.991              | 26|
| 60| Incorrect assumptions                                                            | 3.96 | 0.914              | 27|
| 61| Increase design staff members, rather than increasing the number of hours of work | 3.96 | 0.939              | 28|
| 62| Tight design schedule                                                            | 3.95 | 0.966              | 29|
| 63| Allocation of staff to many projects at the same time                            | 3.91 | 0.991              | 30|
| 64| Improper use of design software                                                  | 3.89 | 0.933              | 31|
| 65| Concurrent or overlapping activities                                            | 3.85 | 0.882              | 32|
| 3 | **Owner Related Factors**                                                        |      |                    |   |
| 66| Low design fees paid by owners                                                   | 4.10 | 1.123              | 1 |
| 67| Selection of designers on the basis of lowest price selection strategy           | 3.99 | 0.905              | 2 |
| 68| Frequent design changes by client                                                | 3.97 | 0.944              | 3 |
| 69| Provision of wrong or insufficient information by the client                     | 3.96 | 0.914              | 4 |
| 70| Lack of client knowledge of the importance of the design phase to construction economy and maintenance operation | 3.95 | 0.919              | 5 |
| 71| Selection of designers on the basis of reputation instead of efficiency          | 3.94 | 0.971              | 6 |
| 72| Erroneous and Conflicting information from the client                            | 3.89 | 0.990              | 7 |
| 73| Lack of motivation to consultants                                               | 3.86 | 0.985              | 8 |
| 74| No focal person on client team responsible for design coordination and providing information | 3.85  | 0.961              | 9 |
| 75| Change in project requirements by client at later stages                          | 3.85  | 1.024              | 10|
| 76| Lack or inadequate client’s review of interim and final design documents submission | 3.84  | 0.973              | 11|
4.2.1 Design documentation related factors

This category is composed of 33 factors as presented in Table 4.4. Analysis indicates that 22 factors had mean scores from 4.03 to 4.45 indicating their high level of significance. However, inadequate and insufficient documentation was ranked highest with a mean of 4.45 whiles error in design calculation had a least mean score of 4.03. These factors are consistent with studies by [4-7, 19, 20, 31, 35, 48, 50-52].

4.2.2 Designer’s (consultants) related factors

This category is composed of 32 micro factors as presented in Table 4.4. Analysis indicates that 22 factors had mean scores range from 4.00 to 4.31 indicating their high level of significance. However, inadequate design staff was ranked highest with a mean of 4.31 while terms of reference not consistent with expected deliverables scored a mean of 4.00. These factors are consistent with studies by [3-7, 14, 19, 20, 30, 31, 35, 36, 39, 45, 48, 50-53].
4.2.3 Owner related factors
This category is composed of 21 micro factors as presented in Table 4.4. Analysis indicates that low design fees had a mean score of 4.10 representing the highest ranked factor in this group. The remaining 20 factors had mean scores range from 3.64 to 3.99. Selection of designers on the basis of lowest price had a mean score of 3.99 while client type (public or private) scored a mean of 3.64 as the least score in this category. These factors are consistent with studies by [3-7, 14, 19, 20, 30, 31, 35, 36, 39, 45, 48, 50-53].

4.2.4 Collaboration related factors
This category is composed of 11 micro factors as presented in Table 4.4. Analysis indicates that in exception of insufficient and poor pre-design project meetings that had a mean score of 3.98 representing the least score in this category, all the other 10 factors had mean scores range from 4.05 to 4.29 which is an indication of their high significance. This shows the importance of collaboration during design documentation production. However, lack of continuous and effective communication between parties was ranked highest with a mean of 4.29 whiles discrepancies between different design disciplines scored a mean of 4.05. These is consistent with studies by [3-7, 14, 19, 20, 30, 31, 35, 36, 39, 45, 48, 50-53].

4.2.5 External related factors
This category is composed of 12 micro factors as presented in Table 4.4. Analysis indicates that lack of quality control criteria imposed by statutory authorities on design outputs had a mean score of 3.80 representing the highest ranked factor while frequent statutory changes in regulations and requirements scored a mean of 3.31 as the least score. These factors are consistent with studies by [3, 6, 7, 14, 19, 20, 30, 31, 35, 36, 39, 45, 48, 50-53]. The conclusion and recommendation is presented in the next section.

5. Conclusion and Recommendation
There are construction projects that progresses from inception to completion without significant design documentation challenges while others experiences significant challenges that ends up affecting the efficiency of the project. Therefore this study aimed to evaluate factors that influences design documentation quality and rank them on the basis of significance. A total of 139 factors composed of 19 quality attributes of design documentation, 11 indicators for measuring design documentation quality and 109 design documentation quality influential factors were used in this study.

On design documentation quality attributes, factors such as fit for purpose, completeness, relevance, accuracy, clarity, easily communicated and constructed, safety, final checking, aligned with the owner’s requirements, conformity, standardization, coordination, conciseness, certainty, legibility, consistency, timeliness, unambiguous and coherent design documentation were highly ranked. On quality assessment indicators, factors such as revisions to drawings, the number and analysis of Requests for Information (RFI), value of rework, the submission of field technical queries, and the number of variation orders were considered as most significant indicators. On factors influencing design documentation quality in the construction sector, there were 5 groups under this category. However, analysis of the factors in the various groups places design documentation related factors first; followed by designer’s (consultants) related factors; collaboration related factors; owner related factors; and external related factors in that order respectively. This is indicative that design documentation related factors influences design documentation quality to a high extent followed by designer’s (consultants) related factors and collaboration related factors.
The findings of this study provide valuable data to stakeholders, researchers, and academics and will help enhance project performance in the construction sector particularly in the production of design documentation. It offers a pragmatic data and an empirical evidence to expand knowledge on design documentation quality. The study however recommends a future research to build on the current study by considering a case study on specific projects to provide a more robust view of the current state of design documentation quality in the construction sector.

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