Information and communication technology application challenges in the construction industry: A narrative review

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Abstract. The measure of construction activity affects the general wellbeing of the construction industry. An improved method of construction delivery reduces the problems encountered in the construction process. Studies posit that the use of Information and communication technologies (ICT) tends to improve construction output. However, there are barriers to ICT applications in the construction industry. To date several, the literature on challenges to ICT has been limited to a specific study area. This study conducted a narrative literature review to identify the challenges to ICT application in the construction industry across Europe, Australia, North-America, Africa, and Asia. The review was conducted using selected relevant academic journals from SCOPUS database. The findings from the review identified that challenges to ICT application are classified into Technology, Process and People related factors. The attitude of staff and Management to ICT, technical barriers and cost related factors are identified as the common factors to the three classified categories of challenges to ICT used in the construction industry. The implication of the findings is to address a platform for better and innovative construction process. It is also important in addressing people, process and technology which are interwoven for construction work.

Keywords: ICT, application, construction industry, review, Challenges

1. Introduction
The construction industry is a germane sector of any economy. This is because describes that construction activities are measured based on its output [1]. As such, there is a relationship between the level of construction output and the means to executing construction works. Hence, output level is a subject of much discuss in the built environment. Evidence gathered from literature showed that the output of construction work is affected by the type of Information and communication technologies (ICT) used, the people applying the ICT tools, cost of ICT applications, the process of the application and other factors [2,3]. A reduced output level has an adverse effect on construction activities since the method of project delivery are hindered. Therefore, there is a need to identify challenges to the application of ICT in the construction industry.

A Literature review method of research is extensively used for empirical construction management studies. Reviews on critical success factors for public-private partnership project [4], critical analysis of partnering research trend in construction industry [5], and factors affecting green building cost premiums [6], among other studies been conducted using various literature reviews.
approaches. Reviews methods used in previous studies includes narrative review, systematic review, critical review and, comparative review. Narrative literature reviews current literature that leans towards qualitative knowledge evidence [7]. It has been established that there is extensive literature on critical issues in the construction sector. It is therefore, imperative to identify the challenges facing ICT applications in the construction industry. Thus this study seeks to address this problem using a narrative review. After this introduction, their research method used for thesis study is described. Thereafter, the methodology used, the result gathered, discussion of findings of the result and the conclusion to the study follows.

2. Research Methodology
This study used the narrative review approach to identify the challenges facing ICT application in construction industry. Database search was carried out to identify relevant studies for this narrative study. This review used “SCOPUS” database for the search. SCOPUS database was selected since it has a large array of the indexed journal in construction and other fields [8]. The search was conducted using their adequate keywords; (i) ICT challenges (ii) ICT barriers, and (iii) ICT applications. The search was restricted to articles published in the English language; articles published in journals; full-text availability; and focus (i.e. ICT in Construction industry).

The search for the study was carried out in three different phases, database search; filtering and qualitative analysis. After completing the initial search on the SCOPUS database, a total of 80 papers were found. The search results were filtered to eliminate studies that did not meet the inclusion criteria. Also, publication tagged as “Research note”, "book reviews", "book chapter", "book", and other papers not based on empirical work were excluded. Also, duplicate articles were removed. In the end, 18 relevant articles were used for the study. These studies used questionnaires, interview, study case, focus group and mixed method for the research methodologies. It was discovered that the questionnaire survey is the most used tool (50%) of the selected articles. Table 1 below provides a summary of the research methodologies used.

| Research Methodology       | Number | Percentage |
|----------------------------|--------|------------|
| Questionnaire Survey       | 9      | 50.00%     |
| Interview                  | 3      | 16.70%     |
| Focus group                | 1      | 05.50%     |
| Case study                 | 2      | 11.10%     |
| Mixed                      | 3      | 16.70%     |

3. Results
A narrative review was conducted to identify empirical evidence as regards the challenges facing ICT applications in the construction industry. The findings of this study are based on a review of 18 construction industry literature from across the world. There are 5 works of literatures from Europe; 1 from North America; 1 from Australia, 9 from Africa and 2 from Asia. This distribution depicts the worldwide importance of the topic of discussion. An overview of these selected studies published from 2005 to 2018 is presented in table 2. Construction professionals were the key sample population used in the studies.

| Country     | Author(s) |
|-------------|-----------|
| United Kingdom| [3,9–11] |
| Nigeria     | [12–15]   |
3.1. Challenges affecting the application of Information and Communication Technology (ICT)

The main objective of the study is to identify the factors hindering the use of ICT application in the construction industry. The numerous factors identified are summarized in table 3 below. A review of the challenges will help develop strategies to enhance ICT application in the construction industry. Eighteen factors challenging the use of ICT in the construction industry were identified across the studies. They are afterward grouped under three categories Technology, People, and Process (Table 4). These categories are inspired by similarities of factors and previous literature. For instance, the work of Greene and Stitt-Gohdes [25] grouped factors into personal and external factor classification.

| Factors | References |
|---------|------------|
| Poor attitude towards use ICT on staff and firm level | [2,10,12,14,15,21,22] |
| Technical barriers | [3,11,21,26,27] |
| Cultural barriers | [2,11,13,16,26] |
| Cost issues | [2,11,15] |
| Standardization problem | [3,20,24,27] |
| Inadequate ICT construction education training | [12,15,28] |
| Low return on ICT investment | [12,15,22] |
| Accessibility to ICT infrastructures | [2,11,16] |
| Legal Issues | [2,3,16] |
| Security/privacy issues | [2,12,16] |
| Knowledge of level of users | [2,15,16] |
| Full potential of ICT tools not exploited | [14,18] |
| Reliability of ICT tools | [13,16] |
| Diverse nature of ICT systems | [2,16] |
| High cost of employing IT professionals | [2,12] |
| Short life span of hardware/software | [12] |
| Inadequate/erratic electricity supply | [12] |
| Fear of Job displacement | [12] |

The tag “C1 to C18” represents the number listing of the challenges according to table 3. “Technology” classification is the first category of barrier identified in the study. The factors that are grouped under the technology classification are C1, C2, C4, C6, C10, C13, C14, and C16. They are Poor attitude towards use ICT on staff and firm level, respectively, Technical barriers, Cost Issues, Inadequate ICT construction education training, Security/privacy issues, Reliability of ICT tools, Diverse nature of ICT systems, and Short life span of hardware/software, respectively. This grouping refers to challenges...
posed to ICT applications as implied to Technology itself. For example, the study of Sardroud [29] classified technology related problem as one of the challenges to ICT application in the construction industry.

“People” classification is the next category of challenges to ICT application identified in the study. The classification “People” refers to the challenges posed to ICT application by the users. Factors such as Poor attitude towards use ICT on staff and firm-level respectively (C1), technical barriers (C2), Cultural barriers (C3), Legal Issues (C9), Cost Issue (C4), Knowledge of level of users (C11), full potential of ICT tools not exploited (C12), Reliability of ICT tools (C13), High cost of employing IT professionals (C15), and Fear of Job displacement (C18). People are the core driving process and technology. Studies showed that people factors are also challenging to the use of ICT in the construction industry [21,29,30]. People factor are the most germane factors affecting ICT use in the construction industry.

| Table 4. Technology, People and Process classification of challenges to ICT application |
|-----------------------------------------------|
| **Technology**                               |
| Poor attitude towards use ICT on staff and firm level respectively, |
| Technical barriers                            |
| Cost Issues                                   |
| Inadequate ICT construction education training |
| Security/privacy issues                       |
| Reliability of ICT tools                      |
| Diverse nature of ICT systems,                |
| Short life span of hardware/software,         |
| **People**                                    |
| Poor attitude towards use ICT on staff and firm-level respectively |
| Cultural barriers                             |
| Technical barriers                            |
| Legal Issues                                  |
| Cost Issue                                    |
| Knowledge of level of users                   |
| Full potential of ICT tools not exploited      |
| Reliability Of ICT tools                      |
| High cost of employing IT professionals        |
| Fear of Job displacement                      |
| **Process**                                   |
| Technical barriers                            |
| Diverse nature of ICT systems                 |
| Cost issues                                   |
| Standardization problem,                      |
| Low return on ICT investment,                 |
| Accessibility to ICT infrastructures           |
| Legal Issues                                  |
| Full potential of ICT tools not exploited      |
| Inadequate/erratic electricity supply          |

“Process” Classification is another category of classification used in the study. Factors such as Technical barriers, diverse nature of ICT systems, Cost issues, standardization problem, Low return on
ICT investment, Accessibility to ICT infrastructures, Legal Issues, full potential of ICT tools not exploited, and Inadequate/erratic electricity supply are classified as C2, C4, C5, C7, C8, C9, C12 and C17 respectively. Classifying some challenges of ICT application in the construction industry into Process is a meeting point of the challenges due to technology and users. For instance, studies of Sardroud [27] revealed that process inclined challenges are one of the classifications for ICT challenges in the construction industry.

4. Discussion of findings
This study conducted a narrative review of challenges affecting ICT application in the construction industry. The reduced output from construction activities has been linked to the problems facing construction ICT. This study showed that ICT application challenges can be grouped into people, technology and process related factors. In these groups, barriers linked to the attitude of staff and management, technical issues and cost-related issues are prevalent among these categories. There is a need to improve the output of construction activities by overcoming the challenges enlisted in table 3 above.

Findings from the review described that there is a need for integration of people and process. This will improve the use of ICT construction industry. This finding is consistent with evidence from developed countries. In the UK for example, the barriers to ICT applications are categorised into investment and people factors. Insufficient ICT tool research and development (R&D), confidence using new technologies, cultural influence, organizational culture, insufficient technical skills, socio-economic hindrances are addressed as “People” factors facing ICT tool application in UK construction industry [29,31,32]. The investment related factors are majorly reduced funds for ICT tools and cost investment of such tool [30]. Also, this is consistent with evidence from a developing country’s perspective. In Ghana for example, [33] described that ICT applications face problems like lack of right technical skills, initial cost, resistance by people and culture, and lack of interest by management, for e-business activities in construction. The interconnection of people, process and technology is, therefore, necessary to overcome the challenges posed to ICT applications in the construction industry.

5. Conclusion
The output of construction activity is a major discussion in the field of construction management. The ineffective use of Information and Communication Technologies can be linked to reduced construction output. The study seeks to identify the challenges facing ICT application in the construction industry using a narrative review. The study resolved that there are three broad categories for ICT challenges in the construction industry. They are challenges related to Technology, People and Process. In these categories challenges such as Poor attitude towards use ICT on staff and firm level, Technical barriers and, Cost issues cut across the three categories. The findings of this study provide information for the construction industry on the challenges affecting ICT use in the construction industry. The implication of the findings is to address a platform for better and innovative construction process. It is also important in addressing people, process and technology which are interwoven for construction work. However, this study is limited by the methodology applied and the sample population. Future work should address the solutions to ICT application problems in the construction industry.

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