Descriptive perspective on factors affecting the complete adoption of information technology systems in the construction firms

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Abstract-
Information technology as a strategy to process, store and transfer information is pivotal for the success delivery of information within different industries, construction in particular. Given the benefits associated with the use information technology this study focuses on the factors that may affect construction firms from being recipients of the benefits of completely adopting information technology systems in South Africa. A quantitative approach was employed to determine factors that require urgent eradication, construction professionals responded to the questionnaire survey that was undertaken. Prior to the survey, data was descriptively analysed using frequencies, percentages, mean item scores and standard deviations. Findings from the study clearly reveal that for construction firms in South Africa to entirely realise the benefits of completely adopting IT systems focus must be shifted away from resisting change, providing inadequate training and employing personnel with no management skills. More so, results show that certainty is required regarding lack of integrity, durability and reliability of the systems, on-going maintenance costs as well as the importance and introduction of client leadership. Above any other barrier, the aspect of costs associated with the complete adoption of IT systems is crucial, while the extent of involvement of key role players needs to be further determined.

Key words: Information technology, tools software, computer aided design, client leadership, integration and connectivity layout

1. Introduction
The construction sector remains one of the economy’s prevalent sectors in South Africa, being at the forefront of trade industries, corporates and also commercial spaces, [12] enunciates that construction industry encourages economic growth, despite having unstable outlooks for the erstwhile quarters. However, it remains one of the most highly attractive industries, yet at the same time it is challenged with the lethargic introduction of innovation and technology [19]. The construction industry is one amongst other sectors that still invests in traditional methods of storing, transferring and presenting information [5].

Technology remains one of the biggest sectors of how core skills of professionals can be improved, for effective and efficient way of delivering expected results to the end user. In an attempt to keep up with the rest of the world, it is absolutely necessary to introduce technological advancements concepts and systems into the construction sector as a methodology to increase productivity and maximise profits, while adhering both to the end users’ environmental and socio-economic conditions. [9] defines information technology (IT) as the study, maintenance
or management of computer-based information systems, used for storing, retrieving and sending information. These systems include but not limited to robot structural analysis professional tools, software and communication networks, revit building information management, navisworks, primavera and procor. Information technology typically includes hardware, software, databases and networks.

One of the benefits of incorporating IT systems in the construction firms as stated by [22] include providing an outlook of almost 20 percent reduction in total life cycle costs of a project, as well as substantial improvements in completion time, quality and safety. In addition [9] speaks of how information technology frequently manages the procurement, processing, loading and distribution of digitalised statistics, or data, produced over the disciplines of computing and telecommunications. It concentrates on handling technology and refining its utilisation to develop the all-inclusive business goals. [8] adds that the use of IT systems is important for planning, organising, operating and controlling projects.

While the importance of technology has been established in the construction industry, the study thus determined and assessed factors delaying the complete adoption of IT systems in the construction firms in South Africa. The findings of the study are a contribution to knowledge on which factors require urgent attention in fulfilling the ultimate objective of the construction sector of moving towards an innovative and technological space, through the use of IT systems. While technology is advancing in a way that it has never been before, it is important for firms to adopt systems that are more accurate on the project life that also saves time and cost.

2. Factors affecting the adoption and use of Information Technology (IT) systems

Factors affecting the use of information technology (IT) systems in the construction firms were identified and discussed. Solutions to the barriers of using IT systems is of paramount importance. The solutions will contribute to the complete adoption of IT systems in the construction firms in South Africa’s construction industry. There are always challenges in convincing role players in the construction firms to migrate from a culture of oral communication to methods and forms that allow for significant use of IT, thus causing difficulties in establishing a track record of the technology’s reliability and durability.

Reasons for the slow uptake of IT have been investigated and well documented by [4]. These reasons include the nature of how the construction industry operates one-off projects, industry fragmentation, lack of client leadership, low level of technology awareness and training, required up-front investment, on-going maintenance costs and resistance to change [10], [13]. The development of new information technology systems has become either a hindrance or serves as a competitive urge to achieve optimum result. The industry, however, seems to make slow progress towards capitalising on the opportunities IT offers, to gain competitive advantage and enhance performance.

Soluble barriers affecting the complete use of IT systems include but not limited to employee’s lack of software trainings, financial implications or costs related to maintenance, replacement and updating of the systems [4]. [18] alluded that lack of confidence in the information technology systems also contributes to the hesitant use of IT systems in the construction firms. Likewise [1] and [15] were also in support of the phobia of introducing innovation and technology in the current set up of delivering sustainable projects. High number of uninformed
employees, low value of telecommunication infrastructure, petite support on the information technology systems [18] will also delay the transition of firms into the era of the fourth industrial revolution. [7], [21] stated that other barriers include the resistance to change; inadequate training on daily operations of the software, staff shortages of personnel who can implement and maintain IT systems.

**Lack of system knowledge**
Lack of knowledge and understanding by managers regarding IT systems and what they can do for the construction firms has also contributed to a large amount of employees being hesitant to use and completely integrate the systems in their daily activities. [21], [2]. Construction firms under financial and personnel constraints, are rightfully hesitant to invest in technology and hence their inability to provide a timeframe to change operations and train employees. However, increased confidence in introducing innovation and technology to the daily operations of the firms might be the answer to struggling firms [15], [7].

**Lack of training**
Lack of time for training and changing operations is taken into account when considering IT implementation, time reserved for training introduces delays in the daily operations of the firms, thus affecting productivity. [11], [20] added that there is lack of training and time put during the implementation and use of IT systems. This causes employees who are interested in learning about the systems to miss out on the opportunity to learn and groom themselves while passing on the information to the next working force. According to [7] it is inevitable to not consider the confidentiality and security of these trainings. Some companies prefer training employees whom they are absolutely sure that they will stay longer and expose them to all their software trainings and beyond.

**Resistance to change**
[17], [18], all agree that the biggest cultural barrier for introducing IT systems in construction firms is mainly resisting to change, and the complex use of the applications. The introduction of new and improved techniques and equipment is always a major concern to the production margins of many construction firms, having to provide training and resources to equip the employees with new technology in a short space of time always works against the budget and productivity margins of the firms. Even though the shortfalls can only be experienced short term. Additionally, even with the awareness and training of employees provided employers still experience difficulties with completely incorporating information technology systems to the daily activities of the firms, employees still prefer their conventional ways of working [6; 16]. Thus it is difficult to convince workers to change to a new and often unfamiliar strategy of improving productivity in the construction firms.

**Information technology trainings highly costly**
There are high costs associated with the training of staff to utilise the IT systems, more so even prior to the training, costs associated with the implementation, maintenance and updating of the systems for optimal efficiency are precisely high [15]. [18] adds that the IT systems require frequent maintenance and updates, which requires firms to have financial means to service the systems. Firms often struggle with the financial implications of IT systems. Hence with most of these firms the biggest barrier in using the information technology systems is finance. The overall cost needed to fund these systems is more than what they can afford.
Lack of integration and connectivity
It is evident as a result of complicated and complex techniques employed in the construction industry that there is poor integration of actors and information technology systems across different areas when it comes to the implementation phase of the project [23], [7], [14] has observed that among other difficulties shortages of information and poor integration of different stakeholders during the construction phases negatively affect the outcomes of the projects, thus contributing to the failure of information systems in place. To ensure the promotion of a well advanced industry sufficient information as well as proper techniques to integrate and connect different actors in the construction phases are of paramount importance.

3. Methodology
The study evaluated factors affecting the use of information technology (IT) systems in the construction firms in South Africa. A quantitative approach was adopted for the study, where a structured closed-ended questionnaire with two sections was distributed to professionals that had knowledge about the use of IT systems. Section A of the questionnaire refers to the background information of the professionals, this is to provide quality check on the received data, whether the professionals fell within the predetermined criteria. The factors affecting the use of IT systems in construction consulting firms captured in Section B were extracted from the reviewed literature, where only key factors were selected. A 5-point Likert scale was employed to respond to the questionnaires in Section B. For its accessibility convenience sampling was adopted. The following professionals provided responses to the factors affecting the use of IT systems in the construction consulting firms in South Africa; Construction project managers, construction managers, mechanical engineers, electrical engineers, industrial engineers, civil engineers, quantity surveyors and architects, as well as the managing directors and operations managers of the construction consulting firms. A total of 50 questionnaires were distributed, however only 44 were returned and eligible for analysis. Representing 88.0% response rate. The reliability of the research instrument was tested using Cronbach’s alpha test. Cronbach’s alpha measures the internal consistency that is how closely related the variables are as a group. The higher the Cronbach’s value (above 0.70) the better the internal consistency. The value for this study was 0.902. Excel was used to undertake the analysis for the background section, frequencies to compute pie charts and bar graphs were generated. SPSS was used to analyse factors affecting the use of IT systems in the construction consulting firms. The factors were thus ranked in their descending order using mean item scores and standard deviation.

4. Results and discussions
Biographical Information of Respondents
The results obtained from the respondents clearly revealed that males with 52% dominated women with 48% for this study. The results further revealed that in terms of the age group 45% of the respondents were between the ages of 21-29 years old, while 30% of the 44 respondents were between the ages of 30-39 years old. Only 20% of the sampled respondents were between the ages of 40-49 years old and 5% of the same respondents was above the age of 59. More so, 80% of the 44 respondents fulfilled undergraduate degree, while the remaining 20% acquired postgraduate degrees. The current employment professions that were captured revealed that 9.0% of the respondents were Architects, 16.0% of the respondents were Quantity surveyors,
14.0% of the respondents were civil engineers, electrical engineers and construction managers each had 11%, 3% of the respondents were mechanical engineers, while 20.0% of the respondents were construction project managers and 16% of the respondents opted for other. From the 44 respondents sampled 80% had work experience in the construction consulting firms of 5-15 years. While 20% of the remaining respondents had experience of 15 years and above.

Factors affecting the adoption of IT systems in the construction firms
The factors affecting the adoption of information technology systems in the construction firms were identified and discussed. Respondents had to provide the extent of agreement to the factors presented in the questionnaire, using five point scale of; 1=Strongly disagree (SD); 2= Disagree (D); 3= Neutral (N); 4= Agree (A); 5= Strongly agree (SA). The results in Table 1 shows that out of 16 factors affecting the adoption of IT systems respondents only agreed to three (3.5<MIS<4.4), disagreed on two (1.5<MIS<2.4) while eleven (2.5<MIS<3.4) of the factors the respondents were not sure if indeed they were affecting the adoption of IT systems in the construction firms in South Africa. Resistance to change (MIS=3.84; SD=1.430), lack of training (MIS=3.75, SD=1.278) and lack of personal skilled in the management (MIS=3.70; SD=1.322) were highlighted as key factors that require urgent attention for the complete adoption of IT systems in the construction firms in South Africa. The respondents were not certain of the following factors whether they had any impact in the slow introduction and complete adoption of IT systems in the construction firms in South Africa; Lack of staff who can implement IT systems (MIS=3.43; SD=1.319), high rate of computer illiteracy amongst employees (MIS=3.20; SD=1.322), lack of integration (MIS=3.05; SD=1.275), on-going maintenance costs (MIS=2.89; SD=1.146), require up-front investment (MIS=2.70; SD=1.440), lack of client leadership (MIS=2.68; SD=1.343) and poor quality and/or quantity of telecommunications infrastructure (MIS=2.16; SD=1.275).

The information technology systems required for holistic integration of models and data with stakeholders during preconstruction include but not limited to robot structural analysis professional, revit building information management, navisworks, primavera and procor. The findings of the study were in agreement with [17], [18] and [11] that resistance to change was amongst the highlighted factors affecting the innovative and technological systems into the daily operations of the firms reviewing projects. The construction industry is one of the sectors that is persistently vested in traditional ways of doing things, in addition to resistance to change lack of training and personal skilled management were also pivotal for the advancement of technology in the construction firms [7], [11], [15] further shares that the cost associated with training of staff to utilise the IT systems is incredibly high, that also includes the cost of implementing, maintaining and updating the specific software [4]. While existing literature [2], [18], [1] further highlights the importance of resilient and tenacious confidence to adopt IT systems and the quality and/or quantity of telecommunication infrastructure, the findings disregard this notion. The findings reveal that lack of confidence and poor quality and / or quantity of telecommunications infrastructure have no impact in the slow adoption of IT systems in the construction firms in South Africa.
Table 1: Factors affecting the adoption of IT systems in the construction firms

| Factors                                         | SD     | MIS   | R |
|-------------------------------------------------|--------|-------|---|
| Resistance to change                            | 1.430  | 3.84  | 1 |
| Low level of training                           | 1.278  | 3.75  | 2 |
| Lack of personnel skilled in the management     | 1.322  | 3.70  | 3 |
| Staff shortages of personnel who can implement software’s | 1.319  | 3.43  | 4 |
| High rate of computer illiteracy amongst employees | 1.322  | 3.20  | 5 |
| Lack of integration                             | 1.275  | 3.05  | 6 |
| On-going maintenance costs                      | 1.146  | 2.89  | 7 |
| Durability                                      | 1.316  | 2.89  | 7 |
| Low level of technology awareness               | 1.316  | 2.89  | 7 |
| Lack of connectivity                            | 1.478  | 2.84  | 8 |
| Reliability                                     | 1.173  | 2.70  | 9 |
| Required up-front investment                     | 1.440  | 2.70  | 9 |
| Lack of client leadership                       | 1.343  | 2.68  | 10|
| Low use and support of IT                       | 1.316  | 2.61  | 11|
| Lack of confidence in IT                        | 1.250  | 2.20  | 12|
| Poor quality and/or quantity of telecommunications infrastructure | 1.275  | 2.16  | 13|

MIS: Mean item score; SD: Standard deviation; R: Ranking

5. Conclusion
This study embraced the use of information technology systems in the construction firms and further assessed factors affecting the complete adoption of the systems in South Africa’s construction firms. Based on the results firms needed to pay attention to; resistance to change from conventional methods, low level of training and lack of personnel skilled in management to completely adopt/ and make use of Microsoft Project, CAD, BIM and WinQS. More so, to ensure the complete adoption of IT systems certainty regarding computer literacy, awareness, integration, on-going maintenance costs of the systems, durability, reliability and client leadership must be provided. The implementation of the study’s results can go a long way in accelerating the complete adoption of information technology in South Africa’s construction firms. This includes appropriate evaluation of construction costs, management of quota data and accurate billing of quantities. The establishment of monitoring and evaluation mechanisms to determine and guide the complete adoption of IT systems is of paramount importance.

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