An Assessment of the Significant Bottlenecks Towards Adoption of Information and Communication Technology by Kenyan Building Contractors

Elias Nyaga Nelson, Ahmad Omar Alkizim, Anthony Kiplimo Mutai

Abstract : ***In the competitive market of the construction industry, construction firms attempt to implement projects within the least cost and time, and the highest quality. One of the factors that has been established to affect these parameters is the utilization of information and communication technology (ICT) Many ICT platforms have been developed to help in execution of projects. Kenyan construction firms have attempted to utilize several of them. However, many of the contractors have not managed to adopt many of the available ICT platforms This research explored the factors that hinder the Kenyan building contractors from achieving higher levels of ICT adoption. Eighty construction firms were selected mainly in class NCA1 and NCA2 through sampling. Practitioners directly involved in project implementation within various construction firms were interviewed to establish the factors that hinder them from achieving higher levels of this ICT adoption. The responses were analyzed and a narrative interpretation developed which established that the most prevalent factor hindering adoption is the rapid changes in ICT technologies, high cost of employing ICT professionals, satisfaction with the existing method of working, Inadequate knowledge about return on ICT investment, high cost of training ICT professionals and inadequate financial resources.***

Keywords: Construction, Information and communication technology

I. INTRODUCTION

The construction industry is the means through which physical development is achieved, and that is truly the locomotive of the national economy. The increasing complexity of infrastructure projects and the environment within which they are constructed place greater demand on construction managers to deliver projects on time, within the planned budget and with high quality (Enshassi et al 2003). Research has been carried out widely by various practitioners over a long period of time on the various factors that affect the performance of construction projects and have drawn many conclusions and given many recommendations on how construction project performance can be improved and many have recommended that the construction industry adopt more of information and communication technology.

In the recent past many construction Project operators have however made effort to adopt the information and communication technology in various project cycles beginning from the initiation to completion. Information and communication technology is defined as a collective reference to the integration of computing technology and information processing and comprises a wide range of technical approaches to a variety of problems in construction industry (El-Ghandour W. and Al-Hussein 2004) This research explored the factors that hinder the Kenyan building contractors from achieving higher levels of ICT adoption

1.1 The Background of Kenyan Construction Industry

Construction industry in Kenya is one of the key drivers of economic growth for the last five years. The Kenyan construction industry contributes 7% to the country's GDP and employs more than one million people. According to a report by Kenya National Bureau of Statistics (KNBS). Economy of Kenya grew by 4.9% in the first quarter of 2011 mainly due to improved productivity in the construction industry. The industry added KES 12.6 billion to the country's GDP in Q1 2011It is coming out Cleary that despite the challenges facing the building and Construction Industry, the industry is still resilient and any research towards its improvement may see the market grow significantly.

II. ROLE OF ICT IN THE CONSTRUCTION PROCESS

The benefits offered by ICT on construction project are well documented which include among others improved access to richer information to aid decision making, quicker information, improved information flow, greater management control and getting geographically dispersed group to work together (Peansupap, 2004). Research has also strongly indicated that application of ICT in early project phases that is feasibility, concept design, detailed design, and construction planning is quite high, however, application of ICT during construction stage is quite low and can be clearly demonstrated by figure 1 below

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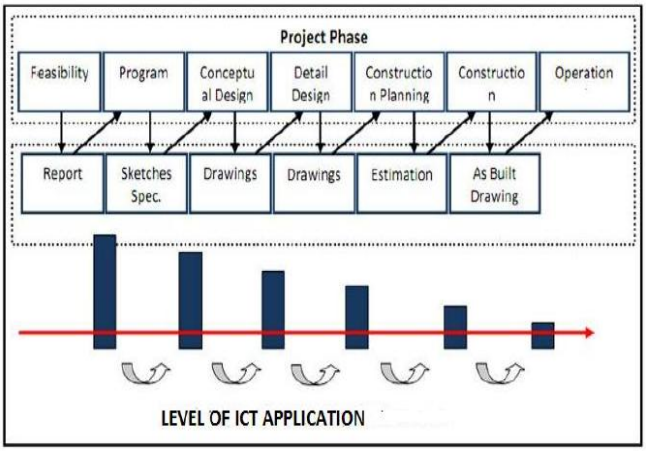

Fig 1 level of ICT application in all phases of a construction project

Source: Reconstructed from (CIDB 2003)

III. RESEARCH METHODOLOGY

Nairobi County was selected for this research because being the largest city in Kenya it hosts a large number of reputed building contractors ranging from small to large who are involved in construction projects that range from simple to complex and therefore sampling Nairobi County gives a representative result that most likely represent same scenarios in many parts of Kenya. A structured questionnaire was prepared and administered to contractors, registered with the National Construction Authority in Class NCA1, NCA2.these two classes of contractors were selected because the researcher believes that by virtue of their financial class and nature of works have the capacity and requisite personnel to invest and use ICT for their operations and are likely to have better knowledge about the subject in question. For purposes of clarity, national construction authority classifies contractors from NCA1 to NCA8 with NCA1 being the highest and NCA8 being the lowest. The questionnaires were administered specifically to different professionals, supervisors and workers in these firms who are directly involved with these projects and who to my opinion have relevant information to this study. A list of all registered local contractors in class NCA1 and NCA2 and based in Nairobi as at February 2015 was obtained from the national construction authority register and found to contain 559 in Class NCA1, and 361 in NCA2 The first section, "General Information" dealt with the demographics with respect to firm's financial class, years of experience in construction and the professional background of respondents. This aspect was deemed necessary in order to ascertain the reliability and credibility of the data provided. The second section "construction stage" asked more specific questions in relation to the Extent of ICT usage and in detail inquires about challenges faced by the firms in the attempt to adopt ICT in their functions. Five point type Likert ordinal scale was employed to determine the Factors hindering ICT usage. The responding firms were asked to score identified reasons hindering the use of ICT by contractors in the construction industry. Based on the criteria identified, the Likert rating scale was adopted to extract the appropriate ratings as per their influence as a reason hindering use of ICT by contractors in Kenya. A formula developed by Kish in Kish (1965) was used to determine the sample size calculated as 80. From the adjusted register number in NCA1 is 227 while number in NCA2 is 192 which is a ratio of 1.2:1. Therefore 43 were picked from NCA1 and 37 from NCA2 to make a total of 80 tabulated as follows

Table 1 Sample frame of the contractors

Contractor class	Questionnaires allotted
NCA 1	43
NCA 2	37
TOTAL	**80**

Source: Research data

Simple random sampling was then used to pick the 80 used for study The final list for the study was made by combining the 43 from NCA1 and the 37from NCA2 to make a total of 80 Telephone contacts were sought from the directory to locate their geographical locations in Nairobi for the administration of questionnaires The administration of the main questionnaire was carried out in Nairobi between 4th July to mid-august 2015. A total of 60 questionnaires were returned from both classes of contractors representing 75%

The data obtained from the field survey were analyzed through a five-point Likert-type scale to measure a range of opinions from "Very weak" to "Very strong" by use of Mean/average Index Score and One Sample T-test In order to generate the result. SPSS and excel software were mainly used for data analysis

IV. DATA ANALYSIS, RESULTS AND DISCUSSION

Table 2 below shows the breakdown of the number of response received from the selected organizations. From the survey results twenty nine (29) questionnaires out of 60 were received from NCA1 contractors and thirty one (31) out of 60 received from NCA2 contractors constituting 48.3% and 51.7% responses respectively. It is noticeable that, the gap between the responses from the two groups of contractors in the survey was not generally wide.

Table 2 Details of Response Rate

Contractors class	Questionnaires administered	Questionnaires received	Response rate (%)
NCA 1	43	29	67.4
NCA 2	37	31	83.7
TOTAL	**80**	**60**	**75**

Source: Research data

4.1 Firms' experience profile

The working experience of the companies surveyed indicated that 6.7% had worked as contractors in the construction industry for over 20 years, 13.3% between 11-20 years, 48.3% between 6-10 years and 31.7% between 0-5 years as indicated by fig 4 below. The high cumulative percentage of 68.3% of firms with experience of over 6 years is significant to provide some understanding on ICT uses and challenges. It also assumes the contractor had time to accumulate adequate resources to invest in ICT adoption

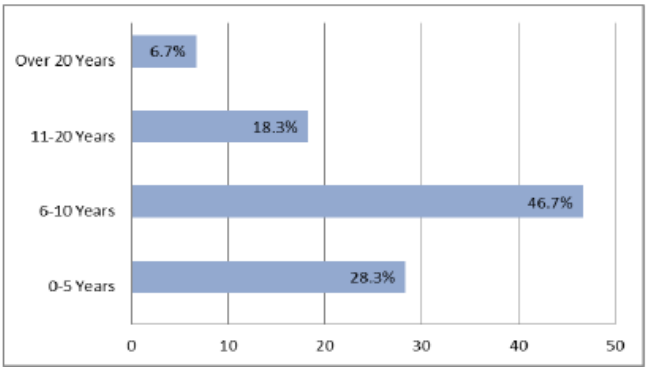

Fig 2 Firms' Experience Profile

Source: Research data

4.2 Demographic variables and profiles of respondents

The data analysis also revealed that varied professional backgrounds in the contractor's organizations were represented in the survey. According to Fig 3 below, the backgrounds of respondents comprised 16 contractors/builders (26.7%), 12 construction project managers (20.0%), 5 sub-contractors (8.3%), 5 site/resident engineers (8.3%), 3 quantity surveyors (5.0%) 7 clerk of works/site agent (11.7%),skilled laborers(6.7%), site supervisors(5.0%), 5 building construction Consultants (8.3%), The high representation of contractors and project managers (46.7%) was crucial as these are the very key targets of this study as directly involved in project implementation. Presence of other professionals in varied percentages represents a normal distribution

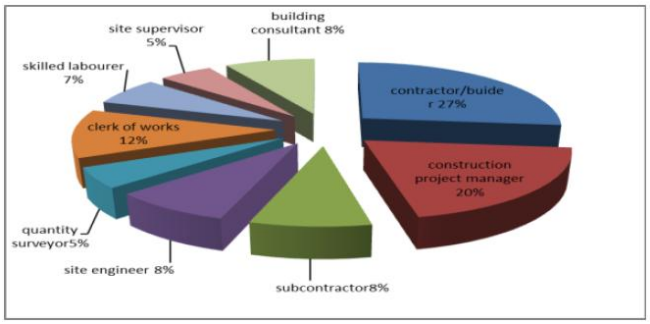

Fig 3 Demographic variables and profiles of respondents
Source: Research data

4.3 Respondents personal experience

Concerning respondent's personal experience in the construction industry, the survey revealed as shown on figure 2 that a majority constitute (46.7%) and have been in the industry for between 6-10 years, while only 6.7% have over 20 years of experience and 28.3% had between 0-5 years of experience.

4.4 Respondents age brackets

The study revealed that majority of the respondent age is between is 31-40 forming 48.3% and that the majority 36.7% have been involved in between 6-10 Projects this is a generally young generation but have gained enough experience. This is significant since the older generation is perceived to have less computer skills therefore their input on ICT issues may not be relied on. These percentages are clearly indicated by table 3 below

4.5 Challenges facing Kenyan building contractors during adoption

The one sample t-test was employed to analyze the challenges facing building contractors in their effort towards ICT adoption. This statistical tool was employed basically to ascertain the significant and most important reasons hindering usage by contractors. The one-sample t-test compares the mean score found in an observed sample (sample mean) to a hypothetically assumed value and establishes whether the sample mean is significantly different from a hypothesized mean. Typically the hypothetically assumed value is the population mean. By the central limit theorem, a normal distribution can be assumed when the sample size is more than 30 (Hair et al, 1998). Therefore, with a sample size of 80

4.6 T-Test Results

It can be assumed that, the underlying suppositions of the central limit theorem were applied and that, the sample size is relatively adequate for use in this statistical inference. Typically, a one sample t-test reports on the mean of the test group, degree of freedom for the test, the t-value (which is an indication of the strength of the test) and the p-value (which is the probability value that the test is significant) (Hair et al, 1998). With the use of SPSS, a statistical analysis was performed to determine whether the population agreed on a particular factor as a strong reason or not. The t-test analysis from SPSS usually produces two reports, namely, the one sample statistics and the one sample test showing test significance. If the difference between the sample mean and the test mean is large relative to the variability of the sample mean, then is unlikely to be equal to the test mean. With reference to the 5-point Linkert rating scale adopted, ratings of 4 and 5 representing severe and very very severe reasons respectively. By that, the populations mean μ o was set at an appropriate level of 2.0 and the significance level was also set at 95% in accordance with expected risk levels (Cohen, 1992). Therefore, based on the five-point Linkert rating scale, a factor was considered critical if it had a mean of 2.0 or

Table 3 Respondents age bracket

	Frequency	Percent
18-30 Years	18	30
31-40 Years	29	48.3
41-50 Years	10	16.7
Over 50 Years	3	5
Total	**60**	**100**

Source: Research data

more. Where two or more criteria have the same mean, the one with the lowest standard deviation was assigned the highest importance ranking (Field, 2005). The standard error is the standard deviation of sample means and is a measure of how representative a sample is likely to be to the population. A large standard error suggests that there is a lot of variability between means of different samples. A small standard error suggests that most sample means are similar to the population mean and so the sample is likely to be an accurate reflection of the

population. Clearly, the standard error for all the means is in the close of zero which indicate that the sample chosen is an accurate reflection of the population.

4.7 T-Test significance

With the use of SPSS, a statistical analysis was performed by a two tail test on each factor to determine the significance values (p-value) of each factor hindering adoption of ICT by the contractors. The two tailed significance value was divided by two to obtain a one tailed significance value which was then used to provide a basis for a statistical decision to be made as to whether or not the population mean and sample mean are equal and the results tabulated.

4.8 Interpretation of results

by interpreting the results obtained, it can be deduced that the most important factors from the study are: Rapid changes in ICT technologies (Mean= 3.37), High cost of employing ICT professionals (Mean= 3.35), High cost of training ICT professionals (Mean= 3.20), Satisfaction with the existing method of working (Mean=3.15), Inadequate knowledge about return on ICT investment (Mean= 3.13), Inadequate financial resources (Mean= 3.10), Fear of job losses/making professionals redundant (Mean= 2.98), Software and hardware reliability problems (Mean= 2.97), Security concerns / privacy fears (Mean= 2.95), Lack of legal support for use of ICT (Mean= 2.95), Little return on investment(Mean= 2.95), Lack of qualified personnel to handle ICT adoption(Mean= 2.75) and Lack of information by contractors on areas of adoption(Mean= 2.65) in that order.

When these factors are considered together with the Results of One Sample Test showing test significance it is revealed that the significant ones where respondents seem to have greatest agreement on as reasons hindering the use of ICT by the contractors are:

1. Fear of job losses/making professionals redundant
2. Lack of qualified personnel to handle ICT adoption
3. High cost of training ICT professionals
4. Satisfaction with the existing method of working
5. Rapid changes in ICT technologies

The T- test also clearly indicate that whereas rapid changes in ICT technologies (mean= 3.37, P=0.185) came out as the highest ranked factor, Lack of information by contractors on areas of adoption (mean=2.65, P= 0.18) was ranked the lowest in terms of the factors hindering ICT usage by the respondents. This suggests that although Lack of information by contractors on areas of adoption may appear very significant, it was largely perceived by the respondents as not an important barrier to ICT usage.

The perception of the respondents also suggests that, their focal concern was *rapid changes in* ICT technologies. This basically agrees with the growing challenge of how to cope with rapid changes in ICT technologies as sited in the literature review. It is further revealed that High cost of employing ICT professionals (mean=3.35, P= 0.0195), Satisfaction with the existing method of working (mean=3.15, P= 0.18), Inadequate knowledge about return on ICT investment (mean=3.13, P= 0.235) and Inadequate financial resources (mean=3.10, P= 0.284) were ranked 2nd, 3rd, 4th and 5th significant factors respectively.

The fact that the cost of employing ICT professionals was ranked second at a significance of (*P=0.0195).* brings to the fore the need to recognize that, there are still less professionals trained and qualified to handle ICT in construction hence the simple rule of demand and supply dictating the cost of employing these professionals. As a result, focus on training for ICT use in construction by both private organizations and government is quiet critical. Universities and technical training institutes that offer training in building related fields should focus more on training ICT professionals in a more practical way than the way they seem to do it. It also agrees with the findings of songer and weippert (Songer *et al.* 2001; Weippert *et al.* 2003). These studies found lack of training as a key barrier to adopting and using ICT applications. Traditionally, problems in learning and training in training institutions has been use of outdated curriculum and especially in ICT that seem to change more rapidly compared to other fields. It is therefore notable to justify training as an essential factor for success of ICT implementation and usage. It is important to note that *satisfaction with existing method of working* was ranked third at a significant of *(P=0.18).* Basically this may reflects the respondents‟ strong view of their level of ICT literacy that still ties with the issues of training since people are by nature reluctant to expose their ignorance. This position of respondents seems to suggest the need for Kenya to seriously re - think ICT in its construction education to include a robust construction software skills acquisition and culture. This may be necessary both in certificate, undergraduate / postgraduate courses to create more receptive and highly trained construction professionals .It is therefore important to restate that, education in these levels play a great role in developing and shaping the understanding of ICT as a form technological change and innovation in construction. With the view that *Majority of respondents have little knowledge about return on ICT investment*, the respondents considered it at a significance level of *(P=0.235)* and ranked fourth on the scale. Clearly, this finding suggests the need for an increased awareness campaign especially by designers of these ICT technologies to contractor organizations on the available ICT resources at their disposal Another point worth noting is that, whereas factors such Lack of qualified personnel to handle ICT adoption *(mean= 2.75, P= 0.0925)* Lack of information by contractors on areas of adoption *(mean=2.65, P= 0.18),* are considered unimportant (mean < 3.0) by the respondents and ranked 10^{th} and 11^{th} respectively, they were surprisingly found to be statistically significant ($p \leq 0.2$). This appears to suggest that, although, these factors might not necessarily qualify as major reasons hindering their ICT usage; they should be noted as quiet significant in the context of the Kenyan contractor's organization.

V. SUMMARY, CONCLUSION AND RECCOMMENDATIONS

5.1 Research findings

Responding firms were asked to score identified reasons hindering the use of ICT by contractors in the construction industry and

based on the criteria identified, the Likert rating scale was again adopted to extract the appropriate ratings as per their influence as a reason hindering use of ICT by contractors in Kenya. The results points to a number of key factors that inhibit the extensive use of ICT by the contractors. Data obtained from the survey indicates that, 6 out of 13 factors obtained from literature as hindrances on their use of ICT were identified as important These include: *rapid changes in ICT technologies (Mean= 3.37), high cost of employing ICT professionals (Mean= 3.35), satisfaction with the existing method of working (Mean= 3.15), Inadequate knowledge about return on ICT investment (Mean=3.13), high cost of training ICT professionals (Mean= 3.20) and Inadequate financial resources (Mean= 3.10).*

Finally, a test for on the results has revealed that, the four most significant reasons hindering the use of ICT by building contractors in Kenya include:

1. *High cost of employing ICT professionals;*
2. *Lack of qualified personnel to handle ICT adoption;*
3. *High cost of training professionals in ICT and*
4. *Satisfaction with the existing method of working*

5.2 Conclusion

This paper sought to establish the significant factors hindering the use of ICT by building contractors

The following conclusions can now be confidently drawn from the study: The most significant factors affecting the use of ICT by building contractors are: *rapid changes in ICT technologies, high cost of employing ICT professionals, satisfaction with the existing method of working,*

Inadequate knowledge about return on ICT investment, high cost of training ICT professionals and inadequate financial resources.

These factors should explain the main reason behind current level of ICT usage by among building contractors in Kenya. It is therefore important to acknowledge that, while the interest towards ICT by building contractors in kenya seems promising, these factors continue to be a major issue that stakeholders and individual organisations need to address in order to increase usage and derive the full benefit of ICT.

5.3 Recommendations

On the basis of findings and conclusions drawn from the study, the following recommendations are proposed.

5.3.1 Financial investment by building firms on ICT

Construction firms should be motivated by the direct benefits of ICT and draw deliberate policies that provide some proportion of their internal budget for ICT investments. This will aim to improve both productivity and profitability to their benefit. Again, based on the understanding on the returns on ICT investment, financial institutions can assist building contractors in Kenya to finance their ICT investment by offering flexible credit facilities to firms seeking to invest in ICT. This will support their operations to improve efficiency and payback the facility.

5.3.2 Personnel and training of ICT professionals

By recognizing the importance of ICT education in construction as indicated by the first three challenges hindering higher ICT adoption by contractors it is recommended that a robust content of ICT education which will generate adequate construction ICT skill acquisition should be incorporated in construction courses as a supplement to technical knowledge and expertise in various fields of construction study. Again, there should be a closer cooperation between ICT technology developers and contractors to train professional and also develop ICT systems that will address the specific operational needs of Kenyan contractors.

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