Awareness and Adoption of Information and Communication Technology (ICT) by Architectural, Engineering and Construction (AEC) Industry Educators in Nigeria

O.S. Oyediran

Quantity Surveying Unit, Department of Building, University of Lagos, Lagos, Nigeria

ABSTRACT: The adoption of the ICT in the construction industry has been very slow for Information and Scientifically Underdeveloped Nations (ISUNs), as compared to the wonders of ICT in business and the construction procurement process in the Information and Scientifically Developed Nations (ISDNs). This study set to gather and analyze baseline information about awareness and adoption of ICT in the AEC industry educators in Nigeria. In a stratified sampling survey design research using Nigeria educational institutions offering construction education, it was discovered among others, that majority of the educators are on either stage three or four of IT adoption, with proficiency in word processing packages and at lower level of proficiency on other industry specific packages. The study observed the quest by the younger cadre of educators to acquire training informally. It was recommended that a programme of training the educators through a centrally pooled ICT centre might provide the necessary ICT capacity base for the AEC industry.

1 INTRODUCTION

Oyediran and Odusami (2004) examined the state of the art of computing by QSs in Nigeria at the turn of the last century and observed that there is the need to examine the capacity of the industry educators as a necessary input in designing relevant policy strategy for the industry's IT take-off. Noble (1998) believes that training is central to the adoption of IT and to overcoming the difficulties that may arise as a result of its adoption. Rebolj and Menzel (2004) were right in observing that an important reason for not using IT in construction effectively is education related. They further pointed out that graduated students are powerful agents of change in the industry and agents of technology transfer. A major factor in IT adoption in the construction industry is the inadequacy of human resources and experiences. The industry need highly educated professionals who posses relevant knowledge and understanding of the systems and processes. A shift in education system is not only overdue (Stallings, 2001) but an examination of the IT incapacities of the institutions is indispensable. This will require auditing of both physical and human resources.

There is dearth of industry-wide information about how the ICT technologies are being imported and adopted to build up the capacity level of the AEC professionals in the ISUNs, particularly in Nigeria. The ISUNs are primarily users and consumers of ICTs, while the ISDNs are the primary inventors and developers of these technologies. The developed world has made tremendous progress in application of the technologies in commercial, industrial and educational processes, the less developed countries. The less developed world where the countries in Africa falls are just waking up to the reality of adoption and application of the technologies. However, there has been some rapid progress in the application of ICT in commerce particularly in financial services, of late. This is because of the seamless communication nature of ICT. The construction industry has been sluggish in adoption of ICT despite the amenability of its process to IT operations.

This sluggishness can be traced to conservativeness of the industry, high degree of fragmentation in both the procurement process and production systems, absence of management driven IT strategy (Cartidge, 2002) and low capacity building through education (Oyediran, Odusami, 2004; Rebolj & Menzel, 2003). Rivard (2000) noted the continual demand for upgrading and greater know-how required for IT adoption. This demand for upgrading and know-how underscores the importance and criticality of training at tertiary educational institutions and at continuous professional development (CPD) levels.

Research in construction IT (Sidewell and Cole, 1988, Doherty, 1997, Howard 1998, Rivard 2000, Samuelson, 2002, Rivard, et al 2003; Love et al, 1995, Hua, 2005, etc) has carried out surveys on ICT wage in most developed (ISDNs) nations. It appears in these studies that capacity development of the AEC industry educators have been taken for granted. Reboly and Menzel (2004) reported that several research projects have seen the issues of educating the practitioners and bringing results closer to the practice as the way forward in making the industry use the IT solutions proffered. However they believed that an important reason for not using IT solutions proffered in construction effectively lies in the current education practice. Stallings (2001) also shared similar views when he submitted that a shift in education system is overdue in his argument for the adoption of the virtual university for education in the 21st century.

This study set to gather and analyze baseline information about awareness and adoption of ICT in the AEC industry educators in Nigeria. It sought to understand the resource constraint prevalent among the educators with the aim of determining the policy directions that will promote better rate of IT adoption that will facilitate the performance of the industry particularly with the globalization challenges threatening the developing economies. It is to further discover the challenges faced by the professionals by examining the factors affecting the use and adoption of computer.

2 METHODOLOGY

The research is designed to obtain information from those involved in teaching/research in construction related fields in tertiary institutions in Nigeria. The sampling technique employed is purposive. The data generated were analyzed using mean item scores to generate ranking of the variables of interest using the following formula as commonly used by some researchers in the construction management field (Odeyinka, 2003; Egbu & Botterill, 2002, Kukulanga, Kuotcha, McCaffer & Edun-Fotwe, 2001; Ling, Khee& Lim, 2000; Wang, Tiong, Ting & Ashley, 2000).

$$I_u = \sum_{n=1}^{5} k_i n_i / n_x k$$

where ki = Rank of event i. and ni = Frequency of event i., I=Index of the specified event.

The events measured are: the awareness of the use of various ICT tools, the of adoption of tools and packages as well as the level of deployment of computer in teaching and research and the factors affecting computer usage.

The modal age of respondents falls in the 41-50 years category, while the respondents spread across the professions in the built environment .The average teaching/research experience of respondents is about 11 years, while majority are in the middle lecturership grade. The respondents were drawn from five categories of educational institutions, categorized by ownership.

About 94% of the respondents indicated that they have been using computer/word processor in connection with their academic work, while about 47% claimed to have been using computers in the last five year, and only about 19% have been using computers over ten years ago. Their use of computer is mostly in the office (89%), at home (49%) and in cyber cafe (40%). About 71% indicated that they use computer every day. Access to computer is predominantly through personal purchase (78%) while the office accounted for about 13% access. Institutional Ownership of computers is very poor. The surveyed average computer ownership by the institution indicated that there are about five computers per respondents. About 29% of the respondents have intercom facilities while about 20% have Intranet access. The intranet and video conferencing facilities are very low. The local area Network facility (LAN) is below 10% (Table 2).

3 RESULTS ANALYSIS AND DISCUSSION

Table 1 itemizes some of the communication facilities of ICT and the mean awareness index of the educators.

Table 1: Awareness of the Information Technology Software

Computer Packages	Mean Awareness Index	Ranking
♦ Electronic document data transfer i.e. floppy disk	3.91	1
♦ Internet (www)	3.90	2
♦ Voice mail	2.93	3
♦ Video conferencing	2.51	4
♦ Intranet communication	2.07	5
♦ Extranet communication	1.78	6
♦ Average Mean Awareness Index	2.85	

0 =Very unaware, 1 = unaware, 2 = aware, 3 = moderately aware, 4 = very aware, 5 = highly aware

Four of the facilities (Electronic document transfer, Internet, Voice mail and Video conferencing), while they indicated that they are not aware of intranet and extranet communication. It should be noted that they are on a high scale of awareness for electronic document transfer facilities, such as floppy disk, flash disk, CD Rom etc, and the Internet. They however indicate a moderate level of awareness for voicemail and video conferencing.

Do the departments to which the educators belong have ICT facilities to use in operating the ICT product? Table 2 lists the ICT facilities possessed by the departments. Eleven of the items were listed they indicated that they do not possess or own on line databases and interactive video. However, they claimed to have intercom within the institutions and Internet access. Both accounts for about 55%, the average percentage of department possession of these ICT facilities is about 18%. It is not compulsory for a department to have all these facilities.

Table 2. Possession of IT products facilities by the departments

Facilities	Possession	%
♦ Local Area Network	5	7.35
♦ Internet Access	18	26.0
♦ Intranet	1	1.47
♦ Video conferencing	1	1.47
♦ Reprographic machines	6	8.82
♦ Tele-fax technology	2	2.94
♦ Globile system of Mobile	7	10.29
♦ Intercom within the institution	20	29.41
♦ Voice mail	2	2.94
♦ On line data bases	0	0
♦ Interactive video	0	0

The five essential of these facilities are Intercom within the institution, local area network, Internet access, Internet and video conferencing, having an average percentage of departmental possession of about 24%.

Table 3. For functions for which departments originally acquire the computer(s)

Purpose of computer acquisition	Frequency	Percentage
♦ Word processing	40	58.80
♦ Student records	38	55.88
♦ Designs and Drafting training	12	17.60
♦ preparation of Muliti-media teaching resource	11	16.18
♦ Database management	8	11.76
♦ Estimating	1	1.47
TOTAL	110	

It is further expected that the purpose for which the department of the educators acquired their computer systems (which form the hardware base of the ICT) can partly indicate their awareness of their ICT. As indicated in table 3, two functions form the bulk of the reason why the hardware was acquired. These are to carry out word processing and student records functions. These two broad functions account for over 50% of the respondents. The other technical and industry specific functions and teaching functions account for less than 20% of the respondents.

3.1 *ICT Adoption Thresholds of AEC Industry educators*

Three measures were used to ascertain the ICT adoption threshold of the educators. They are the stages of adoption (table 4), the proficiency level of the educators (table 5) and the level of deployment of IT in teaching and research table 6.

Table 4. Stages of IT adoption

STAGES OF IT ADOPTION	Responses	Percentage
Stage 1: Awareness	2	2.94
Stage 2: Learning the process	4	5.88
Stage 3: Understanding and application of the process	19	27.94
Stage 4: Familiarity and confidence	19	27.94
Stage 5: Adaptation to other contexts	13	19.12
Stage 6: Creative application to new contexts	7	10.29
No stage indicated	4	5.88
Total	68	100

As expected, respondents (about 3%) are still at the lowest stage of IT adoption. Majority are either in stages three (about 28%) or four (about 28%). These stages are the understanding and application of the process and familiarity and confidence. Fewer educators are on the adoption to other contexts' stage and the creative application to new contexts stage.

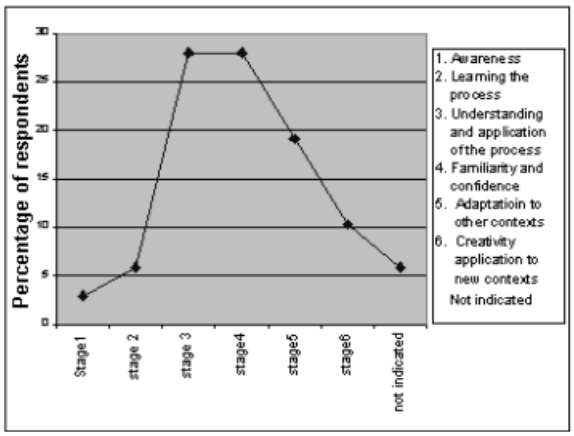

Figure 1. Stages of IT adoption by AEC educators.

The mean proficiency index, constructed on a 6-point Likert type scale of the educators proficiency on software packages 2.5 indicated on table 5. The average mean proficiency index is about 1.75 on a scale of 5. This indicates a moderately proficiency level. Decomposing this to groups of software shows varying levels of proficiency for each of the groups. The educators exhibit, comparatively, highest proficiency, (about 2.53) in the use of computer based communication media software. This is followed by the proficiency level in general-purpose software and then database management packages.

Table 5. Proficiency level in the use of computer packages

Computer Packages	Mean proficiency index	Average mean proficiency index
Word Processing packages (e.g. MS Word)	2.99	
Presentation Packages (e.g. MS PowerPoint, MS Publisher	2.03	2.51
Database management packages MS Access	1.44	
MS Excel, Lotus 1-2-3 or MS Lotus 1-2-3	2.72	2.08
Computer Based Communication media		
E-mail	3.38	
Internet	3.51	
Intranet	0.69	2.53
Design Packages (Auto CAD, Archi CAD etc	1.75	
Quantity Surveying software packages	0.49	
GIS packages	0.96	
Project Management software	1.04	
Property and Facilities Management software	0.85	
Programming languages (Basic, Virtual Basic, Fortran, e^{t++}).	0.90	
Average Mean proficiency Index		

0 = cannot use at all, 1 = not proficient, 2 = moderately proficient, 3 = proficient, 4 = very proficient, 5 = very highly proficient

Their proficiency level in programming languages, and other industry specific software is very low (average mean proficiency index for industry specific software is about 1.02), indicating no proficiency.

Table 6. Level of deployment of IT in teaching and research process

Teaching and research process	Mean development Index	Ranking
♦ Surfing the Net for research information	4.03	1
♦ Research data analysis	3.44	2
♦ Processing student results	3.34	3
♦ Communicating using E-mail	3.25	4
♦ Managing student records	2.99	5
♦ Direct Instruction to students	2.34	6
♦ Preparation of slides	1.71	7
♦ Communicating with students on-line	1.41	8
♦ Average Mean Deployment Index	2.81	

0 = not existent, 1 = very low, 2 = low, 3= moderate, 4 = high, 5 = very high

Table 6 shows the level or degree to which the educators deploy ICT in their teaching and research process. On the average, the mean deployment index of about 3 indicates a moderate level of overall deployment. It is apparent that communication component of ICT is the more prominent areas of deployment of ICT by the educators (Average mean deployment index is about 2.90). They also deploy ICT to research data analysis, process student results and managing student records at moderate level. Evidence of little or no use of ICT facilities in teaching is indicated by the low mean deployment indices for preparation of slides and communicating with students on-line.

3.2 *Factors impeding the deployment of ICT tools in teaching and research process*

All the respondents weakly agree that the eleven listed factors (Average MII = 2.95) table 7 limit or impede the extent of deployment of ICT tools in the teaching and research process. The high cost of hard and software however is indicated as being a leading inhibiting factor.

Table 7. Factors limiting the deployment of IT tools in the educational and research process in institutions

Factors	Mean Index of Inhibition	Ranking
♦ High cost of hard and software	3.71	1
♦ Inadequate telecommunication network	3.28	2
♦ Computer illiteracy among staff	3.19	3.5
♦ Ineffective telecommunication network	3.19	3.5
♦ Attitudes of staff to IT deployment in construction education	3.09	5
♦ Inadequate relevant software	3.04	6
♦ Inertia of senior academics	2.85	7
♦ Lack of interest by the management of the institution	2.79	8
♦ Computer literacy level among students	2.76	9
♦ Personal contact is considered more effective	2.50	10
♦ Reliance on IT seen as disempowering	2.01	11

0 = not sure, 1 = strongly disagree, 2 = disagree, 3= weakly agree, 4 = agree 5 = strongly agree

They disagree that reliance on IT is seen as disempowering and as such it does not constitute attitudinal belief that is capable of weakening the resolve to digitalize teaching and research process. This result seems not to agree with Babajide and Bolaji's (2003) result that observed that the respondent lecturers of pure and applied science related disciplines in the tertiary institution studied seems not to believe in the use of ICT communication media for dissemination of knowledge. At best this may be a tempo-

rary position, as unfolding events in ICT advancement will make such belief unpopular.

4 DISCUSSION OF FINDINGS

Results indicating the level of awareness of the AEC educators show that they are moderately aware of the ICT operating software. This result agrees with Oni's (2003) findings, which indicated that the AEC industry professionals in Nigeria are moderately aware of electronic mail, electronic document transfer and Internet communications. This seems to indicate that the awareness level of educators in Nigeria is not higher than that of the industry practitioners. They seem not to be ahead of the industry unlike in the developed economies where researchers have not only indicated high level of awareness, but have come up with solutions reflecting the extent of use, adoption and application of these facilities to peculiar construction industry contexts (Rebolj & Menzel, 2004; Kalay, 2004; Rivard & Bedard, 2004; Lindemann, et al, 2004; Mangini & Pelli, 2003; Bacblom et al, 2003).

The departmental possession of the ICT facilities is very low. For the most essentials ones needed for training the students, the average percentage indicating departmental possession is less than one-quarter. Various government organs have seen the need for integrating IT culture into the educational system in the country. However, this aspiration has not been met with required implementation seriousness. Busari (2003) has noted that most teacher trainers in tertiary institutions in Lagos State of Nigeria have gotten little or no ICT support from their employers. There has been much rhetoric about ICT deployment in teaching and research and less of reality.

The purpose for which the computers acquired by the departments of the educators also indicate that the educators are operating on general and popular ICT awareness and less of awareness of the industry specific functional specification of ICT needs.

Following the report of Mohammed and Ekpunobi (2003) that ICT has developed in the Nigerian University System through academic computer science departments and computer centers, then the AEC educators who did not go through such academic programme is left with the option of private on-the-job training or self-taught training. Busari (2003) has reported that about 77% of the tertiary education teachers have acquired their capacity level in ICT through self-taught on-the- job training. The preponderance of the self-taught training by educators requires self-motivation on the part of the learners so as to overcome learning struggles without abandoning the learning process. However, it is apparent that self-taught learners, as usual will have to pass through various stages of awareness. While some may overcome the learning struggles and move to advanced stages of awareness and adoption, many may be satisfied with the basic knowledge and be operating at the periphery of ICT knowledge, use and adoption. Formal ICT training for the AEC educators may therefore become imperative if their products will be able to meet the expectations of the ICT-driven industry and global economy.

Proficiency, according to Jacobsen (1998), is the degree to which an individual is relatively measured on the level of expertise in the use of the specified computer software and tools. It can be used as a measure of the threshold of ICT adoption. While the educators specify their stage of adoption, the proficiency measure indicates what level of expertise they can be said to have attained on the specified expertise item.

There appears to be progress in the stage of adoption. Majority are at the middle point of the adoption stages. This corresponds with the proportion that claimed that they have been using computers since the last ten years, cumulatively. The prospect for rapid progress is high since the modal age of respondents fall within the 41-50 years age group. This is still within the age group of those that Jacobsen (1998) found to be integrating computer technology for teaching and research in higher education.

Of all the industry specific software, the design packages (AutoCAD, ArchiCAD, etc.) have the highest mean proficiency index, which indicates moderate proficiency. This is followed by project management software. These low mean proficiency indices for all the industry specific software indicate not only the proficiency of the educators, but the capacity in terms of the number of proficient educators that can train the would-be industry professionals. In reality, most of the AEC industry graduates leave school without any training in these packages. They therefore rely on the employer to provide the training or they acquire it privately so as to be employable in the industry.

5 CONCLUSION

The study has examined the level of awareness and adoption threshold of the AEC industry educators in Nigeria. The results obtained have indicated a moderate level of awareness of the various ICT tools currently available. The awareness level of the educators has been found to be almost at the same level with the industry practitioners.

The departmental possession of ICT facilities and tools is very low. The management of the institutions is to provide such facilities through sufficient budgetary allocations and implementation of relevant IT policy. Management must move from policy formulation to implementation.

It is apparent from this study that AEC educators lack ICT facilities that can integrate IT culture into the educational system of the AEC industry graduates. This is bound to have effect on how the graduates adopt and adapt to ICT in the industry, and consequently the industry is worse of for not having the capacity to deliver value in the project procurement process. This ultimately will affect the capacity of the industry to compete globally.

The proficiency threshold is average. Majority of the AEC educators are already able to understand and apply ICT to the teaching and research process and as well able to use ICT with familiarity and confidence. There is need for acquisition of further expertise so as to be able to move to later stages of ICT adoption.

The expertise level measure in proficiency terms, for the industry specific ICT tools is below average. While the expertise level for design packages is the highest it does almost not exist for other equally relevant packages being in use in the project procurement process.

Cost of hard and software has been singled out as having significant impact in limiting or inhibiting the deployment of ICT tools in teaching and research process. Other factors that show some level of significant inhibition to ICT deployment are inadequate and ineffective telecommunication network, computer illiteracy among staff, attitudes of staff to ICT deployment in construction education and inadequate relevant software.

The AEC industry educators must have ICT knowledge-edge over the industry applicators of ICT tools. This is necessary to provide necessary leadership in education and in research into applications relevant for the use of the industry practitioners. The study hereby advocates the creation of a Construction ICT Centre in any of the tertiary institutions that have infrastructure base and the minimal human capacity for ICT training. The Centre will pool existing and available human resources from various institutions offering AEC industry related courses or programmes.

The Centre is to primarily serve as training the educators (TTE) Centre as well as develop to a center of excellence in construction ICT research and development. The Centre can seek and assess any nationally and internationally available financial resources and as well network with other similar institutions in developed and developing economies of the world. Attaining a high level of ICT awareness and expertise coupled with capacity to keep on the cutting edge of ICT development is a must for the AEC industry educators, in developing economies, if the industry will be able to deliver value to the society.

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