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Assessment of Information and Communication Technology (ICT) Use in Construction Education in Ghana

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Authors' contributions

This work was carried out in collaboration between both authors. Author NAK designed the study, wrote the protocol and the first draft of the manuscript. Author MA managed the data collection, literature searches and performed a draft statistical analysis. Both authors read and approved the final manuscript.

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ABSTRACT

Aim: The construction industry in the last two decades has witnessed remarkable advancements in construction technology, procurement practices, information technology (IT), legislation and client demands. The paper explores the use of ICT tools in construction education in Ghana.
Study Design: The study adopted a survey design and was conducted over a period from June 2013 to September 2014.
Methodology: A five-point Likert scale survey questionnaire was developed and administered to 50 lecturers and 275 students in six selected public tertiary institutions running construction programmes in Ghana. An overall response rate of 84% achieved with response rates of 78% and 85% for lecturers and students respectively.
Results: The study showed that the level of use of ICT tools in construction education in higher institutions in Ghana is moderately low. Further findings revealed that the numerous constraints to the use of ICT tools in construction education in the institutions surveyed may be categorized as; technological constraints, financial constraints, human related constraints, environmental constraints and administrative constraints.

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Conclusion: The study argues for more concerted efforts by educational institutions aimed at overcoming the constraints identified, particularly through effective industry collaborations, innovative funding of ICT budget and training of staff.

Keywords: ICT skills; construction education; curriculum; Ghana.

1. INTRODUCTION

Information and communication technology (ICT) is used in educational institutions primarily; to aid management and administrative activities, to learn and acquire relevant knowledge and skills to meet challenges of the information age, and thirdly for learning and instructional purposes [1]. In this article the focus is on the use of ICT in relation to learning and acquisition of knowledge and skills. The type of knowledge and skills that should be acquired by learners is often contingent on industry demand for it and to some extent educational policy, particularly, that which places emphasis on demand driven programmes. This is the more so since, increasingly, employers advocate for a workforce that can use technology as a tool to enhance creativity, productivity and quality [2]. Arguably, such a focus of learning cannot be achieved in isolation of ICT uptake. In relation to ICT, construction education should be or is necessarily concerned with creation of sustainable knowledge and skilled workforce in information and communication (ICT) application in order to improve upon quality and productivity in the construction sector.

Increasingly, ICT plays an essential role in the transformation of the construction sector from a traditional to an industrialized process [3]. The application of ICT in construction is generally acknowledged to include, but not limited to software deployed for design, project planning and control, cost modelling. Additionally, ICT is used for administrative purposes, information transfer between project participants and automation or robotics [4]. The aforementioned ICT applications provide opportunity for related skills in the job market which hitherto were nonexistent. Consequently, tertiary institutions should be seen to promote professionally relevant courses that reflect the specialist knowledge required in today's competitive job market [5]. This process cannot be effective without an assessment of ICT in construction education.

Education has witnessed concerted efforts by policy makers aimed using ICT to enhance teaching and learning [1]. However, the debate pedagogical effectiveness of ICT is inconclusive as can be seen from findings of many studies reviewed by [1] that seem to place emphasis on soft technology such as innovativeness, content and instructional strategies rather than hardware technology as the cause of improved learning. Rather empirical studies on learning suggest improved learning can result from effective instructional practices such as task design and interventions as aptly stated in five principles; task centeredness, demonstration, activation, application, and integration by [6]. Information and communication technology in itself can be used as a tool for pedagogical innovativeness. In line with innovative pedagogical practices, there is growing use of ICT in cooperative learning and e-learning as typified by the European 'eTwinning' project aimed at promoting new and innovative use of ICT in European school systems [7].

Educational policy on ICT in Ghana is top-down approach driven by the Ministry of Education at the apex. The National Council for Tertiary Education is responsible for advising the Ministry of Education on all matters related to the development of tertiary education, including the assessment of the financial needs and budgetary allocations to the institutions. The National Accreditation Board (NAB) and the National Board for Professional and Technician Examinations (NABPTEX) oversee the accreditation of programmes run by universities and polytechnics in the country. All the polytechnics in Ghana and three public universities (Kwame Nkrumah University of Science and Technology, University of Education-Winneba and KAAF University) offer construction and related programmes. The country has seen a rise in private tertiary institutions over the last decade, few of which also offer construction related programmes. Construction education provides graduates with job-relevant skills to meet the demands of industry and the economy as a whole [8,9].

The impact of information and communication technology (ICT) on construction has been tremendous in the past two decades [10,11].

Knowledge of ICTs application has improved construction productivity through decreased information processing time [12]. In construction, ICT applications were initially developed on computer mainframes to assist construction operations, support decision-making, and prediction of outcomes of uncertain processes [12]. However, these computer applications were developed in research organizations and colleges and they were not widely used for construction activities. By the 1980s, computers were introduced to large construction companies and mainly used for administration, estimating, computer aided design (CAD) and planning. Further expansion in ICT applications in construction industry is witnessed by applications such as virtual reality, 2D & 3D barcodes, and 4D-CAD, handheld devises, internet and remote access mainly developed to improve efficiency in construction processes [13].

Many studies focus on the ICT implementation and diffusion in educational institutions generally [14,15,5,16] or in large construction organisations [12,17]. However, the link between construction education curriculum and the knowledge requirements of the construction industry has largely remained underexplored in the literature. This paper assesses ICT in construction education in Ghana's tertiary institutions. Specifically, the objectives are to; assess the level of use of ICT tools in construction education and identify the constraints to the use of ICT in construction education.

2. MATERIALS AND METHODS

To achieve the aim and objectives of the study, a descriptive survey approach was adopted and data gathered from selected polytechnics and public universities running construction programmes in Ghana within the period June 2014 to June 2015.

2.1 Study Population and Sample

The research population was made up of final year students and lecturers in all tertiary educational institutions running construction related programmes. In all, ten (10) polytechnics and four (4) universities running courses such as building technology, civil engineering and construction technology were chosen as the population for the study. Final year students were chosen for the study because they have gone through the entire programme hence are in a better position to provide the required information for the research. A multi-stage sampling technique was used in selecting the respondents. In the first stage, a simple random sampling technique was adopted in selecting six (6) of the tertiary institutions. Where an institution runs a single construction related programme, such a programme was automatically included in the survey. In the case of institutions where there were more than one construction related programme, one programme was purposively selected to ensure adequate representation. Also, all the lecturers teaching the selected programmes formed the sample for the study. In all, 275 final year students pursuing various construction related programmes and 50 participated in the study.

2.2 Questionnaire Design

The questionnaire used in this research used closed-ended questions and was in three sections: Section 'A'; Section 'B' and Section 'C''. Section 'A' sought personal particulars of the respondents. Section 'B' sought information on ICT skills and application and Section 'C' sought respondents' views on constraints to the use of ICT in construction education. Section "B" employed a five-point Likert ordinal scale to measure the level of usage of ICT tools in construction education by respondents from "Very low" to "Excellent". That is; 1 represented very low, 2 represented low, 3 represented moderate, 4 represented good and 5 represented excellent. Within the same section respondents were asked to rate how often they used ICT tools during lesson delivery and learning. This aspect covered word processing, presentation, architectural design and drawing, project planning, structural design, quantity surveying measurement and estimating, communication using response categories "very regularly" to "not at all". That is; 1 represented not at all, 2 represented very rarely, 3 represented rarely, 4 represented regularly and 5 represented very regularly. Section "C" covered constraints to the use of ICT tools and asked respondents to score factors hindering the use of ICT by lecturers and students in construction education. Similar to Section B a five-point Likert scale was used rate the factors.

2.3 Test of Validity and Reliability of the Questionnaire

To test criterion-related validity, the correlation coefficient for each item of the questionnaire and the total of the field was assessed. The *P*-values

(Sig.) are less than .001 for all results, so the correlation coefficients of each field are significant at α = .01, so it can be said that the paragraphs of each field are consistent and valid to measure what it was set for. An assessment of the field's structure validity was carried out by calculating the correlation coefficients of each field of the questionnaire and the whole of questionnaire. The *P*-values (Sig.) are less than .001, so the correlation coefficients of all the fields are significant at α = .01, so it can be said that the fields are valid and measured what was supposedly to be measured in order to achieve the main and objectives of the study. The less variation an instrument produces in repeated measurements of an attribute, the higher its reliability. For the fields, values of Chronbach's Alpha were in the range from .742 and .883. This range is considered high and therefore ensures the reliability of each field of the questionnaire. Chronbach's Alpha equals .879 for the entire questionnaire which indicates a good reliability of the entire questionnaire.

3. RESULTS

A total of 325 questionnaires were distributed to the survey respondents in the Six (6) randomly selected higher institutions running construction related programmes. Two hundred and seventy-five (275) questionnaires were administered. At the end of the field survey, 274 questionnaires (235 and 39 for students and lecturers respectively) representing (84%) were received for analysis. In terms of gender of the respondents, all 39 lecturers who responded were male whereas 219 representing 93% of the students who responded were male and 16 representing 7% were female. The distribution of the ranks of the lecturers included; 25 representing 64% lecturer, 9 representing 23% senior lecturer, 4 representing 10% assistant lecturer and 1 (3%) associate professor. Four lecturers representing 10% had below 5 years of experience while 16 representing 41% had number of years of experience ranging 6-10 years. Eleven of them representing 28% had 11-15 years of experience and five representing 13% and 3 representing 8% had years of experience ranging 16-20 years and above 21 years respectively.

Seventy-nine representing 34% of the students who participated in the study were below the age of 20 years, while 86 of them representing 37% were aged 21-25 years. A further 32 representing 14% were 26-30 years, 16 representing 7% were aged 31-35 years and 13 representing 6% aged 35-40 years. Nine representing 4% of the students were above 40 years of age. Majority (60%) of the respondent were senior high school certificate holders, whereas 11% were teacher certificate 'A' holders,9% were higher national diploma certificate holders., 7% were technician part III holders, 6% were technician part II holders, 3% were technician part I holders. 2 % were holders of 'A' level, and 'O' level certificates respectively.

3.1 ICT Tools in Construction Education

In terms of the level of use of ICT tools, respondents were asked to indicate their level of use of tools for processing word. The lecturers' level of use of Microsoft word scored an average of 4.3 while students scored an average of 3.9 which all connotes *'regularly'.* Both respondents ranked it as the most regularly used ICT tool. In terms of Word perfect, the lecturer rated the level of use as 1.8 whereas the students rated it 1.3 which connotes *'very rarely'* and *'not at all'* respectively. This was ranked by the lecturers in the 10th position and students ranked it in the 12th position. Table 1 presents the responses on other ICT tools. Similarly, the lecturers' and students' ratings of the level of use of Adobe PageMaker was 1.2 and 1.4 respectively connoting it was not at all used. It was ranked by the students and lecturers in the 16th and 14th position respectively. For MS PowerPoint, average scores of 3.2 and 2.4 was obtained for the lecturers' and students' ratings respectively. This is interpreted as '*rarely*' and '*very rarely*'. It was ranked 4th and 5th by the lecturers and students respectively.

The responses on architectural design and drawing tools showed none were regularly used. For the use of AutoCAD, the lecturers' responses scored an average of 2.8 whilst the students' responses obtained an average of 2.3 which means *'rarely'* and '*very rarely*' respectively. This item received an overall ranking of 6. For ArchiCAD, an average score of 2.8 was obtained for the lecturers and 2.5 for the students which connotes '*rarely*'. This was also ranked in the 5th position by both respondents. The level of use of CorelDraw was rated 1.8 and 2.2 by students and lecturers respectively which is interpreted as very rarely used. It was ranked by both respondents in the 9th position. For Chief Achitect, an average score of 2.6 was obtained for the lecturers and 2.1 for the students which connotes '*rarely*' and '*very rarely*'. This was also ranked in the 8th position by both respondents.

Regarding the use of Project Planning tool, the responses for MS Project indicated the lecturers' rating had a mean of 2.8 which signifies *'rarely'* used. On the other hand, the students' rating was 2.2 which means *'very rarely'* used. It was ranked by students in the 7th position whereas lecturers ranked it in the 5th position. Regarding the use of Primavera, the responses of the lecturers obtained a mean of 1.2 and that of the students recorded a mean of 1.1 which means that it was not used at all. This was ranked by lecturers and students as 19th and 20th respectively. For structural design tools such as APM Civil Engineering, the students' level of use obtained a mean of 1.0 whereas that of the lecturers was 1.1 suggesting the tool was not used at all. For the remaining structural design tools such as Monomakh, Robot, Lira and SCAD, the means of the responses of the lecturers and students were all in the range of 0 -1.49. This means that all the structural design tools were *'not at all'* used by the respondents.

The lecturers' level of use of MasterBill scored an average of 1.8 while students scored an average of 1.6 which all connotes *'very rarely'.* Both respondents ranked it as the 10th most regularly used ICT tool. For Revit, the lecturers' level of use scored an average of 1.8 whereas that of the students was 1.3 which connotes *'very rarely'* and *'not at all'* respectively. This was ranked by the lecturers in the 10th position and students ranked it in the 12th position. With regards to the remaining quantity surveying tools such as WinOS, CatoPro, QS Elite, and Snape Vector, the means of the responses of the lecturers and that of students were all in the range of 0 -1.49. This meant that they are *'not at all'* used by the respondents.

Table 1. Level of use of ICT tools in construction education

Level of use of ICT tools	**Lecturers**		**Students**		**Overall**	
	Mean	**Rank**	**Mean**	**Rank**	**Mean**	**Rank**
Word processing						
1. Microsoft Word	4.3	1st	3.9	1st	4.1	1st
2. Word Perfect	1.8	10th	1.3	12th	1.6	11th
Presentation						
3. Adobe PageMaker	1.4	14th	1.2	16th	1.3	15th
4. MS PowerPoint	3.2	4th	2.4	5th	2.8	4th
5. MS Outlook	1.5	13th	1.4	11th	1.5	13th
Architectural design and drawing						
6. CorelDraw	2.2	9th	1.8	9th	2.0	9th
7. AutoCAD	2.8	5th	2.3	6th	2.6	6th
8. Chief Architect	2.6	8th	2.1	8th	2.4	8th
9. ArchiCAD	2.8	5th	2.5	4th	2.7	5th
Project planning						
10. MS Project	2.8	5th	2.2	7th	2.5	7th
11. Prima vera	1.2	19th	1.1	20th	1.2	19th
Structural design						
12. APM Civil Eng.	1.1	23rd	1.0	24th	1.1	23rd
13. Monomakh	1.3	17th	1.1	20th	1.2	19th
14. Robot	1.3	17th	1.2	16th	1.3	15th
15. Lira	1.2	19th	1.1	20th	1.2	19th
16. SCAD	1.4	14th	1.3	12th	1.4	14th
Measurement estimating						
17. WinOS	1.2	19th	1.3	12th	1.3	15th
18. CatoPro	1.2	19th	1.2	16th	1.2	19th
19. MasterBill	1.8	10th	1.6	10th	1.7	10th
20. QS Elite	1.4	14th	1.2	16th	1.3	15th
21. SnapeVector	1.1	23rd	1.1	20th	1.1	23rd
22. Revit	1.8	10th	1.3	12th	1.6	11th
Communication						
23. E-mail	4.1	2nd	3.4	3rd	3.8	2nd
24. Internet	3.8	3rd	3.8	2nd	3.8	2nd
Overall	**2.05**		**1.78**		**1.95**	

The use of E-mail and internet received favourable ratings by the respondents. For E-mail use, the lecturer's level of use obtained a mean score of 4.1 which connotes *'regularly'* used whereas that of the students' recorded a mean score of 3.4 which means *'rarely'* used. This was ranked by the lecturers and students as the 2nd and 3rd most used ICT tool in construction education in that order. For the use of internet, an average score of 3.8 was obtained for both the lecturers and students which connotes '*regularly*' used. This was also ranked in the 3rd and 2nd position by the lecturers and students respectively.

3.2 Constraints to the Use of ICT in Construction Education

Factor analysis was used to establish the underlying interrelations existing among the very many variables identified as constraints to the use of ICT tools in construction education. This makes it possible to reduce the variables to a more meaningful framework. The rotated component matrix is presented in Table 2. In the preliminary analysis, the Kaiser-Meyer-Olkin (KMO) test of sampling adequacy achieved a score of 0.938. All the 24 factors had communalities of 1.00 or higher, indicating their appropriateness for the factor analysis. The 24 significant factors were further reduced to common factor patterns. This was done to empirically explain the constraints to the use of ICT tools in construction education. In doing this, principal component analysis with Varimax rotation and Kaizer Normalisation was used to determine which factors have significance. Factor retention was based on eigenvalue of 1.0. Only factors that account for variances greater than 1.0 were included in the factor extraction.

Five underlying themes or components were obtained using a cut-off point of 0.50. For component 1; security not guaranteed emerged highest with a factor loading of 0.804, followed by hardware problems (0.796), rapid change in technology (0.763), software problems (0.741), scarcity of professional software (0.737) and integration/ compatibility problems (0.685) in that order. For component 2; high cost of hardware/ software emerged highest with a loading of 0.818, followed by difficulty in proving that the benefit of ICT outweigh the associated cost (0.787), high cost of engaging computer staff (0.634) and Lack of available funding (0.615). For component 3; lack of knowledge/awareness of available ICT tools emerged highest (0.889), followed by fear/mistrust of technology (0.829), inadequate training (0.799), poor teamwork (0.764), poor leadership (0.687) and poor management (0.685). Component 4 had conservative educational managers that are slow to change as the highest (0.819), followed by insufficient/erratic power supply (0.783), project driven industry with short term outlooks (0.667) and inadequate ICT content in construction education (0.644). For component 5, lack of management appreciation of ICT emerged highest with a factor loading of 0.804, followed by administrators' inability to liaise with companies on skills requirement by industry (0.741) and fear of ICT making professionals reluctant to work (0.653).

Table 3 presents the amount variance explained by the components. Component 1 had total variance of 8.201, which accounts for 49.046% of the total variance of the 24 factors. Component 2 has total variance of 2.457 accounting for 6.232% of the total variance of the 24 factors. Component 3 has a total variance of 2.043 accounting for 4.835% of the total variance of the 24 factors. Component 4 has a total variance of 1.432 accounting for 4.524% of the total variance of 24 factors and Component 5 has a total variance of 1.093 accounting for 3.276% of the total variance of 24 factors. These five components constitute 67.913% of the total variance of the 24 factors.

Given that most of the variables in component 1 are directly or indirectly linked to issues relating to technology and the component was therefore labeled as technological issues. Similarly, given that most of the variables in component 2 are linked to financial issues, this has been labeled as financial constraints. The remaining components were labeled as; human resource constraints for component 3, environmental constraints for component 4 and administrative constraints for component 5. To this effect, the numerous constraints to the use of ICT tools in construction education in Ghana unlock separately unto issues relating to technological constraints, financial constraints, human resource constraints, environmental constraints and administrative constraints.

4. DISCUSSION

4.1 Use of ICT in Construction Education

The results showed that Microsoft Word was rated as the most regularly used ICT tool by both lecturers and students in construction education. Education is generally information intensive with a large volume of information generated and consumed by all participants involved. Students mainly use Microsoft word for most of their assignments and other academic activities. Lecturers use Microsoft word to prepare lecture notes and for research. This result confirms the fact that Microsoft Office suite is the most widely known commercially available integrated software for general works [18]. This results is also consistent with literature findings that the common types of software used in construction and construction education include word processing and spreadsheet [19]. In relation to presentation tools, MS PowerPoint was ranked as the 4th most used tool in construction education. MS PowerPoint has gain a lot of prominence in education as a power means of instructional technology [18,20] whereas use of Adobe PageMaker and MS Outlook as presentation tools are waning.

The results further suggest that ArchiCAD and AutoCAD were rated relatively higher (ranked 5th and 6th respectively). Notably, computer Aided Design (CAD) software is widely used by construction professionals in both consulting and contractor organisations, with AutoCAD having the largest share of the CAD market [21]. This market popularity of the software could partly account for the favourable rating received by the survey respondents. ArchiCAD is a popular software among architectural designers and this

Table 2. Rotated component matrix

No.	Constraints	Components				
		1	2	3	4	5
1	Rapid change in technology	0.763				
2	Hardware Problems	0.796				
3	High cost of hardware/ software		0.818			
4	Poor leadership			0.687		
5	Conservative educational managers that is slow to change				0.819	
6	Administrators' inability to liaise with companies on the skill requirement on the field					0.741
7	Inadequate ICT content in construction education				0.644	
8	Poor teamwork			0.764		
9	Lack of available funding		0.615			
10	Lack of management desire to appreciation of ICT					0.804
11	Reliability/ Breakdown Problem	0.683				
12	Difficulty in proving that the benefit of ICT are greater than the associated cost		0.787			
13	Integration/ Compatibility Problems	0.685				
14	Lack of knowledge | awareness of available ICT Tools			0.889		
15	Project driven industry with short term outlooks change				0.667	
16	Fear of ICT making professionals reluctant to work					0.653
17	Inadequate training			0.799		
18	Scarcity of professional software	0.737				
19	Poor management			0.685		
20	Insufficient | erratic power supply				0.783	
21	Fear /mistrust of technology			0.829		
22	High cost of engaging computer staff		0.634			
23	Software Problems	0.741				
24	Security not Guaranteed	0.804				

Extraction method: Principal component analysis
Rotation method: Varimax with Kaiser Normalisation

fact may partly account for its rating by the respondents. Increasingly, these and other new programmes are gradually replacing the traditional drawing board in the production of design information [22]. Project planning software applications uses include portfolio management, planning and scheduling, resource management, budgeting and cost control, contract management and risk management. MS Project was rated as the seventh most used ICT tool in higher education though rarely used. Although use of other planning tools such as Primavera is commonly adopted in practice [23], paradoxically, the results revealed that the respondents never used it. Impliedly, curriculum mainly focuses on manual aspects of project planning and control and use of ICT tools in construction education is yet to be explored by the institutions studied.

Structural design ICT tools such as APM Civil Engineering, Monomakh, Robot, Lira, and SCAD were not used by either category of the respondents notwithstanding structural design features strongly in the curriculum of construction education of the institutions studied. Again, relating this finding to professional practice suggests, plausibly, a gap in training of students that needs to be bridged to render construction graduates more competent in ICT skills that are tailored to the job market. Similarly, for measurement and estimating tools such as WinOS, CatoPro, MasterBill, QS Elite, SnapeVector, Buildsoft, MasterBill, Manifest CATOPro, WinQS and Revit, the respondents indicated that they were not used at all. This results is rather surprising given the wide variety of quantity surveying software that exist and are in use [24,25].

Regarding Communication tools, the respondents rated both E-mail and the internet as the second and third respectively most used ICT tool in construction education. A likely reason for the high rating of these tools is because both lecturers and students embraced these as efficient tools for communication amongst colleagues and enabling easy connectivity globally to vast amount of data which would have otherwise taken much money

Table 3. Total variance explained

Component	**Initial eigenvalues**			**Extraction sums of squared loadings**			**Rotation sums of squared loadings**		
	Total	**% of variance**	**Cummula-tive %**	**Total**	**% of variance**	**Cummula-tive %**	**Total**	**% of variance**	**Cummula-tive %**
1	8.201	49.046	49.046	8.201	49.046	49.046	7.365	27.650	27.650
2	2.457	6.232	55.278	2.457	6.232	55.278	4.264	15.302	42.952
3	2.043	4.835	60.113	2.043	4.835	60.113	4.103	10.051	53.003
4	1.432	4.524	64.637	1.432	4.524	64.637	2.834	8.242	61.245
5	1.093	3.276	67.913	1.093	3.276	67.913	1.874	6.668	67.913
6	0.934	2.645	70.558						
7	0.832	2.454	73.012						
8	0.789	2.324	75.336						
9	0.754	2.254	77.59						
10	0.702	2.145	79.735						
11	0.675	2.056	81.791						
12	0.647	1.982	83.773						
13	0.602	1.864	85.637						
14	0.59	1.807	87.444						
15	0.553	1.791	89.235						
16	0.527	1.737	90.972						
17	0.473	1.636	92.608						
18	0.402	1.538	94.146						
19	0.395	1.312	95.458						
20	0.365	1.286	96.77						
21	0.323	1.178	97.948						
22	0.287	0.899	98.847						
23	0.265	0.656	99.503						
24	0.132	0.523	100.000						

and time [26]. Electronic mail (e-mail) is perhaps, the most popular use of the internet. Messages and documents as attached files can be sent by electronic mails to other colleagues, lecturers and students at different locations and come with distinct advantage of speed. By this, details of projects for instance, can be exchanged between lecturers and students [27].

4.2 Constraints to ICT in Construction Education

Key factors contributing to technological constraints to ICT use in construction education include; rapid change in technology, hardware problems, software problems, security issues, Integration/ compatibility problems and reliability/breakdown issues. A possible effect of rapid change in technology is reluctance of educational managers to invest in new technologies. This could hinder the introduction of ICT tools in construction education. The unassailable constraint of inadequate funding for ICT is cannot be underestimated because of the high cost of hardware/software and also engaging computer staff. Also, lack of available funding and difficulty in proving that the benefit of ICT could offset the cost associated with ICT acquisition and use would make the implementation of ICT in construction education difficult.

A number of human factors impede the use of ICT tools in construction education. These factors include; poor teamwork, poor leadership, poor management, inadequate training, lack of knowledge/awareness of available ICT tools and fear/mistrust of technology. As a result of ineffective leadership and lack of prioritization, available resources may not be used effectively and efficiently. Consequently, this may lead to lowering of morale and enthusiasm of ICT supporting staff. Constraints relating to the environment such as; inadequate ICT content in construction education, conservative educational managers that are slow to change, insufficient/ erratic power supply and project driven industry with short term outlook present further challenges to ICT in construction education. “Insufficient/erratic power supply” as a constraint contrasts sharply with the results of studies in several developed countries [18,19,28,29,30,31] which made no mention of electricity and related infrastructure as obstacles. The conservative nature of educational managers that are slow to change is a challenge because of the difficulty in changing the minds of people who have managed educational institutions for a long period of time in a particular way. The curriculum of construction related programmes in higher education in Ghana do not contain enough ICT content contributing to the shortfall in the use of ICT tools.

Administrative constraints negatively influence the use of ICT tools in construction education in the institutions studied. The contributory factors in this case include; lack of management appreciation of ICT, fear of ICT making professionals reluctant to work and educational administrators’ inability to collaborate with industry on skill requirement in connection with ICT courses. For construction related ICT tools to be effectively introduced into construction education, there will be the need for education managers to interact with construction organizations and professionals in the industry to come up with the necessary skills requirements. Nonetheless, educational administrators are not able to initiate this move. Perhaps a key reason for the lack of collaboration is the lack of sufficient emphasis on industry collaboration by the traditional mode of delivery. This is in contrast with competency based training where it is mandatory for educational institutions establish industry collaboration.

4.3 Contribution of Findings to Existing Body of Knowledge

The findings of the present study provides empirical evidence that shows a mismatch between the use of ICT tools in construction education and professional/industrial practice which has a wider implication for curriculum design and/or revision. This is a significant contribution to educational practice as opposed to theory or model, particularly one bordering on pedagogy or andragogy. The findings further confirm existing literature on the use increasing popularity of communication tools in education. The framework of constraints (components) to ICT identified present fresh insights into the nature of constraints to ICT use, particularly in the context of developing countries though further qualitative study is required to give complete understanding of the interrelationships and effects of these constraints that emerged from the study.

5. CONCLUSION

It is evident from the research findings that there is a wide gap between the use of ICT in construction education and their use in professional practice or industry. To bridge this gap, the paper argues for concerted effort at addressing the constraints to the use of ICT identified. While some of the constraints are external, more effort should be directed at controlling constraints that are internal such as those that border on curriculum, human resource development and school management. Specifically, industry collaborations should be strengthened, innovative funding sources such as productive ventures to boost internally generated fund and developing a staff development policy in the area of ICT. It is recommended that a further research employing qualitative research design be undertaken to provide a rich data set to provide further corroborative supporting evidence or otherwise of the findings of the study whilst at the same enabling a qualitative understanding of the interrelationships and effects of the constraints to ICT use in construction education.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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