



¹. K. AGYEKUM, ². J. AYARKWA, ³. A. ACHEAMPONG

INCORPORATING INFORMATION TECHNOLOGY IN QUANTITY SURVEYING PRACTICE IN GHANA: CHALLENGES AND BENEFITS

^{1,2,3}. Department of Building Technology, Kwame Nkrumah University of Science and Technology, Kumasi, GHANA

Abstract: This paper aimed at examining challenges and benefits associated with the incorporation of information technology in Ghanaian Quantity Surveying practice. A structured questionnaire survey was carried out to solicit the views of 45 Chief Quantity Surveyors of quantity surveying firms in Kumasi and Accra on the issue under investigation. The findings from the study revealed that the Microsoft project, Autodesk Quantity Takeoff, Masterbill, In-house software, QSPlus and QS Elite are the six most frequently used Quantity Surveying softwares in quantity surveying practices. The results further showed that 'inadequate training and education in the use of IT tools', 'high cost of innovation/learning a new technology' and 'low margins resulting in little scope for investment in IT innovation and learning are the topmost challenges to the adoption of IT in QS practices. Increase in productivity through streamlined data entry and management', 'increased productivity through automated quantities and cost calculations and improved savings in operation cost are among the benefits perceived to be associated with the adoption of IT in Quantity Surveying practice. Identification of the challenges and knowing the benefits associated with the adoption of IT should encourage industry practitioners to embrace the future prospects of IT adoption.

Keywords: Information Technology, Quantity Surveying, Challenges, benefits, Construction Industry

1. INTRODUCTION

The role of the Quantity Surveyor within the construction environment is of great importance to both clients and other industry professionals (Perera et al., 2007). The important services Quantity Surveyors offer their clients differ from other consultants and contractors. Quantity Surveyors are now forming ongoing relationships with construction companies, assisting in tendering and cost planning, amongst other things. According to Dada and Jagboro (2012), Quantity Surveyors add value primarily to the financial and contractual management of construction projects at the various stages of construction. Rivard et al. (2004) stated that in construction projects, information affects two key areas; specification of the resulting product (design information) and the initiation and control of the activities required for constructing the facility (management information). However, among the design consultants who are largely responsible for the production and dissemination of design and management information among the various project participants, the Quantity Surveyor is heavily criticized (Oladapo, 2006). The construction industry has for many years suffered from difficult-to-access, out-of-date and incomplete information (Shoosmith, 1995). The reasons are that Quantity Surveyors rely heavily on the traditional means of communication such as paper take-off and traditional form of estimating. In the Ghanaian Construction Industry, the situation is worsened by the lack of adoption of modern Quantity Surveying softwares.

The Quantity Surveying profession is constantly scrutinized, with regular demands for accuracy (Doyle and Hughes, 2000). The management of construction, like most other industries, requires accurate information, and the need to increase the efficiency of information management has long been recognized (Oladapo, 2006; Deng et al., 2001). However, with the increasing complexity of construction projects the constant demands for greater accuracy of Quantity Surveying profession provides a challenge (Doyle and Hughes, 2000). Information Technology (IT) is a wide-ranging term that includes all technologies for the manipulation and communication of information (Kasim, 2011). Optimal use of IT is a basic requirement for achieving international best practice and competitiveness, and ensures long term prosperity (Smith, 2001).

Dada and Jagboro (2012) opined that the Quantity Surveying profession is constantly confronted with challenges and opportunities in new markets. However, these opportunities are often passed over, predominantly because of the lack of relevant skills and competencies. The challenges and opportunities will not be fully leveraged if these skills are not addressed. The core skill needed to improve to harness the potential benefits of IT is computer literacy. Reports exist on the implementation of the use of IT in construction industries of developed countries (Rivard et al., 2004; Toole, 2003; Issa et al., 2003). However, literature on the use of IT in construction industries within developing countries is very scanty (Pamulu and Bhutta, 2004). From the escalating global nature

of construction activities, failure to invest in IT will not only result in an inability to compete on an international scale but will also place firms at serious risks of losing their domestic market shares to overseas competitors more amenable to maximizing the benefits that IT can confer (Smith, 2001). Despite the extensive study on the adoption of IT in developed countries, most of the findings may not be applicable to the construction industries in developing countries. The reasons may be due to the differences in the cultural, socio-economic and regulatory environments (Dewan and Kraemer, 2000). One of the keys to competitive advantage lies in the intelligent application of IT. Many African countries which were relatively slow on the uptake of IT in their construction industries are now undergoing significant and swift changes in terms of IT utilization and development. There is therefore the need to undertake this study which aimed at examining the challenges and the benefits associated with the incorporation of information technology in the Ghanaian QS practice. To achieve this aim the study sought to identify the softwares which are used in Quantity Surveying practice in Ghana, identify the challenges associated with the use of IT in quantity surveying practice in Ghana and identify potential benefits in adopting IT in quantity surveying practice in Ghana.

2. LITERATURE REVIEW

2.1. Overview of the Quantity Surveying Profession

A quantity surveyor is a professional in the construction industry who has the ability to analyse both cost components and practical physical construction works of a project in a successful way so as to be able to apply the results of his analysis in solving problems peculiar to each project (Badu and Amoah, 2003). From being a trade-based vocation, quantity surveying had developed into a full-fledged profession widely accepted in the construction industry. The Quantity Surveyors, in their present day construction industry, use their ability to analyse cost components of a construction project in a scientific way and apply the results of their analysis to a variety of financial and economic problems confronting the developer and the designer.

The roles played by the Quantity Surveyor (QS) are essential in the construction industry. Being in charge of financial matters carries with it a great responsibility and the Quantity Surveyor has the expertise to provide independent advice on these matters (Dada and Jagboro, 2012). Among the roles played by the Quantity Surveyor are financial advisors, construction advisors (Perera et al., 2007; Ashworth and Hogg, 2002), and contract administrators (Leveson, 1999).

2.2. Information Technology (IT) in Quantity Surveying Practice.

With the recent developments in the industry and the recent explosion of information technology, the industry stakeholders are finding it almost impossible to disseminate all pertinent and available information (Perera et al., 2007). The fragmented nature of the Construction Industry (Oladapo, 2006), and the demand of heavy exchange of data and information between project participants on a daily basis (Maqsood et al., 2004) make it more imperative to implement IT.

ICT is often used as an extended synonym for information and communication technology, but is a more specific term that stresses the role of unified communications and the integration of telecommunications (telephone lines and wireless signals), computers as well as necessary enterprise software, middleware, storage, and audio-visual systems, which enable users to access, store, transmit, and manipulate information. The term ICT is also used to refer to the convergence of audio-visual and telephone networks with computer networks through a single cabling or link system.

A common competency required of construction professionals is the ability to manage and communicate project information and documents (Oladapo, 2006). Indeed, effective management of information, in the form of information flows that allows the rapid inter-organizational transaction among project participants drives productivity (Mohamed and Stewart, 2003).

There are a number of IT tools which are adopted for use in different areas of construction works. Some of the tools are commonly required in architectural, engineering and quantity surveying practices. For Quantity Surveying practices, the most common ICT tools used include WinQS 32, QS Plus2001, QSCAD, CATA, Vector and Masterbill among others (Murray et al., 2001; Willis et al., 1994). These tools do not only speed up but also enhance the accuracy of quantity surveying functions from estimating to final accounts.

2.3. Challenges in the adoption of IT in quantity surveying practice

Despite the recognition of the potential benefits of ICT in the construction industry, its application has been limited. A study conducted on 115 construction companies that adopted the use of technological innovations confirmed improvement in their quality of services (Musa et al., 2010). However, despite the unparalleled benefits IT offers, Quantity Surveyors do not pay particular attention to the advanced adoption of IT (Usman et al., 2012). Among the reasons stated for the limited use of IT in the Quantity Surveying practice are operational inhibitors, educational problems, poor return on investments, and high costs of softwares, among others (Oyediran and Odusami, 2005). In a study conducted by Smith (2001), Quantity Surveyors in Australia faced several challenges in the adoption of IT in their practices. These challenges included high cost of innovation/ learning new technologies, low margins that result in little scope for investment in IT innovation and learning, fear of over-investing in IT, among others. Gajendran et al. (2005) conducted an extensive review of literature (Love et al., 2001; Smith, 2001; Betts, 1999; Betts, 1995) and classified the barriers to the

adoption of IT into six main themes. These themes included strategic/ tactical direction, time commitment, financial dimension, value perception, awareness/knowledge and risk attitude.

2.4. Benefits of adopting IT in the Quantity Surveying Industry

Research has found that despite the reluctance of many firms in the adoption of IT, its proliferation has been met with unmatched benefits. The construction industry is currently experiencing a paradigm shift from traditional paper-based information sharing to digitally based information exchange, which other industries such as aircraft, manufacturing and banking have since adopted and benefited from long ago (Rivard et al., 2004). According to Ruikar et al., (2005), IT can greatly impact the traditional processes of professional organizations in construction and result in change in organizational processes, working methods and culture. Wong (2007) as cited in Chan (2013) lists some benefits of IT to include process efficiencies across geographically dispersed teams and project partners, improved internal communication and information flows, reduction in the cost of learning and knowledge acquisition, increased global competitiveness and enthusiasm to be at the forefront of technology development. According to Smith (2001), the benefits associated with the adoption of IT in Quantity Surveying practice include increased productivity through streamlined data entry and management, increased productivity through automated quantities and cost calculation, increased productivity through the use of digitizers for measurement, elimination of measurement in many areas through direct extraction of quantities from CAD files, etc. Peansupap and Walker (2005) also stated that reduction of time for data processing and communicating information within other professionals, and improvement in communications for effective decision-making and coordination among construction/project participants are some of the benefits associated with the adoption of ICT in QS practice. Liston et al. (2000) stated that the adoption of ICT in QS practice in the long run will enhance construction productivity.

3. RESEARCH METHODS

The study sought to examine the views of Quantity Surveyors on the incorporation of ICT in quantity surveying practice in Ghana. A cross-sectional survey was adopted to seek the views of the quantity surveyors on softwares which are used in Quantity Surveying practice in Ghana, the challenges associated with the use of ICT in quantity surveying practice in Ghana and potential benefits in adopting ICT in quantity surveying practice in Ghana. The population for the study was made up of Chief Quantity Surveyors from Quantity Surveying Firms in Kumasi and Accra registered with the Ghana Institution of surveyors (GhIS). A total number of 45 firms were purposively selected from a list of about 75 firms fully registered with the GhIS.

A thorough review of literature was undertaken to extract information on available softwares for quantity surveying practice, challenges to the adoption of ICT and benefits associated with the adoption of the ICT (Goh, 2005; Ruikar et al., 2005; Peansupap and Walker, 2005; De lapp, 2004; Arif and Karam, 2001; Murray et al., 2001; Rivard, 2000; Liston et al., 2000; Willis et al., 1994). A structured questionnaire survey which targeted the Chief Quantity Surveyors from the QS firms was prepared and used for the study. The questionnaire was divided into four sections. The first section sought the demographic information on the Companies. The second section sought the views of the respondents on the softwares which their companies used in real practice. Respondents were asked to score on the Likert scale of 1 to 5 (where 1= highly infrequent and 5= highly frequent) how frequent the softwares were used. The third section of the questionnaire further sought information on the challenges which the firms encountered in the adoption of ICT for their practices. In this section, respondents were asked to score the significance of the challenges on the Likert scale of 1 to 5, where 1= 'Highly Insignificant' and 5= 'Highly Significant'. The last section of the questionnaire also required the respondents to score on the Likert scale of 1 to 5 (1= 'Highly Insignificant' and 5= 'Highly Significant') the benefits which they perceived to be associated with the adoption of ICT in quantity surveying practices.

Data obtained from the survey was analyzed by Mean Score (MS) ranking and Relative Importance Index (RII). For this study, a factor was deemed significant if it had a mean score of 2.5 and above. A factor was also deemed important if the RII value was 0.5 and above.

4. RESULTS AND DISCUSSION

4.1. Demography of respondents

Demographic information is imperative to meaningful quantitative analysis. As a result, background and general information of the respondents were sought. Figures 1 and 2 show the summary of demographic information of the respondents. Analysis of the feedback reveals that 81% of the respondents had more than 5 years of experience in Quantity Surveying. The results also showed that 68% of the respondents had completed Bachelor's degree.

The firms surveyed were mainly involved in the provision of services such as estimating/ cost planning, contract administration, bill of quantities, amongst others.

4.2. Softwares used in Quantity Surveying Practices

The respondents were asked to indicate the softwares which they frequently use in their quantity surveying practices. The results from Table 1 show that only six out of the 13 quantity surveying softwares identified were frequently used among the respondents.

The mean scores of all the six frequently used softwares were greater than the mean value of 2.5. The results further showed that the Microsoft project, Autodesk Quantity Takeoff, Masterbill, In-house software, QSPlus and QS Elite were ranked as the six most frequently used Quantity Surveying softwares among the respondents.

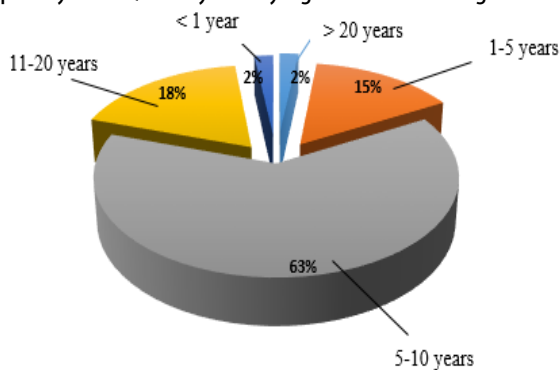


Figure 1. Years of experience

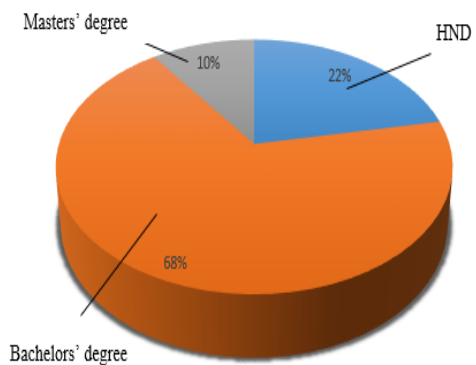


Figure 2. Academic qualifications of respondents

Table 1: Quantity Surveying Software in Use

Software	Mean Score	Standard Deviation	Rank
Microsoft Project	4.17	0.737	1st
Autodesk Quantity Takeoff	3.26	1.442	2nd
Masterbill	3.06	1.259	3rd
In-house software	2.68	1.249	4th
QSPlus	2.59	1.282	5th
QS Elite	2.57	1.267	6th
WinQS	2.48	1.149	7th
Primavera	2.46	1.120	8th
Mensura Genius	2.34	1.187	9th
Causeway CATO	2.31	1.255	10th
Snape Vector	2.20	1.106	11th
Pathmaker	2.14	0.944	12th
CatoPro	2.00	1.090	13th

The findings further revealed the respondents were not very familiar with softwares such as Causeway CATO, Snape Vector, Pathmaker and Cato Pro. These softwares were not frequently used, hence, mean scores were less than the mean value of 2.5. These findings corroborates literature which stated that WinQS 32, Masterbill, QSPlus, among others are softwares which are highly used and which enhances the accuracy of quantity surveying functions from estimating to final accounts (Akinagbe and Adalakun, 2014; Chan, 2013; Smith, 2001).

4.3. Challenges to IT usage in the Quantity Surveying Industry

Respondents were also asked to indicate the factors which pose as the most significant challenges to the adoption and use of IT in Quantity Surveying practices. Table 2 presents the views of the respondents. The results show that the mean scores of all the 20 factors evaluated as possible challenges to the adoption of IT in QS practices were greater than the mean value of 2.5. The results further showed that 'inadequate training and education in the use of IT tools', 'high cost of innovation/learning a new technology', 'low margins resulting in little

scope for investment in IT innovation and learning, 'inadequate IT content in construction education' and 'resistance to re-engineering/ organizational change' are considered as the first five challenges to the adoption of IT in QS practices.

These findings corroborate literature which identified operational inhibitors, educational problems, poor return on investments, high costs of softwares, among others as factors which inhibit the adoption of IT in QS practice (Oyediran and Odusami, 2005). In a similar study by Smith (2001), Quantity Surveyors in Australia faced several challenges in the adoption of IT in their practices. These challenges included high cost of innovation/ learning new technologies, low margins that result in little scope for investment in IT innovation and learning, fear of over-investing in IT, among others. These findings are therefore in agreement with literature. The findings suggest that the problems confronting Quantity Surveyors in Ghana in the adoption of IT in their practices are similar to those in other countries.

Mingaine (2013) and Mwalongo (2013) identified inadequate training and education in the use of IT tools to be a major inhibitor to the adoption of IT in public schools in Kenya and Tanzania respectively. The situation is not only peculiar to the school set-up. In industries, such as the construction industry this challenge is still present and persistent. Sekou (2012) identified this problem as one of the leading challenges to ICT usage in the Ghanaian Construction Industry. Similar issues were identified in the studies undertaken by Weippert et al. (2002b) and Songer et al. (2001). These studies all identified inadequate training as a barrier to adopting and using ICT applications. The Quantity Surveying industry being a part of the Construction Industry suffers the same fate. In Ghana, ICT has not well been incorporated in university curriculum, especially technical programmes such as Quantity Surveying. It is therefore not surprising that the factor serves as an impediment to ICT tools usage.

The cost of original software has also been identified as one of the challenges to the adoption of IT in the construction industry. Kasim (2011) and Oladapo (2007) found that the high cost of software inhibited people from purchasing. Oyediran and Odusami (2005) noted that the cost of original software is the major challenge under the cost factors in his study. The situation is worsened in the

Quantity Surveying industry because the firms are mostly SMEs and can thus not afford investment in ICT systems development (see for instance Alaghbandrad et al., 2012). This was perceived as a challenge to ICT usage in the Quantity Surveying Industry confirming the earlier conducted studies in other parts of the world.

Table 2: Challenges to the adoption of IT in QS firms

Challenges	Mean	Standard Deviation	Rank
Inadequate training and education in the use of IT tools	3.83	0.845	1st
High cost of innovation/learning a new technology	3.72	0.849	2nd
Low margins resulting in little scope for investment in IT innovation and learning	3.72	1.162	3rd
Inadequate IT content in construction education	3.69	0.951	4th
Resistance to re-engineering/ organizational change	3.64	1.268	5th
Lack of industry standards	3.56	0.909	6th
High/Additional cost of engaging computer staff	3.50	1.207	7th
Lack of management desire and appreciation of IT	3.44	1.157	8th
High rate of obsolescence of software/hardware	3.28	1.256	9th
Reliability/Breakdown problems	3.22	1.376	10th
Job sizes and fees not enough for IT	3.19	1.064	11th
Limited range of available software for specific tasks	3.06	1.393	12th
Low return on investment in IT	2.94	1.013	13th
Security and privacy not guaranteed	2.94	1.330	14th
Fear of IT making professionals redundant	2.83	1.183	15th
Fear of personnel abuse	2.75	1.105	16th
Client resistance	2.75	1.052	17th
Lack of guidance from relevant Institutions	2.65	1.524	18th
High cost of hardware/software	2.55	1.422	19th
Inadequate/Erratic power supply	2.52	0.830	20th

In studies conducted in countries where there is frequent and consistent power outages, inadequate/erratic power supply appeared to be a significant challenge to IT usage. For instance, Oladapo (2006) identified erratic power supply as a main constraint to adoption of IT in Nigeria. However, in developed countries the issue of inadequate/erratic power supply as a challenge is marginalized (e.g. Goh, 2005; Rivard 2000). Unfortunately, in the developing countries supply of electricity is unreliable, leading to high production costs for firms that invest in procurement of power generating facilities. This not only adds significantly to the cost of using ICT, but the cost of operation in general. The situation had worsened at the time of conducting this study. Hence, it was therefore not surprising the factor was ranked as a key challenge.

Table 3: Benefits of ICT usage in the QS industry

BENEFITS	FREQUENCY OF RANKING					TOTAL	ΣW	MEAN	RII	RANKING
	1	2	3	4	5					
Increased productivity through streamlined data entry and management		1	4	14	17	36	155	4.306	0.8611	1
Increased productivity through automated quantities and cost calculations			4	21	11	36	151	4.194	0.8389	2
Savings in operation cost		1	4	18	13	36	151	4.194	0.8389	3
Elimination of measurement in many areas through the direct extraction of quantities from CAD files		1	4	19	12	36	150	4.167	0.8333	4
Enhances easy coordination among project participants		2	4	17	13	36	149	4.139	0.8278	5
Faster and more efficient transmission of quality/cost through e-mail		3	3	16	14	36	149	4.139	0.8278	6
Improvement in the control of operations	2	1	2	21	10	36	144	4.000	0.8000	7
Enhances transparency and accountability.		4	5	14	13	36	144	4.000	0.8000	8
Better financial control		2	6	19	9	36	143	3.972	0.7944	9
Speedy exchange of information		3	7	16	10	36	141	3.917	0.7833	10
Error reduction in data handling operations		3	5	21	7	36	140	3.889	0.7778	11
Increased range and depth of service		3	5	21	7	36	140	3.889	0.7778	12
Expanded services in relation to feasibility, time and cost planning using expert systems		1	10	17	8	36	140	3.889	0.7778	13

4.4. Benefits of ICT usage in the Quantity Surveying Industry

Finally, respondents were asked to indicate the benefits perceived to be associated with the adoption of ICT in QS practices. Table 3 summarizes the views of the respondents on the perceived benefits. All the 13 benefits associated with the adoption of ICT which were identified in literature were considered significant. Among the benefits perceived to be significantly associated with the adoption of ICT in QS practices are that it 'increases productivity through streamlined data entry and management', 'increases productivity through automated quantities and cost calculations', 'improves savings in operation cost', 'eliminates measurement in many areas through the direct extraction of quantities from CAD files', 'enhances easy coordination among project participants', etc. The findings from this study corroborates that identified in literature (Chan, 2013; Wong, 2007; Smith, 2001). According to Smith (2001), the benefits associated with the adoption of IT in Quantity Surveying practice include increased productivity through streamlined data entry and management, increased productivity through automated quantities and cost calculation, increased productivity through eh use of digitizers for measurement, elimination of measurement in many areas through direct extraction of quantities from CAD files, etc.

5. CONCLUSION

ICT has widely been acknowledged as a potent tool for accelerating economic growth and thus bridging the gap between developed and developing economies. Most importantly, because of the indispensable contributions of construction industry to the development of economies, the usage of ICT in the industry is more important than ever. In a Quantity Surveying Firm that is striving to achieve accuracy, ICT usage is very imperative. This study sought to identify the softwares which are used in Quantity Surveying practice in Ghana, the challenges associated with the use of ICT in quantity surveying practice in Ghana and the potential benefits in adopting ICT in quantity surveying practice in Ghana. The study has revealed that Microsoft project, Autodesk Quantity Takeoff, Masterbill, In-house software, QSPlus and QS Elite are the six most frequently used Quantity Surveying softwares used in quantity surveying practices. The findings also revealed that 'inadequate training and education in the use of IT tools', 'high cost of innovation/learning a new technology', 'low margins resulting in little scope for investment in IT innovation and learning, 'inadequate IT content in construction education' and 'resistance to re-engineering/ organizational change' are considered as the first five challenges to the adoption of IT in QS practices. Furthermore more, among the benefits which Quantity Surveying firms derive from the use of ICT are that 'it increases productivity through streamlined data entry and management', 'increases productivity through automated quantities and cost calculations', 'improves savings in operation cost', 'eliminates measurement in many areas through the direct extraction of quantities from CAD files' and 'enhances easy coordination among project participants'. The findings of the study is of utmost importance to professionals in the Quantity Surveying industry, stakeholders of the construction industry, the academia, etc. Identifying the challenges and knowing the benefits associated with the adoption of IT should encourage industry practitioners to embrace the future prospects of IT adoption. The study recommends that Continuous Professional Development (CPD) programmes should be implemented by the industry stakeholders to continuously equip professionals and practitioners with up-to-date information on IT softwares. Further studies in the area of strategies to the adoption of IT in Quantity surveyingpractice should extensively be looked at.

REFERENCES

- [1.] Akinagbe, F.P. & Adedokun, O.J. (2014). Assessment of risks associated with the usage of quantity surveying softwares in Nigeria: The case of Lagos State. *Economy*, 1 (2), 54-60.
- [2.] Alaghbandrad, A., Nobakht, M. B., Hosseinalipour, M. & Asnaashari, E. (2011). ICT adoption in the Iranian construction industry: barriers and opportunities, In CIB Co-sponsored 28th International Symposium on Automation and Robotics in Construction, 280-285, 2011.
- [3.] Arif, A. A. & Karam, A. A. (2001). Architectural Practices and their use of IT in the Western Cape province, South Africa. *Journal of Information Technology in Construction*, 6 (2001), 17-33.
- [4.] Ashworth, A., & Hogg, K. (2002). *Willis's practice and procedure for the quantity surveyor*, 11th ed., Oxford: Blackwell Science.
- [5.] Badu, E. and Amoah, P. (2003). Quantity Surveying Education in Ghana, The Ghana Institution of Surveyors in conjunction with the Africa Association of Quantity Surveyors and the International Cost Engineering Council (Region 3-Africa), International Conference, July 7-10, 2003 at Accra.
- [6.] Betts, M. (1999). *Strategic Management of IT in Construction*, Blackwell Science.
- [7.] Betts, M. (1995). Technology planning frameworks to guide national IT policy in construction. *Automation in Construction*, Elsevier Science, 251-266.
- [8.] Chan, E. (2013). Australian Quantity Surveyors utilize ICT and ERP System to improve efficiency. *Engineering Management Reviews*, 2 (4), 103-114.
- [9.] Dada, J. O. & Jagboro, G. O. (2012). Core skills requirement and competencies expected of quantity surveyors: perspectives from quantity surveyors, allied professionals and clients in Nigeria, *Australasian Journal of Construction Economics and Building*, 12 (4) 78-90.

- [10.] De lapp, J. A., Ford, D. N., Bryant, J. A., & Horlen, J. (2004). Impacts of CAD on design realization. *Engineering, construction and Architectural management*, 11(4), 284-291.
- [11.] Deng, Z. M., Li, H., Tam, C. M., Shen, Q. P. & Love, P. E. D. (2001). An application of Internet-based project management system. *Automation in Construction*, 10 (1), 239-246.
- [12.] Dewan, S. and Kraemer, K.L. (2000). Information Technology and productivity: Evidence from Country-level data. *Management Science*, 46 (4), 548-562.
- [13.] Doherty J. M. (1997). A Survey of Computer Use in the New Zealand Building and Construction Industry. *Journal of Information Technology in Construction*, 2 (1997), 1-13.
- [14.] Doyle, A. and Hughes, W. (2000). The influence of project complexity on estimating accuracy. In: 16th Annual ARCOM Conference, 6-8 Sep 2000, Glasgow Caledonian University, 623-634
- [15.] Gajendran, T., Brewer, G. & Beard, C. (2005), Barriers to ICT Uptake in Professional Quantity Surveying Organisations: an Australian Perspective, QS National Convention, Kuala Lumpur, Malaysia
- [16.] Goh, B.H. (2005). IT barometer (2003): Survey of the Singapore construction industry and a comparison of results, *Journal of Information Technology in Construction*, 10 (1), 1-13.
- [17.] Issa, R.R.A, Flood, I & Caglasin, G. (2003). A survey of E-business implementation in the US construction industry. *Journal of Information Technology in Construction*, 8 (2003), 15-28.
- [18.] Kasim, N. (2011). ICT implementation for materials management in construction projects: case studies, KICEM. *Journal of Construction Engineering and Project Management*, 31-36.
- [19.] Leveson, R. (1996). Can professionals be multi-skilled? *People Management*, 2 (17), 36-39.
- [20.] Liston, K. M., Fischer, M. A., & Kunz, J. C. (2000). Designing and evaluating visualization techniques for construction planning. Paper presented at the 8th international conference on computing in civil and building engineering, Stratford.
- [21.] Love, P.E.D., Irani, Z., Li, H., Cheng E.W.L. & Tse, R.Y.C. (2001). An empirical analysis of the barriers to implementing e-commerce in small-medium sized construction contractors in the state of Victoria, Australia. *Construction Innovation*, 1 (2001), 31-41.
- [22.] Maqsood T., Walker D.H.T. & Finegan A.D. (2004). An investigation of ICT diffusion in an Australian construction contractor company using SSM. In *Proceedings of The Joint CIB-W107 and CIB-TG23 Symposium on Globalisation and Construction*, Bangkok, Thailand, 485-495.
- [23.] Mingaine, L. (2013). Skill Challenges in Adoption and Use of ICT in Public Secondary Schools, Kenya. *International Journal of Humanities and Social Science*, 3 (13), 61-72.
- [24.] Mohamed, S. & Stewart, R.A. (2003). An empirical investigation of users' perceptions on web-based communication on a construction project. *Automation in Construction*, 12, 43-53.
- [25.] Murray M., Nkado R. & Lai A. (2001). The integrated use of information technology in the construction industry. *Proceedings of the CIB 78 Conference: IT in Construction in Africa*, Pretoria, South Africa, 39, 1-13.
- [26.] Musa, N. A., Oyebisi, T. O., & Babalola, M. O. (2010). A study of the impact of information and communications technology (ICT) on the quality of quantity surveying services in Nigeria. *The electronic journal on information systems in developing countries (EJISDC)*, 42(7), 1-9.
- [27.] Mwalongo, A. (2011). Teachers' perceptions about ICT for teaching, professional development, administration and personal use. *International Journal of Education and Development using Information and Communication Technology (IJEDICT)*, 7 (3), 36-49.
- [28.] Oladapo, A. A. (2007). An investigation into the use of ICT in the Nigerian construction industry, *Journal of Information Technology in Construction*, 12 (1), 261-277.
- [29.] Oladapo, A. A. (2006). The impact of ICT professional practice in the Nigerian construction industry. *The Electronic Journal on Information Systems in Developing Countries (EJISDC)*, 24(2), 1-19.
- [30.] Oyediran, O. S., & Odusami, K. T. (2005). A study of computer usage by Nigerian Quantity Surveyors. *ITcon*, 10, 291-303.
- [31.] Pamulu, M.S. & Bhutta, C. (2004). Strategic management of information technology in construction industry: The Indonesian perspective. In *Proceedings of the Joint CIB-W107 and CIB-TG23 Symposium on Globalisation and Construction*, Bangkok, Thailand, 17-19 November, 521-530.
- [32.] Peansupap, V. & Walker, D. (2005). Factors enabling information and communication technology diffusion and actual implementation in construction organizations. *Journal of Information Technology in Construction*, 10(14), 193-218.
- [33.] Rivard, H., Froese, T., Waugh, L. M., El-Diraby T., Mora, R., Torres, H., Gill, S.M., & O'Reilly, T. (2004). Case studies on the use of Information Technology in the Canadian Construction Industry, *Journal of Information Technology in Construction*, 2 (2004), 19-34.
- [34.] Ruikar, K., Anumba C. J. & Carrillo, P. M. (2005). End-user perspectives on use of project extranets in construction organizations. *Engineering, Construction and Architectural Management*, 12(3), 222-235.
- [35.] Perera, B. A. K. S., Hemajith, S. D. M., Dilanthi, A. & Ginige, K. N. (2007). Quantity Surveyor as the Technical Appraiser in the Sri Lankan Financial Industry. *Built Environment Education Conference, CEBE*, pp. 1-12.
- [36.] Sekou, E. A. (2012). Promoting the use of ICT in the Construction Industry: Assessing the factors hindering usage by building contractors in Ghana, Unpublished thesis (MSc). Kwame Nkrumah University of Science and Technology, Kumasi.

- [37.] Shoesmith, D. R. (1995). Using Internet as a Dissemination Channel for construction research. *Construction Information Technology*, 3 (2), 65-75.
- [38.] Smith, P. (2001). Information Technology and the QS Practice. *The Australasian Journal of Construction Economics and Building*, 1, 1 –21.
- [39.] Songer, A. D., Young, R. and Davis, K. (2001). Social architecture for sustainable IT implementation in AEC/EPC', paper presented to Proceedings of IT in Construction in Africa 2001, Mpumalunga, South Africa, 30 May - 1 June.
- [40.] Toole, T.M. (2003). Information Technology Innovation: A view of large contractors. In Proceedings of the ASCE Construction Research Congress Honolulu, Hawaii, March 19-21.
- [41.] Usman, N., Said, I. & Yahaya, A. Z. (2012). Indolent disposition towards ICT acceptance among practicing Quantity Surveyors in Nigeria, *ACTA TECHNICA CORVINIENSIS – Bulletin of Engineering*, 5 (2), 2067-3089.
- [42.] Weippert, A., Kajewski, S. L. and Tilley, P. A. (2002b). Internet-based information and communication systems on remote construction projects: A case study analysis. *Construction Innovation*, 2 (2), 103-16.
- [43.] Willis, A.J., Willis, G.J. & Ashworth, A. (1994). Practice and procedure for Quantity Surveyors, Blackwell Science, Oxford, UK.
- [44.] Wong, C.H. (2007). ICT implementation and evolution: Case studies of intranets and extranets in UK construction enterprises. *Construction innovation, Information, Process Management*, 7 (3), 254-273.



ANNALS of Faculty Engineering Hunedoara – International Journal of Engineering



copyright © UNIVERSITY POLITEHNICA TIMISOARA, FACULTY OF ENGINEERING HUNEDOARA,
5, REVOLUTIEI, 331128, HUNEDOARA, ROMANIA
<http://annals.fih.upt.ro>