

Northumbria Research Link

Citation: Perera, Srinath, Park, Rachael, Udejaja, Chika, Zhou, Lei and Rodrigo, Anushi (2012) Mapping the e-business profile and trends in cost management in the UK construction industry. In: 7th International Conference on Innovation in Architecture, Engineering & Construction (AEC 2012), 15-17 August 2012, The Brazilian British Centre, São Paulo, Brazil.

URL: ##official_url##

This version was downloaded from Northumbria Research Link:
<http://nrl.northumbria.ac.uk/11823/>

Northumbria University has developed Northumbria Research Link (NRL) to enable users to access the University's research output. Copyright © and moral rights for items on NRL are retained by the individual author(s) and/or other copyright owners. Single copies of full items can be reproduced, displayed or performed, and given to third parties in any format or medium for personal research or study, educational, or not-for-profit purposes without prior permission or charge, provided the authors, title and full bibliographic details are given, as well as a hyperlink and/or URL to the original metadata page. The content must not be changed in any way. Full items must not be sold commercially in any format or medium without formal permission of the copyright holder. The full policy is available online: <http://nrl.northumbria.ac.uk/policies.html>

This document may differ from the final, published version of the research and has been made available online in accordance with publisher policies. To read and/or cite from the published version of the research, please visit the publisher's website (a subscription may be required.)

www.northumbria.ac.uk/nrl



MAPPING THE E-BUSINESS PROFILE AND TRENDS IN COST MANAGEMENT IN THE UK CONSTRUCTION INDUSTRY

Srinath Perera, Rachael Park, Chika Udeaja, Lei Zhou, & Anushi Rodrigo
srinath.perera@northumbria.ac.uk, chika.udaeja@northumbria.ac.uk,
lei.zhou@northumbria.ac.uk, anushi.rodriigo@northumbria.ac.uk,
School of the Built and Natural Environment, Northumbria University, Newcastle upon Tyne, UK

The advancement of e-business applications and IT infrastructure has had massive impact on construction business processes over the last decade. The added effects of globalisation coupled with global economic recession have forced businesses to implement e-business applications within their organisations. It is clear in all industries, that e-business technologies have become a key strategic vehicle in improving performance. In Construction, e-business applications complement most of the business functions and have removed geographical boundaries resulting in a global construction market with increased competition, increased collaboration and have helped reducing the fragmentation of the industry. However, even though the successes are inevitable, it is scrutinized that the advancement is still constrained within the industry. Thus there is a need to undertake an analysis of current construction e-business usage and attitude of construction professionals towards e-business trends to ensure a productive and beneficial implementation of construction e-business tools within organisations. This study acknowledged the niche for research into current e-business usage in UK construction organisations and aimed to determine and map the use of ICT in construction cost management activities, and explore the attitudes of professionals towards e-business approaches. Initially a comprehensive literature review was carried out together with an online web search to identify what ICT and software packages are being used for construction cost management activities. Results from this review aided in developing the research questionnaire and a detailed an online structured survey was carried out using the chartered quantity surveying organisations within the UK. This paper presents the findings of the survey and discusses the ICT usage within construction organisations for cost management activities and the attitude of construction professionals towards BIM and construction e-business trends.

Keywords: BIM, Cost Management, E-business usage, ICT, UK Construction Industry

INTRODUCTION

The construction industry is cautious in uptake of new ICT (RICS, 2010, Chen et.al., 2011). A study by Martin (2008) highlighted the UK construction industry's reluctance to implement new e-commerce practice regardless of targets set by UK government. Anumba and Ruikar (2008) suggest this is due to the industries fragmented nature and construction projects being bespoke in type.

The quantity surveyor (QS) has an established reputation as an information manager of the construction industry; this positions the QS at the centre of ICTs (Page *et al.*, 2001). Research by Cartlidge (2006) and Oyediran and Odusami (2005) further discussed the importance of the QS using ICT to improve productivity. QS software benchmarking has been undertaken for Australia (Smith 2003), China (Shen *et al.*, 2003) Northern Ireland (Odeyinka and Doherty, 2008) and Nigeria (Oyediran and Odusami, 2005).

Building Information Modelling (BIM) removes many mundane elements of traditional quantity surveying, such as measurement, take offs and the production of Bills of Quantities (BoQ), by automating these tasks removing human error, increasing efficiency and promoting collaboration. Use of BIM requires many new skills that will challenge the traditional boundaries of the QS profession and should be educated in design, 3d modelling and construction technology to be able to resolve construction interface difficulties and cross traditional professional boundaries.

A review of current literature identified, the extensive research conducted into the development and implementation of information and communication technologies (ICT) within the United Kingdom (UK) construction industry, and in the areas of e-commerce, e-tendering, and e-procurement, however, no definitive statistics have been developed for software used by quantity surveyors (QS) in the UK construction industry. There is limited literature that investigates the benefits of Building Information Modelling (BIM) for cost estimation, cost planning and quantification related services provided by the QS profession. But there is no literature on investigations into the attitudes of QS towards BIM. There is also a dearth of literature in classifying ICT usage in cost management activities in construction. This paper aims to address these issues and provides a classified benchmark of ICT usage in cost management activities in the UK.

E-BUSINESS IN CONSTRUCTION

The term e-business was created by technology and consulting firm International Business Machines (IBM) in the 1990's. IBM defined e-business as “*transforming business process through the use of internet technologies*” (IBM, 1997). DTI (2000) provides a simpler and abstract definition “Integration of ICT to internal processes of a business”. The terms e-business and e-commerce are often confused (Li 2007). E-commerce focus’ on sales and transactions by electronic means; e-business encompasses a broader scope of business activity conduction by electronic means.

A principle of e-business is exploring the innovative capabilities of ICT and the internet to survive and thrive (Li, 2007). E-business aims to aid business process to be more efficient, responsive and develop traditional working methods creating a better working environment, improving efficiency and developing new business processes (Issa *et al.*, 2003, Lou and Alshawi, 2009) and is often paired with communication between companies (Wamelink and Teunissen, 2003). Electronic business processes through the use of ICT has impacted all business sectors, the construction industry is no exception (Ruikar *et al.*, 2004). E-business has removed geographical boundaries resulting in a global construction market with increased competition (Oyediran and Odusami, 2005), increased collaboration and reducing the fragmentation of the construction industry (Anumba and Ruikar, 2008).

E-business applications complement business functions of the construction industry, such as procurement and tendering and business principles including collaboration and partnering; developing into trends such as e-procurement, e-tendering and e-collaboration (Anumba and Ruikar, 2008). Recent enabling technologies such as Cloud computing, BIM and web-based project management software has become a platform from which e-business can be utilised, maximised and maintained. Amor and Jadim-Goncalves (2003) envision e-business providing new and innovative solutions, smooth partnering principles, easy global procurement and a shift in the image of the construction industry from labour workers to professional information controllers.

Eadie *et al* (2010) highlight the level of e-business implementation within the construction industry is lower than expected despite ICT being used within the industry for a number of years. The conservative nature of the industry towards the uptake and usage of ICT has been a contributing factor to the slow development and use of e-business (Chen, *et.al.*, 2011, Olatunji *et al.*, 2010, Shen and Chung, 2007, Smith, 2010). Hardie *et al* (2005) further identified reluctance by the professional bodies towards adopting ICT by the construction industry as a major barrier. Research by E-business w@tch (2006) identified a main barrier to the adoption of e-business in the construction sector to be company size (98% of industry consists of micro and SME companies), complicated installation and cost of new systems, staff training and compatibility issues with existing procedures and technology. Anumba and Ruikar (2008) explain the temporary nature of a construction project provides little incentive for construction firms to invest and implement e-business, especially to small construction firms when payback of new technologies is often gained after project completion.

Ruikar *et al* (2008) describe organisations are slowly adopting e-business for performance improvement, addressing adversarial relationships and to resolve the fragmentation of the industry, leading to the use of e-business for industry functions such as project control, monitoring and communication. This complements research by Lou and Alshawi (2009) who state the construction process is information intensive and e-business has aided the construction industry to develop to modern and efficient ways of working. Eadie *et al* (2010), presents a complete ranked set of drivers and barriers for e-procurement in construction. Drivers for e-business vary depending upon organisation size (Ruikar *et al.*, 2002).

E-BUSINESS AND COST MANAGEMENT

High expectations for professional standards and improved ethical behaviours by the government, public and private clients have acted as a driver for the use of ICT within the construction industry (Ho and Ng 2003) and especially for cost management by the QS profession. Shen and Chung (2007) investigated and documented the trends and uptake of ICT by the QS profession in Hong Kong and found the profession uses Microsoft packages heavily in their work tasks. Similar findings are observed in Doherty (1997) in their research into the New Zealand QS profession. Smith (2010) documents the significant development and increasing usage of communication technologies, such as e-mail and telecommunications by the QS profession, however document slower growth and usage of information technologies such as BIM or web-based collaboration in Australia.

The construction industry has varying perceptions of BIM (Hamil, 2010), however the industry must not fall into the belief that BIM is simply 3d modelling (Barker, 2011). Hamil (2010) defines BIM as: *'...a rich information model consisting of potentially multiple data sources, elements of which can be shared across all stakeholders and be maintained across the life of a building from inception to recycling (cradle to grave)'*

BIM supports many building design and construction activities and can be utilised to produce cost information with auto quantification, a role traditionally carried out by the QS, can now be completed and produced using BIM (Autodesk, 2007). Autodesk highlight the advantage of BIM creating both cost and time savings for the QS, as well as the removal of human error, a cause linked to many construction issues. Matipa *et al* (2007) further concludes the impact of ICT and BIM on the QS profession will be shown through client demand, value for money thus changing the fee structure for the profession, as clients will be reluctant to pay for paper documents when electronic documents and models are available.

The QS profession has used a form of electronic/computer based cost management systems for the past 30 years (Olantuji *et al.*, 2010). Barker (2011) queries why BIM is not being fully utilised by the QS profession, highlighting further advantages of BIM use such as the ability to influence and inform the design process as it develops. This research seeks to identify the usage of ICT for cost management in the UK construction industry while evaluating views on BIM.

RESEARCH METHOD

The research consisted of four stages: Literature review, Pilot study, Questionnaire survey, data analysis and review. A review of previous studies in ICT used by QS professionals (Doherty 1997, Odeiran and Odusami 2005, Smith, 2010, Martin, 2008, Breetzke and Hawkins, 2003) was conducted to identify the status of literature followed by an online review of QS specific software packages. These reviews aided the development of research questionnaire.

The pilot survey was issued to 5 chartered quantity surveyors. Their responses indicated that the questionnaire needed to be simplified with questions that involve scales and tick box types. These responses were then used to remodel the final web based questionnaire. The web-based survey tool Lime Survey™ was used to host the online survey to a selected sample of respondents. The questionnaire consisted of 4 parts: Respondent Profile, Software Usage, Attitudes towards drivers and barriers to e-business, awareness and attitude toward Building Information Modelling (BIM).

The research sample was collated using the Royal Institution of Chartered Surveyors (RICS) directory of firms 2011 (RICS, 2011). Using proportionate stratified sampling (Fellows and Liu, 1997) a sample of 148 was produced from all regions within the UK. All the selected companies were contacted to obtain consent for participation and 55 companies agreed to participate. This amounts to a response rate of 37% which is considered successful (Hoxley, 2008).

MAPPING E-BUSINESS IN COST MANAGEMENT PROFILE

A total of 60 responses were received, with 53 only fully completed. The respondent profile is presented in Figure 1.

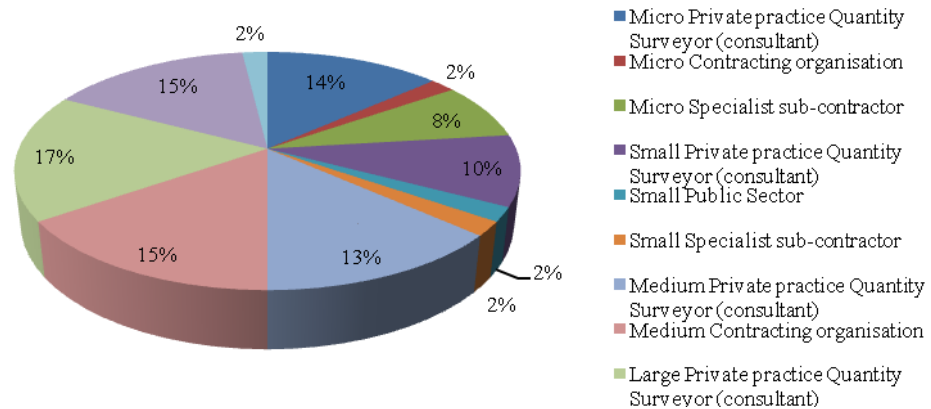


Figure 1 Percentage of respondents per organisation type

The largest responded organisation type is large private practice organisations (17%), followed by 15% medium contracting organisations, 15% large contracting organisations.

Software Usage

Estimating

Results indicate respondents from private practice use the most software for estimating, (a total of 10 different software packages), contractors use 7 different packages, public sector use 6 and subcontractors only using MS Excel. Microsoft Excel is the software most favoured by all respondents for estimating activities with 34 of 53 respondents stating they use this. Out of these 71% are from private practice organisations, 18% from contractor organisations, 9% from subcontractors and 2% from the public sector. 7 respondents indicated they don't use software for estimating or it's not within the parameters of their job role (Figure 2).

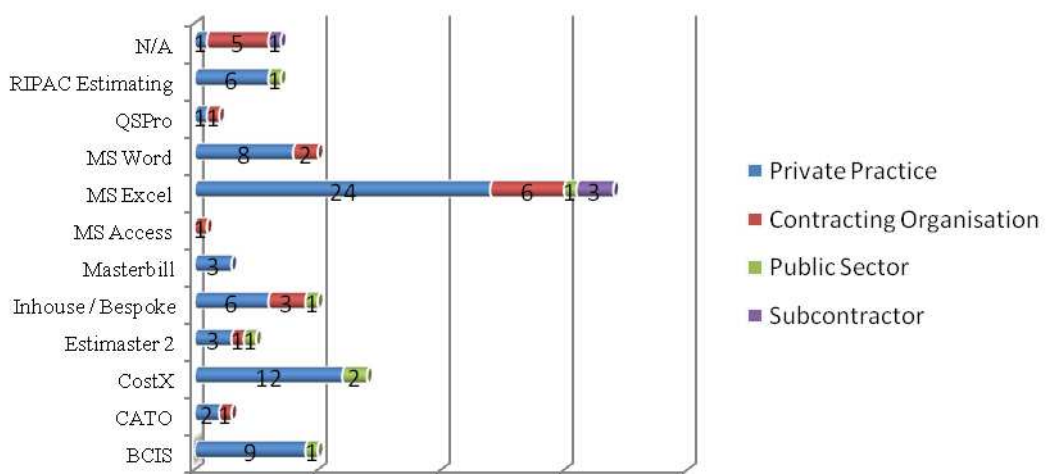


Figure 2 Software used for Estimating

Tendering

Tendering activities such as the production of tender documents and packages are predominantly prepared by MS Excel and MS Word, as indicated by respondents. Respondents also highlighted the use of CATO e-tenderer, in-house/bespoke packages, and the RICS e-tendering service. Respondents from private practice organisations indicated they use a total of 10 different software packages for tendering, respondents from contractor organisations use a total of nine, 7 public sector respondents and 3 subcontractor respondents. 11 respondents indicated they do not use software for tendering or it is not part of their job role (Figure 3).

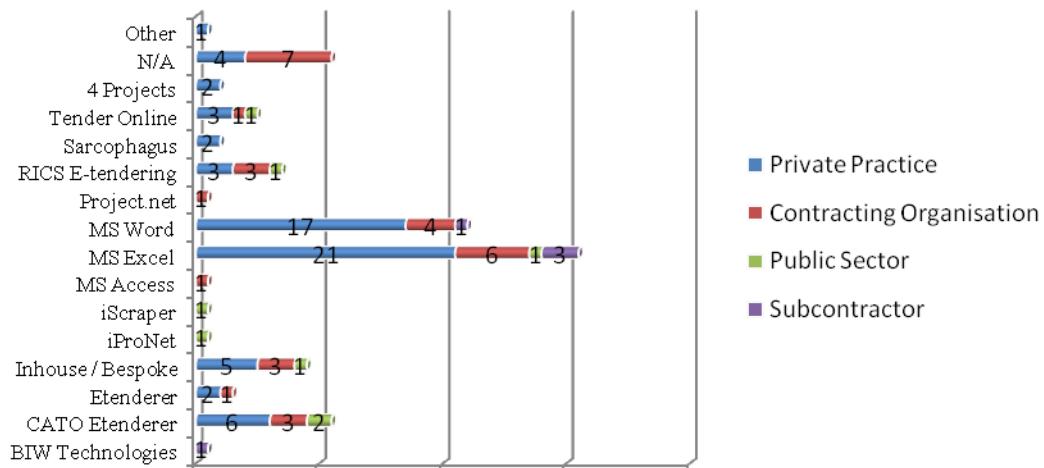


Figure 3 Software used for Tendering

Measurement

Figure 4 again shows respondents heavily using MS Excel for measurement. 100% of respondents from subcontracting organisations indicated they do not use software to aid them with measurement or it is not within their job limitations. Respondents from private practice organisations use a broad variety of software packages, a total of 9, for measurement, public sector 5 and contractors 4.

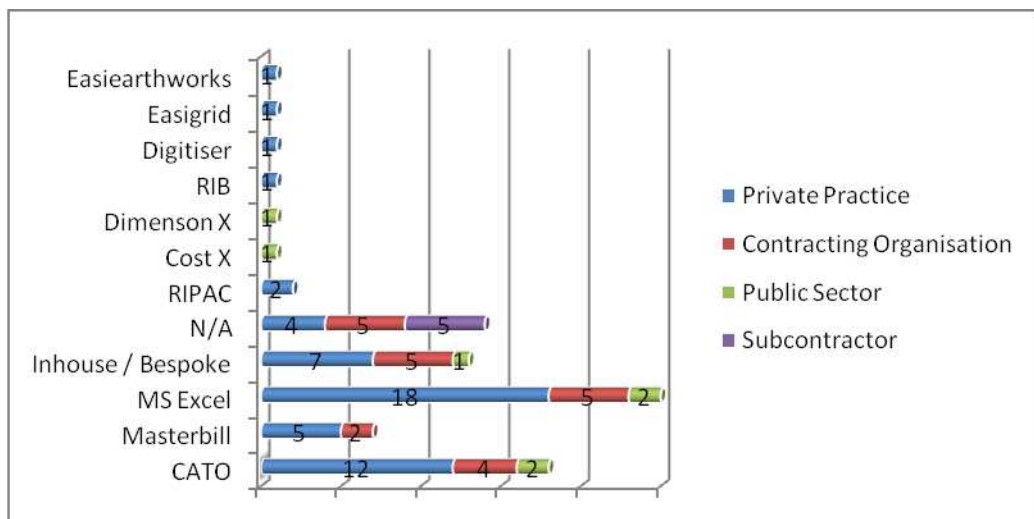


Figure 4 Software used for Measurement

Risk Management

Respondents were requested to identify what software they use for risk management. 45% of respondents (100% sub contractor respondents, 54% private practice organisation respondents and 24% contracting organisation respondents) indicated they either do not use software or conduct risk management activities within their job role. 100% of respondents from the public sector indicated they used risk management software, a combination of commercial and in-house/bespoke software. Of those respondents who identified they use risk management software, it is in-house/bespoke packages that are predominantly used (Figure 5).

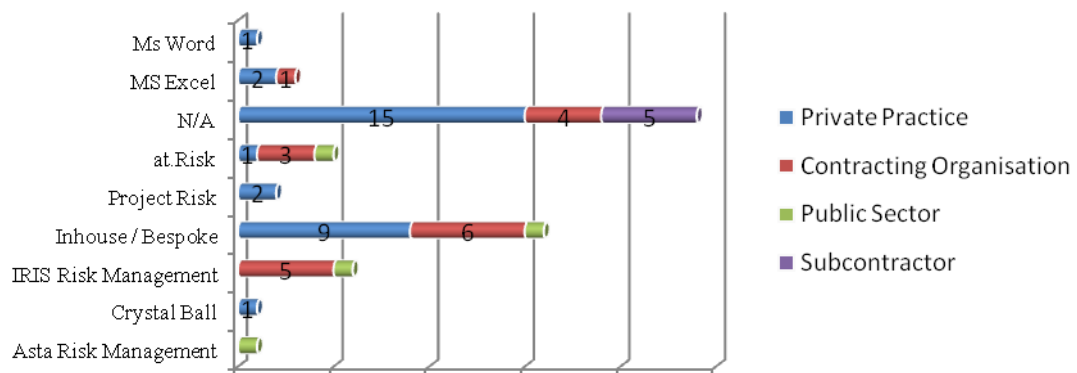


Figure 5 Software used for Risk Management

Attitudes towards Drivers and Barriers to e-Business

Part III of the research questionnaire was designed to gauge respondent's attitudes towards drivers and barriers on a 4 point likert scale.

Statements 1 and 2 required respondents to identify if they agreed or disagreed whether ICT aids cost management activities and the overall project. Statement 1 identified 98% of respondents stated they strongly agreed or agreed ICT specifically aids them in cost management activities. The 2% who disagreed were from private practice organisations. Statement 2 identified all respondents strongly agreed (54%) or agreed (46%) ICT overall aids a construction project.

Statements 3 to 6 were designed to gauge what respondent felt are the drivers for the use of ICT for cost management activities. Figure 6 and Table 1 identify respondent's results. Figure 6 highlights responses from all respondents. Table 1 categories drivers according to organisation type. Results collected from section 4 statements 3 to 6 (Figure 6) shows what respondents felt drive their use of ICT.

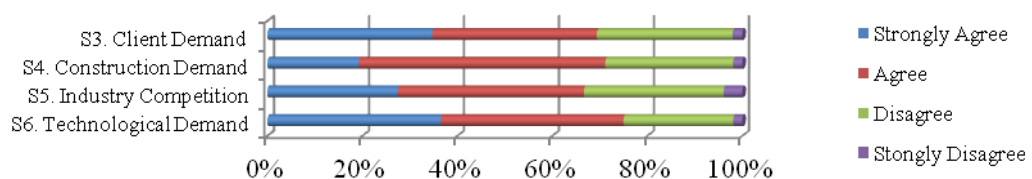


Figure 6 Statements 3 to 6 percentage overall respondents results

Table 1 notes, according to organisation, what respondents from that organisation type feel are the main drivers for why they use ICT.

Table 1 Drivers for use of ICT according to organisation type

Private practice Organisations	Technological Demand (75% agree)	Client Demand (68% agree)	Construction Demand (57% agree)	Industry Competition (54% agree)
Contracting Organisation	Construction Demand (94% agree)	Industry Competition (94% agree)	Technological Demand (76% agree)	Client Demand (65% agree)
Public Sector	Construction Demand (100% agree)	Technological Demand (100% agree)	Industry Competition (50% agree)	Client Demand (0% agree)
Sub-contractor	Client Demand (80% agree)	Construction Demand (60% agree)	Technological Demand (60% agree)	Industry Competition (40% agree)

Awareness and Attitude toward Building Information Modelling (BIM)

The responses to part 4 of the questionnaire provide a gauge of respondent's attitude towards BIM.

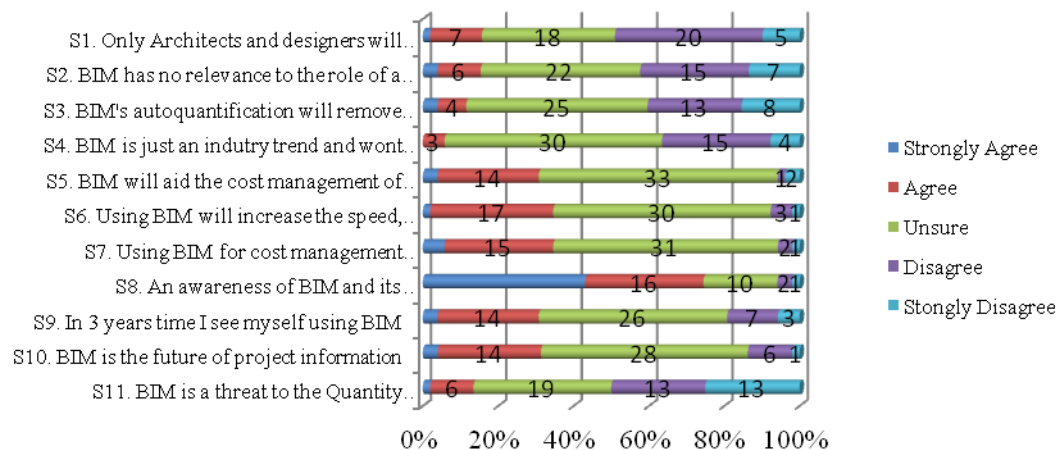


Figure 7 BIM % overall respondents results

Figure 7 provides an overview of all respondents' response and attitudes towards BIM for each statement. Statements 1, 2, 4 and 9 gauge respondent attitudes towards BIM and the future use of BIM by the QS profession.

Results indicated 36% of respondents feel BIM is not an industry trend. 49% of respondents indicated they strongly agreed or agreed BIM will not just be used by

Architects or designers; however 42% of respondents feel BIM has no relevance to the role of QS. 50% of all respondents are unsure if they will be using BIM in 3 years time. Although many respondents were unsure as to whether they will be using BIM, 74% of respondents agreed QS students should be taught an awareness of BIM.

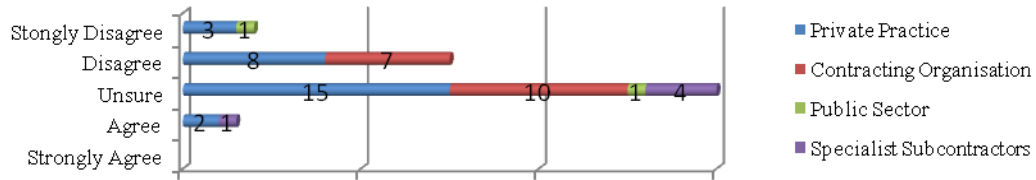


Figure 8 BIM - industry trend; individual responses

58% of respondents are unsure if BIM is just a trend within the UK construction industry (Figure 8). 41% of contracting organisation respondents believes BIM is not an industry trend and will remain within the construction industry, 39% of private practice organisation respondents also feel this way towards BIM.

41% of all respondents felt BIM was relevant to the role of the quantity surveyor. Of these 41%, 63% was made up of respondents from private practice organisations, 32% from contracting and 5% from public sectors. 41% of all respondents were unsure if BIM was relevant to the role of the QS.

When asked about features of BIM and its application by QS's 31% of respondents agreed BIM will aid the cost management of construction projects, 63% were unsure and 6% disagreed (Figure 8). Results show 34% of respondents agreed BIM will further increase the speed, performance and accuracy of their work, whilst 58% of respondents were unsure. Statement 3 highlights 40% of professionals disagree that BIM's auto quantification function will remove the requirement of traditional measurement methods, 48% were unsure, whilst 19% agreed this function would remove 'traditional' measurement methods. Of those 19% respondents who agreed, 2 are from private practice organisations, 3 from contracting organisations and 1 from the public sector. When asked if respondents felt BIM is a threat to the role of the QS 50% disagreed, 37% were unsure and only 13% agreed BIM was a threat to the QS.

CONCLUSIONS

This paper has evaluated the use of ICT for cost management activities within the UK construction industry and gauged the QS professions' attitude towards BIM. The study was carried out using an online survey of chartered QS practices in the UK. Findings of this research indicate QSs use numerous ICTs to aid cost management activities. Microsoft Office (MS) software packages such as MS Excel and MS word are the most predominant software packages with in-house/Bespoke packages are also intensively used. The QS profession acknowledges ICT aids their cost management activities; creating time savings, increasing productivity and accuracy. Drivers towards the use of ICT vary depending upon organisation type and their contractual relation within the industry.

Companies are providing their employees with the necessary ICT hardware in order to carry out and complete cost management activities. Despite various software

available for a variety of cost management activities, Microsoft Office software is the most widely used for cost management activities within the UK construction industry; it is the main software used for all but two cost management activities. The use of inhouse/bespoke software also features heavily in responses from private practice, contractor and public sector organisations. This research confirms the findings of others on QSs world over rarely opting to use QS specific software (Shen and Chung, 2007; Oladapo, 2006; Doherty, 1997 and Honey, 1998). Consulting sector uses the most variety of software for cost management activities, with contractor and public sectors organisations being ranked 2nd and 3rd respectively. Sub-contracting organisations use minimal ICT with clients driving their ICT usage, in line with the trends identified by E-business w@tch (2006) into ICT used within the European construction industry.

Results when broken into respective organisation types (Table 2), show private practice organisations use largest software package rang, a total of 35, for cost management activities with MS Excel being the most selected. Respondents from contracting organisation identified 29 software packages, MS Excel highlighted as the most utilised software for cost management activities. Public sector respondents indicate 28 software package are used, with inhouse/bespoke software being the most utilised in their area of work. Respondents from sub contractors show limited use of software packages, a total of 4, for cost management activities with MS Excel being the most commonly used. Sub contractor respondents did not select any software for procurement, measurement, risk management, whole life cost/lifecycle costs and facilities management. This is attributed to respondents not using software or the selected activity is not carried out.

Table 2 Map of ICT to organisation type

Mapping of ICT used to organisation type				
	Private Practice Organisation	Contracting Organisation	Public Sector Organisation	Sub-Contracting Organisation
Number of respondents from organisation type	28	17	2	5
Total number of software	35	29	28	4

Table 3 Map of ICT to organisation size

Mapping of ICT to organisation size				
	Micro <10	Small 11 - 51	Medium 52- 250	Large >251
Number of respondents from organisation size	12	7	14	19
Total number of software	18	18	31	37

This research has shown the QS profession as having a divided attitude towards BIM, with the majority of respondents unsure as to its development, use and impact on the QS profession. QSs acknowledge BIM will progress, develop, will have relevance to

Qs with increased usage. However, they do not see themselves using BIM within the next 3 years; neither do they see BIM and its many functions as a threat to the cost management (QS) profession. The development and greater usage in the industry will bring pressure to the education sector to adopt BIM education for QS students.

REFERENCES

- Anumba, C.J and Ruikar, K. (2008) *E-business in construction*. Singapore: Wiley-Blackwell.
- Autodesk. (2007) *BIM Cost Estimating*. Available at: http://www.autodesk.com/files/bim_cost_estimating_jan07_1_.pdf.
- Barker, D. (2011) *BIM – Measurement and Costing*. Available at: <http://www.thenbs.com/topics/BIM/articles/bimMeasurementAndCosting.asp>. (Accessed: March 2011).
- Brandon, P., and Kocaturk, T. (2008) *Virtual feature for Design, Construction and Procurement*. Oxfordshire: Blackwells.
- Breetze, K and Hawkins, M. (2003) Project extranets and e-procurement: user perspectives. *RICS Construction Faculty*. Available at: http://www.rics.org/site/download_feed.aspx?fileID=2924&fileExtension=PDF (Accessed 31 January 2011)
- Cartlidge, D. (2006) *New Aspects of Quantity Surveying practice: a text for all construction professionals*. 2nd Edn. UK : Elsevier Butterworth-Heinemann.
- Chen, S., Ruikar, K., Carrillo, P., Khosrowshahi, F. & Underwood, J. (2011). *Construct IT for Business, e-Business in the Construction Industry*, Loughborough University.
- Doherty, J.M. (1997) ‘A survey of computer use in the New Zealand building and construction industry’. *ITcon*, 2, pp. 73-86. Available at: <http://www.itcon.org/1997/4>. (Accessed: 1 February 2011).
- DTI. 2000. *Closing the Digital Divide: Information and Communication Technologies in Deprived Areas*. London: Department of Trade and Industry.
- Eadie R, Perera S, Heaney G (2010) A cross-discipline comparison of rankings for e-procurement drivers and barriers within UK construction organisations, *ITcon* Vol. 15, pg. 217-233, <http://www.itcon.org/2010/17>
- Ebusiness w@tch. (2006) *ICT and e-business in the construction industry – ICT adoption and e-business activity in 2006* [Online]. Available at: http://www.ebusiness-watch.org/studies/sectors/construction/documents/construction_2006.pdf. (Accessed: 2 21 March 2011).
- Fellows, R and Liu, A. (1997) *Research Methods for Construction*. 2nd edn. India: Blackwell Science.
- Hardie, M., Miller, G., Manley, K and McFallan, S. (2005) *The quantity surveyors role in innovation generation, adoption, diffusion in the Australian construction industry*. QUT Research Week 4-8th July, Brisbane: Australia.
- Hamil, S. (2010) *What is BIM and how is it being used*. Available at: http://www.thenbs.com/pdfs/What_BIM_is_and_how_it_is_being_used.pdf (Accessed 21 February 2011).
- Ho, M and Ng, C. (2003) ‘Quantity surveyors background and training, and their ethical concepts, conceptions and interest considerations’. *Construction Management Economics*, 21, pp. 43-67.

- Howard, R and Bjork, B. (2008) 'Building Information Modelling – Experts views on standardisation', *Advanced Engineering Information*, 22, pp. 271-280.
- Hoxley, M. (2008) 'Questionnaire design and factor analysis', in Knight, A and Ruddock, L. (ed.) *Advanced Research Methods in the Built Environment*. Singapore: Wiley-Blackwell, pp. 122-134.
- IBM. (1997) *The new blue* [Online]. Available at: <ftp://ftp.software.ibm.com/annualreport/1997/ibm1997.pdf> (Accessed: 25th December 2010).
- Issa, R., Flood, I and Caglasin, G. (2003) 'A survey of e-business implementation in the US construction industry'. *Journal of operations and production management*, 19 (19), pp. 909-921.
- Li, F. (2007) *What is e-business? How the internet transforms organisations*. Great Britain: Blackwell publishing.
- Lou, E and Alshawi, M. (2009) 'Initial success factors for e-tendering implementation in construction collaborative environments: people and process issues'. *Journal of Information Technology in Construction, ITCon*, available at: <http://www.itcon.org/2009/10>, (Accessed: 18 December 2010).
- Martin, J. (2008) 'E-Tendering about time too', RICS paper (Available online <http://www.rics.org/NR/rdonlyres/5B41E38D-2433-4AEE-A3DC-5B3C3BB84FB5/0/EtenderingabouttimetooJoeMartin.pdf> (Accessed: 21 October 2010).
- Matipa, W., Keliher, D and Keane, M. (2007) 'How a quantity surveyor can ease cost management at the design stage using a building product model'. *Construction Innovation: Information, Process, Management*, 8(13), pp. 164-181.
- Odeyinka, H and Doherty, C. (2008) 'An Evaluation of quantity surveying software usage in Northern Ireland', *The construction and building research conference of the Royal Institution of Chartered Surveyors*. Dublin Institute of Technology, 4-5 September 2008. London: RICS.
- Olatunji, O., Sher, W and Gu, N. (2010) 'Building Information Modelling and quantity surveying practice'. *Emirates journal for engineering research*, 15 (1), pp. 67-70
- Oyediran, O and Odusami, K.T. (2005) 'A study of computer usage by Nigerian quantity surveyors', *Journal of information technology in construction*, 10, pp. 291-303
- Page, M., Pearson, S and Pryke, S. (2001) 'Innovation, business strategy and the quantity surveying firm in the UK', *The construction and building research conference of the Royal Institution of Chartered Surveyors*. RICS Foundation London. London: RICS.
- Royal Institution of Chartered Surveyors. (2010) *Construction Management: Keeping pace with technological change*. Available at: http://www.rics.org/site/scripts/documents_info.aspx?documentID=854 (Accessed 16th October 2010).
- Royal Institution of Chartered Surveyors. (2011) *RICS Directory of Firms 2011*. UK: RICS Publications
- Ruikar, K., Anumba, C.J. and Carillio, P.M. (2002) *Industry perspectives of IT and e-commerce*. *Proceedings of the 3rd International Conference on Concurrent Engineering in Construction at University of California, Berkley*, July 26-40.

- Ruikar, K., Anumba, C.J and Carrillo, P.M. (2003) 'Reengineering construction business process through electronic commerce'. The TQM magazine, 15(3), pp. 197-212.
- Ruikar, K., Anumba, C.J and Carrillo, P.M. (2005b) 'VERDICT - An e-readiness assessment application for construction companies', Automation in Construction, 15, pp. 98-110.
- Shen, Q., Li, H., Shen, L., Drew, D and Chung, J. (2003) 'Benchmarking the use of information technology by the quantity surveying profession', Benchmarking: An International Journal, Vol. 10 (6), pp.581 - 596.
- Shen, Q and Chung, J. (2007) 'The use of information technology by the quantity surveyor profession in Hong Kong'. International journal of project management, 25, pp. 134-142.
- Smith, P. (2003) 'Trends in the Australian Quantity Surveying Profession 1995-2003', Project Management Department, Sydney: University of Technology, pp.1-15 [Online] Available at: <http://www.icoste.org/korev2004a.pdf> (Accessed: 20 October 2010).
- Smith, P. (2010)'Quantity Surveying practice in Australia and Asia-Pacific Region. FIG Congress 2010: Facing the challenge – Building the Capacity. 11-16 April 2010, Sydney: Australia.
- Wamelink, H and Teunissen, W. (2000) 'E-business in the construction industry: a search for practical applications using the internet'. Proceedings of the 20th ISARC. Eindhoven: Holland.