BIM and People Issues: A Scoping Study Exploring Implications for Curriculum Design

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Abstract

Government sponsored reports have highlighted the need for improvements in people skills for those working in the UK construction industry. The mandatory use of Building Information Modelling on government projects by 2016 (Government Construction Strategy 2011) highlight these issues and bring their own specific challenges. It is in the construction organisation's interest that they have to innovate and adopt BIM. However evidence suggest that innovation is always met with resistance in organisations. One of the reasons for resistance is the expectation that innovation brings about the need for new skills and that some traditional skills become obsolete. The aim of this study was to get a better understanding of the 'people' related challenges when organisations are adopting BIM and particularly focuses on education and training requirements and the extent to which BIM implementation affects the dynamics of people skills. This is particularly crucial considering that some of the key features of BIM implementation (such as coordination, collaboration and communication) are people related issues. The research places the discussion within a quantity surveying professional practice context to see how representative organisations are addressing some of these challenges. A review of literature suggests that the adoption of BIM is relatively slow in UK quantity surveying organisations but does not find any evidence of resistance to adopting BIM as a management process or a set of digital technologies. The findings suggests that employers are generally not very concerned with BIM-specific technical training but wish to see the focus on providing education and methods of assessment for the BIM process, of collaborative working, communicating, independent working and ability to interpret data. The findings from this exploratory study are of relevance to both industry and academia. In particular, as BIM curricula develops, consideration needs to be taken of people skills. It is therefore recommended that more research be conducted on the impact of BIM on soft skills and how that can be reflected in course curricula

Key words: BIM Implementation, people skills, innovation, curriculum design, quantity surveying

INTRODUCTION

Since the mid-1990s successive Government and industry reports have acted as drivers for improvements, innovations and efficiency gains in construction (Latham 1994 and Egan, 1998). In 2011 a new approach that reframed earlier ideas and themes, as part of a vision for *Construction 2025* (*UK Government Construction Strategy,* 2011), introduced a mandate for the use of BIM on Government projects by 2016. An RICS Guidance note published in 2014 addressed the impact of BIM to quantity surveyors from the perspective of tendering strategies (RICS, 2014) and suggest that the construction industry's adoption of BIM will dictate the impact it will have on all services in the construction supply chain. For example they suggest that level 3 BIM promises a fully integrated and collaborative process enabled by 'web services' utilising 4D construction sequencing, 5D cost information and 6D project lifecycle

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management information. Such an approach improves the quality of design information available to all parties.

Like all other professions the role of the Quantity Surveyor is changing, particularly because of new and developing information and communication technologies and the need for new professional services arising from client demands. The traditional role of the Quantity Surveyor as a measurer and valuer of construction work remains but it is the introduction and development of non-traditional services which really show a changing profession. Arguably, BIM now sits at the heart of these changes. Services such as value management, risk management, whole life cost services and project management, for example, represent the future for the profession in a global market place and in an era of increasing automation. The digital world is one of connections and collaboration that is opening up new opportunities for the profession many of whom see the emerging new technologies as a means of elevating the status of Quantity Surveying and enhancing the range of services they are able to provide. Automated measurement and web-based collaborative resources for information sharing and documents management are in use and expanding. Increasingly, professional boundaries will dissipate as clients, in particular, look for single-point contact and responsibility from professionals who might have new designations such as 'Process Engineer'. In terms of people challenges these changes and the emergence of BIM as a process and a series of technologies have clear implications for universities and professional bodies. They also present real challenges for commerce and for employers at all levels of the industry in terms of new ways of working and making choices and decisions for capital investment in IT systems.

Managers are responsible for helping organisations to achieve their objectives and for creating and implementing their plans. The challenge for modern managers is to deal with the need to change in order to survive Hannagan (2008). Both conventional management and change management require effective communications, recognised as vital to the morale and performance of any organisation. This is clearly an area where practice is changing rapidly thanks to new technologies, including BIM. Use of the internet and email has been common from the mid-1990s and many organisations now use intranets as a way of widening communications. These work at organisational and project levels. Important and urgent messages continue to be distributed via e-mail and daily or weekly bulletins are not unusual to managers who then relay the information to their teams. It is a natural progression for quantity surveying practices and organisations to extend their use of communications technologies to include BIM capabilities for automating the receipt of digital drawings, digital measurement and estimating, cost reporting and monitoring and general documents and project management.

Curricula design and the essential components of teaching, learning and assessment are major challenges for the HE sector and its partnerships with the professional bodies. Employers, too, should consider the annual goals and strategic initiatives for which their employees have responsibility and plan for employee education, training and development. To 'do BIM' people must have the ability to use new technologies, adapt to organisational change, work in flatter organisations in which cross-functional skills and knowledge are required, and work effectively in teams and other collaborative situations.

BIM is a particular challenge for educators since new technologies are integral to its adoption. The technologies (AutoCAD, ReVit, and NavisWorks, amongst a growing number of other providers) form an integral part of the collaborative working arrangements and management processes. Educators must think about how students can learn BIM (in terms of thinking about it and doing it) and be cognizant of their learning styles. For the younger students (the millennials) who have grown up with IT and are conversant with social media, getting information from online, processing, learning from it and engaging with wider online communities the challenge is to make it meaningful and relevant. For them learning about abstract theories and concepts from text books and being assessed on what they 'know' might not be too helpful and new ways of engaging them in their BIM education need to be found and shared (Self and Watkin, 2016). For older students and employees whose learning styles might favour more traditional methods of learning alternative approaches have to be considered.

This paper reports on the findings of a preliminary research project which took the form of a collaborative review with construction industry employers' in the Yorkshire and Humber region to investigate current and future Quantity Surveying course provision. The project's initial focus was on the BSc (Hons) Quantity Surveying course to identify which aspects of course provision could be improved or replaced. It was also expected that the findings of the project would help to inform the development of a new post-graduate award of MSc Quantity Surveying Commercial Management. The aim of the study was to explore the use of new BIM technologies in quantity surveying organisations, how BIM is impacting on the provision of traditional and non-traditional quantity surveying services and how course curricula can adapt to meet the expectations of employers on student education, ICT training, skills and employability are discussed.

LITERATURE REVIEW

The integration of theory, practice and the use of technology is fundamental to pedagogy and the implementation of BIM poses a number of challenges to both the HE and business sectors. BIM adoption for educators is inhibited by a number of limitations such as the availability of teaching time, knowledge development and the flexibility of the curriculum to adapt with a fast developing technology (Ghosh, Parrish and Chasey, 2015). Putting BIM into the context of work practice and organisation is similarly challenging for business since, while there appears to be no shortage of information about BIM, there is little guidance on implementation and how BIM impacts on day to day roles and responsibilities – putting BIM into the context of their work (Pittard and Sell, 2016). However, equipping students with BIM technology might not be the ultimate goal for educators since the collaborative process of using BIM to solve construction problems has emerged as key to individuals entering the industry (Zhou, et al, 2015). In terms of BIM adoption and implementation guidance there is emerging literature aimed at businesses, particularly smaller enterprises, inspiring and encouraging the adoption of BIM through a series of illustrated case studies (Klaschka, 2014).

But, it is the technology which is driving the process. Ashworth and Perera (2016) identified and summarised ways in which information communication technology (ICT) in construction could help to eliminate redundant, labour-intensive activities by adopting enabling technologies and management techniques to drive innovation and to

improve efficiency. Their work includes an extensive literature review and includes commentary on the drivers and barriers to ICT adoption in the industry. BIM is a key part of ICT adoption for the construction industry and its education providers to consider. The adoption of BIM is expected to impact on quantity surveying skills. For example the people challenges associated with the implementation and adoption of BIM are considerable. Insights into the early BIM experience of QS firms and consultants worldwide, from Australia (Aibinu and Venkatesh, 2013), New Zealand (Ryan and Thurnell, 2014) and Ireland (Crowley, 2013) suggest that others are more advanced in the adoption of BIM than in the UK. The findings of Zhou et al, (2013) basing their work on a case study of a SME Quantity Surveying practice in the UK address readiness for BIM, are instructive, attest to difficulties at organisational and project levels and show that QS firms appear to be behind other professionals in adopting BIM despite the overwhelming benefits identified of better project coordination, accuracy of the project and improving efficiency. In education the US experience at Arizona State (Ghosh, Parrish and Chasey, 2015) concluded that pedagogy must combine fundamental learning of theory, practical experience and the use of technology in a collaborative environment to effectively implement BIM into an undergraduate curriculum.

The paper attempts to evaluate BIM, how it is impacting on the provision of traditional and non-traditional quantity surveying services and how course curricula can adapt to meet the expectations of employers on student education, ICT training, skills and employability.

METHODOLOGY

An extensive literature review and desk-top survey was used in the first instance and augmented by an online questionnaire survey, developed using Google Forms. Semi-structured interviews were then held with senior representatives of two employers' organisations (both international cost consultants) with regional offices in Leeds. The interviews gave more scope to finding out how ICT and BIM technologies were being used and introduced to business activities, the skills issues identified and how much the employers felt this needed to be reflected in a BSc Quantity Surveying course content.

Both the questionnaire and the interview questions have been informed by a similar research exercise carried out by Marasini and Barfoot (2012). Their contribution to this paper is acknowledged. In their stud, the methodology was based on survey questionnaires and industry workshops and presentations. That exercise was also wider in scope than this paper. Here, the range and type of questions were based on the Marasini and Barfoot (2012) template and used a Likert scale (Strongly agree to Strongly disagree responses) to record views to 20 questions that were based on the employers' satisfaction levels with course content and with the technical and non-technical knowledge and skills areas found in recent quantity surveying graduates.

This qualitative approach to gathering data for descriptive and interpretive analysis attempts to develop a comprehensive view of BIM adoption from the perspective of practitioners and managers in quantity surveying practice and recognises that meaning is socially constructed, negotiated between people and changes over time (Fellows and Liu, 2008). In this instance it was believed that an online questionnaire followed by semi-structured interviews with at least two representative employers would help to

establish parameters for a later and more in-depth project with a larger population sample and provide some much needed phenomenon-based insights into what is happening in terms of BIM adoption and its attendant challenges within quantity surveying organisations.

DATA COLLECTION AND ANALYSIS

As an exploratory study, invitations were sent by email to 30 regional employers. The email contained a link to an online survey questionnaire. Disappointingly, only 8 responses were submitted, just over 25% response rate and more work is suggested on the questions used in this pilot survey to see if the questionnaire design needs some improvement. After the initial results had been received and disseminated two semi-structured interviews were held with regional professional quantity surveying firms at Senior Director level. Both interview participants had also completed the survey and had indicated that they would be prepared to assist the research project by participating in an interview. Interview questions were based on seeking more in-depth information from data captured in the questionnaire. The purpose of the study was to explore the expected skills levels of graduate Quantity Surveyors and to assess the perceived importance of BIM related people skills.

QUESTIONNAIRE RESULTS

Table 1 shows the participants responses with regard to their views on the appropriateness of a range of skills and knowledge which are suitable for fresh graduates to commerce employment. Respondents were asked to indicate the extent to which they perceived fresh graduates joining their practices exhibited appropriate levels of skill and knowledge. As can be seen, the majority of employers are agreeable as to the skills level of fresh graduates. Eighty five percent of employers where either strongly or mostly agreeable on the range of skills suitable for fresh graduates with a quantity surveying degree.

Table 1: Perception of graduate skills

Criteria	**Percentage**
Strongly disagree	0%
Mostly disagree	13%
Neither agree nor disagree	13%
Mostly Agree:	63%
Strongly Agree:	13%

One of the objectives of this study was to explore the perception of the relative importance of various skills. A number of skills where identified based on a review of literature. These were also considered to be BIM-relevant. Respondents were asked to rate their levels of satisfaction with fresh graduates' skill in the identified areas on a scale of 1 to 5 where 5 is Excellent and 1 is Poor. Figure 1 presents a summary of the findings. It is interesting to note that competence in IT skills and communication scored high. These two stills are particularly seen to be critical BIM skills. In addition it can be seen that people-related skills are perceived important as in each case the score was above the 2.5 score. What is interesting also is that respondents felt that working independently and multi-disciplinary team working are areas where graduates skills could be improved. It is possible that this can be as a result of the need for greater collaboration between parties on a construction project, a natural platform for effective BIM working.

Respondents were also asked to indicate other areas that they felt could be strengthened within undergraduate degree provisions. Table 2 lists some of the key skills. Cost estimating, contract knowledge and measurement were identified by most respondents followed by report writing, presentation, sustainability and negotiation skills. Answers to this question have provided further useful insights into aspects of education provision in terms of technical and personal skills. As can be seen in table 2, there is a mixture of both technical and people related skills. An examination of the data show that the priority areas for employers are technical skills. All soft/people related skills are seen to be medium priority. In addition research, drawing and BIM software applications were seen to be of low priority for fresh graduates.

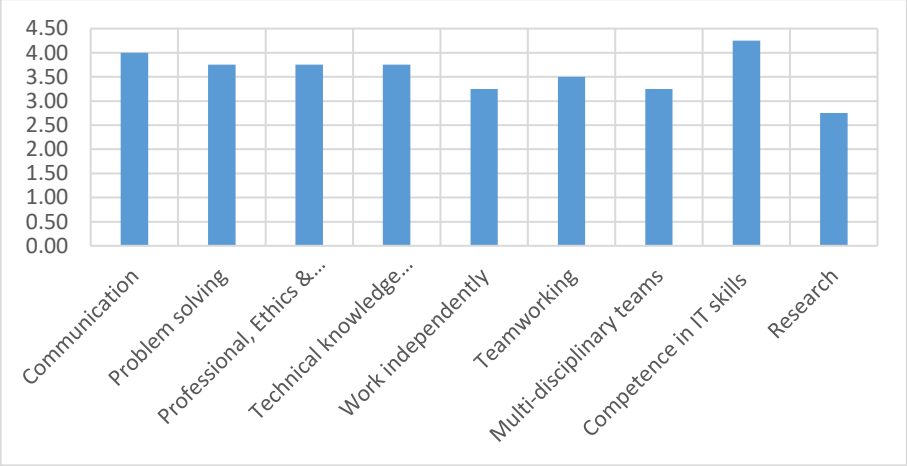

Figure 1: Satisfaction with skills

Table 2: Graduate priority areas

Priority	Skill	Type
High priority	Cost estimating	Technical
	Contract knowledge	Technical
	Quantity surveying measurement and measurement principles	Technical
Medium priority	Report writing	People
	Presentation skills	People
	Environmental and sustainability issues	Technical
	Practiced negotiation skills	People
	Research Skills	Technical
	Drawing skills	Technical
	BIM software skills	Technical

The questionnaire also provided an opportunity for respondents to make their own comments. These included maintaining education focus on the core subjects of measurement, estimating and commercial management. Increasing the emphasis on measurement in accordance with the NRM and with clear links to general construction technology so that students can see how the items they are being taught to measure fit together into the wider context of a construction project. Most of the respondents commented on the importance of measurement and construction technology as '*basic skills which underpin future progression in the industry and to enhance students' technical understanding*.'

Taken overall, these results are encouraging and show no real cause for wider quantity surveying education provisions. It is clear where some attention is required from the above data sets and qualitative comments. Interestingly, the highest score for employer satisfaction with their graduate students is in IT skills which shows that BIM adoption from a technological viewpoint should not be particularly onerous and this is also borne out by comments in the two semi-structured interviews, below. However, the lowest score in terms of satisfaction is with students' ability to work effectively in teams, a key attribute for successful BIM adoption and this seems to emphasis that it is the interpersonal soft-skills sets rather than the harder, technical aspects of BIM that employers are concerned about most.

Interview Results

Two interviews were conducted with Directors in Quantity Surveying professional practices. The focus of the in interview was to investigate their perception on the implications of BIM adoption on skills requirements. One of the concerns for many quantity surveying education providers is the identification of specific software packages suitable for training quantity surveying graduates. Therefore to begin the conversation, the interviewees were asked to give an overview of software usage within their practices.

Table 3 presents a summary of the respondents' views concerning software packages in use. Both respondents use Microsoft for general business management and administration and find that most staff of all ages and levels, including new entrants, are conversant with the use of MS Word, Excel and Powerpoint. Both did not see the need for any course education or training on these software applications (although happy to see forms of assessment based upon MS exercises to be continued). Similarly, and interestingly, both interviewees did not see any need for the inclusion in course or modular content of any CAD teaching (e.g. AutoCAD, Revit, and Sketchup) for quantity surveying students.

Table 3: Software

Interviewee 1	***Interviewee 2***
'I think the issue you'll come across there … is that there are so many systems. So whichever one that you choose to teach them on, no doubt they'll be not using that system in their office environment. For example, at the moment, we're using three systems ourselves for different clients. We use CATO, RIPAC, and CostX. CATO's good for cost planning, but not as user-friendly for bills and quants. RIPAC's not so good for cost planning but very good for bills and quants. And CostX is the system we are using with BIM at the moment'.	*'I think nowadays, it's a given that you're competent on, say, Microsoft Office. Obviously the two main programmes we use are Excel and Word. Some of the older guys are still without, that's because they're not used to it…. We do use CAD Measure and it's a completely different software ……. and I think that will come further into it now that BIM's coming on board. And we also use QS software called CATO, but there are other programmes available. …'*

The findings in the questionnaire survey suggests that the primary priority for fresh graduates should be the technical skills. Table 4 and table 5 below present a summary of respondent's views on technical and people skills requirements for graduates. The general consensus seem to be that technical skills should take priority for fresh graduates. However soft skills are still looked at as an important component. For

example Interviewee 1 emphasised measurement and estimating skills as key technical attributes and communication skills in writing and presenting work to others as key non-technical features they require from their graduates. Similarly interviewee 2 indicated the importance of technical know-how in addition to the relative importance of soft skills such as team working, communication and managing client expectations.

Table 4: Technical skills requirements

Interviewee 1	**Interviewee 2**
'Technical skills we require from graduates: measurement is a key underpinning factor. The ability to understand and measure from drawings and to be able to estimate the cost of the works measured is the key technical skill and a skill that underpins the whole service that we provide. Yes, it goes on to be much more than that but if you haven't got the basic technical skill then we can't depend that you could do the rest of it…'	*'An all-round knowledge of the building process, and how buildings are put together. … I think the view from the market is current graduates don't have the all-round knowledge of how buildings get put together. It wouldn't do you any harm in getting key subcontracts in for the key elements-- say for cladding, cladding contractors come and tells you all about how it's put together. Because that's what we do here-- if there's a new product on the market, we get the supply chain in, and they explain to us how it works, and how it integrates into a building-- say for foundations and things like that. Because ultimately, they're the guys that have to detail it out. Another big one is mechanical and electrical. And just having that bit more interaction, it probably, I think, would help'*

Table 5: None-Technical Skills

Interviewee 1	**Interviewee 2**
'*It's a factor of our industry that a lot of people who have the technical skills are not necessarily the most communicative of people…..you need to be able to communicate.to your client and/or to other stakeholders in a scheme in a coherent way, so there is an element of written communication and verbal communication that are key issues. … we just measure things and price them…that's a basic skill…people are looking to do that with the computer. Some graduates are very confident but their work is sometimes lacking. Others can produce excellent work and they just aren't confident in putting it across….but we try and encourage people to be both accurate in their work and confident in putting it across'.*	'*… obviously, a big part of the construction industry is working as a member of a team-- so ability and self-awareness, really, and being able to integrate into a team environment. And obviously a big one from a client point of view is managing people's expectations'.*

Table 6: BIM Skills

Interviewee 1	***Interviewee 2***
'I think if they know how to do technical measurement and if they've got the technical knowledge to be able to do it on pen and paper, most youngsters these days pick up IT just like that and they will pick up any system that you put in front of them in a short amount of time in terms of training'.	*'We have to train them, but it's a two-day training course within the firm. It's probably, I'd say, a month. A month would be an estimate'.*

Table 6 presents respondents' views on BIM skills. When asked if quantity surveying courses should include teaching, learning and assessment on a BIM-compliant software product, Interviewee 1 was of the view that this is not a priority as long as graduates have the technical know-how since they will pick-up of use of specific software packages. Similarly Interviewee 2 saw no problems with graduates not having direct competence with particular BIM-compliant software products. Like the other interview participant his organisation was also using CAT and had just introduced Cost X and was engaged in training staff on its measurement, cost planning and reporting products and working on real-time BIM projects. In response to the question: How long does it take a novice, coming to you with a degree, have done measurement, but they don't know anything about CAD Measure. The general view is that graduates are likely to be fast learners as they are used to the digital platform. The use of specific BIM-related training seem to be a common feature in most organisations as reflected in interviewee 2's comments. These views might not, however, meet current students' expectations and it is inevitable that choices will have to be made to introduce into course curricula some element of hands-on practical experience of BIM-compliant software and /or internet applications as part of teaching and assessment.

CONCLUSIONS & RECOMMENDATIONS

The purpose of the study was to explore the people skills implications of the adoption of BIM by quantity surveying professional practices and also to consider the potential implications of such on quantity surveying courses curriculum design. The research found no resistance to the introduction of BIM, it is already accepted, but noted that its implementation was still in a relatively early stage with some uncertainty apparent about which capital investment choices to make and which staff training provisions to choose. These uncertainties also apply to higher education providers in designing and managing curricula against BIM and maintaining pace with the rate of change. Overall the findings suggests that employers are ggenerally satisfied with fresh quantity surveying graduates as they generally have requisite basic skills and knowledge to embark on their career. The findings also suggests that students are effective working in quantity surveying teams but less effective in working as part of a multi-disciplinary team. One of the objectives of the study, was to explore the people skills implications of BIM adoption on quantity surveying practice and by extension on course curriculum. Employers in this sample are at a relatively early stage in BIM adoption but working on BIM projects. The findings suggests that employers are generally not concerned with BIM-specific technical training but wish to see the focus on providing education and methods of assessment for the BIM process, of collaborative working, communicating, independent working and ability to interpret data. These are important people skills that quantity surveying education providers need to take into consideration in course designs.

This initial research appears to corroborate findings in other studies (Chou et al, 2015 and Crowley, 2013) that quantity surveying firms are behind other professionals and other countries in adopting BIM. The diversity and range of choice of BIM-compliant quantity surveying software and internet related products means that there is no 'one size fits all' approach to incorporating specific products and systems into university courses and teaching and learning methods. Employers want traditional quantity

surveying disciplines to be retained in course curricula and will provide their own training for IT and BIM-related software applications. The interviewees' views on not incorporating some technical aspects of BIM will have to be considered against the findings from the literature which suggest that combining theory, practice and use of technology in a collaborative setting will need to be a part of course curricula.

The study recognises the sample size as a limitation. However given that this was a pilot study, key issues have been identified for further research. In particular the study identifies the need for a further investigation of soft skills requirements in a BIM environment.

BIBLIOGRAPHY

Aibinu, A and Venkatash, S (2014) Status of BIM adoption and the BIM experience of cost consultants in Australia, *Journal of Professional Issues in Engineering Education and Practice, Vol.140, Issue 3*

Ashworth, A and Perera, S (2015) *Cost Studies of Buildings, 6th*. Ed. London, Routledge

Crowley, C (2013) Identifying opportunities for Quantity Surveyors to enhance and expand the traditional quantity surveying role by adopting Building Information Modelling *In: Proceedings of the CITA BIM Gathering, November 14th-15th*

Zhao, D., McCoy, A. P., Bulbul, T., Fiori, C., & Nikkhoo, P. (2015). Building Collaborative Construction Skills through BIM-integrated Learning Environment. *International Journal of Construction Education and Research, 11(2), 97-120.*

Egan, J. (1998) *Rethinking Construction: Report of the Construction Task Force*, London: HMSO

Fellows, R and Liu, A (2015) *Research Methods for Construction, 3rd. Ed.* Oxford, Wiley-Blackwell

Government Construction Strategy 2013, Cabinet Office, London: TSO

Ghosh, A, Parrish, K and Chasey, A (2015) Implementing a Vertically Integrated BIM Curriculum in an Undergraduate Construction Management Program, *International Journal of Education and Research, Vol.11, Issue 2 pp 121 -139*

Hannagan, T (2008) *Management Concepts and Practices, 5th. Ed*. London, Pearson Education

Klaschka, R (2014) *BIM in Small Practices: Illustrated Case Studies*, NBS

Latham, M (1994) *Constructing the Team; joint review of procurement and contractual arrangements in the UK construction industry; final report,* Department of the Environment, London

Marasini, R and Barfoot, J (2012) *Building with Employers: An evaluation of Built Environment Courses*, Southampton Solent University

Morton, R and Ross, A (2008) *Construction UK: Introduction to the industry*, 2nd. Ed. Oxford, Blackwell

Pittard , S and Sell, P (2016) *BIM and Quantity Surveying,* Abingdon, Routledge

RICS (2014) *Guidance Note: Tendering Strategies*, London, RICS

RICS (2015) *Assessment of Professional Competence Quantity Surveying and Construction, Pathway Guide*, London, RICS

Ryan, S and Thurnell, D (2014) The benefits and barriers to implementation of 5D BIM for quantity surveying in New Zealand, *Australasian Journal of Construction Economics and Building , Vol.14 , Issue 1, pp 105-117*

Self, W and Watkin, W (2016) There will be blood. *Times Higher Education, No. 2,263 14-20 July 2016, pp 33-37*

Zhou, L. Perera, S, Ueaja, C and Paul, C (2015) *SME Readiness of BIM: A case study of a Quantity Surveying organisation,* Northumbria Research Link, Northumbria University