BIM AWARENESS AND READINESS OF POSTGRADUATE BUILT ENVIRONMENT STUDENTS IN WEST MIDLANDS UNIVERSITIES, UK

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Abstract:

Several reports and studies have been conducted on Building Information Modelling (BIM) awareness and readiness of the construction industry in UK ever since the directive by the UK Government for the use of fully collaborative 3D BIM at Level 2 as a minimum by 2016. These reports and studies revealed that the industry is not yet ready to implement BIM at maturity Level 2 because of lack of training and lack of professionals who can work in a BIM enabled environment. Key to the implementation of BIM is education and training of all affected people. However, a significant number of organisations are reluctant to invest and develop in BIM capability mainly because of the cost involved. There is a growing and urgent demand for higher educational institutions to provide specialised training for students to meet the current needs of the industry because most companies are finding it difficult to find existing employees who have the experience to implement BIM. Researchers have highlighted the need for building information modelling to be an integral part of the curricula of higher educational institutions. Some universities have responded by incorporating BIM into their curricula. However, not much is known about BIM awareness and readiness of built environment students who are required by the industry and employers to fill the skill gaps.

This paper investigated BIM awareness and readiness of postgraduate built environment students of universities in the West Midlands, UK. To achieve the aims and objectives of this research, a positivist research approach was adopted. The population of the study consists of postgraduate built environment students in the West Midlands universities. Data was collected using a self-completion online survey. The results indicated that students have heard about BIM but do not understand its concepts. It also indicated that the respondents were not ready to work in a BIM enabled environment because their courses have not prepared them well. However, most of the respondents would like to explore BIM as part of their course. Training will be required for all affected staff in order to prepare students for successful careers in the built environment industry.

KEYWORDS: AWARENESS, BUILDING INFORMATION MODELLING, POSTGRADUATE STUDENTS, READINESS, AND UNIVERSITIES

1. INTRODUCTION

After several years of using paper and lately Computer Aided Design (CAD) to create plans and drawings, a process seen to be error-prone, the UK construction industry appears to be preparing for the adoption of building information modelling (BIM). The UK government, the industry’s biggest client in 2011 mandated for the use of fully collaborative 3D BIM at Level 2 as a minimum on all centrally procured government construction projects by 2016. This is to enable stakeholders on a project collaborate for an efficient, productive, sustainable, and competitive industry (Cabinet Office, 2011). All organisations (either small or large) are likely to be affected and will be engaged in the

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BIM process because of their involvement with a supply chain partner or a government department (BIM Task Group, 2013).

Key to the implementation of BIM is education and training of all affected people (Building Smart 2010; McGraw-Hill Construction, 2008; Khosrowshahi and Arayici, 2012). Though education and training play a big role in the BIM adoption process, a significant number of organisations are reluctant to invest and develop in BIM capability mainly because of the cost involved. For instance, small and medium sized enterprises (SMEs) which form a significant portion of the UK construction industry are far behind with only 1 in 10 planning to train their staff whilst 1 in 2 larger organisations were planning to do so (NFB, 2012). The lack of training and development activity in the industry (BIS, 2013) is seen as a major barrier to BIM adoption (Building Smart, 2010; Becerik-Gerber et al., 2011; McGraw-Hill Construction, 2008; Khosrowshahi and Arayici, 2012). There is a growing and urgent demand for higher educational institutions to provide specialised training for students to meet the current needs of the industry (Göransson and Brundeniu, 2011; Hardin, 2009). This is because most companies are finding it difficult to find existing employees who have the experience to implement BIM (Kymmell, 2008). Race (2013) and Wong et al. (2011) highlight the need for BIM to be an integral part of the curricula of higher educational institutions. Khosrowshahi and Arayici (2012) mentions that there is a necessity for an up skilling of the current workforce but since such standards are rare, there is currently a growing need for academic organisations to host such educational programmes. Johnson and Gunderson (2010) highlights that not much is known about how educational institutions are moving to address these changes through their courses to prepare their students. Students on construction management programmes should be taught BIM because most construction organisations will consider employing graduates with BIM skills over those who do not have the knowledge of BIM (Dean, 2007; Hardin, 2009). This papers seeks to investigate the level of awareness and readiness of built environment graduates on BIM implementation.

2. THE UK CONSTRUCTION INDUSTRY AND THE NEED FOR BIM

In spite of the contributions the construction industry makes to the UK economy, several researches and reports on the state of the industry in the last 80 years have highlighted its inefficiencies, waste, adversarial and fragmented nature (e.g. Banwell, 1964; Bosson, 1934, in Cain 2004; Egan, 1998; Emmerson, 1962; Latham, 1994; Simon, 1944). These reports revealed that collaboration among stakeholders and the modernisation of the industry are the way forward to overcome its challenges in order to deliver value to its clients as well as make reasonable profit. The recommendations for improvement from these reports were also ignored by the industry due to poor client involvement and a lack of legislation to reinforce them (Cain, 2003; Cain, 2004; Potts, 2008). However, the UK Government mandate for the industry to embrace 3D BIM at Level 2 as a minimum on all
centrally procured government contracts from 2016 will change the way the industry works.

The agenda of the UK government on construction for several years has been to improve efficiency (Wolstenholme, 2009). The HM Government (2013) report on the industrial strategy for the construction sector set out a clear vision for the sector to deliver 33% lower costs in the initial cost of construction and the whole life cost of built assets. It also called for a 50% faster delivery of construction project for new build and refurbished assets; 50% lower emissions, and halving the export trade gap for construction products and materials by 2025. In the UK, there is an increasing demand for construction as the economy emerges from the recession of 2008. This has led to an increasing demand for a capable workforce that can deliver transformational changes (HM Government, 2013). There is also a major opportunity for UK-based construction business to win in the expanding markets especially in the developing world. To achieve this will require that the sector is BIM ready to gain a competitive edge (Saxon, 2013b).

The UK construction sector faces a challenge of recruiting skilled workforce (CITB, 2014) to meet these future demands and take advantage of the global and domestic market opportunities. A report by the UK Commission for Employment and Skills (2012) highlights the need for employers to invest in the skills of its workforce over the skills shortage. There is little training and development activity within the construction sector compared to other sectors (BIS, 2013; Egan, 1998). The total spending on training has fallen by £2.5 billion since 2011 (UKCESS, 2014). The report also forecast a higher future demand for construction managers and professionals especially for new job opening. A survey by the Office for National Statistic indicates that the number of graduates leaving higher education into the industry is promising. Employees with degrees or equivalent in the construction contracting sector moved up from 12% to 22% between 2001 and 2012 (HM Government, 2013). These graduates are expected to keep abreast with the current development in the industry because recruiters expect graduates from the universities to be BIM ready (Kymell, 2008). Wong et al. (2011) points out that BIM integration in higher education would serve the high demand for BIM capable professionals whiles producing fresh opportunities for students to deal with fresh challenges with high efficiency achieved by BIM application.

3. THE ROLE OF HEIS IN PROMOTING BIM ADOPTION

The growth and prosperity of nations depends on their universities because they serve as the providers of human capital as well as incubators for entrepreneurial activities (Göransson and Brundeniu, 2011). According to Lamond et al. (2013), higher education (HE) courses are the main providers of future built environment professionals for the construction industry. Educators are expected to equip the future design and construction professionals with the knowledge and skills needed by industry in a collaborative environment to create and construct the built environment (McCuen and Pober, 2013; Ngo, 2012). Göransson and Brundeniu (2011) and Hardin (2009) maintained that there is a growing and urgent demand on HE institutions (HEIs) to adjust to the changing needs
of society and economy by providing specialised training to students. HEIs are required to
develop and transfer technologies to industry for a smooth transition to BIM. The
NBS (2011, p. 20) mentions that “Educational establishments clearly have a major role to
play in this transition, they should and will seed the next generation of professionals who
understand BIM as a technology that supports collaborative working.” For this reason,
curricula of HEIs are to be designed to ensure it mirrors the needs of the industry
(Morton, 2012; Becerik-Gerber et al., 2011).

Some universities around the world have started incorporating BIM into their built
environment curricula either through seminars, workshops, presentations or through the
development of a specific course for BIM at undergraduate and postgraduate levels to
prepare students for the industry in response to the lack of BIM knowledge and skills. This
includes universities in countries such as Australia, Canada, Finland, Hong Kong,
New Zealand, Norway, UK and the U.S. (Becerik-Gerber et al., 2011; Rooney, 2014;
Sabongi, 2009). In the UK, some universities have incorporated BIM courses into their
built environment curricula at postgraduate level whiles at undergraduate level BIM has
become a feature (Rooney, 2014). Evidence suggests that there are barriers to BIM
integration into the curriculum of HEIs (Becerik-Gerber et al., 2011; Sabongi, 2009).
Kymmell (2008) mentioned that the barriers that HEIs face in introducing BIM into their
curriculum may be one or more of the following factors: conceptual issues (a lack of
understanding); technical issues (inability to use the required tools); and environmental
issues (circumstances). Sabongi (2009) conducted a survey of 119 institutions in the US,
which offered built environment undergraduate programmes. The results indicated that
the main barriers to the introduction of BIM in higher education included: lack of time
and resources to prepare a new curriculum; lack of room in the curriculum to include new
courses to existing curriculum; the limited number of courses (requirements and
electives) that can be taken by students within the period they are expected to complete
their courses; and a lack of appropriate materials and educational resources to teach BIM.
Other barriers identified by the research include: BIM complexity; lack of interest or
willingness to explore new technology by students; lack of support from faculty
colleagues and/or administrators; unwillingness to change curriculum to add BIM when
BIM itself may be replaced by another technology program in a few years; and
uncertainty about which BIM platform (Revit, Bentley or something else) will become
dominant. Becerik-Gerber et al. (2011) in their survey of 101 Architecture, Civil
Engineering and Construction Management programs in the U.S. also identified lack of
trained personal in BIM; the time it takes for the implementation of BIM; and a lack of
curriculum focus on BIM as barriers. Although a lack of interest or willingness to explore
new technology by students is seen as one of the barriers to the integration of BIM into
HEIs, Hardin (2009) argued that students will study software if chosen to be part of the
curriculum. Table 1.1 below presents the barriers to BIM integration in HEIs found in the
literature.

**BIM Awareness**

For the purpose of this study, the following definition of awareness from the Cambridge
Advanced Learner’s Dictionary (2008) is used. It defines awareness as the “knowledge
that something exists, or understanding of a situation or subject at the present time based on information or experience” was used. In establishing BIM awareness of built environment students, the survey questionnaire examine whether the student had heard about BIM; how they heard about BIM; what their basic understanding of BIM is and their knowledge on current development in the UK construction industry with regards to BIM adoption.

**BIM Readiness**

The definition of readiness has been discussed (Aziz and Salleh 2011; Subramaniam et al., 2013; Othman et al., 2012). Aziz and Salleh (2011) mentioned that the concept of readiness cannot be defined but depends on contexts, situations and the individuals involved. For instance, the Harvard University Centre for International Development (2001) in a report on ‘Readiness for the networked world’ defined readiness as “the degree to which a community is prepared to participate in the Networked World.” Othman et al. (2012) in studying the readiness of students towards entrepreneurship education defined readiness as “the willingness and ability to do something.” Subramaniam et al. (2013) in their study of ‘E-Content Development in Engineering Courses: Students Needs and Readiness’, used the Cambridge Advanced Learner’s Dictionary (2008) which defines readiness as “willingness or a state of being prepared for something.” It can be deduced from all the definitions that readiness measures willingness and capability (ability) therefore the survey used these two elements to inform the student’s BIM readiness. For the purpose of this study, BIM readiness is defined as the student’s willingness to explore BIM and their ability to work in a BIM enabled environment. The research therefore intend to establish the willingness of built environment students to explore BIM as part of their courses and their ability to work in a BIM enabled environment.
Table 1: Barriers to BIM integration in higher educational institute

<table>
<thead>
<tr>
<th>Barriers</th>
<th>Authors</th>
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<tbody>
<tr>
<td>Lack of time and resources to prepare a new curriculum</td>
<td>Barison and Santos, 2011; Becerik-Gerber et al., 2011; Sabongi, 2009;</td>
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<td></td>
<td>Ngo, 2012</td>
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<td>Lack of room in the curriculum to include new courses to existing</td>
<td>Rooney, 2014; Sabongi, 2009</td>
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<td>curriculum</td>
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<td>The limited number of courses (requirements and electives) that can</td>
<td>Ngo, 2012; Sabongi, 2009</td>
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<td>be taken by students within the period they are expected to complete</td>
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<td>their courses</td>
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<tr>
<td>Lack of appropriate materials and educational resources to teach BIM</td>
<td>Barison and Santos, 2011; Sabongi, 2009; Race, 2013; Sabongi, 2009;</td>
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<td></td>
<td>Ngo, 2012</td>
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<tr>
<td>The complexity of BIM</td>
<td>Sabongi, 2009</td>
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<tr>
<td>Lack of interest or willingness to explore new technology by students</td>
<td>Barison and Santos, 2011; Sabongi, 2009</td>
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<td>Lack of support from faculty colleagues and/or administrators</td>
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<td>Unwillingness to change curriculum to add BIM when BIM itself may be</td>
<td>Sabongi, 2009</td>
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<td>replaced by another technology program in a few years</td>
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<td>Uncertainty about which BIM platform (Revit, Bentley or something else)</td>
<td>Barison and Santos, 2011</td>
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<td>will become dominant.</td>
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<td>BIM tools are expensive</td>
<td>Barison and Santos, 2011; Rooney, 2014</td>
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<td></td>
<td>Rooney, 2014</td>
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<td>Unfamiliarity of lecturers with BIM and other fast-paced technologies</td>
<td>Becerik-Gerber et al., 2011; Race, 2013</td>
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<td>and workflows.</td>
<td>Barison and Santos, 2011; Rooney, 2014; Ngo, 2012</td>
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<td>Reluctance of some lecturers to alter established teaching methods</td>
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<td>coupled with an unwillingness by some to retrain in new topics</td>
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<td>Lack of trained personnel in BIM</td>
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<td>Inability to bridge the current disintegrated traditional form of</td>
<td>Becerik-Gerber et al., 2011</td>
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<td>department in order to deliver collaborative course and programmes-</td>
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<td>both culture and facilities require modification</td>
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<tr>
<td>Lack of curriculum focus on BIM</td>
<td>Barison and Santos, 2011</td>
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4. METHODOLOGY

This study investigated BIM awareness and readiness of postgraduate students of the six (6) universities in the West Midlands, namely Aston University, University of Birmingham, Birmingham City University, Coventry University, University of Warwick and University of Wolverhampton using purposive sampling. These universities offer built environment courses such as Architecture, Architectural Technology, Building Services Engineering, Building Surveying, Civil/Structural Engineering, Civil Engineering Surveying, Quantity Surveying, Construction related programmes (Construction/Project management), BIM related programmes and other built environment courses. The study adopted a positivist (quantitative) research approach. Data was collected by means of a self-completion online survey questionnaire consisting
of twenty items divided into three sections. The first section had ten items to ascertain
BIM awareness, followed by five (5) items on BIM readiness (Section 2). Section 3
consists of five (5) items on the respondent’s profile. Closed ended questions were used
to make it easier and quicker for the respondents to answer. It also enabled easier
comparison of answers from different respondents. Most of the questions were 5 point
Likert-like items based on a scale from “strongly agree” to “strongly disagree” where a
score of 5 means strongly agree and 1 means strongly disagree. The names of the
universities were coded from 1 to 6 for confidentiality. A variety of statistical analysis
were used to analyse the data using statistical package for social sciences (SPSS).
Descriptive analysis was performed to provide insight of the data and a summary of the
results. A more detailed analysis was performed to compare the results of different
samples using Spearman's rank correlations. In all, thirty-five students from three out of
the six universities responded to the survey.

5. ANALYSIS AND DISCUSSION OF RESULTS

Respondents to the survey were from Architectural Technology, Civil/Structural
Engineering, Construction related programmes (Construction/Project management), BIM
related programmes and other built environment courses. All respondents answered that
they had heard about BIM. However, more than half (51.4%) answered that BIM was not
introduced as part of their modules. Sixty percent (60%) of the respondent answered that
they either heard about BIM through Trade journals, seminars, at work or other sources.
The data suggests that most of the students may have heard about BIM before it was
introduced on their courses. This could be attributed to the high level of reports and
journal papers on BIM in the last 5 years. BIM has become one of the most discussed and
written about topics in the construction industry within the last 5 years (Crotty, 2012;
Harding et al., 2014). A google scholar search on Building Information Modelling returns
3,170,000 results.

To ascertain the understanding of BIM among the students, the questionnaire asked
whether BIM is a synonym for 3D CAD drawing. Of the total respondents, almost three-
quarters (74.3%) answered ‘Yes’ or ‘Did not know’ to the question. The results suggest
that although all the respondents had heard about BIM, many of them did not understand
what BIM is. This could be attributed to the unlimited number of BIM definitions in
circulation which leads to the tendency for misinterpretation by readers because most
publications attempt to define BIM in their own terms (Barlish and Sullivan, 2012).
Many people perceive BIM as the file that is created using 3D CAD software programs
(Reddy, 2012). The level of BIM awareness of built environment lecturers will impact on
the students they teach. However, Rooney (2014) highlighted that some lecturers are
unwilling to retrain in new topics such as BIM. Many of the lecturers in the respondents’
institutions may have touched on BIM without adequately explaining what BIM was to
their students. A lack of trained BIM personnel, lack of curriculum focus on BIM in
higher educational institutions (Becerik-Gerber et al., 2011; Race, 2013), the lack of
materials and educational resources to teach BIM (Barison and Santos, 2011; Sabongi,
2009), and unfamiliarity with BIM among lecturers (Barison and Santos, 2011; Rooney,
2014) could be affecting the delivery of BIM to students in the higher educational institutions. This situation calls for the training of the affected built environment lecturers to ensure that they are better able to deliver BIM topics.

The results to ascertain postgraduate (MSc) built environment students’ knowledge of current developments in the UK construction industry suggest that 62.9% were aware that BIM will become mandatory across all centrally procured UK Government construction projects by 2016. However, almost two-third (65.7%) were not aware of the maturity levels of BIM whilst 71.4% were not aware of the maturity level expected as a minimum for the UK construction industry. A cross-tabulation was performed to compare the relationship between respondents’ awareness that BIM will become mandatory across all centrally procured UK government construction project with respondents’ awareness of the BIM maturity levels. The results indicated that of the total respondents (62.9%) who answered that BIM will become mandatory across all centrally procured UK government construction project, 45.4% answered that they were not aware (strongly disagree, disagree or neither agree nor disagree) of the BIM maturity levels. Those who answered that they were aware of the maturity levels of BIM add up to 54.6%. Of the total respondents (5.7%) who answered (No) that BIM will not become mandatory across all centrally procured UK government construction project, all (100%) answered that they were unaware (strongly disagree) of the BIM maturity levels. Of the total respondents (31.4%) who answered that they do not know BIM will become mandatory across all centrally procured UK government construction project, 100% answered that they were unaware (strongly disagree, disagree or neither agree nor disagree) of the maturity levels of BIM. The results shows that majority of the respondents who answered that they were aware BIM will become mandatory across all centrally procured UK government construction project were also aware of the BIM maturity levels. The relationship between ‘I am aware of the BIM maturity levels and What BIM maturity level is expected of the UK construction industry by 2016’ was investigated using Spearman’s rank correlation coefficient. To ensure that there was no violation of the assumption of normality, linearity and homoscedasticity, preliminary analyses were performed. The results revealed a significant and negative correlation \( r = -0.47, N = 35, p = 0.04 \) between the two variables with high levels of BIM maturity level awareness associated with lower levels awareness of mandatory BIM by 2016. The correlation was moderate in strength.

Sixty percent (60%) of the survey’s respondents answered that collaboration is needed by teams on a BIM project for better results. The remaining respondents disagreed or were not sure. The results suggest a lack of awareness of the central principle of BIM among some postgraduate (MSc) built environment students. The National BIM Standard-United States (2013) points out that a vital principle of BIM is collaboration by all the teams for an efficient industry. The concept of BIM is collaboration to create a single integrated model (McGough et al., 2013). BIM therefore thrives in a collaborated multidisciplinary environment from project inception. BIM would ensure that several companies work in a fully collaborated 3D environment so that the teams involved in the project can work on a common platform to reduce the costs of transaction and errors (Cabinet Office, 2011).
Overall, only 14.3% answered that they were satisfied with the level of BIM knowledge they have received through their courses. This result clearly suggest that 6 out of 7 respondents (85.7%) were not satisfied with the BIM knowledge received through their university courses.

6. BIM READINESS

The questionnaire asked the respondents whether their courses have prepared them well enough to perform within a BIM enabled environment. Of the total respondents, only 11.4% or almost 1 in 9 respondents answered "Yes" to the question. The results of students overall satisfaction with the BIM knowledge received through their courses and their ability to perform in a BIM enabled environment because their course has prepared them well paints a gloomy picture considering that the construction industry is counting on professionals from the higher educational institutions to fill the skills gap (Kymnell, 2008, McCuen and Pober, 2013). This suggests that majority of respondents were not fully aware of current developments in the industry.

The relationship between ‘Overall satisfaction with BIM knowledge received through my course’ and ‘My course has prepared me well to perform within a BIM enabled environment’ was investigated using Spearman’s rank correlation coefficient. The results revealed a moderate, positive correlation (r = 0.37, N = 35, p = 0.03) between the two variables with higher levels of overall satisfaction with BIM knowledge received through their courses being associated with higher levels of My course has prepared me well to perform within a BIM enabled environment.

Further to the above question, respondents were asked whether they could perform well in a BIM enabled environment. About 1 in 7 (14.3%) of the respondents answered that they could perform well in a BIM enabled environment. It is interesting to note that the result was 2.9% more than those who answered that their course had prepared them well to perform in a BIM enabled environment. Of all the respondents to the survey, 28.6% answered that they could use one or more BIM tools (software) as shown in Figure 1.1. The result indicate that Revit (Arch, Struct, MEP), was the most common BIM tool that respondent answered they could use.

The results of the survey indicated that more than three quarters (77.2%) of the respondents were willing to explore BIM as part of their course. Almost three quarters (71.4%) of the respondent answered that they will willingly add BIM to their course if it were an elective module. The results from this survey differ from Sabongi (2009) who conducted a survey of built environment undergraduate programmes in US institutions and concluded that a lack of interest or willingness by student to explore new technology such as BIM was a barrier to BIM integration in the undergraduate courses. It must however be noted that respondents to this survey were on postgraduate (Masters) programmes. The UK government mandate for the industry to adopt level 2, fully collaborative 3D BIM, or higher on all public sector contracts by 2016 could account for
respondents’ interest and willingness to explore BIM as part of their courses in order to gain a competitive edge during their job search.

Figure 1.1 Ability to use one or more of the following BIM tools (software) in a BIM enabled environment

7. CONCLUSION

The adoption of BIM by the UK construction industry will ensure efficiency in projects delivery predictably to the required quality, time and budget. It will also enable the industry to gain a competitive edge in the expanding global market. UK firms that adopt BIM at level 2 as a minimum by 2016 will gain a competitive edge over those that do not. A lack of in-house expertise and training of the affected employees will mean that many organisations, especially SME’s will lose out. Most of these organisations will be counting on HEIS to equip their graduates from the built environment schools to fill the skill gaps. However, the results of the research suggest that HEIS are far behind in preparing their postgraduate (MSc) built environment students to be enable them work in a BIM enabled environment. This situation must be addressed by higher educational institutions to ensure that their students are equipped with the essential BIM knowledge to succeed in a BIM enabled environment. Ngo (2012) points out that educational institutions have a crucial role to equip the next generations of graduates with the necessary BIM knowledge to perform their task in the BIM enabled environment.
Institutions that integrate BIM into their built environment curricula early stand to gain a competitive edge in that students will be attracted to them. The current situation calls for the training all affected lecturers in the built environment schools to enable them deliver BIM topics. HEIS are seen by many as the solution for a smooth transition from 2D CAD to BIM.

8. REFERENCES


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