BIM Awareness and Acceptance by Architecture Students in Asia

Euisoon Ahn and Minseok Kim

1 Ph.D. Candidate, Department of Architecture & Architectural Engineering, Seoul National University, Korea
2 Assistant Professor, Department of Architecture, Pukyong National University, Korea

Abstract

Building Information Modeling (BIM) and Industry Foundation Classes (IFC), which is another key concept of BIM, are becoming globally-recognized standards. Although BIM education in schools is important in order to advance the adoption of BIM in the industry, such education has yet to be achieved. This study examines the degree of awareness and acceptance of BIM and BIM education among architecture students in Asia. A survey was conducted to measure recognition, interest, and experience with BIM and IFC among students participating in a design workshop in Busan, Korea. The students were moderately aware of BIM itself, yet had no familiarity with IFC. The more they know about BIM, the more likely they are to have an interest in it. Korean students are more aware of BIM than students from other Asian countries, and 'Upper class' (3rd year and higher) students are more aware than 'Lower class' (1st and 2nd year) students. This difference in awareness may be due to the strong government led initiative in Korea. Although for effective adoption of BIM and IFC, they should be introduced earlier to raise an awareness and interest in them.

Keywords: BIM; IFC; awareness; acceptance; architectural education

1. Introduction

In recent years, the adoption of Building Information Modeling (BIM) in the architectural field has been accelerating worldwide. The United States had a pioneering role in BIM adoption, as the General Services Administration (GSA) had already mandated the application of BIM to public procurement projects in 2007. In the case of Korea, the phase-in of BIM was affirmed as a government initiative. The Public Procurement Service (PPS) of Korea mandated the application of BIM on public procurement projects costing over 50 billion won (about 42 million USD) from 2012, and on all public procurement projects from 2016.

All countries adopting BIM are commonly recognizing the limitations of the existing CAD, and noting the potential of BIM to bring a paradigm shift – similar to what CAD initially brought.

BIM is a technology which produces and manages various information for construction activities throughout the life cycle of a building, from the initial planning to the maintenance stage. Away from the limitation of the existing CAD technology, BIM features a broader and more aggressive approach throughout the building life cycle.

A significant change is required in the conventional construction process for BIM to be introduced and utilized appropriately. Therefore, BIM education is a vital key for students as well as practitioners.

Industry Foundation Classes (IFC) is also a very important concept for introducing BIM. IFC is a standard data format created for the purpose of data compatibility and interoperability among different BIM software. IFC is becoming the recognized standard format in many countries, including the United States, Norway, Finland, and Singapore. In the case of public procurement projects in Korea, delivering the BIM model in the IFC format is mandatory (Kim, 2014).

Currently, BIM education in the architecture industry in Korea usually appears in two forms. One is in-house education within a company itself, and the other is through private BIM education which is operated by BIM professional groups. However, it is difficult for architecture students to access these two forms because they are primarily targeted at practitioners. Thus colleges, being the main educational institutions in architecture, are required to assume responsibility for BIM education as well.

This study aims to check the sufficiency and satisfaction on BIM education in colleges from the students' viewpoint. The authors examine the degree of awareness and acceptance of BIM education for architecture major students in Asia, and determine the
current status of BIM education in colleges to seek a way forward for the future of BIM education.

2. Related Studies

2.1 BIM Education in College

The introduction of BIM requires major changes in the architectural field. BIM modelling needs to be more precise and detailed in order to enhance design quality. Also, interoperability among BIM software is important for collaboration between participants. Various data from material information to environmental analysis should be exchanged in the form of a BIM model between participants. Therefore, BIM education for broader participants is required in order to fully take advantage of BIM technology.

In response to this, BIM education curriculums were created and implemented in colleges worldwide. It appears in various forms, from adding BIM software exercises to existing CAD courses to organizing a new curriculum dealing with BIM and IFC. For example, Pennsylvania State University in the U.S. provides BIM education in close contact with the design process by implementing BIM and environment analysis in architectural design studio courses (Messner, 2008). Several graduate schools in Korea, including Chung-Ang University and Kyung-Hee University, have established Master's courses specializing in BIM and also provide higher BIM education programs. There are also various studies on the goals and strategies for BIM education in colleges.

Table 1. Preceding Studies Regarding BIM Education

| Subject | Author         | Year |
|---------|----------------|------|
| A Study on the Process of Architectural Design Education Using BIM | Min & Jeong | 2013 |
| The Experiment of Architectural Design Education by means of BIM | Kim & Yang | 2012 |
| A study on the Practical Adaptation of BIM Programs for Architectural Education | Shin | 2011 |
| Improvement of the architectural engineering design education process through an analysis of BIM courses | Kang & Shin | 2010 |

2.2 Awareness and Acceptance of BIM

The awareness of BIM represents a range of perceptions that the subjects have towards BIM, such as recognition, interest, and prejudice. BIM awareness among members affects the attitude of the group, thereby affecting both the utilization of BIM and the effectiveness of its use.

John (2011) and Lee (2011) studied the awareness of BIM in architectural design firms in Korea. They found that most designers have never used BIM software, and the adoption of BIM is limited to projects in which its use was mandated.

Park (2013), while assessing BIM acceptance at architecture, engineering, and construction (AEC) participants in Korea, analyzed the impact of BIM awareness and BIM acceptance by applying the Technology Acceptance Model (TAM). The intention to use BIM by Korean AEC participants was influenced by the level of belief that their job performance would be higher by using BIM, as well as by the perceived ease of use (Park, 2013). Lee (2013), in a research on professionals in construction industries in Korea, also found that the willingness to use BIM voluntarily influences BIM acceptance in construction organizations.

Thus, the lack of awareness among practitioners was commonly cited as a barrier to accelerate the adoption of BIM in most of the research on BIM awareness and acceptance. This is a problem which BIM education could resolve by raising its awareness.

Although there are many preceding studies on BIM awareness and acceptance among practitioners, only a few studies on students exist. The lack of awareness would also affect students, therefore BIM education can be evaluated by measuring the level of BIM awareness and acceptance among students. And, a more effective strategy for BIM education is expected to be drawn from the study.

3. Methodology

3.1 Purpose

The purpose of this study is to assess the awareness and acceptance of BIM, and BIM education among architecture students in Asia.

3.2 Subjects

The subjects of this survey were the students participating in the 2014 Busan International Architectural Design Workshop. It was expected to include students from diverse Asian countries and many architectural schools, although participation in the workshop was not officially limited to architecture students or students in Asia.

3.3 Questionnaire

This study investigates the awareness and acceptance of BIM through the survey, which is similar to precedent research. The subjects of the survey received a written questionnaire and were asked to self-report.

The questionnaire consisted of two main parts: asking about BIM and IFC, respectively. Because IFC is crucial for interoperability in the use of BIM in practice, students' understanding of BIM can be assessed multi-dimensionally by asking about IFC as well as BIM. Each part contained questions regarding recognition, interest and experience on the topic. The questions ranked their opinions on the topic using a 5-point Likert scale.

The authors distributed copies of the questionnaire to the subjects at the workshop with the authorization of the festival committee. The questionnaire was provided in two languages, Korean and English, which the students could choose. After the survey, 69 completed questionnaires were received.
3.4 Statistical Analysis
The general characteristics of the respondents' awareness and acceptance of BIM and IFC were analyzed by descriptive statistics. Also, factors affecting BIM awareness and differences between subgroups were determined, and finally a T-Test and ANOVA analyses were carried out.

4. Results
4.1 Response Statistics
The respondents are mainly 3rd or 4th year architecture students. Two thirds of them are Korean, and others are Asian from China, Japan, etc. The majority of students were familiar with design software such as AutoCAD, Photoshop, and Sketchup.

The students were asked questions about their awareness of BIM (1: Not aware at all, 5: Very well aware). They had heard about BIM (3.84), but did not know well what it is (3.35). Interest concerning BIM (3.52) and the need for introducing BIM to design (3.56) was also not high.

When asked about their experience of BIM education (multiple response), less than half of the students responded that they had learned about BIM in school, and about half responded that they had never experienced BIM education. However, 70% of the respondents felt that there was a need for BIM education in school. Therefore, the study finds that the role of colleges in BIM education is accepted as a crucial element by the students.

Regarding the use of BIM software (multiple response), 49% of the respondents have used Revit, and 21% have used ArchiCAD. Yet only 33% and 9% respectively of the students have used the software in architectural design work. Furthermore, 40% had never used BIM software, and 58% had never used it for design.

Thus, it reveals that the current implementation of BIM education is not effective as half of the students have never learned about or applied BIM software, even though the need for BIM education is high.
The respondents were asked about their awareness of IFC (1: Not aware at all, 5: Very well aware). Unlike BIM, there were those that had never heard about IFC (1.28), and those that did not know it at all (1.25). Furthermore, there were students that do not have an interest in IFC (2.16) or feel the need for it (2.34).

Most of the students have never studied IFC (91%), or used IFC software to design (92%). Therefore, the students are ignorant and indifferent to IFC, which means that their knowledge on BIM is superficial and limited.

When asked about the need for IFC education, although half of the students answered that it should be taught in school, 27% responded that they do not need IFC education, which is much higher than the 7% of BIM.

This indifference to IFC could be interpreted as the result of a vicious circle, in which a person that did not learn about IFC does not know what it is, and therefore does not feel the need to use it and thus, does not seek to be educated about it. To break this circle and advance education concerning IFC, it would be helpful if IFC was taught in schools as part of the required curriculum, as well as BIM.

4.2 Factors on Awareness

Factors affecting awareness of BIM and IFC were investigated by conducting factor analysis on the responses. Using the Principal Component Analysis method and Quartimax rotation, three factors that explain 80.8% of variance were extracted.

Table 2. Rotated Component Matrix

| Component | 1      | 2      | 3      |
|-----------|--------|--------|--------|
| I have heard about BIM | .767   | -.394  | .045   |
| I know what BIM is | .814   | -.358  | .137   |
| I am interested in BIM | .836   | .166   | -.051  |
| I think BIM needs to be introduced to architectural design work | .810   | .240   | -.068  |
| I have heard about IFC | .049   | .063   | .956   |
| I know what IFC is | -.030  | .164   | .930   |
| I am interested in IFC | .008   | .905   | .117   |
| I think IFC needs to be introduced to architectural design work | -.076  | .892   | .110   |

Factor 1 explains the variance of all four questions concerning BIM awareness well, and thus is named 'BIM Awareness'. It contains both recognition ('heard', 'know') and interest. Factors 2 and 3 explain recognition and interest concerning IFC respectively, and are thus named 'IFC Interest' and 'IFC Recognition'. All three factors are normalized to have an average of 0 and a variance of 1 for further analysis.

Table 3. Descriptive Statistics

|                    | Min. | Max. | Mean | Std. Dev. |
|--------------------|------|------|------|-----------|
| BIM Awareness      | -2.627 | 1.816 | 0.000 | 1.000     |
| IFC Recognition    | -1.567 | 2.230 | 0.000 | 1.000     |
| IFC Interest       | -0.764 | 4.485 | 0.000 | 1.000     |

The fact that those who are more aware of BIM are more interested in it means that education should focus on teaching what BIM is, in order to encourage students to be more eager to seek further education about BIM. On the other hand, although none of the students knew what IFC is, some of them had an interest in it and were willing to use it. The focus on IFC education should be to provide opportunities for education to those who already show an interest.

4.3 Difference between Countries

The difference in the awareness and acceptance of BIM and IFC between countries was analyzed. Due to the fact that two thirds of the students came from Korea, students from other countries (23 in total) were grouped into the category 'Asia (excluding Korea)' due to the small sample size.

Regarding the awareness of BIM and IFC, the differences in two out of three factors, BIM Awareness (p=0.004) and IFC Recognition (p<0.001), were highly significant.
There is a large difference in recognition of BIM between countries. Students from Korea had heard about BIM and knew what it is more than those from other countries in Asia. There is also a small difference in interest in BIM, possibly due to differences in recognition.

On the other hand, although the difference concerning the IFC recognition factor was statistically significant, the actual difference between countries was minuscule.

From the ANOVA test concerning questions about the acceptance of BIM and IFC (source of learning, need for teaching, and software usage), there are no significant differences between countries except one, which was the difference in general design software usage (p=0.001). While the majority of Korean students use AutoCAD (93%), Photoshop (84%), and SketchUp (78%), students from other countries are using more diverse tools which is represented as 'Others' (43%).

### 4.4 Difference between Grade Years

Analysis on the difference in awareness and acceptance of BIM and IFC between grade years of the students was conducted. Because most of the students are in their 3rd or 4th year, students in their 1st to 3rd year were grouped as 'Lower class', and students in their 4th year or higher were grouped as 'Upper class'.

Concerning BIM and IFC awareness, only the difference in BIM Awareness was highly significant (p=0.005).

### Table 4. T-Test between Countries

|                          | t     | df | Sig. | Mean Diff. |
|--------------------------|-------|----|------|------------|
| BIM Awareness            | 3.150 | 28.878 | .004** | .880 |
| (Equal variances not assumed) |       |      |      |            |
| IFC Recognition          | -4.031 | 63 | .000** | -961 |
| IFC Interest             | .436  | 63 | .664 | .116 |

There is a considerable difference in recognition of BIM between upper- and lower-class students. Upper class students had heard about BIM and knew what it is more so than lower class students. There is also a small difference in regards to their interest in BIM.

From the ANOVA test on questions about BIM and IFC acceptance, differences in three questions were highly significant. Upper class students were more educated by all sources of learning.

The majority of them used BIM software Revit in general (69%) and for design works (53%). On the other hand, most lower class students had never experienced BIM education (60%) nor used BIM.
software to design (71%). Therefore, lower class students are less aware of BIM and IFC than upper class students because BIM education is mostly provided in the upper class curriculum.

5. Conclusion

In this study, a survey was conducted to measure recognition, interest, and experience with BIM and IFC among architecture students in Asia, and statistical analysis was conducted with the survey results. It can be concluded that architecture students in Asia mainly use CAD software to design rather than BIM software, and half of them have never experienced BIM education or software. Nevertheless, the demand for BIM education is high.

Regarding IFC, the students were not aware of it at all and had never experienced using it. Because utilizing IFC is important for practicing BIM, it means that present BIM education in colleges is neither sufficient nor comprehensive enough to train students for practice.

The students' awareness of BIM and IFC was affected by three factors: BIM Awareness, IFC Recognition and IFC Interest. Students who are more aware of BIM have more interest in it, but this is not the case with IFC. Therefore, BIM education should focus on raising the recognition of BIM, and IFC education by providing more opportunities to learn.

Compared by country, Korean students were more aware of BIM than other Asian students. This difference in awareness could reflect the strong government led initiative to introduce BIM in Korea.

Compared by grade year, upper class students were more aware of BIM, received more education, and used BIM software more widely than lower class students. This results from the fact that BIM education is focused on the upper class curriculum. It makes sense in that BIM is closely related to Integrated Design, nevertheless a balanced BIM curriculum for both lower class and upper class students need to be considered and arranged.

References

1) Park, C. (2013) Assessment of BIM Acceptance Degree of Korean AEC Participants. Thesis (M.A.). Sungkyunkwan University.
2) John, Y. and Song, K. (2011) An Analysis on Domestic BIM Usage of Big Architectural Firms Regarding Effective Design Management. Journal of the Architectural Institute of Korea Planning & Design, 27 (9), pp.55-64.
3) Kang, D. and Shin, K. (2010) Improvement of architectural engineering design education process through an analysis of BIM courses. Journal of the Korea Institute of Building Construction, 10 (3), pp.145-153.
4) Kim, M. (2014) Utilizability of BIM Software Tools in the Early Stage of Architectural Design. Journal of the Regional Association of Architectural Institute of Korea, 16 (6), pp.65-72.
5) Lee, S., Bae, K., Yang, H., and Jun, H. (2011) A Basic Study on the Awareness of BIM and Development of BIM Template for Practical Application of BIM to Small and Medium Sized Architectural Design Firms. Journal of the Korean Institute of Culture Architecture, 33, pp.87-96.
6) Lee, S. and Yu, J. (2013) Key Factors Affecting BIM Acceptance in Construction. Journal of the Architectural Institute of Korea Planning & Design, 29 (8), pp.79-86.
7) Lee, S. and Yu, J. (2014) Moderating Effect of Organizational Culture on the Relationship between Influence Factors and BIM Acceptance. Journal of the Architectural Institute of Korea Planning & Design, 30 (2), pp.51-59.
8) Messner, J.I. (2008) The Story of BIM Adoption at Penn State. buildingSMART alliance™ National Conference 2008, W207. Available: http://www.nibs.org/?page=bsa_natconf08 [8 Feb 1999].