Diagnostic and Introduction of the Main BIM-related Professions and Competencies in Architecture, Engineering & Construction (AEC) Industry

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Abstract– With the emergence of Building Information Modeling (BIM), different organizations and companies have started to use it, and consequently, the demand for skilled and experienced personnel has increased. To get benefit from the effective implementation of BIM, it is important to clearly identify the jobs, responsibilities and competencies of different professionals, specialist and users who get involved in BIM related activities. This study aims to explore and classified different BIM-based jobs and responsibilities; and introduce the required competencies which need to be learned and applied on the job. To do so, a comprehensive literature review was carried out and different job titles were classified into two types by analyzing the correlation between the tasks and responsibilities. The same approach used to compile the different competency-related terms, and then the most effective and essential competency elements dedicated to the revealed jobs. The results of this paper provide an increased understanding of BIM professions and their competencies, which contribute to a better recruiting and training BIM experts in both industry and academia.

Keywords– Building Information Modeling (BIM), BIM jobs, BIM responsibilities, BIM competencies

INTRODUCTION

Building Information Modeling (BIM) has now been adopted to varying extents by different organizations in Architecture, Engineering and Construction (AEC) industry [1] and the number of projects that utilize it has increased rapidly [2]. However, the wide spread use of BIM has escalated the demand for prepared and skilled BIM personnel [3]. It is also been said that the lack of specialist with specific BIM competencies can act as a deterrent and slow down the implementation of BIM in practice [3], [4], [5], [6]. Several investigations have been conducted to identify BIM jobs and related competencies in all project life cycle phases, from design to operations and maintenance [1], [2], [7], however, the scope of tasks and related responsibilities remains unclear and poorly defined. As the adoption of BIM has increased between organizations, companies and academic staffs, it has become evident that BIM is not simply about basic software and technologies, but involves changes in processes, responsibilities and management [8], which rise the need for a comprehensive set of associated competencies required by each sector. This paper aims to address an outline of BIM jobs, responsibilities and related competencies by collecting and analyzing a wide range of sources, such as guides and standards developed internationally by different sectors. The following section provides an in-depth overview of the literature. The next
two sections highlight the areas, functions and individual responsibilities of the BIM jobs. In the next section, associated competencies have demonstrated, and a further section provides the findings and results.

LITERATURE REVIEW

Previous BIM-related studies have highlighted different definitions, categories and classifications of both BIM-jobs and associated competencies. Considering types of jobs, Joseph [9] classified BIM jobs into seven types and Abdulkader [10] proposed eight types of BIM jobs, based on their experiences and observations. Besides, Barison and Santos [3] introduced eight types of BIM jobs by reviewing job advertisements in the US. Several other studies also proposed some types of competencies related to different BIM-based jobs. For instance, Barison and Santos [3] have proposed six competencies for BIM managers. Cerovsek et al. [11], Bohlouli et al. [12] and Dainty et al. [13] have focused on design, maintenance management and construction project management respectively. Nonetheless, these studies were all conducted based on the actual phenomenon, without a theoretical orientation. Through the literature review, with a specific focus on documents which provide information on roles, responsibilities and associated competencies, we identified the necessity of taking a theoretical orientation research approach to present a comprehensive outline of BIM jobs and their competencies.

JOBS & RESPONSIBILITIES

Generally speaking, the term “job” refers to the activities that are performed. Although “role” is considered as a synonym for “job”, there are fundamental differences. While the term “role” indicates the “pattern of expected behaviors, which is not necessarily defined regarding specific job tasks” [14], the term job refers to an integration of tasks involving detailed work activities that follow a goal and should be both measurable and verifiable [15]. For this paper, the term “job” was selected to define the positions for BIM users, professionals and specialist, and the term “role” was selected to introduce a clear definition of responsibilities regarding each job position.

A. Job Classification

A wide variety of job titles are used to define BIM specialists [3] and many of them include overlapping descriptions and requirements [2]. By analyzing the resemblance of different subtitles and studying the correlation between associated requirements, BIM jobs fall into two categories of a) project roles, and b) organizational roles. The first group includes the jobs with the primary function within the project team, and the second one refers to the jobs that primarily performed at the company level. The difference between project and organizational level roles can be distinguished by studying the descriptions of activities or role expectations provided by BIM guides and standards [16]. Table 1 highlights the classified roles based on the two mentioned categories, in indicates the variety of job titles that can be used instead of each.

Table I

<table>
<thead>
<tr>
<th>Classification</th>
<th>Type</th>
<th>Job titles included</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>BIM Manager</td>
<td>BIM leader, BIM consultant, BIM discipline head</td>
</tr>
<tr>
<td></td>
<td>BIM Coordinator</td>
<td>BIM facilitator, BIM integrator, BIM practitioner, BIM specialists</td>
</tr>
<tr>
<td></td>
<td>BIM Modeler</td>
<td>BIM technician, BIM operator, BIM user, BIM designer, BIM draftermen</td>
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<tr>
<td></td>
<td>BIM Engineer</td>
<td>BIM architect, BIM operator, BIM user, BIM designer, BIM draftermen</td>
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B. Roles & Responsibilities

The following sections are developed to explain the correlation between the role definitions and responsibilities for each of the four identified BIM job titles.

1) BIM Manager: Since the main function of a BIM manager is to manage people in the implementation and/or
maintenance of the BIM process [1], this leadership role requires a specific four-way set of skills in order to have a successful collaboration with stakeholders within the firm: Leadership Skills, Technology Skills, Business Understanding and Art of Innovative Persuasion [9]. At the project level, BIM manager is also responsible for the development and delivery of the BIM execution plan [16], and examining and evaluating its process and the availability of resources [17]. Besides, organizing BIM project meetings and managing project records is also part of the role [16]. According to another document [18], BIM manager role is expected to pass between different parties, depending on the situation. BIM manager may also serve other additional functions such as setting design templates and coordinating the integration of model, however, the main function is to guide the team in decision making [19].

2) BIM Coordinator: It has been said that the Project Coordinator is the most highly competent member of a project team [20]. The function of a BIM Coordinator is described as a secondary role under the leadership of the BIM Manager, who is responsible for conducting each individual discipline within the project framework [16]. Training other professionals who are not yet skilled in operating BIM [1], prioritizing tasks and performing administrative work [2] are also defined as responsibilities of a BIM coordinator. Other described responsibilities include quality control, ensuring that the outcome complies with the agreed and defined standards, providing guidelines for the team and communicating data transfer needs and processes with other disciplines. [16]

3) BIM Modeler: BIM Modeler role is broadly known as a production role in developing the BIM model [16], a job that can be represented by professional architects and/or engineers depending on their training, role in the firm and technology appetite to execute design utilizing BIM [9]. The task of a BIM modeler is to create, to develop and to extract visual documentation (2D and/or 3D) from BIM models [21]. It is specified [22] that “BIM Modelers (technicians and operators) will have particular discipline experience … with a minimum of 3 years of 3D CAD modelling knowledge”. However, a CAD specialist would not always become a BIM modeler because experienced CAD users are more resistant to change [1]. Depending on their focus, the BIM modeler can also have the following additional denominations: 3D modeler, Cost modeler, Sequencing modeler and Detailing modeler [23]

4) BIM Engineer: BIM engineers are professionals who contribute, along with experts in different areas of the AEC industry, to the different phase of a project lifecycle. A BIM Engineer, depending on their focus – BIM architect, BIM Designer or BIM structural drafter – can work in design, construction or MEP sector [20].

IV. COMPETENCIES

The term “competency” is derived from the Latin word “competens”, and it usually explains “an individual’s ability to perform a specific task or deliver a measurable outcome [7].” In North America, competencies are known as a set of characteristics (knowledge, skills and attitudes) that underlie the performance and behavior of individuals at work [24]. In Europe, competencies are identified when employees achieve or exceed expected results in their work [25]. In this paper, the term competency refers to a set of requirements for BIM-related jobholders. By analyzing jobs advertisements, descriptions and requirements, a research [2] has done to determine the competencies required for each BIM jobholders. A total of 5998 competency terms were found and grouped into 136 competency elements based on the O*NET classification system. O*NET – developed, revised and validated by the US government [26] – is the most frequently used job description system. Table IIBIM Competency Elements – retrieved from: [2]
The main competencies of each BIM job group were distinguished by applying the Pareto Principle to the BIM job competency analysis [2]. The Pareto Principle indicates, for example, 20% of the workers produce 80% of the results. For the purpose of this paper – introducing the required competencies of the four aforementioned BIM jobs – those 20% competency elements that play the most important role in each job are selected and presented in Table 2 (numbers in gray cells indicate over 20% of each BIM jobs’ main competencies). As it can be seen, there are some essential competencies that are required by all job groups, such as: cooperation, speaking skills, design and technology knowledge, related work experience, thinking creatively, interacting with computer, drafting and documenting, and a further one is establishing & maintaining interpersonal skills. These competencies. Besides, a competency that is required by less than two-thirds of jobs and is limited to some BIM job groups is called job-specific competency. Quality control analysis and determining workflow are the examples of job-specific competencies required by BIM coordinator and BIM manager respectively.

CONCLUSION

The diversity of BIM guides and standards has resulted in multiple interpretations of BIM jobs, roles, responsibilities and related competencies. Considering the correlations and overlaps, the jobs are classified into the project and organizational levels. Based on the role descriptions, the two job titles of BIM Manager and BIM Coordinator are dedicated to project level; likewise, BIM Modeler and BIM Engineer are included in the organizational level. Then, the required competencies for each job title derived from the literature. Numerous benefits arise from identifying, classifying and aggregating BIM jobs and competencies:

From an industry standpoint, a structured set of BIM jobs and competencies would help organizations and project leaders to a) measure the capability of individuals and team members, b) define and meet project requirements, c) facilitate organizational and project workflows, d) develop a training program and e) establish a set of criteria for hiring BIM personnel. From an academic standpoint, a structured set of BIM jobs and competencies would help academic leaders to a) develop structured BIM education programs b) organize investigations based on a standardized set of competencies and c) measure the capability of students and lectures using a common reference. This study was conducted based on the literature and previous BIM-related studies over the past few years. Since the AEC industry and BIM technology are continuously evolving, the results of this paper, the roles and competencies for BIM jobholders, may vary in the time ahead. Future studies could refine and finalize a framework for BIM jobs and competencies.

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ISBN:9780998900063

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