The Competencies of BIM Specialists: a Comparative Analysis of the Literature Review and Job Ad Descriptions

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ABSTRACT

An effective implementation and use of BIM technologies and processes requires the inclusion of new professionals in AEC organizations. Each position must have particular competencies. In seeking to fulfill the market demand for these professionals, universities are making an effort to integrate BIM in their curricula, especially in the fields of architecture, civil engineering and majors in construction management. However, to ensure a proper planning of how to integrate BIM in the course programs, it is necessary to find out what competencies are required from BIM professionals. The same information is useful for companies that adopt management competency models or those that need to select and recruit BIM specialists. This Paper describes the results of a research project based on the Content Analysis of BIM job ads and the technical literature. Competency lists from both sources were compiled and compared. The results of the analysis show that, although there are different focuses, both the job market and specialists are generally in agreement about which competencies a BIM Manager should have, to perform well.

INTRODUCTION

With the dramatic rise in the demand for BIM technology worldwide, the shortage of people with BIM competencies has become a significant constraint that delays and slows down the use of BIM (Sacks and Barak 2010). Training has been identified as a key issue in adopting BIM (Gu and London 2010), as team members increasingly need the appropriate knowledge and skills that can allow them to participate in BIM-enabled processes.

Higher education institutions are unable to meet this demand in the short term. This means that companies will have to quickly develop BIM skills internally among their employees (Smith and Tardif 2009). An alternative strategy that has been adopted to lessen this problem is to outsource services by hiring specialized companies for staff training or to help in the construction of models. A medium and long-term solution is to teach BIM competencies at schools. Education (not in the sense of training) will be the largest investment required for this (Smith and Tardif 2009) but it is still unclear what exactly the BIM roles and their competencies are.
COMPETENCIES

In North American countries, competencies are regarded as being a set of characteristics (knowledge, skills and attitudes - KSAs) that underlie (affect) the successful performance (or behavior) of the individual at work (Slivinski and Miles 1996). In Europe, competencies are understood differently: employees demonstrate the possession of a competence when they achieve or exceed expected results in their work (Parry 1996).

Companies should select competencies in practical and concrete terms that are aligned with the organization’s goals. Zingheim and Schuster (2009) recommend keeping competency programs relatively simple and easy to understand. Hoff (2010) outlines the steps necessary for creating a competency model: collecting information about a job (tasks and skills), creating a draft model of competencies, collecting quantitative and qualitative feedback to support competencies and, refining the final model.

The present study addresses the research question “what are the individual competencies necessary to perform functions related to BIM?”, and it is limited to the first of the steps mentioned above that are needed for creating a competence model for BIM specialists.

Owing to the different origins of the term ‘competency’ and the wide range of types of competencies, it has been defined in various ways. For the purposes of this study, the definitions that are considered are those that are relevant to the domain of human resources.

Although many studies about the issue of ‘competency’ have been published in recent years, the concept of competency is often mixed up with other terms such as aptitude, qualifications, skill/ability, knowledge and attitude (Table 1). The present study demarcates individual competencies in accordance with the terms and definitions outlined in Table 1.

Table 1. Terms and definitions for individual competencies.

<table>
<thead>
<tr>
<th>Terms</th>
<th>Definitions</th>
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</thead>
<tbody>
<tr>
<td>Aptitude</td>
<td>Natural ability to acquire relatively general or specialist types of knowledge or skills (Colman 2001).</td>
</tr>
<tr>
<td>Qualifications</td>
<td>Educational degree obtained and years of professional experience.</td>
</tr>
<tr>
<td>Skill/Ability</td>
<td>Ability is a developed skill, competency, or power to do something; an existing capacity to perform some function, without further education or training (Colman 2001). A skill is a combination of abilities, techniques and knowledge which allows someone to achieve a high standard in undertaking a task.</td>
</tr>
<tr>
<td>Knowledge</td>
<td>‘Foundation knowledge’ is the kind of knowledge required by someone to understand what needs to be done. An individual needs knowledge to learn how to carry out a task.</td>
</tr>
<tr>
<td>Attitude</td>
<td>A stable, long-lasting, learned predisposition to respond to certain things in a certain way (Statt 1998).</td>
</tr>
</tbody>
</table>
METHODOLOGY

A survey of the technical literature was conducted with the aim of searching for references to any competencies that BIM specialists might need.

Job ads from the main labour market for BIM-related careers (i.e., that of the United States) were collected from the Internet, particularly from “BIM Wiki” and “LinkedIn” weblogs. The job descriptions analyzed were from more than 20 large companies in the U.S., some of them with international branches. Thus, this study was confined to the social context where these jobs can be found.

A Content Analysis process (Krippendorf 2004) was performed using input from BIM job descriptions and the technical literature. Content Analysis is a process that involves categorizing qualitative textual data into clusters of similar entities or conceptual categories, in order to identify patterns and relationships between themes, which can either be identified a priori or just emerge from the analysis. In this method, the texts are broken down into units. This study has identified the units by author and by job title.

The literature review and job descriptions covered individual competencies in accordance with the five categories set out in Table 1. A list of competencies was generated from the responsibilities and functions of several BIM professions from both sources. A comparative analysis was carried out between the required competencies in the job market for BIM-related careers and those cited in the literature.

RESULTS

A large number of the job ads published online between 2009 and 2010, advertising BIM related positions, were collected and analyzed (N=31). Although the job titles in the ads varied, their classifications were standardized in this work. Table 2 provides a statistical summary of the ad sample (breakdown into categories of job and company).

<table>
<thead>
<tr>
<th>BIM specialist</th>
<th>Number of ads (%)</th>
<th>Company</th>
<th>Number of ads (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIM Manager</td>
<td>22 (71%)</td>
<td>General Contractor</td>
<td>12 (38.7%)</td>
</tr>
<tr>
<td>BIM Modeler</td>
<td>3 (9.7%)</td>
<td>Architectural Design</td>
<td>7 (22.6%)</td>
</tr>
<tr>
<td>BIM Trainer</td>
<td>2 (6.5%)</td>
<td>MEP Consulting</td>
<td>4 (13%)</td>
</tr>
<tr>
<td>Director of BIM</td>
<td>1 (3.2%)</td>
<td>Consulting Services</td>
<td>3 (9.6%)</td>
</tr>
<tr>
<td>Technologies</td>
<td>1 (3.2%)</td>
<td>Software Company</td>
<td>3 (9.6%)</td>
</tr>
<tr>
<td>BIM Consultant</td>
<td>1 (3.2%)</td>
<td>(Tools and Services)</td>
<td></td>
</tr>
<tr>
<td>Manager of BIM Marketing</td>
<td>1 (3.2%)</td>
<td>Construction</td>
<td>2 (6.5%)</td>
</tr>
<tr>
<td>BIM Software Applications</td>
<td></td>
<td>Management Services</td>
<td></td>
</tr>
<tr>
<td>Support Engineer.</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The analysis was restricted to the most frequent type of BIM specialist (the BIM Manager) as the sample was too small to obtain meaningful results for any of the others. As the BIM Manager is the professional responsible for most BIM-related tasks in companies, including the implementation and training of BIM (Barison and Santos 2010), it is natural that most job ads seek this kind of professional, especially at this early stage when most firms are just embarking on this technology.
The results of the content analysis that was conducted for the job ads and literature are summarized in Table 3. In this table, the numbers between parenthesis ( ) in the left-hand column refer to the number of ads mentioning the item, and those between square brackets [ ] in the right-hand column refer to publications in the reference section, which are marked in the same way. There were no aptitudes mentioned in the job ads that were collected.

DISCUSSION

In terms of education, the requirements collected from the job ads indicate that companies sometimes accept applicants with a lower degree than that stipulated in the literature. This is probably because the specific responsibilities of a BIM Manager vary a lot among companies, sometimes with priority being given

Table 3. The competencies required for a BIM Manager in BIM job ads and specified in the technical literature (items are listed in higher-to-lower order of frequency).

<table>
<thead>
<tr>
<th></th>
<th>From 22 job ads*</th>
<th>From 24 authors**</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aptitudes</td>
<td>Ability to work with computers, observation and detailed planning skills sufficient to allow a good visualization of the building before its construction [17]</td>
<td>BSc Degree (or equivalent) in Construction Management, Engineering or Architecture [11]</td>
</tr>
<tr>
<td>Experience</td>
<td>Normally 5-7 years (6,1) Ability w/ multiple BIM applications (19) Organization and Prioritization (10) Experience in giving training to employees (5) Implementing BIM in the company (5) Presentation skills (4) Working in a collaborative environment (4) Understanding construction drawings (3) Giving support on BIM tools to employees (3) Using programming language (3) Leadership (3) Interpersonal skills (2) Mentoring (2) Understand BIM (2) Working independently (2)</td>
<td>Normally 5-7 years (6,1) Ability w/ multiple BIM applications (19) Organization and Prioritization (10) Experience in giving training to employees (5) Implementing BIM in the company (5) Presentation skills (4) Working in a collaborative environment (4) Understanding construction drawings (3) Giving support on BIM tools to employees (3) Using programming language (3) Leadership (3) Interpersonal skills (2) Mentoring (2) Understand BIM (2) Working independently (2)</td>
</tr>
</tbody>
</table>
Making cost estimates with BIM tools [2]
Using scheduling tools [2]
Management [1]
Time management [1]
Graphic communication [1]
Thriving on challenges [1]
Commitment [1]

Knowledge
Design/construction process [3]
BIM workflow process [3]
Construction costs, schedules and financial risks [2]
Parametric object-based design [1]
Construction drawings [1]
IPD concepts [1]
BIM / Project Management [1]
Technology for collaborative systems

Analysis
Implementing and maintaining BIM at the company [8, 14]
Making cost estimates with BIM tools [8]
Using scheduling tools, clash detection, 4D simulation, logistics, clash detection, safety planning [8]
Handling objects by following prescribed rules [3]
Learning [1]

Attitudes
Self-driven / motivated [4]
Enthusiastic about BIM’s potential [3]
Keen to make technical innovations [2]
Willing to act as a team player [2]
Motivation to continually learn [1]
Being quality minded [1]
Showing initiative [1]
Willingness to travel [1]
Team player [1, 16, 18]
Motivation to continually learn [1]
Involved and interested in BIM [7]
Appreciation of the value of professional practice [5]
Not overly ambitious [8]

*(number of job ads) ** [reference, in the reference section]

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Both the AEC companies and the reviewed authors regard some core abilities like oral communication, team/collaborative work and management as very important for a BIM Manager. In contrast, the analysis also showed that the job market is more focused on functional skills related to systems & technological abilities, especially skills in BIM software/applications, while the literature is more concerned that the BIM Manager has the foundational skills of critical and systemic thinking.

With regard to the necessary background knowledge, the literature suggests that information technologies, construction processes and management are the most important areas that a BIM Manager must know. The job market also expects professionals to have this same background knowledge, although it focuses more on specific BIM-supported activities.

Finally, the job market seeks to hire self-driven professionals, who are motivated by the benefits of BIM technology, as well as those who have a positive attitude to
teamwork, whereas the literature more often concentrates on the need for attitudes conducive to working in a team environment.

A Competent BIM Manager

On the basis of information from 22 job ads and 24 technical papers, a profile for a competent BIM Manager was defined, as outlined below.

A competent BIM Manager should possess a Bachelor’s degree in an AEC-related area and have at least 5 years of professional experience. To be appointed to this position, a professional needs both foundational and functional skills: the former mainly consist of communication skills and thinking skills (both critical and analytical). The most essential functional skill is an ability to handle multiple BIM software, the tools he/she will be using on a daily basis. Interpersonal functional skills, like teamwork and leadership are also very important for a BIM Manager, as well as resource skills of basic management. Apart from this, a competent BIM Manager also needs to possess cognitive abilities to understand evolving BIM concepts, in addition to construction processes and drawings. Moreover, this specialist must have the capacities needed for implementing BIM, giving support and training and, coordinating and developing BIM models.

Regarding the question of expertise, a competent BIM Manager needs to be familiar with the following: Information Technology, design and construction processes, management, BIM standards, BIM workflow, coordination practices, project management, construction drawings and costs, schedules and financial risks, parametric object-based design and other disciplines.

However, these qualities are not enough unless accompanied by positive attitudes such as, for example, being self-driven, highly motivated, involved and interested in BIM and its new technological aids. Moreover, it is essential to be a team player, a lifelong learner, have initiative and be always ready to educate others and travel to branch offices when necessary.

CONCLUSIONS

This study has outlined the competencies of a BIM specialist through a Content Analysis which compares several job descriptions with those given in the literature. By this means, it was possible to identify the profile of the BIM Manager.

The comparative analysis between the job ads and the literature revealed several patterns for the kind of competencies required by BIM Managers that the universities must cater for as soon as possible. Among those are abilities which are usually developed in quality higher education courses like teamwork, communication skills and critical and analytical thinking skills. Others require changes or adaptations in the curricula, to include the following: contact with several BIM tools, BIM standards, BIM workflow, BIM-enabled coordination practices and project management, development of construction drawings, making estimates and schedules with BIM applications and a knowledge of parametric object-based design concepts.

However this study has been subject to a number of constraints. The analyzed job ads are only from large companies and mainly located in the U.S. It has not been possible to discuss the differences between different types of BIM specialists because there was very little information about BIM specialists, apart from the BIM Manager. The study was limited to the first step for creating a competence model. Future
studies for collecting quantitative and qualitative feedback from BIM professionals to support the competencies listed here could refine and finalize a model of competencies.

ACKNOWLEDGEMENTS

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REFERENCES

Note: The number in [n] at the end of some references refers to Table 2.


