OVERVIEW OF BIM EDUCATION IN THE FIELD OF CONSTRUCTION MANAGEMENT AT THE FACULTY OF CIVIL ENGINEERING IN KOŠICE AND THE FACULTY OF CIVIL ENGINEERING IN ZAGREB

PREHĽAD BIM VZDELÁVANIA V OBLASTI RIADENIA STAVIEB NA STAVEBNEJ FAKULTE V KOŠICIACH A STAVEBNEJ FAKULTE V ZÁHREBE

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ABSTRACT

Building Information Modelling (BIM) is the current trend of the Architectural, Engineering and Construction (AEC) industry today. BIM is an intelligent 3D model-based process that gives architecture, engineering and construction (AEC) professionals the insight and tools for more efficient planning, designing, construction, and managing buildings and infrastructure. For its successful adaptation, education and standardization are one of the key success factors. In education, BIM provides development of students' critical way of thinking and enables them to understand the complexity of the construction industry. This study discusses issue of BIM implementation in educational process in Croatia and Slovakia. Aim of research is to give overview of BIM education process and usage of BIM software in field of construction management at the Faculty of civil engineering in Košice and the Faculty of civil engineering in Zagreb.

Keywords: BIM education, construction management, Croatia, Slovakia.

ABSTRAKT

Informačné modelovanie stavieb (BIM - Building Information Modeling) je dnes súčasným trendom v oblasti architektúry a stavebného inžinierstva (AEC - architecture, engineering, construction). BIM je inteligentný proces založený na 3D modeloch, ktorý poskytuje odborníkom v oblasti architektúry, inžinierstva a stavebníctva prehľad a nástroje na efektívnejšie plánovanie, návrh, konštrukciu a správu budov a infraštruktúry. Pre úspešnú implementáciu je vzdelávanie a štandardizácia jedným z kľúčových faktorov úspechu. Vo vzdelávaní poskytuje BIM rozvoj kritického myslenia študentov a umožňuje im porozumieť komplexnosti stavebného priemyslu. Táto štúdia rieši problematiku BIM vo vzdelávacom

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procese v Chorvátsku a na Slovensku. Cieľom výskumu je vytvoriť prehľad vzdelávacieho procesu BIM a používania softvérov BIM na stavebnej fakulte v Košiciach a na stavebnej fakulte v Záhrebe.

Kľúčové slová: BIM vzdelávanie, riadenie stavieb, Chorvátsko, Slovensko.

INTRODUCTION

Knowledge of project management theory is important to participate on a project (Peterson et al., 2011). Although the development of digital competence is often the only answer to the acute problem and it is rarely supported by long-term strategy (Mesároš, et al., 2016). Academics universally agree that practically applicable knowledge about construction management tools and methods is difficult to learn. This is mainly because explicit understanding about how to apply formal methods and tools within the unique situations encountered on most construction projects is hard to gain (Peterson et al., 2011). The possibility of using new technologies in construction project management (especially for design of buildings, drawing and planning of construction projects generally) is steadily increasing by developing new software solutions (Mesároš, et al., 2016). Using these methods and technologies in the educational process is one of the ways to better prepare students for future practice. There are also clear arguments that the need for teaching is necessary. In hindsight, a story of a successful application of a method to a project management problem if told well, sounds obvious, while applying a method to solve a problem with whom someone faces is not so easy. To overcome this dilemma a combination of the two learning methods is necessary, during which students apply formal methods within simulated contexts of real- world construction projects. The design of such projects within the tight boundaries of construction management classes is not easily possible because it simply takes too much time for students to understand the method and all the project-specific information to apply the method (Peterson et al., 2011). Due to this problem, construction professionals still acquire much knowledge through learning-by-doing with on-the-job training activities (Dewey, 1958), and it is not surprising that many criticize construction management university programs as ineffective (Thomas and Mengel, 2008). The integration of project management tools based on Building Information Modeling (BIM) can help educators to develop project management class projects that simulate realistic practical situations (e.g. generating complete bid package based on a complete set of bid documents).

BIM is an intelligent 3D model-based process that gives architecture, engineering, and construction (AEC) professionals the insight and tools to more efficiently plan, design, construct, and manage buildings and infrastructure (Tkáč and Mesároš, 2015). In the context of construction industry, BIM means the process of delivering assets using well-structured digital information (Kreider and Messner, 2008). Further, as flexible platform, BIM allows users to work effectively with documents (e.g. project documentation of construction project). As BIM technology improves communications within project participants, it is very important to include it when developing communication skills through the education. Finally, BIM is an appropriate tool for project collaboration and project management simultaneously for investors, designers, contractor and sub-contractor (Calvert, 2015). As such, BIM brings many advantages to the construction management (CM) field, both to performance of the construction companies and education. Larger companies with more employees find BIM in

constructability and visualization to contribute the most to the success of their projects (Johnson, Gunderson, 2009; Taiebat, Ku, 2010). According to Becerik-Gerber et al. (2011), the most important knowledge areas which should be reached in CM programs are constructability, 4D scheduling, model based estimating, followed by design, visualization and sustainability (Becerik-Gerber et al., 2011). Moreover, BIM (43 %) is put on the second place of top areas for PhD research conducted in CM programs. Furthermore, reasons for absence of BIM in the curricula of civil engineering practices can be found in inadequate staff, inadequate resources to make the curriculum change and the fact there is no space left within curriculum (Becerik-Gerber et al., 2011). Nevertheless, Kim (2012) found the following objectives of CM education: evolve student's skills, ability and construction knowledge to develop appropriate levels of cost estimates; evolve communication skills and ability to function in multidisciplinary teams (Kim, 2012). Besides, 3D visualization enhances the student's ability to conceptualize, understand and solve the CM problems in projects (Glick et al., 2010). Thus, BIM represent tool whose usage should have positive impact digital skills development.

In addition, it is obvious that BIM education is necessary in higher education of civil engineers so the main objective of this research is to highlight the issue of BIM education for better usage in practice. Furthermore, in this study we will connect current BIM education with BIM usage in Croatia and Slovakia. In other words, we will consider current BIM education in context of Croatian and Slovak market. Thus, this paper presents detail overview of BIM education at Faculty of civil engineering Košice and Faculty of civil engineering Zagreb and brings discussions of given educational programs. Besides, paper gives overview of BIM courses at Bachelor's and Master's level of education in construction management field on both faculties. Nevertheless, we will also open new research questions and raise more serious research problem in area of BIM education. In the end, paper brings steps for future work and points the possibilities of spreading BIM education in field of construction management.

1. BIM EDUCATION IN THE FIELD OF CONSTRUCTION MANAGEMENT AT FACULTY OF CIVIL ENGINEERING IN KOŠICE

The Faculty of civil engineering in Košice seeks to take the most modern ways of teaching and implement them into the teaching process. From this point of view there are many subjects where Information and communication technologies (ICTs) are used in the learning process for uprising competencies and skills of students in practice. However, the issue of BIM, is more difficult as already outlined. Reasons are several. One of the main reasons is the low implementation and legislative support in the Slovak construction industry. Within this, BIM meetings and conferences are organized with representatives of the association, but also academics. Despite these facts, BIM issue is largely the theoretical term than practical. This also influences the conditions in the teaching process. On the one hand, it is pressure on faculties to improve and expand BIM education. On the other hand, the pressure from practice is not as intense as compared to Western Europe countries. In any case, the Faculty of civil engineering in Košice has implemented BIM into the teaching process which means that all study programs have received subjects that include acquaintance with BIM issue.

At the first level of education (Bachelor's level) in the field of construction management there are some BIM courses with which provide experiences with BIM technology. BIM

courses are Computer support for BIM, Graphics, visualization and BIM, Computer design support and Computer support for CM. Especially, it is more intent for students of Architectural Engineering study program (table 1). These students have mandatory BIM courses. Study programs as Engineering and transport structures, Engineering and transport structures, Technology and management in construction, Buildings with environmental aspects and Realization of transport structures have option to enrol some of BIM courses. Table 1 shown opportunity of students participate on subject with BIM education in the field of CM.

Tab. 1 Overview of BIM courses at Faculty of civil engineering in Košice (all study program in the context of Construction management field)

LEVEL OF EDUCATION AND STUDY PROGRAMS	**BIM COURSE**			
Bachelor's level - 1st level of education	**Computer support for BIM**	**Graphics, visualization and BIM**	**Computer design support**	**Computer support for CM**
Architectural Engineering				
1st year	**M**			
2nd year		**M**		
3rd year				**O**
Engineering and transport structures				
2nd year	**O**	**O**		
Technology and management in construction				
2nd year	**O**	**O**		
Buildings with environmental aspects				
2nd year		**O**		
Realization of transport structures				
2nd year			**O**	
Master's level - 2nd level of education	**Computer support for BIM**	**Graphics, visualization and BIM**	**Computer design support**	**Computer support for CM**
Technical equipment of buildings				
2nd year				**M**

M – mandatory course

O – optional course

2. BIM EDUCATION IN THE FIELD OF CONSTRUCTION MANAGEMENT AT FACULTY OF CIVIL ENGINEERING IN ZAGREB

The Croatian construction industry is missing integration of 3D drawings, cost, time and planning but also collaboration and interoperability amongst participants of the design and execution stages. Moreover, only 0-25 % of the construction companies in Croatia use BIM in their businesses. Such situation is on some way a result of disengagement of the Croatian state authorities in supporting BIM implementation (Kolarić, et al., 2015, Kolarić, et al., 2016). On the contrary, the situation on the marketplace is much better which is proven by many studies related to BIM usage in the AEC industry. Thus, implementation of BIM education at the Croatian universities is necessary.

At the Faculty of civil engineering in Zagreb, CM field, BIM education is not implemented in teaching process at Bachelor's level (table 2). In other words there are no courses in CM field at Bachelor's level which are connected with BIM. On the contrary, BIM education was implemented in educational program of Construction management 2 course four years ago. This year implementation of BIM has started in teaching process of course Construction technology 2. According to results in table 2, Construction management 2 is mandatory course at first year while Construction technology 2 is optional course at the second year of Master's level at Construction management study program (one of seven offered study programs at Faculty of civil engineering in Zagreb).

Tab. 2 Overview of BIM courses at Faculty of civil engineering in Zagreb (construction management field)

LEVEL OF EDUCATION	**BIM COURSE**	
Bachelor's level - 1st level of education	**-**	
1st - 3rd year	-	
Courses at Master's level - 2nd level of education (Study program: Construction management)	**Construction management 2**	**Construction technology 2**
1st year	**M**	
2nd year		**O**

M – mandatory course

O – optional course

BIM education within educational program of Construction management 2 course involves usage of listed BIM software: Autodesk Revit, Nemetschek Allplan, GALA and Autodesk Navisworks. Final student's product at the end of the course is 5D BIM model which creation during the semester consist follow steps (Kolarić, et al., 2015, Kolarić, et al., 2017). First step is creation of 3D BIM model which ends with IFC export of the model. Second step is creation of bill of quantities using Allplan or Revit. Third and fourth steps relate to making bill of cost and schedule using software GALA. Last step represents connection of 3D BIM model, schedule and costs in Navisworks. So, final product is 5D construction simulation or 5D BIM model (figure 1).

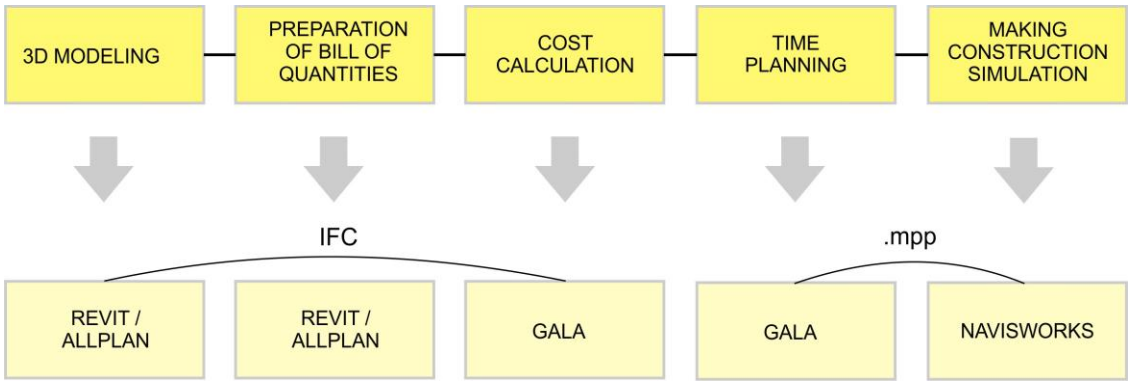

Fig. 1 Schematic representation of the methodology steps and related BIM software (Kolarić, et al., 2015)

This methodology was validate and proven as successful and as such can be used in further practice (phases of preparation and execution of the project). Furthermore, the current BIM education gives students basic BIM knowledge and skills to perform data analysis with existing BIM models and to use BIM visualization and communication tools. Moreover, it encourages a way of creative and critical way of thinking in a collaborative virtual environment (Stober, et al., 2015, Kolarić, et al., 2015, Kolarić, et al., 2017).

CONCLUSION AND FUTURE WORK

The construction industry presents one of the most valuable sectors in the economy. To increase productivity and efficiency is generally much pressure to automate processes where BIM technology represents one way of doing that. This is one of the reasons why BIM have widespread usage within construction companies. On the contrary, BIM usage among Croatian and Slovak AEC industry is not so popular and disseminated. Reasons for this are disengagement of state authorities in supporting BIM implementation, low legislative support but also the fact that BIM issue is often only theoretical term not practical. Thus, BIM should be involved in the teaching process so that it can be used extensively in practice. Based on these facts and the initial theoretical analysis, addressing BIM education issue is very important.

Regarding previously, BIM education in the field of construction management at Faculty of civil engineering in Košice is not fully extended to the Master´s level (2^{nd} level of education). There are some courses with BIM education, but not in the construction management field. Students have good opportunity to get acquainted with BIM but acquired knowledge is more theoretical than a practical one, especially if BIM education is perceived in the context of the construction management. Extension of BIM education in the construction management field is beneficial in practice but it is another area of scientific questions.

Furthermore, the academic experience which is reached through BIM education at Faculty of civil engineering in Zagreb is a single course collaboration because BIM is introduced only through one discipline within university. Knowledge areas which are missing are coordination, interoperability and clash detection but could be realized by extending education through two or more disciplines within the Faculty of civil engineering Zagreb (interdisciplinary collaboration) or two or more distance universities (distance collaboration) (Kolarić, et al., 2017).

With this study, we showed that Croatian and Slovak market are similar and demands implementation of BIM technology in education to increase BIM usage in practice. Moreover, this paper represents a start point in further comparison of BIM education at Faculty of civil engineering in Košice and Faculty of civil engineering in Zagreb. Current educational programs on both faculties seek deeper analysis and comparison to spread BIM knowledge areas among construction management filed. Thus, future work will include definition of comparison criteria, learning outcomes and list of necessary knowledge areas connected with BIM education.

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