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INFRASTRUCTURE PROJECTS AND BUILDING INFORMATION MODELLING IN BOSNIA AND HERZEGOVINA

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Abstract

Building Information Modelling (BIM) is a relatively new technology. The industry, especially when it comes to infrastructure projects, is just beginning to realize the potential benefits of it. Large capital projects are being done today using BIM technology and standards, while in Bosnia and Herzegovina today, we do not have a project implemented by it. BIM is still exhibiting varying states of maturity among its participants. The research was carried out in B&H to realize perceptions of BIM in the infrastructures projects from the perspective of different participants (investor, consultant, designer, supervising engineer, contractor, supplier). The following aims are to demonstrate perception about BIM, the willingness to apply it, and different varying states of maturity among its participants and the current degree of application in practice.

Keywords: BIM technology, research, construction industries, B&H, results

1 Introduction

Building Information Modelling (BIM) technology provides an integrated and comprehensive information repository and makes the sharing of visual, integrated, quality information possible for the project implementation. BIM introduction in infrastructure generates some changes in the process. The designers, contractors, companies, managers, universities, public and private research centres and others are involved in that innovation. From the conceptual to the execution phase, every step of the life cycle phase of the infrastructure project involved [1].
The Hong Kong Institute of Building Information Modelling defined BIM as "the process of generating and managing building data during its life cycle [which typically] uses three-dimensional, real-time, dynamic building modelling software to increase productivity in building design and construction." BIM is not just a "three-dimensional drawing tool but a new tool to holistically manage information relating to construction projects from the preparatory stage to construction and operational stages" [2].
In the context of Industry BIM is a powerful methodology, which has been implemented with great success in the domain of Architecture, Engineering, and Construction. The construction industry has been working intensively on the implementation of the BIM methodology in several segments, BIM is a collaborative work concept, strongly based on technological advances in computation. BIM tools enable the development of building projects during their lifecycle, including the design, construction, maintenance, management, and demolition phases. However, it is as yet hardly ever used in the transport infrastructure sector (roads, railways, bridges, tunnels, airports, and ports), [3].

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Although BIM is significantly present in the world, especially in the construction industry, there is still resistance to the application of BIM methodology in an infrastructure project in Bosnia and Herzegovina. The article presents the results of research on the possibility of applying the BIM methodology in infrastructure projects in Bosnia and Herzegovina from the perspective of all participants in the project (investors, designers, contractor supervision, etc.).

2 Implementation of BIM – review

According to the Smart Market Report in 2013, 55 % of contractors in the US used BIM at a very high and high level, in France 39 %, Germany 37 %, Australia 33 %, Canada 29 %, the United Kingdom 28 %, Japan 27 %, Brazil 24 % and South Korea and New Zealand 23 % Recent research, the results of which are presented in the NBS International BIM Report 2016 shows that in 2016 in Denmark 81 % of construction companies applied BIM, in Canada 71 %, the United Kingdom 50 % , Japan 49 % and the Czech Republic 30 %.[4]
In 2015, the use of BIM was highest in North America, where BIM has been used for 8.5 years, and the rate of BIM use is 73 %. Behind North America are Oceania (application rate 7.7 years; application rate 65.5 %), the Middle East and Africa (application 5.9 years; application rate 60 %), Europe (application 5.3 years; application rate 55.9 %), South America (3.4 years; application-level 55.7 %) and Asia (application 4.9 years; application-level 46.4 %). Also, construction is the phase in which the level of BIM application is highest in North America, Asia and South America, and in Oceania, Europe and the Middle East and Africa it is the design phase. A study of the application of BIM in the Middle East (participating countries are Saudi Arabia, the United Arab Emirates, Kuwait, Oman, Bahrain, Qatar, Yemen, Jordan, Lebanon, Iraq, Syria, Egypt, Sudan, Libya and Algeria) shows that 20 % of organizations in the construction sector apply BIM with the most significant number of BIM projects in the United Arab Emirates and the smallest in Lebanon and Jordan. Thus, although BIM is recognized as a new way of digitized work in construction, its application is still very diverse in different markets, in companies and projects. [5]
Benefits of using BIM are recognized in all countries. The most significant ratio (93 %) of engineers who see some value in BIM use is in the USA. However, only 29 % of them see BIM's full potential. Although in other countries the percentage of BIM users who report some value in it is smaller (76-89 %), number among them who see the significant potential is almost identical (in the range 25-31 %). The reason for these numbers may be in short experience in overall BIM use and possible high initial investments in training and equipment. [4]
Among the list of 13 benefits from BIM use, most of the respondents selected these five as crucial: fewer errors, greater cost predictability, a better understanding of the project, improved schedule and optimized design. The biggest advantage of BIM is recognized during the design stage (49 %) while the least respondents (0 % in Germany and the USA, and 12 % in France) said that BIM provides the most significant value in post-construction phase. When it comes to the future of BIM, training and software and hardware development were recognized as the key aspects. [4]
The analysis of the results in Croatia shows that in 2016 BIM was used by 23.33 % of business entities, and in 2017 by 21.12 % compared to the results from 2015, when 0 to 25 % of Croatian companies used BIM, the use of BIM and on the Croatian market for three years. A comparison of the use of BIM in Croatia with the results of the latest survey on the use of BIM in the United Kingdom, according to which 69 % of businesses use BIM, shows that the use of BIM in the United Kingdom is 45 % higher than in Croatia. [5]
The results from 2016 and 2017 show that the importance of BIM has increased. Survey participants plan to apply BIM, most of them within two years and are aware of the benefits that BIM brings to business (the most significant advantage is that BIM improves the coor-

dination of participants). The results show that project participants in the Croatian market are generally not ready for the full implementation of BIM, with designers being the most prepared and contractors the least ready. This is confirmed by a detailed analysis of the application of BIM towards project participants, where designers stand out as participants who use BIM the most (25 % of survey participants use BIM), and architecture as an activity in which BIM is widespread (25.29 % apply BIM, of which 17.82 % work most of the time in a BIM environment). [5]

Although awareness of the benefits of BIM has increased over the three years, it is still shallow, as evidenced by data that 65.94 % of participants did not use BIM, that 61.15 % believe that BIM is only 3D software, that 23.81 % of them never plans to apply BIM and that they are of the opinion that the application of BIM should be legally regulated even though project participants in Croatia are not ready for its application. The misperception about the meaning of BIM and working in a BIM environment is confirmed by the analysis of BIM's understanding of activities and project participants, where most of them still believe that BIM is just a 3D tool. [5]

Last nine years NBS make a detail report about BIM use in the UK. In the survey for 2019 year, 988 professionals participated, and 98 % of them were aware of BIM and used it. BIM is still the goal for many organizations, and 96 % of them have the plan to use BIM in the next five years. Only 7 % of current users regret adopting it, while 63 % of them think they adopted BIM successfully. Most of the active users (73 %) said that BIM results in operation maintenance savings. Also, 69 % of respondents said that they need manufacturers to provide BIM objects. Besides the advantages, the main barriers to using BIM are recognized. The most significant barriers are lack of client demand and experience. Other significant barriers are cost, no time to get up to speed, small project on which BIM cannot be applied (or there are no big benefits of doing that), lack of standardized tools and protocols. At the same time, respondents thought that the Government does not sufficiently support BIM use and that private clients do not see the benefits of BIM approach. [6]

Dodge Data & Analytics conducted a survey in 2017 among 368 engineers and contractors in France, Germany, the UK and the USA. [1] The most of active BIM users are involved with tunnels engineering (86 %) followed by the bridge (79 %) and road engineers (76 %). Over 75 % of respondents use their own models, while the rest use already built models. This situation is very similar in all four countries. It was expected to grow BIM use in all of these countries by more than 60 % in the period 2015-2019. Based on this research, the USA has the most experienced BIM users (over five years of work) with 46 % of them. At the same time, Germany and France have less than 20 % of experienced BIM users. One of the critical element of BIM growth is how frequently clients are requesting BIM approach. More than one-third of investors are asking for BIM use in these countries. [4]

In 2013, "BIM France" (association of architects and engineers) later followed by the French government, public customers and professional organizations decided to support the development of BIM in France. In 2014, the Ministry of Housing and Construction declared that the use of BIM will be mandatory in public markets from 2017. There is no regulation on BIM in Sweden, but some initiatives are underway, especially among public project owners. Sweden's most significant transport project administration, the Swedish Transportation Administration, published a BIM strategy in 2013 to include BIM for all new investment projects from June 2015. [7]

3 Method

3.1 Questionnaire and statistical methods

After reviewing the literature, consulting with participants in construction projects in B&H and expressing the need to review the state of BIM in B&H, a questionnaire was prepared and distributed via e-mail. The surveys covered a large number of questions, and this paper shows the results of some of them. We sent a questionnaire (targeted) to participants in road and railway infrastructure projects for this research. Investor, designer, consultant/ supervising engineer, contractor/ supplier participated in the research conducted through surveys related to BIM in B&H construction.
The part of the questionnaire contained questions related to using of the offered technology was evaluated according to the Likert scale of assessment (1 - I did not use, 2 - I occasionally used, 3 - I mostly used, 4 - I used most of the time). The part of the questionnaire contained questions related to the BIM perception and their importance was evaluated according to the Likert scale of assessment (1 - strongly disagree to 5 - strongly agree). The application of BIM contributes to the competitive advantage of the company.
Cronbach's alpha coefficient is 0.942, which measures the level of reliability of the measuring scale. A higher Cronbach's alpha coefficient indicates higher reliability of the scale used to measure the latent variable. The set measuring scale has an excellent level of reliability.
Statistical analysis is conducted on the results of the surveys. The significant BIM perception are determined and validated using the relative importance index (RII).

$$RII = \frac{\sum w}{A \cdot N} \tag{1}$$

Σw is the sum of grades given to each factor, A is the max. given assessment for each factor and N is the total number of respondents. The value of RII is in the interval 0 ÷ 1, ordinary rating scale used in research, and many researchers advocate this way of ranking. The BIM perception is more important if the higher RII.

3.2 Survey sample

The application of BIM to different activities and project participants was analysed. Construction project investors, civil, geotechnical, mechanical and electrical engineers and others took part in the survey, out of 64 questionnaires filled-in by the respondents. The percentage of respondents are 52.3 % micro, 15.7 % small, 14 % medium and 17.9 % large companies by annual income. Figure 1 shows the percentage of respondents by group: investor – 34 %, designer – 16 %, consultant/ supervising engineer – 17 %, contractor/ supplier – 33 %.

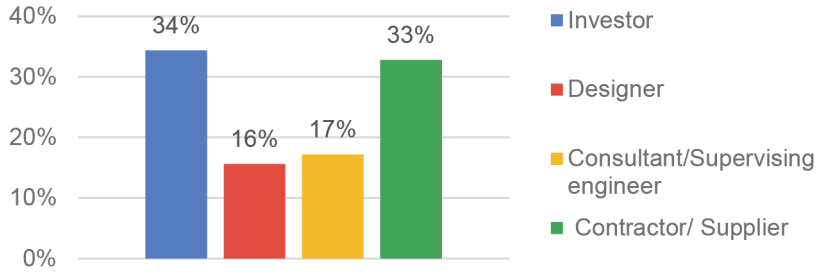

Figure 1 Participation of respondents by group

4 Results and discussion

Table 1 shows how much investors, designers, consultants/ supervising engineers, contractors/ suppliers have used 2D, 3D and BIM technology so far. Most respondents produced 2D digital drawings, 77.0 % designers 66.8 % contractors/ suppliers, 36.3 consultants/ supervising engineers and only 22.7 investors worked or used most of the time. Even 45 % of consultants/ supervising engineers and contractors/ suppliers did not use or create a 3D digital model. Over 20 % of designers and investors did not or occasionally used the 3D model. Over 70.3 % of the 64 respondents participating in that survey indicated that they did not use BIM model (table 1).
Participants' thoughts on the benefits of using BIM: the application of BIM enhances the success of the project, BIM improves the coordination of participants in the preparation of project documentation and the application of BIM contributes to the competitive advantage of the company are shown in Table 2 and Figure 3.

Table 1 The % of use of 2D, 3D and BIM technology with survey participants

		2D	3D	BIM
Investor	1	0.00	0.0	63.7
	2	36.4	27.2	22.7
	3	40.9	22.7	4.5
	4	22.7	50.1	9.1
Designer	1	1.0	12.0	60.0
	2	2.0	10.0	20.0
	3	20.0	18.0	10.0
	4	77.0	60.0	20.0
Consultant/ Supervising engineer	1	45.5	48.0	63.6
	2	9.1	19.5	18.2
	3	9.1	15.1	9.1
	4	36.3	17.4	9.1
Contractor/ Supplier	1	4.7	47.6	85.7
	2	9.5	33.3	9.5
	3	19.0	14.3	4.7
	4	66.8	4.8	0.0

The statements that BIM is currently too expensive to implement in our company by all respondents, Consultants/ Supervising engineer and Contractors/ Suppliers is the last ranked. All respondents think that BIM is not too expensive to implement in the company (RII=0.544). That the BIM is intended only for large companies 1.6 % (RII=0.422) (table 2, fig.2).
As many as 46.9 % of respondents use only BIM 3D software, and only 14.1 % of respondents were not accurate. 37.5 % disagree with the statement that BIM is intended solely for large companies. Over 85 % of respondents agree or strongly agree that investors will to insist on the application of BIM (RII=0.784). The application of BIM contributes to the competitive advantage of the company is recognise like the advantage of using BIM (table 2, fig.2).

Table 2 RII- relative importance index, the BIM perception

	Adopting of BIM enhances the success of the project	Investors will insist on the application of BIM in the future	BIM improves the coordination of participants during the preparation of project documentation	Adopting of BIM contributes to the competitive advantage of the company	BIM is 3D software	The implementation of BIM requires the assistance of a consultant.	The application of BIM requires the assistance of a consultant.	BIM is currently too expensive to implement in our company	BIM is intended only for large companies
	Rang								
All resp.	1	2	3	4	5	6	7	8	9
Investor	1	3	2	4	5	6	8	7	9
Designer	2	3	1	4	6	7	8	5	9
Consultant...	1	3	4	2	6	7	9	8	5
Contractor...	2	1	4	5	3	6	7	8	9

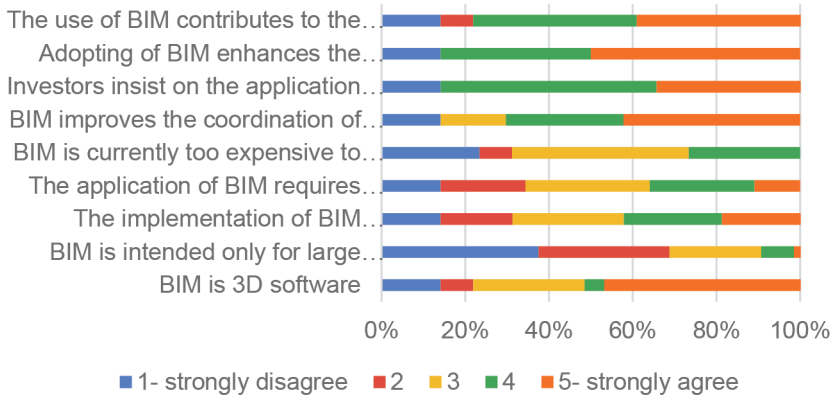

Figure 2 BIM perception by participants

5 Conclusion

BIM is now recognized as the current best practice methodology to have a go at building and infrastructure projects [8]. This research dive an exciting overview of BIM technology utilization in Bosnia and Herzegovina and challenges to widespread adoption of this technology in infrastructure projects. We assessed the perceptions of participants (investor, designer, consultant/ supervising engineer, contractor/ supplier) on the relative importance of BIM perception in the infrastructure projects using RII.

The implementation of any project full according to BIM technology is not present. The understanding of BIM as a 3D technology is very present, as this research shows. The legal norms and framework in Bosnia and Herzegovina still do not acknowledge the Building Information Modeling. The infrastructure projects participants if want can use BIM, but they do not must do in this technology. The participant's road infrastructure projects are the ones who have so far realized the advantages of this technology in construction projects. The road and rail infrastructure participants are on the first step towards understanding the BIM importance and benefit, only when they understood that, it would be possible to start drafting regulations and legal acts.

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