PERCEPTION OF BUILDING INFORMATION MODELING WITHIN THE CROATIAN CONSTRUCTION INDUSTRY

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Abstract

Building Information Modeling (BIM) has been subject of numerous research for a long time and will certainly change the way construction projects are being procured, designed, constructed and maintained. Recognizing many benefits of BIM, governments of the most developed members of the European Union (Great Britain, Finland, Denmark) have decided that construction projects till 2016 need to be procured in BIM - level 2.0. The past studies show that supporting the usage of BIM by the state authorities increases the percentage of private companies that use BIM in their own business. Furthermore, the longer BIM is applied in an organization, a higher level of expertise in application of BIM is achieved. Currently there are no studies about application of BIM technology on the Croatian market. Furthermore, this study sought out to obtain the data how Croatian construction sector applies and perceives BIM. The survey was sent to contractors and investors/consultants. We have found that only 0-25% companies use BIM technology and that there is a great scarcity of knowledge regarding to BIM and BIM tools in general. Further, there are no national standards present which would support its implementation by either public or private companies. Nevertheless, participants showed high affiliation to BIM and expressed a need for its standardization.

Key words

BIM; Level 2.0; construction industry; Croatian market; perception

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1   INTRODUCTION

Building Information Modeling (BIM) content has become the most advanced approach to integrating information in construction projects from very earliest project phases onto the project ed. It combines professions such as architecture, civil engineering and other engineering disciplines. BIM has a wide application in the world and has been subject of numerous research for a long time and will certainly change the way construction projects are being procured, designed, constructed and maintained. As such BIM reduces errors and omissions; improves collaboration within stakeholders during the design and construction phases; reduces rework, construction cost and the overall project duration; increases cost control, predictability and profit of the company; brings new business; improves safety; maintains repeat business and many other things [1]. Recognizing many benefits of BIM, governments of the most developed members of the European union (Great Britain, Finland, Denmark) have decided that construction projects till 2016 need to be procured in BIM - level 2.0 [2].

BIM implementation is steadily gaining popularity in construction industry which confirms the fact that there are big number of research and studies made on the barriers and strategies of BIM application. Many survey and research are conducted in order to identify barriers that make practical implementation of BIM difficult. In Hong Kong best rated barriers are: the lack of demand from the clients and other project team members and also the notion that the current practice is satisfactory [3]; in Germany: technological issues, financial issues, normative issues (standardization) and education issues [4]; in Australia: the lack of BIM expertise, awareness, resistance to change, interoperability and legal issues [5]; in UK: the insufficient familiarity of companies with the usage of BIM, and the reluctance to initiate new workflows and train staff [6, 7]; in USA: learning curve, lack of skilled personnel, and the cost or lack of company investment [8]; in Singapore: lack of training, expertise, requirement and legal aspects [9, 10]. To conclude, although to the many advantages that implementation of BIM returns in the business of some company there are also many barriers. Most common barriers to the introduction of BIM are: insufficient training, lack of expertise and technical support, high cost of introducing, opinion that CAD design is better, lack of interoperability and the fact that investors are not looking for the application of BIM [11, 12, 13]. In order to increase the application of BIM, many authors suggested several strategies: provide training, government support, increase awareness and understanding of BIM, develop BIM guidelines, improve data exchange standards, provide education at university level, reduce cost and changes in procurement method factor [11].

Croatia is low in BIM application and, as a member of the European Union (the EU parliament endorsed BIM in 2014, UK, Denmark and Finland demand BIM in large project), will be forced, through public tenders, to go forward with the application of BIM [2]. The current problem of Croatian construction industry regarding BIM is hard adaption to changes and initiation of BIM in the business and lack of state authorities' involvement in order to encourage BIM application. Therefore, the objectives of the research were to gain information about the BIM application on the Croatian construction market, effectiveness of BIM technology throughout specific phases of a construction project and willingness of the employees to implement BIM in the company's operations.

First this paper presents the status quo of the application of BIM in the world. Then it will explain the methodology of the Croatian market research; discusses the results of this research

and in the end proposes how to increase awareness of BIM within the construction industry in Croatia.

2 CURRENT BIM APPLICATION IN THE WORLD

According to figure 1 and Smart Market Report 2013 [14], the pioneers of applying and implementing BIM in Europe are considered to be: France, Germany and United Kingdom where 12% of companies use BIM technology in their business operations for 6 or more years. Furthermore, for the same countries it is obvious that, in the past three years, BIM has entered in the business of 47% companies. Looking at the world states, Canada and USA are on the top of BIM usage (there are 8% companies with the tradition of using BIM in business for more than 11 years and also 50% operate in this way already 3 - 5 years). They are immediately followed by Japan, South Korea, Australia and New Zealand, which do not have such a long tradition, but the percentage of usage over time increases very fast. In Brazil we can notice a great progress in BIM usage last 3 years [14].
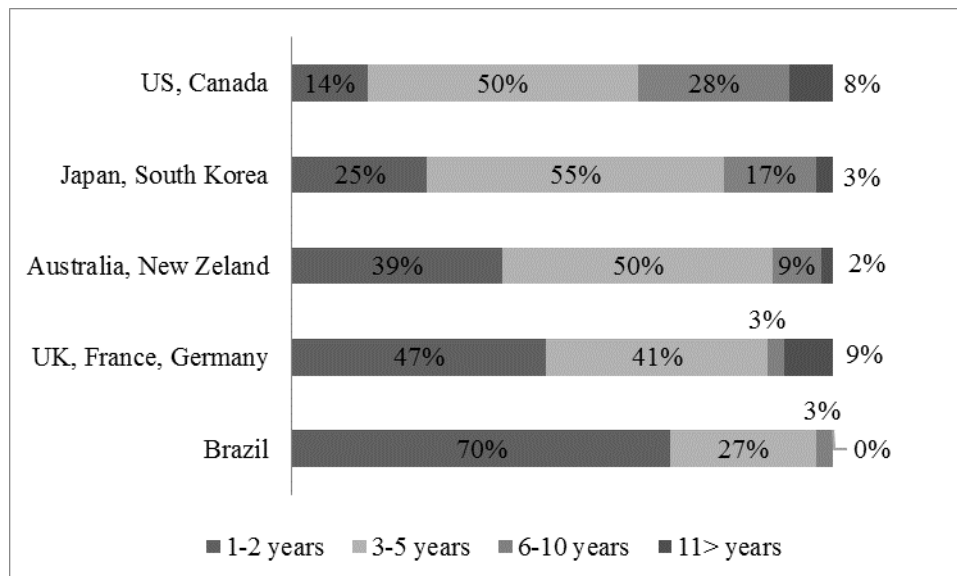

Figure 1. Length of BIM Usage (By Region / Country) [14]

On the table 1 it can be seen that in all the countries under consideration, BIM is used in more than 50% private investment projects (offices, retail, hotels), while the percentage is slightly lower in the case of public buildings financed by the state budget (not only public buildings but also schools and health centres). Statistics from Smart Market Report 2013 [14] shows that supporting the usage of BIM by the state authorities increases the percentage of private companies that use BIM in their own business. Accordingly, in the United Kingdom, the United States and Canada, application of BIM during the execution of public facilities is very high compared with the rest of the countries. Further, as expected during the construction of residential buildings and family houses application of BIM is rare because they present small project where introduction of BIM will be bigger outgo of the project cost [14].

Table 1. Percentage of General Contractors That Selected Individual Trades Among the Top Three for BIM Proficiency (By Country) [14]

Building projects	UK	FR	GER	US	CAN	BRA	JPN	KOR	AUS/NZ
Commercial (Offices, Retail, Hotels)	69	68	59	66	54	53	63	48	70
Institutional (Education, Healthcare, Religious)	61	32	31	77	41	31	23	35	39
Government/Publicy Owned (Courthouses, Embassies, Civic/Sports and Convention)	54	10	22	68	44	12	0	51	37
Multifamily Residential	33	35	44	18	26	19	23	20	26
Single Family Residential	17	19	22	1	10	16	0	1	4

	Over 40%		30% - 40%		15% - 29%		Under 15%

According to figure 2 and NBS International BIM Report 2016 [15], the usage of BIM is increasing and within five years it is expected that its usage in design professions in most world countries will be over 80 %. Currently usage of BIM in UK is 50 %, in Canada is 71 %, in Denmark 81 %, Czech Republic only 30% and in Japan is 49 %. By 2021 it is expected that the usage will be as follows: UK 95 %; Canada 71%; Denmark 93%; Czech Republic 90 % and Japan 88% [15].
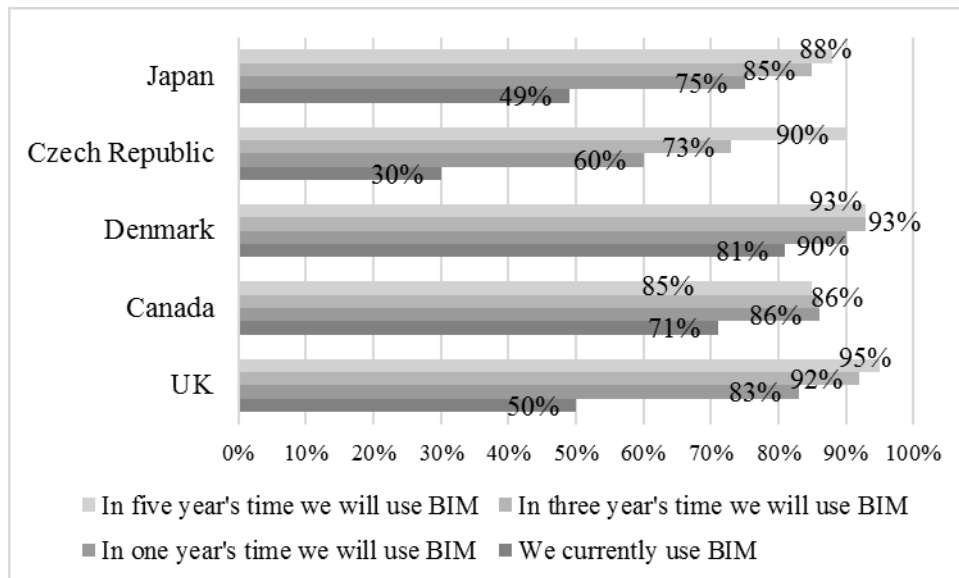

Figure 2. Future use of BIM [15]

3   METHODOLOGY

In order to get insight into BIM application in Croatia, electronic survey entitled 'Survey about the application of BIM technology' was conducted. Survey contained 3 types of questions. The first type, select one of the answers, another type, pairing with the number of points on the scoring Likert scale 1-4 (given scale; 1-minimum value of the offered answers; 4-highest value to an answer) and finally the third type yes / no questions. The concept of questions was taken from 'Smart Market Report' [14]. The survey was sent to 400 e-mails where the 82 (20,5%) responses representing a sufficient number for research. The analysis was based on the Relative Importance Index (RII), according to the formula (1):

$$RII = \Sigma w / (A \times N), \tag{1}$$

where w represents the assessment or response of the individual participant of the survey, A, the highest score given by the survey participants while N is the total number of respondents who participated in the study [16]. RII refers to a value in the range from 0 to 1. The higher value of the index RII element is more important or have better perception.

According to figure 3, the survey involved 31% employees from micro companies, 22.9% from small companies, 20.5% from medium and 24.1 % from large companies. Except size of company, annual revenue of company was observed. According to analysis, 49 % of companies have annual revenue less than 2 million euros, while there is the same number of those whose annual revenue is between 2 and 10 million and 10 and 50 million euros and is 15% of them who generates annual revenue above 50 million. Therefore, smaller companies account for almost half of all respondents which is evidenced that in Croatian construction industry dominate small companies, with smaller annual revenue.
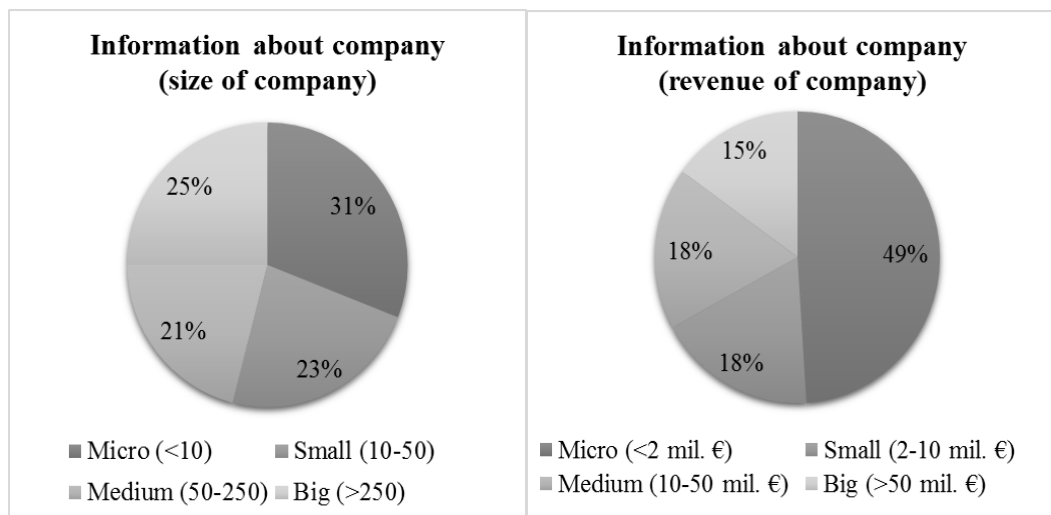

Figure 3. Information about companies whose employees was surveyed

Majority of participants in the study work in the operational management (project manager, team member), specifically 63 % of them, in the higher management (administration, executive part) 28 % of them and 9 % are in the middle management (department head). Thus, operational management, which consists of project leaders and members of individual teams, contribute most to the survey results. Furthermore, construction engineering is the most common profession in the survey (84 %) which is followed by architecture (5 %),

electrical engineering (1 %), geodesy (1 %), mechanical engineering (1 %) and other professions (6 %). Such results have expected to get since the objective of research is to examine the usage of BIM in the construction industry. Also, 26 % participants considered like contractors while most participants (74 %) considered like investors or consultants (figure 4).
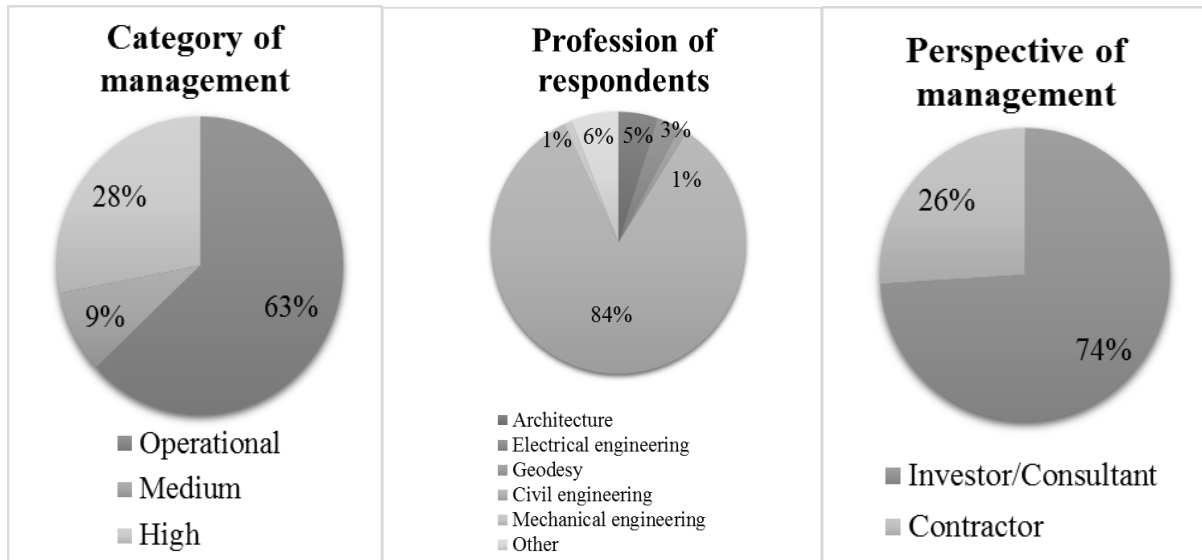

Figure 4. Information about participants of the survey

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Although the majority of respondents believe that CAD and Microsoft tools are insufficient for real planning, in table 2 can be seen that there is a great lack of knowledge regarding BIM (31 of 82 respondents had never heard of BIM). The answers show that more participants know what the term BIM technology means, but also that 38% do not know term. Such information proofs that application of BIM on the Croatian market is on low level. This is indicator which shows how slow global trends creep into Croatian market. Also, the participants find necessary to integrate 3D drawings, cost, time and plans, but it is obvious that they are not interested in innovation on the global market that solve the above mentioned problems.

Table 2. Analyse of responses on question: 'Do You know what the term Building Information Modeling (BIM) represents?'

		YES	NO
Perspective of management	Investor/Consultant	25	36
	Contractor	14	7
Size of company	Micro	14	11
	Small	15	4
	Medium	12	6
	Big	10	10
All participants		**51**	**31**

By examining the type of software used in construction engineering and satisfaction with the work of the same statistic shows that the mostly perceived BIM software are: Microsoft Project, ArchiCAD and software from Nemetschek Group (table 3, figure 5). The fact that the Microsoft Project was singled out as the best rated software (RII = 0.568), shows disappointing fact that the 31 respondents thought of Microsoft Project as a BIM application software. The fact that Microsoft Project is not a BIM software, confirms the low BIM awareness of the local construction companies. ArhiCAD (RII = 0.515) and Nemetschek (RII= 0.490) fall into the first category and their performance is evaluated as average. The medium used software in Croatian practice are Gala, Civil 3D and Revit, while in group rarest used software includes Bentley, Navisworks and Vico. Medium used software was evaluated with an average performance too, while the software from the third category, rarely used software, evaluated with bad performance. This leads to conclude that rarely used software may not be used in an appropriate way.

Table 3. Analyse of responses on question: 'Which BIM tools do You know?'

|		Revit	Civil 3D	Microsoft Project	Gala	Navisworks	Vico	Bentley	ArhiCAD	Nemetcheck
Perspective of management	Investor/ Consultant	0.455	0.426	0.516	0.426	0.400	0.406	0.416	0.494	0.494
	Contractor	0.427	0.427	0.664	0.536	0.409	0.382	0.391	0.527	0.436
Category of management	Operational	0.362	0.369	0.577	0.404	0.250	0.246	0.285	0.523	0.465
	Middle	0.400	0.514	0.600	0.429	0.286	0.257	0.343	0.657	0.657
	Higher	0.365	0.252	0.617	0.365	0.226	0.209	0.226	0.522	0.400
Size of company	Micro	0.344	0.328	0.496	0.376	0.240	0.248	0.256	0.552	0.480
	Small	0.533	0.422	0.689	0.400	0.278	0.233	0.344	0.600	0.556
	Medium	0.289	0.411	0.633	0.433	0.244	0.244	0.256	0.456	0.444
	Big	0.330	0.270	0.610	0.400	0.240	0.230	0.260	0.550	0.400
All participants		0.459	0.437	**0.568**	0.466	0.412	0.410	0.420	**0.515**	**0.490**
		3.505	3.420	**5.402**	3.769	2.573	2.456	2.777	**4.880**	**4.332**
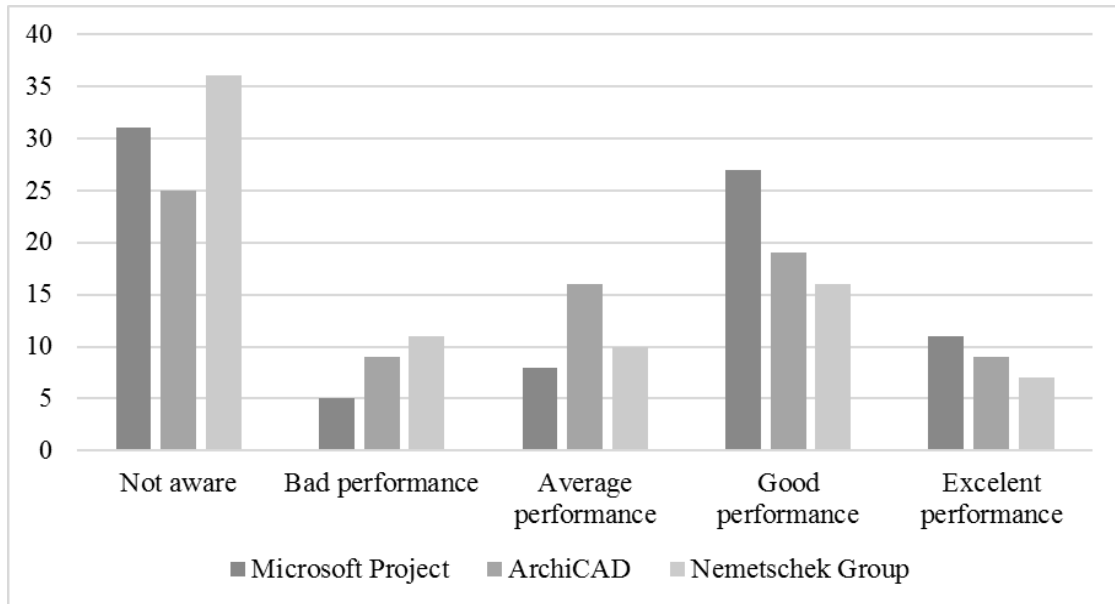
Figure 5. The most used construction management software in Croatia

According to research (table 4) the advantages that the application of BIM brings in business of Croatian companies are: better collaboration with other stakeholders which it seems as the most important advantage (RII = 0.900), followed by reducing errors (RII = 0.800) and reducing projects costs (RII = 0.750). Results of the analysis show that participants are aware of the benefits that BIM brings in operation of the company. Realistic picture about the same issue could be obtained after a certain time, when the BIM will be properly implemented in the business of various companies for longer time [17].

Table 4. Analyse of responses on question: 'Which advantages of BIM implementation do You recognize in your business?'

		Reducing errors	Better collaboration with other stakeholders	Reducing rework	Reducing project cost	Increasing cost control and predictability	Better promotion of the company	Maintain the overall project duration	Increasing profit	Faster decision of all stakeholders	Faster reactions on changes in project	Improving safety measures
Perspective of management	Investor/ Consultant	0.78	0.717	0.804	0.685	0.8	0.72	0.79	0.66	0.73	0.73	0.64
	Contractor	0.75	0.685	0.685	0.739	0.73	0.55	0.69	0.69	0.72	0.71	0.59
Size of company	Micro	0.8	0.781	0.885	0.781	0.84	0.72	0.76	0.7	0.77	0.76	0.66
	Small	0.86	0.778	0.778	0.75	0.86	0.64	0.78	0.72	0.76	0.79	0.64
	Medium	0.81	0.708	0.764	0.792	0.79	0.64	0.75	0.75	0.79	0.81	0.6
	Big	0.8	0.789	0.763	0.816	0.83	0.68	0.83	0.78	0.84	0.83	0.72
All participants		**0.8**	0.75	**0.9**	**0.8**	0.75	0.6	0.65	0.65	0.75	0.75	0.65
		5.6	5.209	**5.579**	**5.363**	5.61	4.55	5.25	4.94	5.36	5.37	4.49

Analysis of the responses in table 5 shows that all participants are relatively considered that the application of BIM is important for the design phase. This shows the score of analysis answers of all participants (RII=0.750) and from the summary score (5.2). To conclude, importance of BIM in business is significant, particularly in the design phase. With the application of BIM through the same phase, tasks which can be done are: automatic update of the draft when making changes within the project and visualization of the future building. These tasks are issue in the development of BIM project and represent an important segment of the companies that participated in the survey [17].

Table 5. Analyse of responses on question: 'According to the stages of construction project, define the efficiency of BIM technology.'

		Defining and planning	Designing	Execution	Maintenance
Perspective of management	Investor/Consultant	0.707	0.728	0.728	0.696
	Contractor	0.630	0.717	0.696	0.533
Size of company	Micro	0.740	0.740	0.688	0.646
	Small	0.722	0.806	0.722	0.653
	Medium	0.681	0.722	0.764	0.556
	Big	0.724	0.737	0.737	0.592
All participants		0.800	0.750	0.800	0.600
		5.003	5.200	5.134	4.275

Furthermore, the majority of participants actually did not find relevant whether BIM was supported in Croatia by the state authorities. Besides, application of BIM is not encouraged through the legislation activities nor there are actions to promote the usage of BIM in the Croatian industry (figure 6).
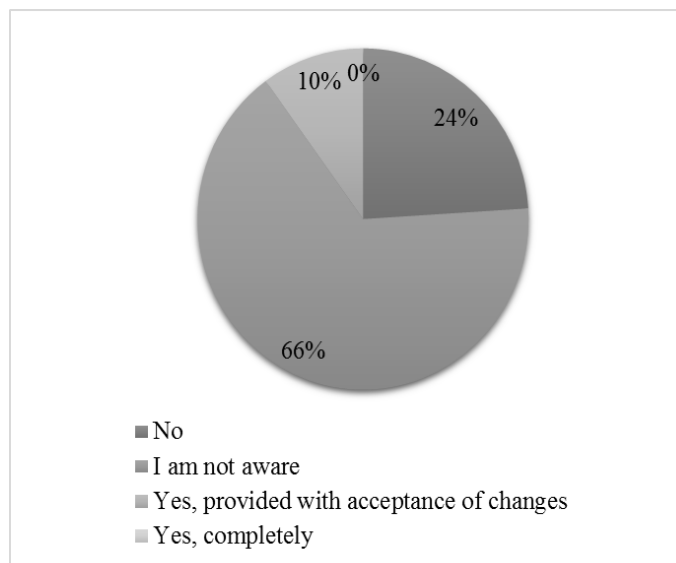

Figure 6. Analyse of responses on question: 'Do You think that in Croatia application of BIM technology is supported by state authorities?'

5   CONCLUSION

With this study we have found that the main perceived advantages that Croatian companies get from BIM are better predictability and project cost control during the design phase. Further, that there is lack of integration of 3D drawings, cost, time and planning as well as communication amongst participants in the stages of design and execution. In general, employees were familiar with the term BIM technology, but the majority of respondents were not aware with BIM tools (i.e. IT applications).

Finally, in Croatia only 0-25% of construction companies use BIM in their own business which is much worse than in the developed economies. In some way this is a result of disengagement Croatian state authorities in supporting BIM implementation although this was one of success factors of implementing BIM (figure 7). Therefore, we suggest further development similar to results found by Salleh and Phui Fung [11]: raising awareness about the BIM issues, establish rules, regulations, standards and code of practice, provide training, incentive and subsidies and finally adoption and enforcement all of that. This steps are proven in many countries and for sure can be good start in BIM implementation in Croatia.
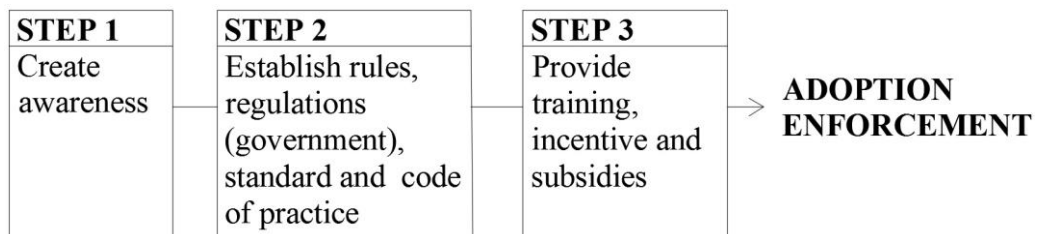

Figure 7. Steps for easier BIM implementation (adopted from [11])

To conclude, BIM implementation is necessary for Croatian market because it will activate construction industry which will become more competitive on the global market. BIM application will also increase level of communication and integration within stakeholders who are involved in construction projects. In future research is necessary to examine appropriate ways of applying the available BIM tools in Croatian construction industry in order to achieve as more benefits as possible.

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