

An analysis of 3D, 4D, 5D and 6D models of Building Information Modeling (BIM), in construction and building management: Comparative assessment, opportunities and challenges in the Greek construction industry

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Abstract – The main subject of this diploma thesis is a presentation of Building Information Modeling (BIM), its characteristics, features, and expected evolution in the years to come. Moreover, the benefits and constraints of BIM usage are investigated during the construction and management of a building throughout its life cycle, from construction to demolition. A further aim is a comparative assessment of the different technologies and capabilities that BIM could provide along with an estimation of the interoperability of data between the different models. Finally, a research of the Greek construction industry was conducted for the implementation of BIM in Greece and the opportunities, challenges and benefits from its usage according to the opinion of stakeholders in relation to the financial crisis.

Keywords: BIM; Greek Construction Industry;

I. INTRODUCTION

Building Information Modeling (BIM) is one of the most important tools of project management and is expected to be a common construction practice in the years to come and become necessary and obligatory, initially in the larger and gradually in all projects (Koritsa, 2016).

If a brief definition of BIM could be given, it would refer to the methodology of 3D representation of a structure, but with more information beyond the simple geometric

characteristics of the structural elements. It now includes the relationship between them and the connection attributes. This information in a Building Information Modeling relates to the properties and characteristics of each segment (Wong, Wong, & Nadeem, October 2009).

In its implementation, BIM can reach various "depths" depending on the parameters the user wants to model. Thus, there is a 3D BIM, which incorporates only the geometric and structural properties of the elements with their attributes, the 4D model, where time and schedule factors of the project are incorporated, the 5D, which also implements the cost within the model and finally 6D, which models the structure after the completion of the construction, the facility management and management up to the end of its life cycle. Thus, from the application of BIM, multiple benefits can be gained in terms of efficiency in construction and management, reduced cost and reduced construction time. In addition, it is possible to have more direct and easy design changes and have more efficient communication between the working groups within the project (Hergunsel, 2011) (Faghihi & Kang, 2012).

Some of the most important BIM software are ArchiCAD, Revit, AlphaplanBIM and 4M, which are among the industry's leading programs and incorporate different capabilities. Nowadays there is a variety of BIM software in the market that could be categorized by discipline, by their primary functional category, the stage of the project that can be implemented and by the Input/Output application. For BIM to be adopted in a coordinated and standard way, there are guidelines Standards and protocols for

the adaptation that is lead centrally, from the authorities of each country with some of the most important being the GSA BIM Guides for Design and Construction (US), the Building SMART uBIM Guides (Spain), the Statsbygg BIM Manual (Norway), the Common BIM requirements (Finland) and the Soft Landings (United Kingdom) (Austrian Standards, 2015) (BSRIA, 2016) (Building Construction Authority, 2013) (Construction Industry Council, 2014). In the years to come, the biggest challenge BIM faces is the prevalence of common standards so that different programs aiming to different discipline can coordinate and interact on a common platform. This effort over the past few years is mainly expressed through the IFC and gbXML file types.

II. METHODOLOGY

In the framework of this diploma thesis a market research of the Greek construction industry was conducted, in order to investigate the opinion of stakeholders for the capabilities, opportunities challenges and implementation of BIM in the Greek market. For this survey of the Greek construction industry, the use of a questionnaire was chosen which will be answered by stakeholders. According to (Boone, 2004), (Salant & Dillman, 1994) and (Wright, 2005) a questionnaire for a web based survey should be brief and inclusive to receive targeted information. In addition, the questionnaire should be spread to individuals as targeted as possible and it should be ensured that only stakeholders related to construction industry will have access to it.

In order to meet those criteria, as a research tool was chosen a questionnaire through the Google Forms platform, which ensures a pleasant user interface and speed in the process so that the user is not tired and can continue to respond spontaneously. In addition, this form allows control over who is responding and giving automatic feedback.

The questionnaire was chosen to be spread to stakeholders only by sending emails to personal or corporate user email accounts that are professionally related to the construction industry and not through an open invitation to respond to applications, electronic pages and social networking pages. This choice was made to ensure a full control of the sample, in order to

avoid any affect, the objectivity of the survey. The sample with the emails to which the form was sent numbered 312 addresses.

The first data processing was done automatically by the Google Forms application, and then the results were exported to a spreadsheet for further process and visualization through charts.

The questionnaire was first sent to 312 emails on Saturday, March 11, 2017, and a courtesy reminder was also sent on Wednesday, April 5, 2017. Then, telephone contacts were made with those available to ask them to answer the questionnaire. Thus, a total of 113 responses were received by Monday 1 May 2017, when the data process begun.

III. SELECTED RESULTS

In the Greek market, BIM still has a very low penetration, mainly due to the economic crisis that has prevailed over the construction industry. However, a distinctive example where BIM has been successfully implemented is the “Stavros Niarchos Foundation Cultural Center”. Despite this, penetration remains low and, according to the market survey carried out in the context of this study in a sample of 113 individuals working in the construction sector in Greece, the percentage of people who are aware of BIM is only 17%, which is very low.

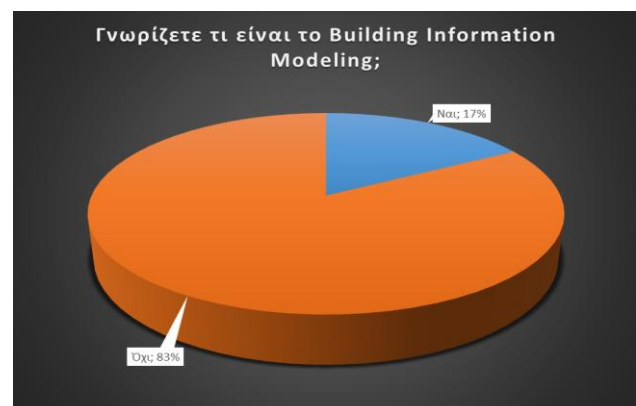


Figure 1: Percentage of stakeholders aware of BIM in Greek construction industry

Moreover, according to results of the survey a 75% of stakeholders couldn't answer if the software that are already using for design or management has BIM capabilities.

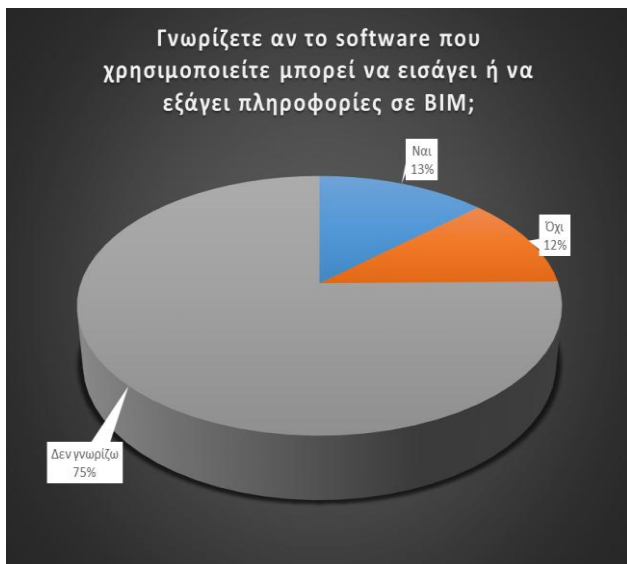


Figure 2: Percentage of stakeholders aware of BIM capabilities of their design or management software

Another example of the low implementation in the Greek construction industry is that only 2% of the individuals answered the questionnaire have used BIM while 77% answer they haven't used and another 21% didn't know.

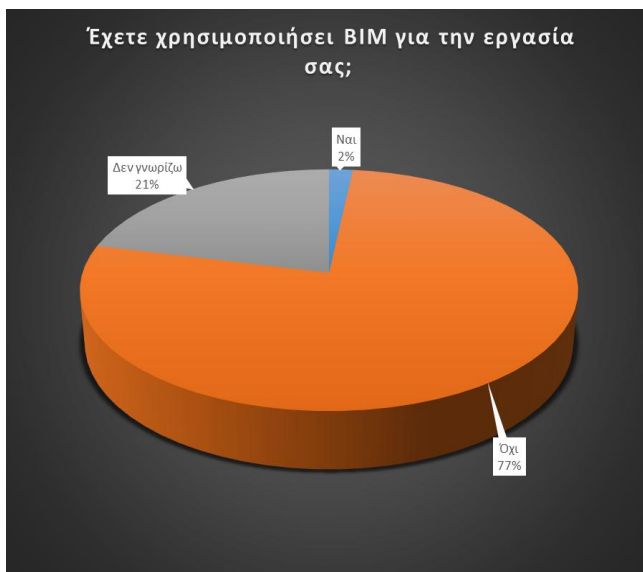


Figure 3: Percentage of stakeholders that have used BIM

At the same time, the results of the questionnaire where obviously affected by the financial crisis that had shrink the construction industry of Greece by 92% comparing to 2007 (Hellenic Statistical Authority (ELSTAT), 2017). Thus, a 96% answered that financial crisis have affected their turnover to a large extend while another 4% answered that it had been affected in a smaller extend and 0% answered that it hadn't been affected at all.

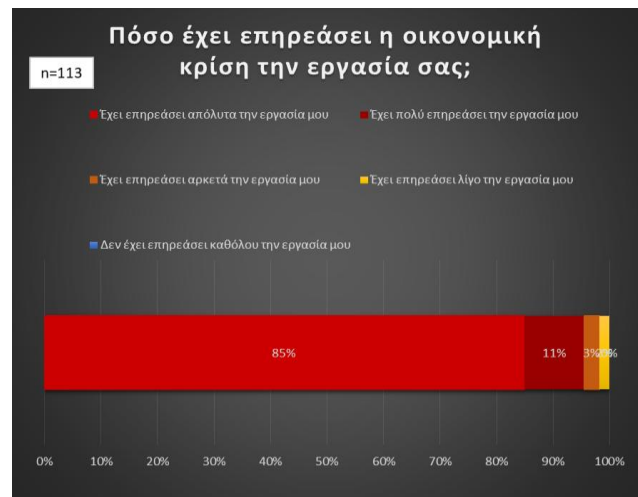


Figure 4: Results on the degree that financial crisis affected their turnover

Although their turnover had been affected in a large extend they still remain optimistic as 39% believe that the next years their turnover will recover or stop deteriorate while 35% disagree on that statement.

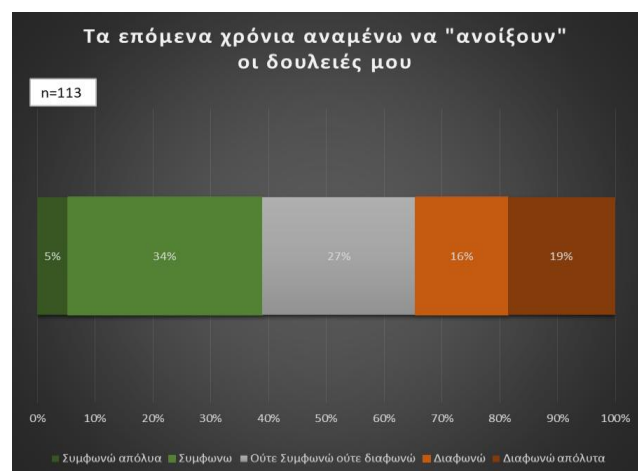


Figure 5: Agreement level on statement "my turnover will improve in the years to come".

As a result, even though they are willing to be trained in Building Information modeling to a percentage of 45% and 31% would invest time to be trained, only an 18% are willing to invest money to be trained in Building Information Modeling.

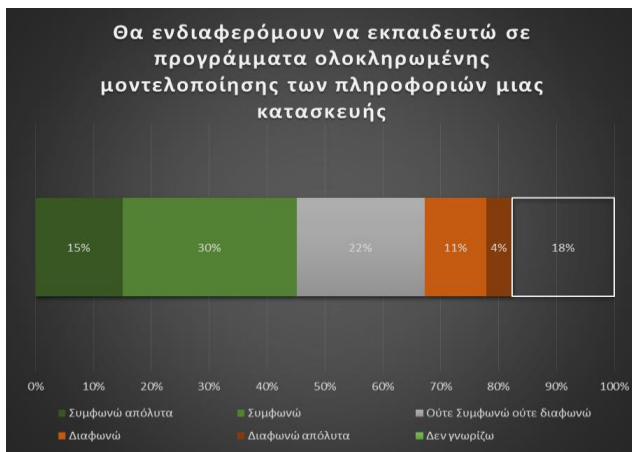


Figure 6: Agreement level on statement “I would be interested to be trained on BIM”.

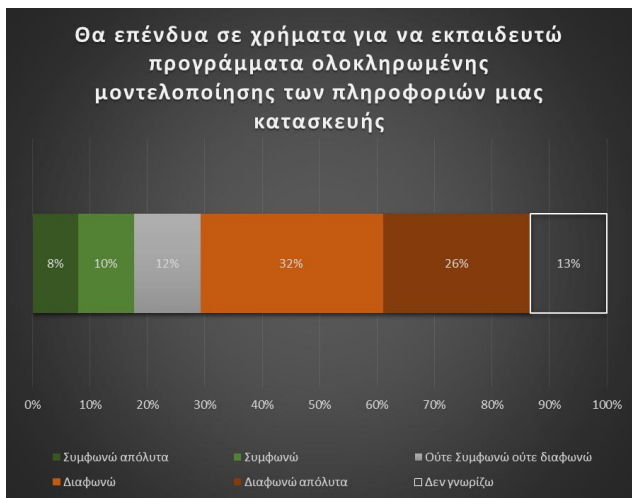


Figure 7: Agreement level on statement “I would invest money to be trained on BIM”.

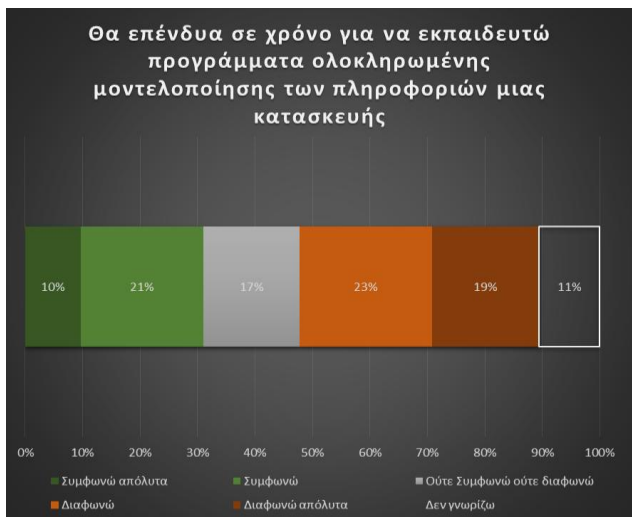


Figure 8: Agreement level on statement “I would invest time to be trained on BIM”.

Finally, from the results obtained from the questionnaire it was more than clear that the Greek construction industry is not mature enough for BIM, as only 23% disagreed on statement “BIM is just for large projects” and

only 20% disagreed with the statement “BIM is just for large organizations”.

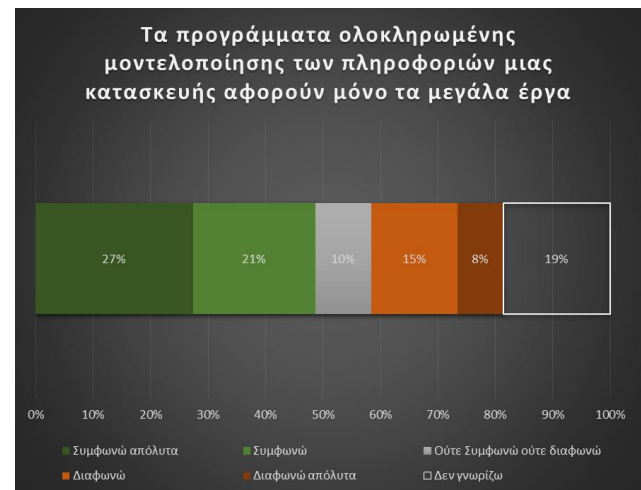


Figure 9: Agreement level on statement “BIM is just for large projects”

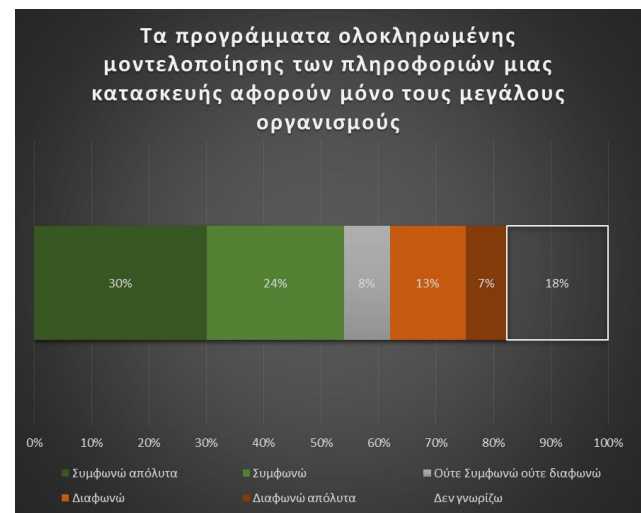


Figure 10: Agreement level on statement “BIM is just for large organizations”

IV. CONCLUSIONS

At a first glance, it is obvious that the penetration of BIM in the Greek market is very low. This fact had begun to emerge from the beginning of this study and especially during the research of case studies using BIM in Greece, where there was a clear lack of completed projects that have used BIM and no work that has used BIM, during its operation and/or maintenance.

Moreover, the ignorance of the construction industry in Greece about BIM as to the meaning, the capabilities, the advantages and the benefits is more that obvious from the questionnaire, which can be addressed through information campaigns about BIM by chambers and associations or companies. Moreover, it can be

concluded that there is willingness from the industry to "follow the current" and to be trained for this new (for Greece) tool.

Also, from the way that the stakeholders answered the questionnaire it was clear that the construction was affected in a big extend by the financial crisis. This is one of the main reasons behind the consolidation of BIM in Greece, as on the one hand there is no mood and money to invest in the knowledge of a new tool but mainly there are no projects that will make the investment in such a tool efficient and Return on Investment Time reasonable.

When the results of this survey are compared with results from surveys in other countries (Malleeson, 2016), it is obvious that Greek BIM market is in an infantary stage, as the penetration of BIM is only 2% while in Great Brittan is 58% (Malleeson, 2016). Moreover 65% disagree that BIM only for large projects which is much bigger than the 23% that answered that disagrees to that statement in Greece. Finally, form the results, in Great Britain a 77% responded that they consider BIM to be the future of Project Management while in contrary the same answered only by 36% in Greece. Yet just 25% think that BIM is only for large organizations as opposed to 54% in Greece and 73% disagrees with the fact that BIM has no difference with 3D CAD, compared with 31% responding to disagree with that statement in Greece.

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