



Implementation of BIM in Spanish construction industry

Implementación BIM en la industria española de la construcción

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- ◊ The research's aim is to ascertain BIM implementation in the Spanish AEC market.
- ◊ BIM tools are being used in the design stages.
- ◊ BIM user profile is an Architect, between 35 and 49 years old, who is self-taught.
- ◊ Use of BIM tools in the construction stage is minor.

The Spanish construction industry has been subject to EU Directive 2014/24/UE. This directive allows member states to encourage, specify and even require the use of Building Information Modeling (BIM) in construction projects financed by EU public funds as of 2016. The QBIMInvest Project (supported by the Universidad Europea de Madrid) has conducted a survey, which is the subject of this article, on the implementation of Building Information Modeling in the Spanish AEC industry. This research uses 548 responses from a sample of Spanish AEC professionals to demonstrate that currently BIM tools are only being used in the design stage of residential buildings. There are few cases of them being applied in the construction, operation and maintenance stages or in other project types. On the other hand, professionals think that they will need at least 3 to 5 years to finish implementing BIM in projects.

BIM, Architecture, Building Engineering, Construction

- ◊ El objetivo de la investigación es conocer la implantación del BIM en el mercado español de AEC.
- ◊ Las herramientas BIM se utilizan en las etapas de diseño.
- ◊ El perfil de usuario de BIM es un Arquitecto, entre 35 y 49 años, autodidacta.
- ◊ El uso de herramientas BIM en la etapa de construcción es menor.

La directiva UE 2014/24 invita a los Estados miembros a que fomenten, especifiquen y requieran el uso de Building Information Modeling (BIM) en los proyectos de construcción financiados con fondos públicos de la UE a partir de 2016. El Proyecto QBIMInvest (financiado por la Universidad Europea de Madrid) ha llevado a cabo una encuesta para conocer el uso de BIM en el sector AEC español. Las 548 respuestas, obtenidas de una muestra de profesionales españoles del sector, muestran que las herramientas BIM actualmente solamente están siendo utilizadas en la etapa de diseño de edificios residenciales. Hay pocos casos en los que se aplica en las etapas de construcción, operación y mantenimiento o en otros tipos de proyectos. Por otro lado, los profesionales piensan que van a necesitar por lo menos de 3 a 5 años para completar la integración de BIM en los proyectos.

BIM, Arquitectura, Ingeniería de Edificación, Construcción

1. INTRODUCTION

BIM is one of the most promising advances in the Architecture, Engineering and Construction (AEC) industry. Currently, the industry is continuing to inform their association members, stakeholders, etc. about BIM adoption in various ways [1]. Collaborative working software like BIM, which enhances the coordination between multidisciplinary teams throughout the building design and execution process [2, 3], has appeared in the AEC industry over the last decade. This methodology covers and manages all the building lifecycle information, simulating and updating digital representations for all the construction stages, functioning, demolition, and recycling.

BIM solutions create and operate with digital databases for

collaboration; manage changes in these databases, ensuring that a change to any part of the database is reflected in all the other parts; and capture and preserve information for reuse by other industry-specific applications. By applying information technology to the problem of describing a building in software, they enable higher quality work, greater speed, and more cost effectiveness for building design, construction, and operation [4]. These data-rich models can be effectively used by other members of the design team to coordinate the fabrication of a building's different systems. This has innumerable advantages in off-site construction domain including speed, economy, sustainability, and safety [5].

Since February 2014 the Spanish construction industry has been subject to EU Directive 2014/24/UE [6], which seeks to modernize European Government procurement and reduce costs in the 28 EU member states. This directive allows member

states to encourage, specify and even require the use of Building Information Modeling (BIM) in construction projects financed by EU public funds as of 2016 [7]. In July 2015 the Ministry of Development established a commission for BIM methodology implementation in Spain, scheduling its Regulatory Approval for 2018 and compulsory use in Public Tenders for Building in 2018 and for Infrastructure in 2019 [8].

1.1. BIM ADOPTION

Many reports indicate that BIM is now widely used in some countries. However, BIM has experienced slow and limited circulation and adoption in others [9]. According to the NBS National BIM Report 2015 [10], which analyzes BIM adoption in the UK, 50% of responders are aware of BIM tools and use them on a regular basis, and 83% expect to use them within one year. In North America industry-wide adoption of BIM surged from 28% in 2007 to 70% in 2012, and Architects, Engineers and Contractors presented almost the same adoption levels (70%, 67%, and 74%) [11]. The recent 2015 NBS National BIM Report [10] shows that BIM adoption in the UK is going from being led by innovators and early adopters towards becoming a more mature market. Time, levels of expertise and cost remain barriers to BIM adoption. There is still a lack of clarity in the industry and many are skeptical of the claims some people are making about BIM.

In their study on using BIM, Succar and Kassem [12] indicate that there is a lack of research on how this innovation is being promoted in the construction industry. The available studies addressing BIM implementation and promotion in the market rely heavily on surveys created and launched by commercial service providers. Some of the most important studies have been conducted in Europe, the US and Canada, the UK and Australia: The business value of BIM in Europe, SmartMarket Report 2010 [13], The business value of BIM in North America [11], The business value of BIM in Australia and New Zealand, SmartMarket Report [14], NBS, International BIM Report 2013, 2014 and 2015 [10, 15, 16], National Guidelines for Digital Modelling [17]. While there is also academic research on adopting BIM in other countries such as China [18], Finland [19], Iceland [20] and India [21], no such project has been undertaken in Spain until now. The QBIMInvest Project (supported by the Universidad Europea de Madrid) has recently conducted a survey, which is the subject of this article, on the implementation of Building Information Modeling in the Spanish AEC industry.

1.2. BIM BENEFITS

The benefits of implementing BIM processes and technologies have been widely espoused. They include [25]: reduced construction costs [22, 23, 24]; better quality of design information; integration of project systems, data and teams; a lower propensity for change orders; improved interoperability; and whole lifecycle asset management.

The research conducted by Eadie, Browne, Odeyinka, McKeown, & McNiffen in 2013 [22] draws the following

conclusions: the collaborative aspects have the most positive impact; the process aspects are more important than the software technology; BIM requires investment in software and training (however, smaller practices can afford this) [13]; clients receive the most financial benefits from BIM, followed by Facility Managers; BIM is not being used to its full potential in the facility management stage; the operation and maintenance stages (facility management) make up 60% of the total project cost [26]; in 2013 less than 10% of professionals were using BIM technology in this field; and BIM is mostly used in the early stages of the project lifecycle.

The recent 2015 NBS National BIM Report in the UK [10] shows that the professionals who have adopted BIM are keen to promote the benefits. These include improved cost efficiencies, client outcomes, co-ordination, delivery speed, and information retrieval. These benefits are perceived by the majority of BIM users. With 92% stating that they will be using BIM within three years, these benefits are expected to be felt across the board. In the UK the AEC industry sees BIM as assisting the country to meet at least two key targets: a 33% reduction in construction and whole-life costs, and a 50% reduction in the overall time from inception to completion.

1.3 BIM disadvantages

The disadvantages or challenges of implementing BIM relate to software and hardware issues. The AEC industry has identified interoperability as a problem. The causes are that the various players have to use many diverse applications and systems, and that dynamics and adaptability are essential to operate in this sector [27, 28]. While there are interoperability issues between different BIM software packages, such technical issues are likely to be resolved by the package providers over time. More difficult to resolve are the related issues of people agreeing on common IT platforms, cooperating with each other to share their BIM data models, and not restricting the flow of information to and from other parties by protecting the ownership and intellectual property rights of BIM-generated output. [28]. Together with cost/benefit analysis, there also needs to be more awareness-raising and general up-skilling in the sector. Hence, senior managers at construction companies will need to invest in BIM education and staff training [22, 28].

2. METHODOLOGY

To ascertain the extent to which BIM has been implemented in the Spanish AEC market, a quantitative methodology based on surveys has been adopted. The survey design is a Descriptive, Observational, Prospective and Cross-sectional Study type.

The Target Population of the survey is Architects, Technical Architects, Building Engineers, Civil Engineers, Highway Engineers and Industrial Engineers working in the construction sector.

No probability convenience sampling has been applied. This is also known as accidental sampling because the selected sample is made up of individuals who chose to participate in

the survey was developed with the open-source software SurveyMonkey [29], which allows users to create personalized surveys online. It also offers analysis and data representation tools.

To select the survey questions other similar studies were referred to, among which it is worth mentioning the NBS National BIM Report [10] [14] [15], the national survey on BIM use conducted in Chile in 2013, [30] and the analysis by Eadie, R., Browne, M., Odeyinka, H., McKeown, C. and McNiff, S. on BIM implementation in construction projects across the UK [22].

To circulate the survey the professional network LinkedIn was mainly used [31]. It was published in 45 professional groups connected to the national construction industry, which means that it could have reached 139,332 individuals. Although it must be taken into account that a single user may be a member of several groups, so it is likely that the actual number of individuals who accessed the survey is lower.

In each of the professional groups, the survey was published in the “debates” area, generating a new update for all the group members. Two reminders for each publication were scheduled, with an interval of between 7 and 10 days for each. The survey was also circulated at the Universidad Europea de Madrid.

It was emailed to the professors in the Building Technology & Management Department at the School of Architecture, Engineering and Design. It was also published in the “Campus

Virtual” General Forum of the subject Foundations (Bachelor’s Degree in Building Engineering). Finally, the research team members also sent the survey to their professional contacts associated with the sector.

All participants were informed of the study objective and their responses were treated confidentially. Participation was completely voluntary and no economic incentives were given.

Responses were received from April 22nd to May 27th 2015 (35 days). During this period 1200 entries were registered. From these entries, 456 stopped completing the survey or did not respond to the question on whether they used BIM tools. As a result, there are 744 valid entries. These are divided into two groups: one for Spanish nationals and another for other nationalities. 548 entries were completed by Spanish professionals, of which 292 subjects responded that they use BIM tools, while 256 said that they did not.

For a population of 140,000 subjects with a 5% error margin, a t of 1.96 and a confidence level of 95%, the valid sample is 383 [22, 32]. Given that the number of valid responses considered is 548 for a confidence level of 95%, the error margin is less than 5% (4.18%).

This study’s sampling method, instrument type, sample size and confidence level comply with the industry standard in international studies on the same topic, such as the SmartMarket Report [15] or the study conducted by Eadie to analyze BIM use throughout the building project lifecycle in the UK [22].

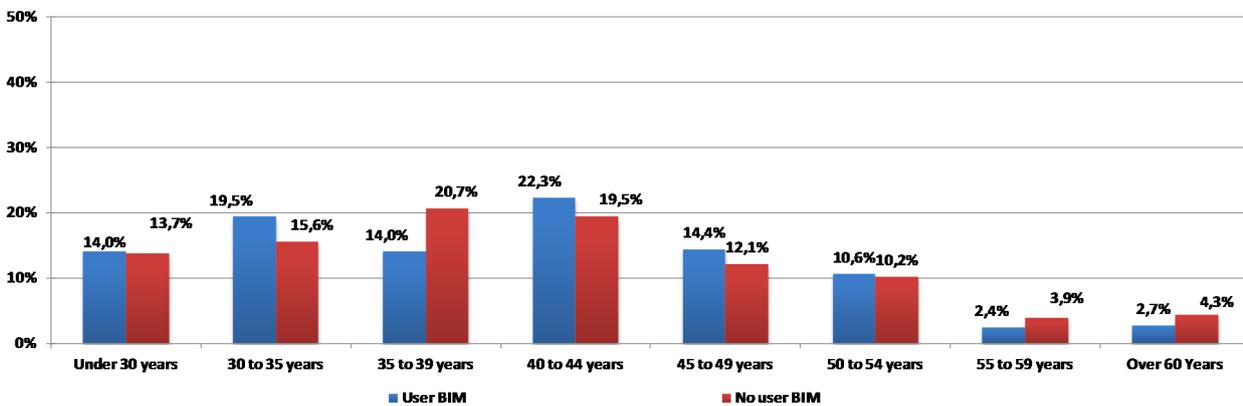


Figure 1: Ages of BIM users

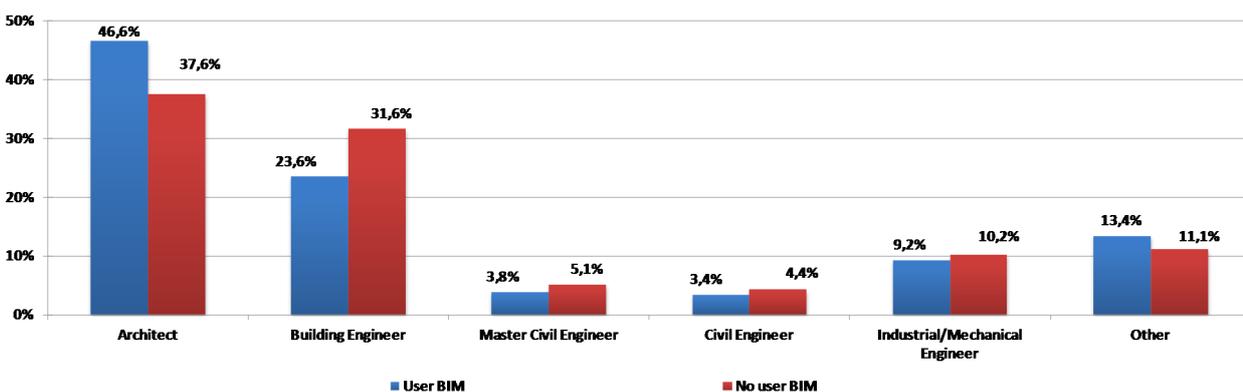


Figure 2: University Degrees of BIM users

3. BIM STATUS IN THE SPANISH CONSTRUCTION INDUSTRY

3.1 SAMPLE PROFILE

The surveys received provide a sample divided into similar percentages between professionals who use and do not use BIM tools. In this sense there are no big differences between any of the age groups. The professionals who assert that they use BIM tools are in the 30 to 45 years age group. It is

noteworthy that even in the professionals under 30, the percentage of users and non-users is balanced. Figure 1. 37.6% of the sample are Architects, followed by Building Engineers with 31.6%. It should be highlighted that 46.6% of the Architects state that they are users as opposed to 23.6% of the Building Engineers.

On the contrary, 27.3% of the Architects surveyed affirm that they do not use BIM tools as opposed to 40.6% of the Building Engineers. (Fig. 2).

The random nature of the sample meant that responders came

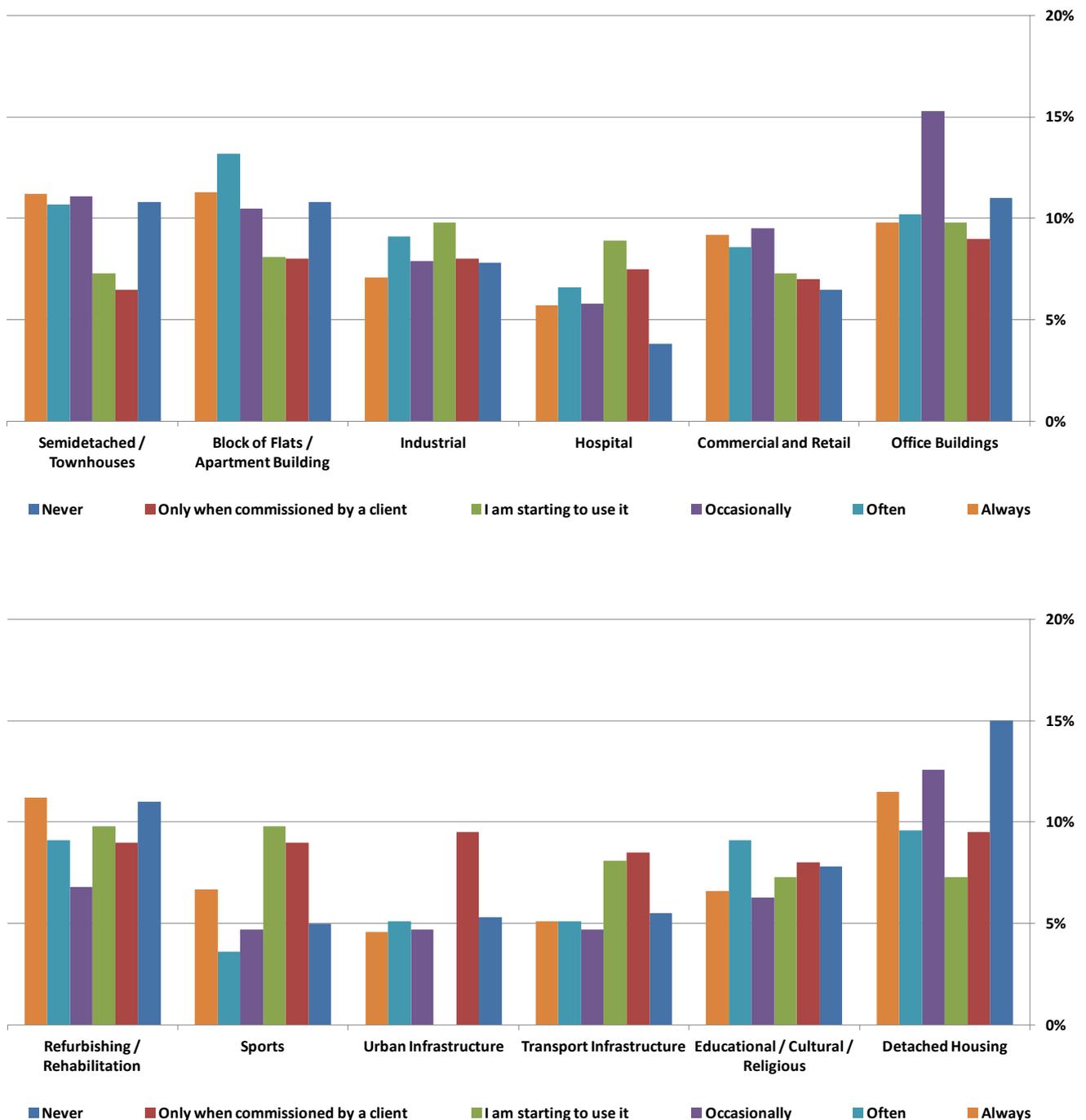


Figure 3: University Degrees of BIM users

Responders could select all the professional tasks they performed. Selecting more than one task indicated that their practices were multidisciplinary.

In the sample, the BIM users' specialties are to a large extent Designer/Architect, Take-off and Budget Estimate, and Project Supervisor. These tasks are normally performed by Architects in Spain. Hence, the results confirm that the large majority of professionals who responded to the survey are Architects working on the technical and economic design and definition of construction works.

3.2 PROJECT TYPES AND STAGES IN THE LIFECYCLE WHEN BIM TOOLS ARE USED

BIM tools are mainly used in all types of residential building projects, making up 30% of the total, followed occasionally by office buildings and refurbishment projects. Figure 3.

That the percentages for the projects in which the responders affirm that they always or never use BIM tools are concentrated in the same project types is because, as seen in table 1, the sample is divided almost by 50% between BIM

users and non-users.

Regarding infrastructure projects, as there is not a significant number of Engineers in the sample studied, the results for these cases are not representative. However, it can be observed that the Engineers who participated in the survey are starting to use and learn about BIM tools.

With respect to project stages, BIM tools are mainly being used in the design stages (conceptual design, preliminary design, detailed design, and take-off and budget estimate). In the other stages, the BIM tools available on the market are scarcely being used. The main use (over 75%) is in project modeling and definition, as well as clash detection activities occasionally. (Fig. 4).

3.3 OPINIONS ON THE IMPORTANCE OF IMPLEMENTING BIM TOOLS IN THE CONSTRUCTION SECTOR

It is worth emphasizing that the responders who are BIM tool users and those who are not mainly coincide in stating that BIM is important (32.9%) or very important (61.1%) for improving professionalism in the construction sector.

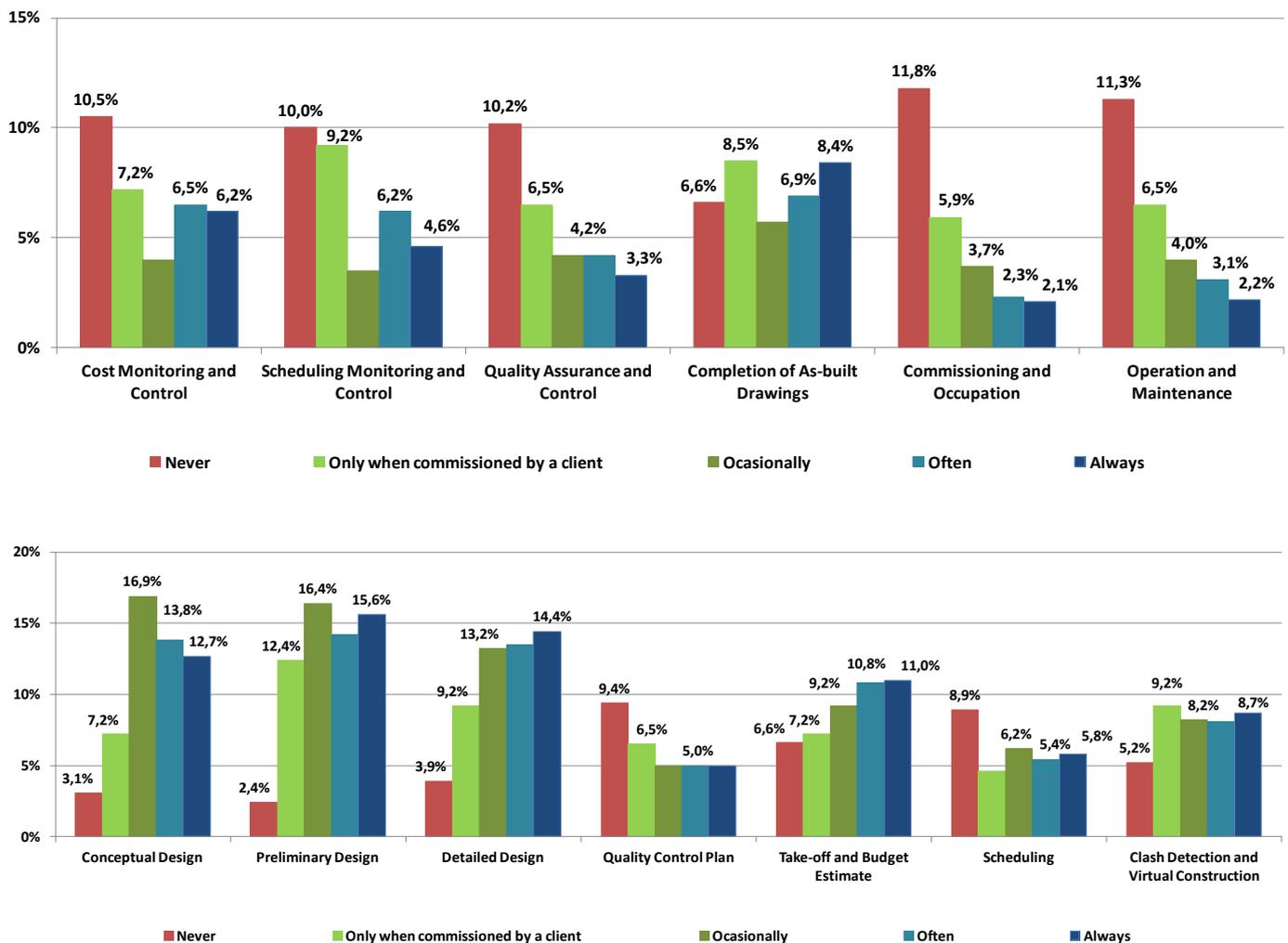


Figure 4: Use BIM tools - Stages of the project lifecycle

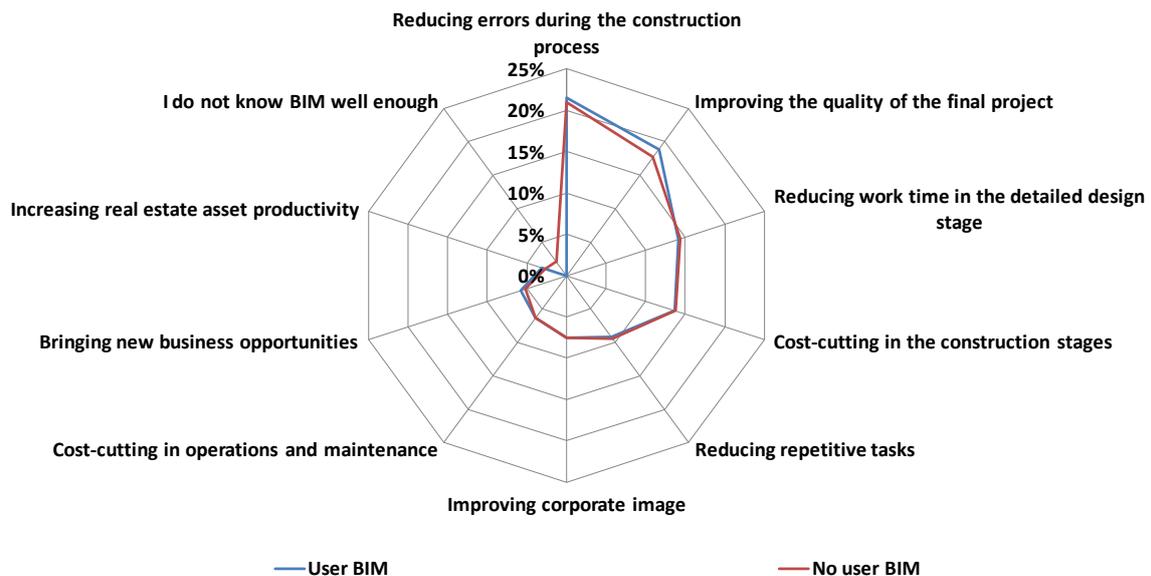


Figure 5: The main benefits using BIM tools

In relation to the opinions on the minimum time needed to implement BIM tools in the construction sector, 41.0% think that it will take 3 to 5 years, closely followed (36.2%) by those who believe that it will take 6 to 10 years.

The survey was conducted in 2015. If we jump forward 3 years to 2018, we reach the year in which the Spanish Government wants the use of BIM tools to be compulsory in public building projects.

3.4 BENEFITS AND BENEFICIARIES OF USING BIM TOOLS

Regarding the benefits of using BIM tools, both users and non-users have similar opinions. The main benefits (figure 5) are:

- ◆ Reducing errors during the construction process (21.0%)
- ◆ Improving the quality of the final project (17.7%)
- ◆ Reducing work time in the detailed design stage (14.4%)
- ◆ Cost-cutting in the construction stages (13.8%)

Error reduction during the construction process generally leads to an improvement in the quality of the final project, so these benefits are closely linked.

It is significant that workload reduction in the design stage also appears as one of the main benefits. The sample, as has been shown, is fundamentally made up of Architects who work in this project stage. This means that they are already obtaining these benefits.

On the other hand, it is interesting that cost reduction in the construction stage appears as the fourth main benefit because, as shown in figure 5, BIM tools are not being used in this stage yet, or they are only being used occasionally. Hence, there is no clear information to draw this conclusion, despite the assumption of the professionals participating in this survey.

Meanwhile, the benefit of cost-cutting in operations and maintenance appears in the last positions, which is remarkable

when compared to the results of surveys conducted in other countries and research published on this topic, where the majority of researchers confirm that the main benefit of using BIM in projects is streamlining the building's operation and maintenance costs [22]. However, responders also state that BIM are only being used during this stage in 10% of projects.

The responders believe that the greatest beneficiaries of working with BIM are the Draftspeople (21.4%), followed by the Property Developer (14.8%), the Principal Contractor (13.3%) and the Project Manager and Quantity Surveyor (11.6% and 11.1%). Interestingly, the Owners and the Facility Manager appear in the last positions. These are the people who have an impact on operation and maintenance which, according to most researchers, are the activities that will benefit most from implementing BIM tools [22].

3.5 REASONS FOR NOT USING BIM TOOLS AND HOW TO ACQUIRE TRAINING

Considering that the sample is divided by almost 50% between those who state that they are BIM users and those who are not, it is important to identify the reasons why the non-users, despite acknowledging the importance of these tools, are not using them yet. These reasons are essentially:

- ◆ Software cost (17.1%)
- ◆ Our clients do not request it (16.7%)
- ◆ We do not have trained staff (16.2%)
- ◆ We are currently training but still need more time to prepare (14.3%)

In relation to how professionals from the sector are being trained, it is very representative that 38.4% are teaching themselves, which is a higher percentage than that accumulated by the options of company internal training (11.9%), college courses (10.8%) and professional associations (10.3%). (Fig. 6).

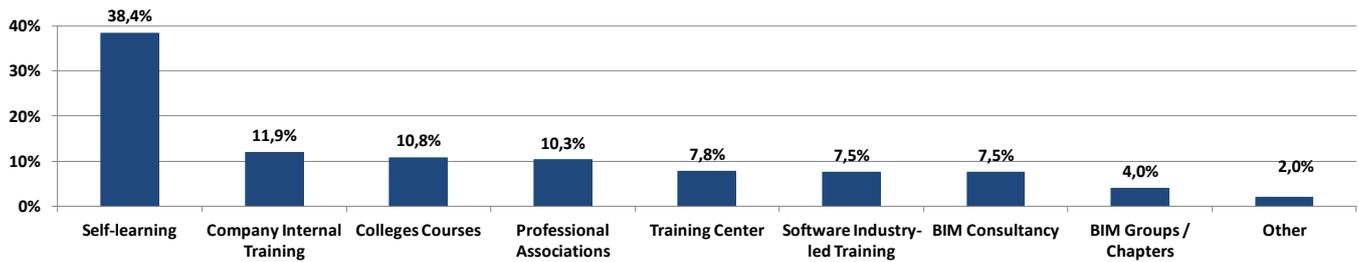


Figure 6: BIM training

4. CONCLUSIONS

According to the data obtained in the survey, it can be concluded that the BIM user profile in Spain is an Architect aged between 35 and 49 years who is self-taught and applies BIM tools in the design stage.

The results show that the Spanish market is very immature in terms of collaborative work with BIM, with superficial knowledge and partial application in the design stage, mainly as a drawing and modeling tool.

Use of BIM tools in the construction stage is minor. In addition, the BIM model of the project is not developed until it has become an as-built model to use for operation and maintenance activities, which are the stages that supposedly benefit most from the use of these tools.

It is worth highlighting the similarity between the opinions of BIM users and non-users. It is believed that this is because the non-users repeat the message that they hear from users and software distributors.

As shown in the study, BIM tools are being used in the design stages. However, the concern regarding intellectual property disputes that is being expressed in other studies conducted in countries that are more advanced in the use of these tools has not been detected [28], which could also be considered a lack of maturity.

On the other hand, there is a shortage of professionals trained in the proven work methodology. The majority are self-taught. It is essential to have formal training that does not exclusively focus on how to use the modeling program; rather, it should cover the various tools as a whole, their interoperability and suitable project management in the different stages.

5. ACKNOWLEDGEMENTS

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