

THE NEED OF BIM TECHNOLOGIES IMPLEMENTATION TO DESIGN COMPANIES



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ABSTRACT

The aim of this article is to analyze BIM technologies need to the design companies. Increased effectiveness of design companies using BIM was assessed. Article discusses BIM design challenges, barriers, problems and solutions. In order to assess the need of BIM technologies for design companies right, 10 BIM programs using companies designers were interviewed. Also there were identified factors which influence design firms to implement BIM programs. According to the respondents the greatest influence of BIM software installation for their company had calculations of 3D construction. Furthermore, there was assessed the increased effectiveness of the design services using BIM. The paper discusses the BIM technologies need for the design companies. There was estimated demand for BIM technologies for micro company which carries out design work in Lithuania. When project ordering demand is moderate, company is not willing to expand and economical situation in the country stays the same, it is not profitable to implement BIM for „micro” company when it is not making complex projects.

KEY WORDS

BIM, BIM technologies implementation, design companies, BIM implementation affecting factors

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INTRODUCTION

Nowadays construction industry is very demanding, specialist must have knowledge about different construction areas, be able to work with multifunctional complex computer programs. BIM design has many advantages, which make the traditional design model gradually lose its value. Many design firms gradually switch to BIM design. Editing of the project becomes easier when using BIM programs in design companies, whereas graphical subjects are spaces, walls, structural elements. When information about chosen structures physical and functional characteristics is collected comprehensive complete project is being generated.

Design company effectiveness is evident when complex project with all parts is needed.

Results of this design methodology is not just a creation of the Architects design intentions and spatial relationships shown in 3D, a BIM is a repository for digital information and data generated by the design process and simulations; it is the design, fabrication information, erection instructions, specifications, materials palette, schedule, and project management logistics in one database (Schinnerer, 2006). Data models will exist for the life of a building, can be used to manage the client's asset, and will exist as the „As-Built”

documents for future additions, renovations, and upgrades (Kuehmeier, 2008). The question is, when does the need to implement BIM technologies to design companies arise?

1. BIM TECHNOLOGIES NEED TO DESIGN COMPANIES

Despite the fact that the development of the ArchiCAD software program in 1982 in Hungary is viewed as the real beginning of BIM, implementation of BIM has been relatively slow in the construction industry compared to industries such as manufacturing and engineering for over two decades. There was a significant shift in momentum over the past five years as technology and implementation issues improve and the industry realizes advantages (Smith, 2014). McGraw Hill (2014) has been tracking the evolution and implementation of BIM in the global construction industry since 2007 through extensive global surveys. They have found significant change over that period and quite dramatic implementation increases over the past few years in particular. In North America their survey results showed that BIM adoption by contractors escalated from 28% in 2007 to 71% in 2012. The United States have long been a global leader in BIM development and implementation in the construction industry. The Scandinavian region is also a global leader in BIM adoption and implementation. BIM technology is ideally suited for popular in the region prefabrication construction methodology. A survey undertaken by the China Construction Industry Association in 2012 found that less than 15% of 388 surveyed Chinese construction companies used BIM (McGraw Hill, 2014). McGraw Hill found that the Chinese industry had structural barriers such as difficulties with changing traditional methods and that on many projects the Chinese law requires the design and construction stages to be separated with contractors not involved in the design stages. Therefore, it is not possible to use one of the main advantages of BIM collaboration in the work process.

Among small design companies BIM programs for complex design are used rarely because small companies usually engage in the small objects design. Therefore it is not possible for them to feel benefits, changes and payback for their companies fast. In addition, most of the companies are specialized, work in design area making projects of certain buildings or structures, engineering communications.

Building information model technologies are more popular among large design companies, manufacturing enterprises, design centers, and so on. The use of BIM creates an opportunity for construction companies to create workplaces in the design companies subdivisions: buy BIM programs, train staff. The most important benefit is received in the construction management area, because BIM helps to prevent from errors occurring during construction stage.

BIM technology is suitable for all construction objects, but it became popular after using BIM for the design of complex buildings and construction: multi-storey buildings and skyscrapers, bridges and flyovers, roads, highways, and etc. Today, construction productivity lags behind other industries. There was made a research, which analyzed 100 tallest skyscrapers in the world (Reizgevičiūtė et al., 2013). The study analyzed construction period, when BIM was not yet used in the world. There was compared the productivity of the construction of skyscrapers built before 1990 and after 1990. According to the research results, it is noted that the construction speed in the last years decreased more than 36%.

According to foreign authors, once BIM technology is widely used by small and medium enterprises, it would be worthwhile to investigate the difference between the perceptions of architects in large organizations and architects in small and medium sized organizations (Son et al., 2015).

Despite the many advantages of BIM design many companies delay buying expensive BIM programs. There are several reasons which influence designers' hesitation to use BIM:

- companies accomplish small objects and errors during different construction stages occur rarely;
- it is not possible to carry out the project without the 2D CAD drawings (detailed drawings, site plans and etc. are required);
- designer of a project is chosen by the lowest price and designer's work is not valued considering wasted time or quality, so return of investment is doubtful;
- lack of information about the copyrights (when project is made in BIM environment question is who will ownership copyright because client owns the model);
- when client owns model and builds similar or typical project he might choose a cheaper designer.
- it is important to assess designers priorities when thinking about the need of BIM technologies.

It is important for the designer:

- to design a building, which complies the essential requirements and regulations;
- to provide list of materials, quantities, provide technical specifications, base constructional solutions;
- to provide major non-standard detailed drawings;
- work with project as long as it is profitable.

It is not important for the designer:

- how long construction of a building will take;
- erection of a building delay.

Factors, affecting BIM design implementation in the building industry:

- builders can see that a lot of time is spent for downtime (meanwhile employees receive hourly wage);
- errors calculating materials and quantities estimate for large objects can occur (difference of 10-30%);
- it is hard to control the work of employees;
- it is hard to plan work for several months ahead;
- it is important to ensure workers' safety and health;
- right plot exploitation in urban areas (storage places) is very important factor.

Therefore it is very important that the materials and equipment arrive to the object at the time when they are needed. Using BIM design and planning platforms, it is possible to exploit the construction site effectively. Delay arising on the construction site is significantly rising the construction price. Different factors may influence the rise of downtime. The main reason for the difficulties on construction site-inadequate planning. Without BIM it is difficult to control the delivery of materials in time, correct mistakes. Also delay can occur because of a lack of cooperation between the contractor and the designer. Without BIM technologies these parties do not contact, the work is not coordinated, often work must be repeated, additional time for changing the project is needed.

2. CHALLENGES, BARRIERS, PROBLEMS AND SOLUTIONS OF BUILDING INFORMATION MODELLING

In order to assess the need of Building Information Modelling for the company, it is necessary to consider BIM barriers, challenges that should be solved. Before starting to use BIM usually there are considered these issues: software cost, staff training, training time,

downtime. However, when company starts to use BIM there are faced much more barriers which are different for each individual company and are depending on its size, number of employees, status in the construction sector.

During BIM implementation to design companies there are seen three types of barriers: legal, technical and commercial. One of the biggest legal threats is fluid collaboration. Furthermore, it is important to indicate responsibilities of a different project parties, assess the risks of model ownership. Technical barriers: interoperability, the lack of standards (national). Commercial barriers: inertia (stagnation), needed investments, asymmetric risks and rewards, no standard business models, no standard contract models (Ashcraft et al., 2015).

There are three critical BIM installation issues in the design company:

- selecting software;
- addressing IT issues;
- training up and rolling out.

It is noted that many BIM programs are similar, have following characteristics: 3D modelling environment, „domain” toolkits, cutting drawings, possibility to import and export. However, professional user sees the differences between different BIM programs: some are easier to use, some are geared forward through „traditional practice in 3D”, some handle more complex geometries, some handle larger scale.

The question is how to choose the right software, which would fulfill all the requirements for the quality and planned finances. When commercial software proposals are received, price, opportunities of a program and adaptation for specific design company should be evaluated. In order to choose right it is advised to try at least a couple programs (trial versions). This would create an opportunity to compare strengths and weaknesses of a different programs (Ashcraft et al., 2015).

Fig. 1 illustrates connection between the owner (builder), a building contractor and designer (design company/architect). This model describes standard cooperation model. When project is already made, contractor is searched. It is noted that owner transfers the instructions directly to contractor, who coordinates the construction issues with subcontractors, suppliers, and other participants in the construction. In this case, the designer is left behind and cooperates only with the owner implementing his instructions and tasks. This model

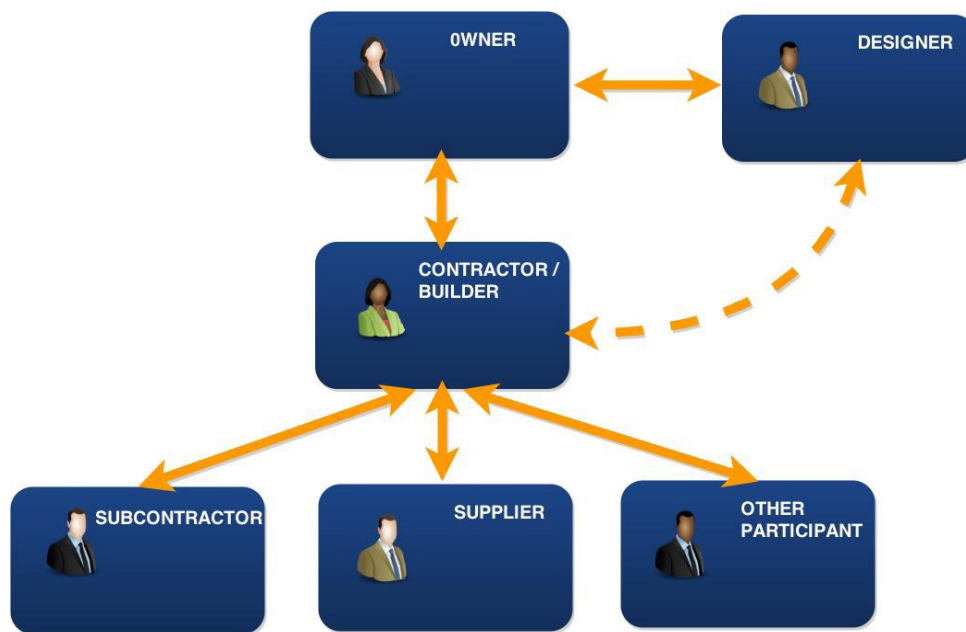


Fig. 1. Standard cooperation model between construction parties

Source: author's elaboration on the basis of (Ashcraft, Shelden, 2015).

refers to a hierarchical management system, individual construction project participants do not communicate, there is no cooperation between the different parties.

Using a Construction Management (CM) firm early in the design process will result in more accurate preconstruction estimates that will keep the owner more informed for bankroll and cost purposes. Fully integrated BIM design process links the CM to the architect at the beginning of the design phase. Each of them will have input to the design of the building, and the end result will be a more cost effective building due to the increased productivity from this type of relationship. They enable the exploration and improvement of the project executing strategy, facilitate improvements in constructability with corresponding gains in on-site productivity, and make possible the rapid identification and resolution of time-space conflicts (Fischer et al., 2004). Although this model is based on a much more complex design process, but it creates opportunity to create the most effective construction project „script”. Fig. 2 illustrates the relations during construction process when building information model is used. Model changes from hierarchical, which is common in today's construction industry, to collaborative model. One of the biggest advantages is the feedback between participants of the construction process.

The biggest disadvantage of BIM model is equal rights to the common project. Everyone can express their opinion in the design phase, so the design process may significantly slow down. Contractor cares to erect building as fast as it is possible. Meanwhile, engineer cares about constructional simplicity, so it would be easy to calculate constructions and building statics. Architect seeks that his/hers designed building would be interesting and impressive. Furthermore, architect cares about comfortable building usage. Often some exterior-interior details cost a lot and are difficult to build. The owner usually seeks to profitably sell, rent premises, as fast as it is possible. Different participants of the project sees design work through a different angle, so this model brings new winds and is very complex in respect of fast design and different opinions.

Important disturbance when deciding to start using BIM is uncertainty whether the investment will return. Complication is that the technology is always evolving and a lot of time and expense can be spent on software and training with unceratin outcomes. The „pioneering” path can be high risk as firms become „test pilots” for certain technologies whilst their competitors wait in the wings to see if the „testing” will result in commercial value and competitive advantage. But this „wait and see” approach is no longer viable for firms that want to be key players in the construction market particularly at the top end (Smith, 2014).

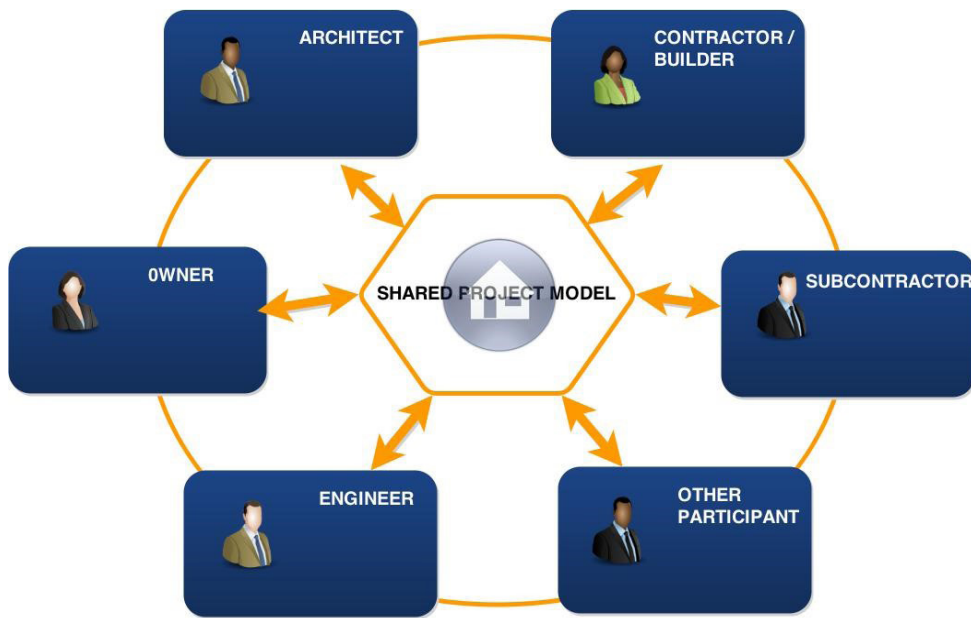


Fig. 2. Reciprocal relationships between various parties involved in the design process and the BIM project
 Source: author's elaboration on the basis of (Ashcraft, Shelden, 2015).

Because the true benefit of a BIM is to the project owner, the push to use a BIM will most likely be a client-driven development. Many owners see the single point of responsibility in integrated practice as an attractive alternative to the „over-the-wall method” of design and construction in which an architect completes a design and hands it over to a contractor for construction. Speed, accessibility, communality, and adaptability are achieved by the use of a common database, early information user input, knowledge representation and information technology, team collocation, and information exchange in small

batches (Elvin, 2007). Based on expert studies, other benefits of BIM include reduced risks, improved productivity, streamlined production, maintenance of design intent, and facilitation of quality control through clear communication and sophisticated analytical tools (Guidelines for Improving Practice, 2007).

Fig. 3 presents different needs of participants in the project. BIM helps to fulfill these needs. In addition, table shows issues, which do not interest particular project participants. Architects and engineers do not care about the construction time

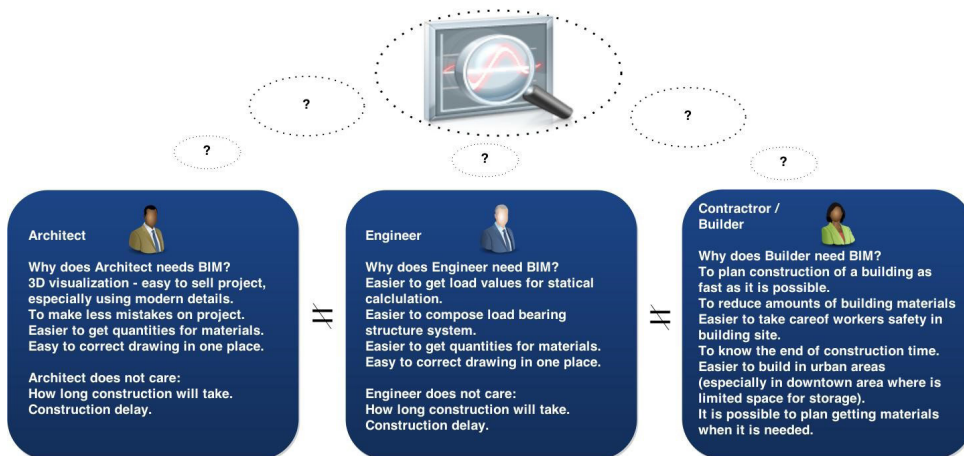


Fig. 3. Different needs of participants in the project

delay. When considering the need of BIM implementation, architect does not care, how long construction of a building will take, project delay. According to the provided information, it is noted that contractor/ builder feels the biggest benefit using BIM. BIM model helps to shorten the construction time, reduce the quantities of materials, to accurately plan the ending of construction. It also helps to ensure workers' health and safety. Building Information Model makes it easier to build in urban areas, plan the arrival of materials on construction site at the right time.

3. IDENTIFICATION OF FACTORS, WHICH AFFECT BIM IMPLEMENTATION

In order to assess the need of BIM implementation correctly and identify factors which affect the design companies to invest in expensive technologies, there were interviewed 10 designers whose companies are using BIM. 12 factors which generally encourage design companies to start using new design software were randomly presented for the respondents. The respondents evaluated BIM installation affecting factors, which influenced their company in 10-point system. 10 points for factors which had the greatest influence; 1 – had least influence. Fig. 4 shows results of the survey.

According to the respondents the greatest influence of BIM software installation for their company had calculations of 3D construction. This factor unanimously got 10 scores from all respondents. It

can be assumed that companies maintain a full complex project so it is convenient to use a single BIM program because constructions are calculated in the same model, which is created and holds information of all building information model in the central file. Therefore, information is always updated and there is no need to change formats, convert files.

According to the respondents second place of the most affecting factors got easy drawing correction (it is enough to change something in one drawing and it automatically changes in all model). This factor got high rating because it helps to decrease time resources – during initial project stage primary project proposals are changed a lot depending on the client's needs.

3-4 places were taken by the list of materials generated by one click and factor that automatically created material list is more accurate. This factor describes the need to accurately calculate materials, also there is less labor cost because data is generated automatically.

Design of complex objects demand got averagely 8 points and was left in 5th place by importance. According to the respondents' opinion, it can be assumed that the object size when choosing BIM programs is not an essential factor, since surveyed companies do not have a large amount of great projects. In addition, it can be assumed that despite the challenges of re-working when using 2D programs, professional designers implement large projects as well as successfully and smoothly as smaller projects.

6-7 places were shared by these factors: multiple model usage and visualization opportunity, which affects easier project sale. Repeated model usage does

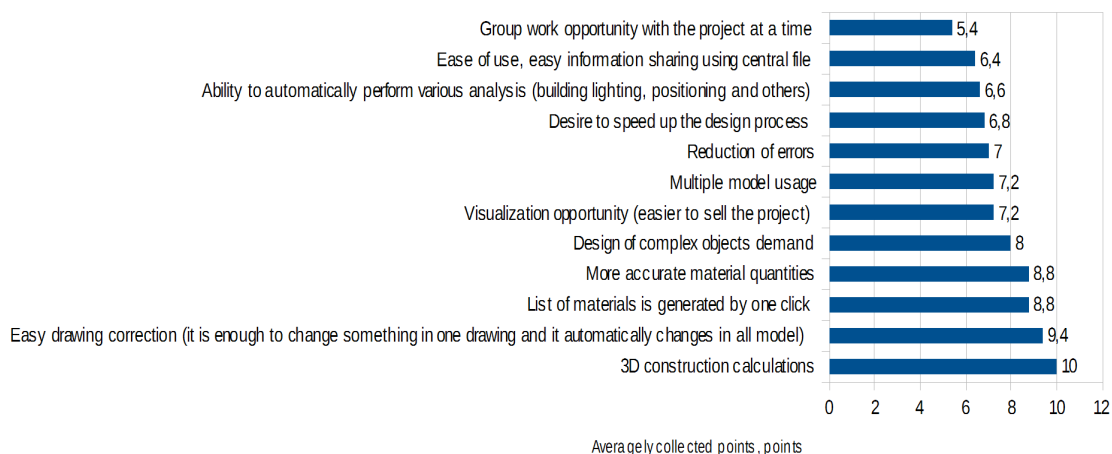


Fig. 4. Factors, which affect BIM implementation

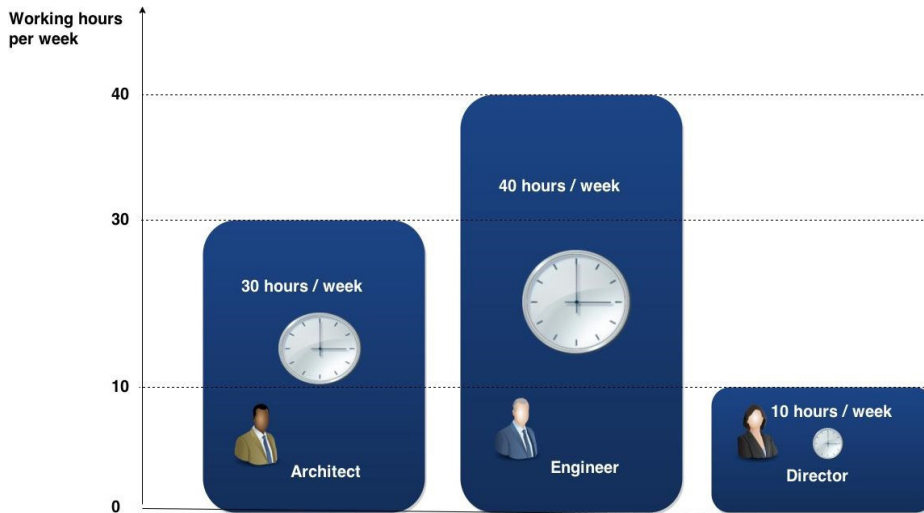


Fig. 5. Distribution of employees in the company

not have a decisive influence, since the projects are rarely similar, so the value of one central file model is mostly beneficial to the builder, who possess the purchased project for his needs during the period of the whole building. Design companies do not get obvious benefits for visualization, because 3D view is often unnecessary for the customer, especially when building is residential, constructed for its own use and not for sale.

Reduction of errors which occur in the project averagely has collected 7 points. It can be concluded that professional users working in the surveyed design companies make few mistakes, so this factor is in 8th place.

The desire to speed up the design process has collected 6.8 points. It is believed that 2D users skills before starting using building information model programs were excellent. Therefore, a decision whether or not to install expensive BIM softwares did not affect the need to speed up the design process, since employees work optimally.

According to respondents opinion, the ability to automatically perform various analysis (building lighting, positioning and others) interests them averagely- this factor has collected 6.4 points. When providing design services it was noted that demand for these analysis from customers is not high, so factor has no significant influence when choosing to use BIM programs. Ease of use and easy information sharing using central file got 6.4 points.

Factor of group work opportunity with a project at a time was left in 12 place and collected 5.4 points.

In today's society, it is noted that professionals often seek to be leaders- show their knowledge, take leadership, make everything perfect to the last detail. Therefore, several professionals are not willing to work together in one project and share their intelligent knowledge, ideas and information. During the survey turns out common opinion of all employees, as companies have implemented BIM technologies for awhile, so owners of the companies had the opportunity to assess the need for BIM technology factors and the most improved employees working areas.

In order to properly assess the importance of BIM technologies and design services need, design company „N” activities were analysed. The company is a private limited company which works more than 2 years. Company „N” is micro enterprise which employs altogether 4 employees (2,5 posts). Since the company is attributed to the group of young companies, it employs few workers not full-time (it is not their main job). By doing this the company has adapted to the changing market and if it is necessary can do larger projects because has available certificates and working professionals. The company carries out different kind of design work. Foreign authors have proven BIM benefits for large companies theoretically and practically. During the research the aim was to find out whether it is beneficial to implement BIM software and spend money for designers training to „micro” enterprise doing business in Lithuania. Fig. 5 shows the staff of „micro” enterprise distribution by profession.

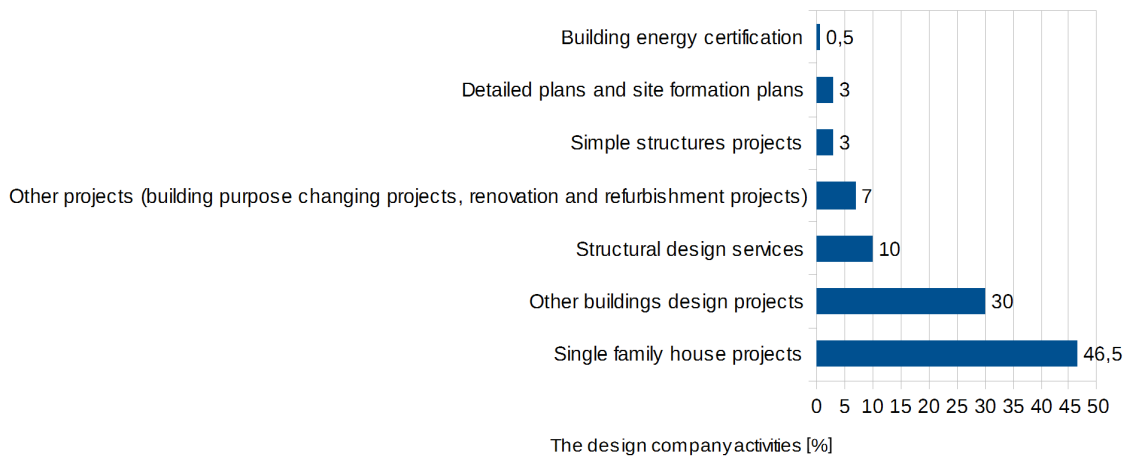


Fig. 6. The design company activities

The company prepares detailed plans and site formation plans, single family houses projects, construction design projects, simple structures and other buildings projects, renovation and refurbishment projects, building energy certification. Company provides a wide range of activities. It was noted that not all activities require complete complex project. It is pointed out that complex project is necessary for the design of single family houses, when architectural and structural parts are required.

Calculations have been carried out according to the company's economic performance and different activities. The cost of the different projects have been evaluated after companies activities were grouped into different areas. Figure 6 shows the price part of different project depending on the total price of all the projects. The biggest part of the company's projects consists of single family house projects – 46.5%. Other buildings design – 30%, 10% – structural design services. Other activities- take only 13%. Despite the fact that single family house design takes the largest part of company's activities (when full complex project is needed with architectural and structural parts), but this activity receives less than half of the company's income.

Not all company's projects are complex. Full complex project is needed with architectural and structural parts only for single family houses. However, company does not offer heating and ventilating, air conditioning, plumbing and other project parts. It is concluded that it is not worth to install BIM programs and train staff for „micro” company, which specializes in many different areas.

Payback time is long because the expenses are needed for programs, training. In addition, the company receives less than 50% of income from complex projects. When project ordering demand is moderate, company is not willing to expand and economical situation in the country stays the same, it is not profitable to implement BIM for „micro” company.

CONCLUSIONS

Implementation of BIM to design companies is a complex process, changing three areas in the company: technology, processes and people (their skills, qualification). Design process is faster, more efficient, cost estimation accuracy increases, decreases unplanned expenses when using BIM. According to the survey, the greatest impact on BIM technologies implementation to the design company has 3D design calculations. It is convenient to use a single BIM design program for companies, which maintain a full complex project, because constructions are calculated in the same model, where all of the building information model central file is being created.

Building information model technology is more often used by large production companies, design centers. The most common reasons why designers' refuse to work with BIM: the design of small objects, 2D drawings demand (detail drawings, site plans), doubtful return of investment, copyright issues. Designers priorities when they assess BIM technologies need: to design a building fulfilling all essential structural requirements, to provide the basic

material quantities, justify used construction solutions, to provide technical specifications, to provide major non standard detail drawings, shorten design time. When considering the need of BIM implementation, designer does not care, how long construction of a building will take, project delay. Building companies feel the maximum benefit using BIM because the possibility of downtime is reduced as with BIM project is planned precisely, list of materials is more accurate, easier control of work, easier work scheduling, easier to ensure workers' safety and health, better storage places and plot exploitation in urban areas.

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