

## PRECONDITION FOR WIDER USE OF PREFABRICATED CONSTRUCTION METHODS

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Prefabrication is one of the key elements of industrialization in construction. Prefabricated construction methods are presenting a range of techniques to improve the building construction, quality and how to reduce the negative impact of building production on the environment. Paper deals about the theoretical apparatus defining a classification of prefabrication in construction. It deals about the criteria that influence the decision on the deployment of prefabricated elements to the project. Article also brings the results of survey focused on the application of prefabricated construction methods in Slovakia.

**Key words:** prefabrication, survey, industrialization.

Заводське виготовлення є одним з ключових елементів індустріалізації в будівництві. Метод збірного будівництва передбачає низку заходів для поліпшення якості будівництва, та шляхів зменшення негативного впливу будівельного виробництва на навколишнє середовище. Розглядається теоретичний апарат визначення класифікації заводського виготовлення в будівництві. Йдеться про критерії, які впливають на рішення про розміщення збірних елементів у проєкті. Наведено результати дослідження обсягів використання методів збірного будівництва в Словаччині.

**Ключові слова:** збірна будівництво, заводське виготовлення, дослідження, індустріалізація.

### Introduction

From the time of Great Industrial Revolution (late 18<sup>th</sup> century), science, engineering and technology having progress by leaps steps in all areas of industry. Industrialization of construction has growth explosive since the middle of 19<sup>th</sup> century. Prefabrication as a tool of industrialization means the production of structural components in a factory, their transport to site and installed within the building. Prefabrication should be synonymous of speed, cost and quality construction with a reasonable cost and low impact on environment.

### Foreign surveys in terms of prefabrication

McGraw Hill Construction [1] made a research in the field of prefabrication and modularization and their impact on labor productivity. Through the online questionnaire between architects, designers and contractors were obtained data about the impact of prefabrication and modularization on key factors of construction productivity. The research also examined the impact on project planning, costs, safety, quality, eliminating construction waste and building of green buildings. The major finding was that 66% of responses pointed shorten construction period, 35% of them for more than 4 weeks. By the question about cost reduction, 65% of the responses declared cost reduction, 41% from them of more than 6% percent. Reduce of construction waste declared 77% of respondents and 44% of them even more than 5%.

Building Information Modeling (BIM) is effective way how to design and document building projects. BIM is representing information modeling technology of building. Information can be effectively used by all participants of construction. Finance, Management consulting, Investment banking for the Engineering and Construction industry (FMI) [2] in their survey investigated the benefits of prefabrication, such as saving labor, time and cost, higher quality and improvement of project. The results showed that although 80% of respondents surveyed reported 5% saving on wages for workers and they are expecting

that this percentage in the coming years will have an upward trend and may reach up to 16%. FMI Corporation from BIM expected to play an important role in the growth and application of prefabrication in projects. Only 18% of respondents currently see BIM as important for prefabrication and 31% say it helps just a little. It is apparent from their inexperience, because at work they are using CAD models not supportive of BIM. 5% of respondents answered that consideration of implementing prefabrication project to be implemented already in the pre-design phase and not during the course of construction.

By implementing prefabrication element into the project, it is necessary to make a decision for it. Luo et.al. [4], in his study demonstrated that the greatest impact on the enforcement of implementing prefabrication into projects should have a contractor because he comes directly to contact with prefabrication and that has an affects on the productivity of the work carried out by its staff. Table 1 defines the impact of prefabrication on project objectives and performance indicators made by Luo.

Table 1

Project objectives and performance indicators [4]

<i>Initial costs</i>	<i>Construction time</i>	<i>Quality</i>	<i>Sustainability</i>
<ul style="list-style-type: none"> <li>○ material</li> <li>○ direct costs</li> <li>○ indirect costs</li> <li>○ design and project planning</li> <li>○ repair and restoration</li> </ul>	<ul style="list-style-type: none"> <li>○ pre-project planning</li> <li>○ production of components and their transport</li> <li>○ mounting elements on the site</li> </ul>	<ul style="list-style-type: none"> <li>○ specifications from investor</li> <li>○ specifications from architect, designer</li> <li>○ construction management</li> </ul>	<ul style="list-style-type: none"> <li>○ health and safety</li> <li>○ environmental impact</li> <li>○ the economic impact</li> <li>○ recycling of materials</li> <li>○ flexibility, adaptation</li> <li>○ operation and maintenance</li> </ul>

In 2000, Haas et.al., carried out a survey [6] in order to identify the advantages of prefabrication from perspectives of participants in construction process. The scale was established on the principle advantages of score. Points 3-5 are considered as advantage prefabrication, points 1 to 2.9 as a disadvantage. The graph in Figure 1 is showing that contractors and designers know about the benefits that come with prefabrication.

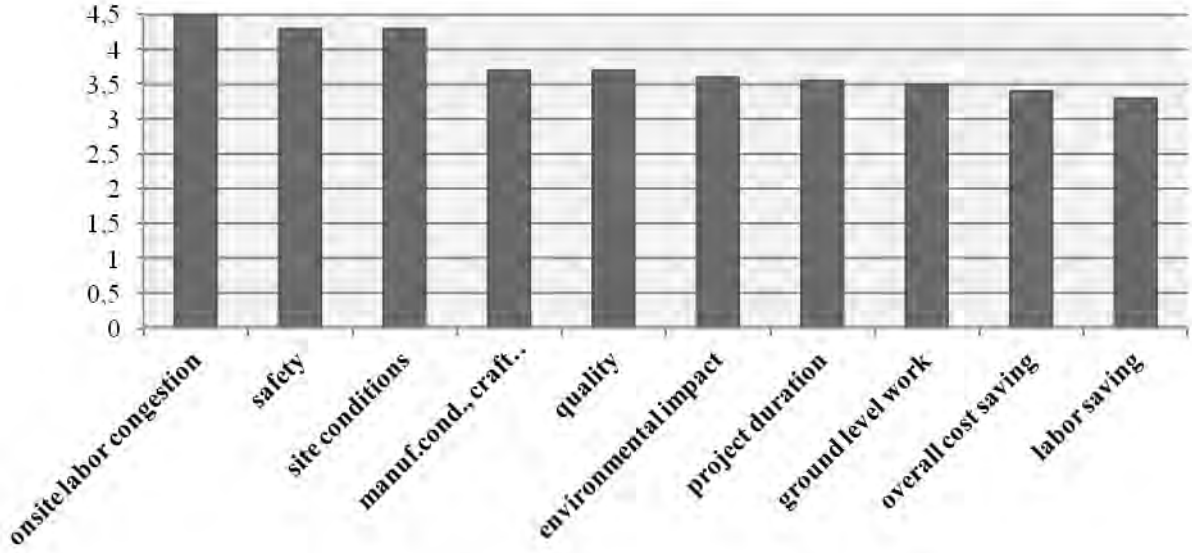


Fig. 1. Benefits of prefabrication (survey Haas et.al.) [6]

But the question is WHY prefabrication is not apply more widely and in different types of projects. Students from Hong Kong University carried out a study [7] with a selection of 24 factors grouped into 5 areas (as shown in Table 2) in order to define criteria restricting the application of prefabrication.

**Challenges in the development of construction industrialization [7]**

<i>Category</i>	<i>Factors</i>
<b>Policy system</b>	F1-Lack of standardization on materials, design, assembly, and construction process F2-Lack of quality certification system F3-Lack of preferential policies on tax, loan, and subsidy
<b>Technology development</b>	F4-Few standardized construction components F5-Low level of industrial production of construction components F6-Low level of assembly technology F7-Low level of mechanization and automation in construction F8-Low level of designing industrialized buildings F9-Low level of effectively transporting precast components F10-Lack of motivation on technical innovation
<b>Construction market</b>	F11-Separation of design, production, and construction companies F12-Unfit tender and bidding system F13-Low willingness of contractors to implement construction industrialization F14-Lack of design institutions and designer for industrialized buildings F15-Lack of precast components manufactures and suppliers F16-Lack of technician for assembling precast components on site F17-Cost pressure at the initial stage F18-Uncertainty of market demand
<b>Company governance</b>	F19-Unfit corporate culture F20-Unfit corporate organization F21-Lack the team with long-term cooperative experiences
<b>Society</b>	F22-Worries on unemployment of migrant workers F23-Attitude of the public on industrialized buildings F24-Worries on single architecture form

It is clear that the factors limiting the use of prefabricated elements occur not only in China, but also in the member states of European Union. With the growing requirements for buildings, such as the construction of efficient, less environmental load, a lower percentage of construction waste produced, economical and energy-efficient construction and so, these factors must be, if not completely eliminate, at least reduced.

### **Survey into the prefabrication of building structures in Slovakia**

The theme of prefabrication in construction is an aim of many surveys carried out in lots of countries. There is need to improve the impact of prefabrication in whole building industry, featuring impact on building cost, time, environmental impact, energy efficiency, etc.

Aim of our survey was to determine the current state of prefabrication in Slovakia. The target groups were contractors of different types of buildings (apartment houses, office buildings, industrial buildings..). This target group was selected because there are in direct contact with the technology of prefabrication and assembly of prefabricated elements. There was sent 205 questionnaires and returned from 105 responses, which is representing 51%.

The initial questions were related to the structure of surveyed firms. From the 105 responses by organizational legal form were 25 freelancers and 80 trading companies. Of these 80 trading companies, were 19 liability companies and 61 limited liability companies. Survey also examined the number of employees in these companies. Most numerous were small companies (10-99 employees-58 replies) and beyond them micro-enterprises (up to 9 employees-44 replies). To the questionnaire responded 2 medium-sized companies (100-499 employees). Large companies (over 500 employees) probably did not respond to the questionnaire.

To the question what is the most commonly implemented segment of construction (Fig.2) by the company the largest share have administrative and polyfunctional buildings. Behind them were industrial buildings, followed by houses and residential buildings.

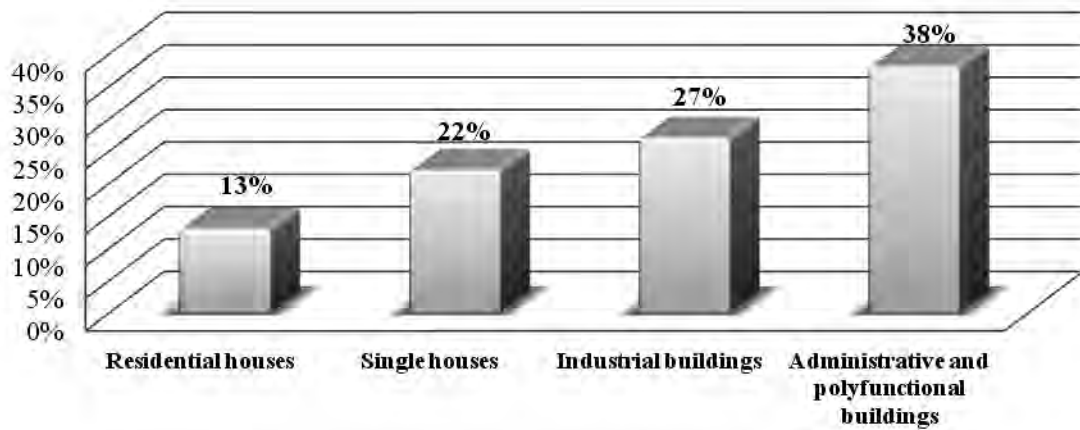


Fig. 2. The most commonly realized segment of construction

In question on what puts investor the main focus (Fig.3), survey show, that he puts the greatest emphasis on the overall cost of construction.

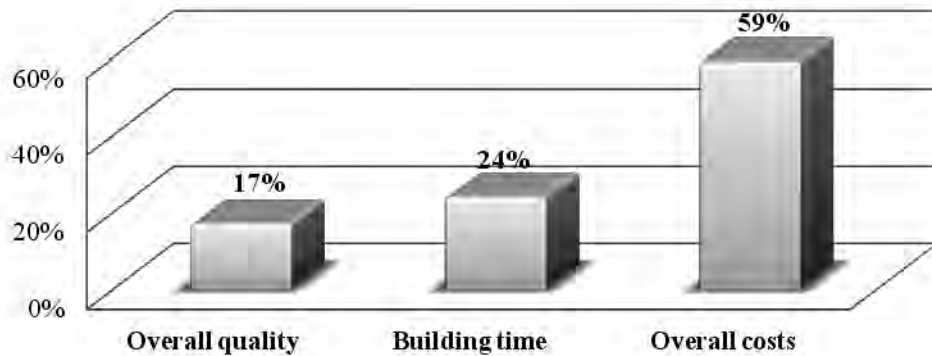


Fig. 3 Investors main focus

Survey examined whether companies know about the benefits of prefabrication (Fig.4). The biggest plus for them seems to be saving the cost of acquisition and construction time saving.

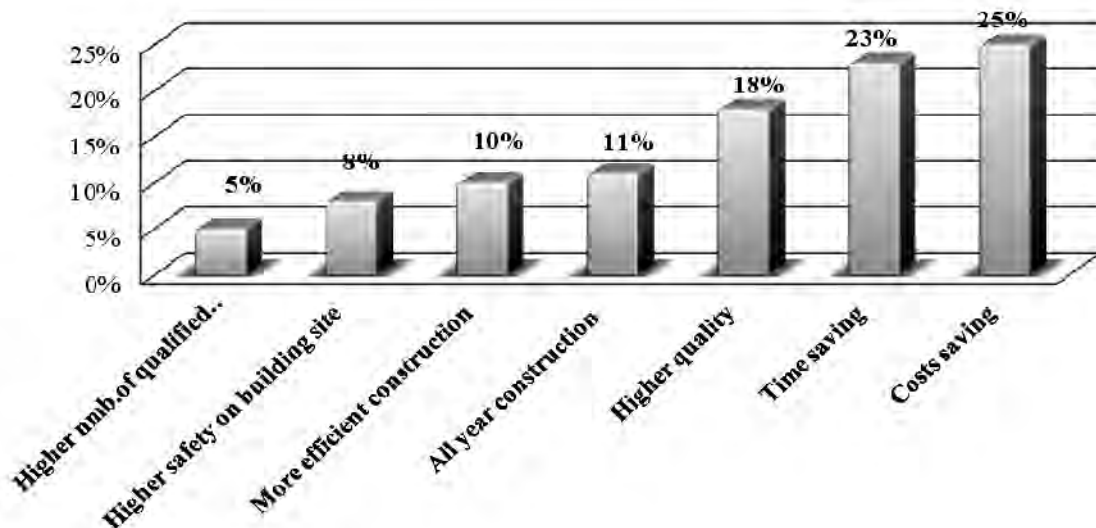


Fig. 4. Benefits of prefabrication

The most common prefabricated elements mounted into the building (Fig.5) are prefabricated column structures, wall construction and floor construction.

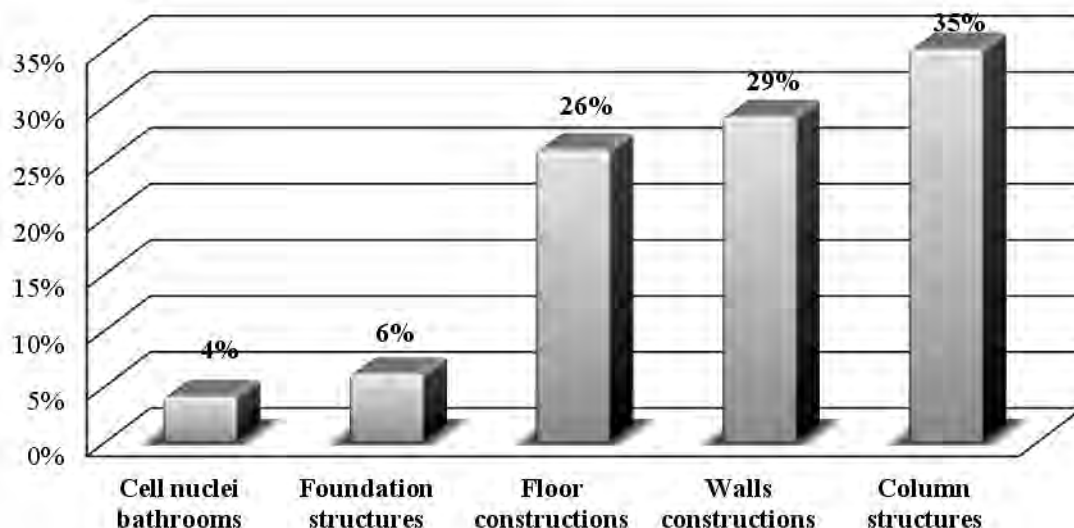


Fig. 5. Commonly prefabricated construction

In the last question the companies should think about the potential of prefabrication, if she can push the traditional methods of construction to the sidelines. Construction companies are aware that the hard part is still to convince investors of the benefits of prefabricated technology. They are particularly interested into the effectiveness of the implementation more prefabricated elements into the project and achieved energy savings.

### Conclusion

Economic potential of energy efficiency in the building industry depends on the actual design and selected building technology. The policy of energy efficiency can offers significant energy expenditure savings in all types of buildings.

Survey results indicate that the contractors are aware of the potential of prefabrication, they are aware of its many benefits, but they also realize that investor as a person who finances the entire financial cost of the project and if he will not want to use prefabricated elements, resp. he don't know about the benefits of the deployment of prefabricated elements, their interest in various types of construction projects will rise very slowly.

On the market is the need to build fast, quality, with low cost and high energy efficiency. It is need to increase number of prefabricated elements in projects, because it is the only way how to achieve these goals.

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