Smarter way to build: Volumetric modular construction system

Abstract
The article deals with the problem of increasing demand for modular buildings as an answer to the construction industry’s current situation and challenges of build environment. The case studies refer to the hospitality and student living sector. The author addresses the following question regarding the near future of the modular construction industry: How would it reflect on urban space, living space and the whole attitude toward modular construction issues? What is the role of the architect during the design-build process? Is it possible to make references to “beauty” in a modular construction context?

Słowa kluczowe: wolumetryczne budownictwo modułowe, prefabrykacja, budownictwo modułowe, architektura

Keywords: volumetric modular construction, modular construction, off-site, assembled architecture, permanent modular architecture

Introduction - Volumetric Modular Construction Growth
Investment in the construction sector has been dynamically growing for several years. According to the European Construction Market Forecast the growth is expected to continue into 2019 and 2020. European construction growth is broad-based and occurs in all major sectors: residential, non-residential and civil engineering. The construction market is at a significant moment. However, this idea relates not only to the dynamic and constant growth of the industry’s input but also to many issues which construction is currently facing. There are several factors shaping the current situation. Mark Farmer, in his report on the UK’s market “Modernise or Die” suggests that the UK’s construction industry faces “inexorable decline” unless longstanding problems are addressed. He identified several critical symptoms of failure, particularly the labor shortage (which relates to demographic issues as well as the poor image of the construction industry), low predictability in the sector, its lack of innovation and collaboration, and its non-existent research and development (R&D) culture. These symptoms are common to many countries in the European Union and North America. High levels of cost inflation, driven by labour shortages, have caused numerous delays as costs have risen prohibitively. This current situation pushes the construction industry into a modern method of building and has a direct impact on the increased demand for modular construction. There are many advantages of the modular construction method. However, in the majority of cases, one of the main reasons for using modular technology is to speed up the delivery time which, compared to traditional on-site construction, can create buildings in a much shorter time frame. The schedule reduction is the biggest incentive that this method of construction ensures. It is also one of the largest claims that the industry has and the major motivation behind why permanent modular construction is used in the projects. Unfortunately the design and build process characteristic of the modular construction industry often limits the role of the architect and architec-

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changing approach: turn-key luxury hotels & student housing units

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Regarding the key benefits (there are more, ones
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product quality (the monitoring system ensures
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articles, including the abovementioned, it is noted
that one important element is frequently omitted –
eaesthetically pleasing architectural design. Nev-
evertheless, architecture based on modular construc-
tion should still represent a work of art. According
Vitruvian theory, a good building should satisfy
the three principles of durability, utility, and beauty
(Latin: firmitas, utilis, venustas). Unfortunately,
the majority of modular buildings reduce the archi-
tecture to numerical parameters and engineering.

The assessment criteria usually concerns execution
time, manufacturing time, assembly time, and the
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els, plasterboards, rock wool and steel, whereas in the interiors natural wood and good quality textiles, wallpapers, paints and LED lighting were used.

**Changing Approach: Turn-Key Modular Micro Living Concept**

Another interesting trend in modular construction is driven by the demand of the student living accommodation. According to Statistics Poland (GUS), almost 20% of Polish students study in Masovian area of Poland. Half of that number includes Warsaw (Szkolnictwo wyższe w roku akademickim 2017/2018 (dane wstępne), 2018). In total, only 9% of students in Poland can be provided with student accommodation. That means, that even if we would take all of those accommodations and put them only in Warsaw, still not every student in Warsaw could have one. According to Emerging Trends Europe survey 2018, student housing was the most considered niche in 2018. What is more, the same report is showing an overall high position in that category in total sector prospects. 4th place in development and 5th in investments. In both cases, it outruns, among others, central city offices and business parks.

When comparing that to Western EU countries and the USA, the situation in Poland is actually not so dramatic. In Spain student accommodation can be provided to 6% (-3% comparing to Poland) of students, in Germany 11% (+2%), USA 12% (+3%), France 15% (+6%), Netherlands 16% (+7%), United Kingdom 24% (+15%).

In Denmark, where basically universities do not have their dormitories, in 2018, that number was around 28% (+19% comparing to Poland), however, this number is inclining rapidly. It could be higher but unfortunately, Copenhagen is lacking a lot of student accommodations (it can deliver currently such places only for 17% of its students). For comparison, in 2018 that number in the city of Aalborg reached 30% (CBRE Denmark, 2018). If taking into consideration, that Aalborg is building 9-11 student housing buildings per year, the city can easily reach 35% in 2022.

Due to the rise in demand for UK luxury student accommodation, Polish-based company was requested to prepare a modular turn-key compact space which integrates quality, design and smartness. The building is being used as Educational and Promotional Room for modular housing solutions. It is a model single room based on a module with dimensions 3,16m x 7,26 m (26,60

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**Ill. 9.** Percent of student accommodations in student housing in different countries. Zbierajewski Piotr, Report: Potential of student housing in Poland. Tips from Denmark. Published on Dec 4, 2018

**Ill. 10.** Student Unit Concept. Prototype. View of the living room. Source: DMDmodular

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**Ill. 2.** Modular Hotel Extension: Bonifacio Spa and Sport Resort, Sochocin, n/Warsaw, Poland. View of the assembling phase. Photo: DMDmodular

**Ill. 3, 4.** Modular Hotel Extension: Bonifacio Spa and Sport Resort, Sochocin, n/Warsaw, Poland; Before and After the modular extension. Photo: BFC and DMDmodular

**Ill. 5, 6, 7, 8.** Modular Hotel Extension: Bonifacio Spa and Sport Resort, Sochocin, n/Warsaw, Poland; Selected interiors: guestrooms on the first floor and fitness room on the ground floor. Photo: DMDmodular

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**Il. 1.** Modular Hotel Extension: Bonifacio Spa and Sport Resort, Sochocin, n/Warsaw, Poland; View of the assembling phase. Photo: DMDmodular
sq.m. gross). The apartment includes a separate sleeping area, a kitchen and a bathroom, thus constituting a multifunctional space. The room was designed on the basis of a module which, owing to its dimensions, enables easy transport and possibility of arranging it in different configurations. Owing to the flexibility of the floor plan, the module can meet the preferences of the investor. It can also be suited to the needs of the disabled or enlarged to create a multi-functional space. In order to give the module a modern look, light materials, large windows were used, and colour was added to the interior. Technical Innovation & Sustainability: The structure of the building is based on a steel structure filled with rock wool, which allows for achieving very advantageous heat transfer coefficients, thus limiting energy loss as well as insulation and service costs. The compact body of the building as well as the lack of thermal bridges are conducive to heat properties. The panelling of the structure includes wood-based panels and plasterboards ensuring high acoustic and fire protection properties. The external cladding is ventilated elevation made of fibre-cement panels and plasterboards ensuring high acoustic and fire protection properties. The flat roof is covered in EPDM membrane that ensures proper water insulation. All the windows contain triple pane sets as well as a membrane that ensures proper water insulation. All the windows contain triple pane sets as well as a suitable sun protection. Owing to the flexible design, the module can be configured in different layouts, expanded, multiplied and disassembled, thus constituting an innovative and attractive solution for investors.

Cost Effectiveness: To achieve the desired turn-key luxury product in the timeframe required proper combination of materials as well as processes. Climate in the UK required energy efficient buildings with higher levels of wall and roof insulation. Only 4 weeks passed from the preparation of the concept to the finish of the prototype. Owing to DMD employees’ experience, we were able to create an attractive and innovative facility in short time. The costs of service of the facility were reduced: double insulation ensures low energy loss, large windows let in light, thus reducing the costs of artificial light, and the possibility of ventilation enables savings on AC. Also, highly effective LED lighting was applied. Due to the ease of multiplication of the module and its elements, the costs of production are relatively low and allow for a precise costs estimation. Adding the possibility of easy assembly and potential relocation, this is an interesting offer for those seeking a quick return on investment.

6. Conclusions

Despite the overwhelming presence of the modular construction developments lacking high aesthetic values which are a carrier of negative connotations, there is more and more projects that present the changing approach to the modular construction industry. Modular Construction technology gives some huge possibilities for architectural creations. The key benefits - competing for traditional technology - are also a base of a much wider range of aesthetic options that allow designers to achieve architectural variety. The last years demonstrated the growing role of the architect during the design-build process based on modules. Architects emerged as stigma-breakers and image-transformers of the dominant negative associations with off-site construction.

Although the process of using modular technics by hospitality and housing sector is very fresh, because it started significantly only three years ago, it is suspected that hospitality and student sector based on modular construction might play a crucial role in redefining image, the position on modular architecture in wider design & visual context by providing cutting-edge architecture. As the same time the fact of many advantages of this method of construction which refer to the environmental values (schedule reduction, disruption reduction, pollution reduction, cost reduction, etc.) has the potential to have positive impact on the future of the build environment and human being.

ENDNOTES

1 European Construction Market Forecast from 2015-2020
2 85th EUROCONSTRUCT Conference Helsinki, 8 June 2018.
4 Modular Building Institute. WOM 2018, Miami, USA. Based on the presentation of Dave Sikora, the MBI’s Board Member at the MBI Meeting in Munich, on 26th Sept. 2018. There are several publications ordered by UK government, i.e. Farmer Review 2016: Modernise or Die. The Farmer Review of the UK Construction Labour Model was commissioned in February 2016 by the Construction Leadership Council on the request of the government.
The research focuses on commercial construction and does not include single family residential. The research uses a case study method to compare PMC projects to traditional site-built projects globally for construction performance parameters such as cost, schedule, quality, and safety.

Project was designed by Anyo Studio, London based architectural studio. The project was designed and built by DMDmodular, the Polish-based manufacturing company lead by architects that aims to integrate three crucial features: beauty, design, and modular technology.

Whole interior and furniture design was provided by DMD.

BIBLIOGRAPHY