

Modular Construction in the United Kingdom Housing Sector: Barriers and Implications

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Abstract

Houses are providing these services. Secondly, there are three transportation methods. The cheaper options are to transport the house on a truck or via rail, although there are places which are not accessible by a truck. If that is the case, then a helicopter must be used, but the costs of this service can be extremely high. A great advantage of modular housing is that the houses can have different layouts and can be extended if needed. "Haus Ott", an energy globe award receiver in 2003, serves as a great example. The Austrian architects/developers "Fuerrot" produced a "Flexible Building System", which allowed building extremely efficiently, whilst keeping the costs as low as possible. The house offers extremely vast variety of internal design and layout, because the bathroom units, balconies, stairs and more are produced off-site as well. The owner has the advantage of choosing the design and layout, depending on the number of inhabitants. The architects state that under ideal circumstances, this modular house can be built in 10 days [4]. Overall, there are many great advantages of modular houses, like sustainability, durability, level of comfort, variable design, minimalized costs and more [5]. Although, it is important to identify the barriers, to understand why this beneficial construction method is not vastly used in the United Kingdom.

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Cambridge Dictionary defines the term sustainability as the "idea that goods and services should be produced in ways that do not use resources that cannot be replaced and that do not damage the environment". This means that sustainable materials are the ones that

for the UK market. The price included planning and building regulations, delivery, site preparation, installation and connections to water, electricity and sewage. The purpose of the house was to create a solution for UK housing shortage [13]. The external design of this house is extremely simple, yet modern and sustainable. The large window provides the room with daylight, and the walls are made from thin, vacuum insulated concrete panels. The house also has solar panels on the roof. The internal design looks natural, because the main material used is wood [14].

To summarize, it is strongly noticeable that main materials for modular houses in UK and Europe are wood, steel, glass and concrete. These materials give modern, natural look for the house, meanwhile, ensuring high thermal and sound insulation, high fire resistance and most importantly high comfortability for the occupiers.

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Studies have shown that modular house shipping becomes more expensive if the distance from factory to site is greater than 300 km [15]. Modular houses can be transported by a truck, train or helicopter. The type of transportation depends of the accessibility of the site. The cost of modular house transportation by a truck depends on the size and weight of it. In the UK maximum vehicle weight is 44 tonnes. The maximum length of the truck can be 18.75 meters, which are allowed only for road trains. Individual truck length cannot exceed 12 meters and articulated truck and trailer length is limited to 16.5 meters. The maximum width for all trucks and load is 2.55 meters [16]. UK government website also states, that there is an option of transporting “Abnormal” loads, which are exceeding the maximum allowance. To do this procedure the house transporter must fill a document called “Notification requirements for the movement of abnormal indivisible loads or vehicles” and notify “Highways England” 10 weeks before transporting the house modules. The allowed transporting measures can be a significant barrier when transporting house modules, because the design must adapt to the transportation method, otherwise the modules cannot leave the factory. The larger the modules the higher the cost of transportation. The option of transporting house modules via rail is possible; however it can be more expensive, because the house must be transported to the train and from the train. However, it depends on the distance. Moving the modules from a transport to another increases the possibility of damaging them. Although, using



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emissions. The study results showed that building modularly saved 55% of time and reduced CO₂ emissions by 43%. Conventional Construction would have made the house in 14.3 months and created 98.9 tonnes of carbon dioxide emissions, whilst the off-site construction produced 56.3 tonnes of CO₂ emissions [23].

0 H W K R G R O R J \

The “Business Dictionary” defines methodology as “A system of broad principles or rules from which specific methods or procedures may be derived to interpret or solve different problems within the scope of a particular discipline” [21]. Methodology employed in an experiment or a research paper is essential in order, to succeed, and bad methodology has harmed many research projects. Methodology is the way how the project is completed and there are different research types, like descriptive, analytical, applied, fundamental, qualitative, and quantitative. Methodology can also be a combination of these research types. The research methods are the tools and actions used in order, to complete the research, for example, interviews, questionnaires, case studies, analysing and examining science journals, videos, books and more [24]. Methodology of the project “Modular Construction in the United Kingdom Housing Sector: Barriers and Implications” involved both, qualitative and quantitative research methods. The use of mixed research methods allowed the researcher to examine the topic in greater depth.

The qualitative research methods used were literature review and interviews. The researcher produced literature review analysing books, journals, web documents, web sites. The books describing modular construction gave wide information, which was deeply analysed and discussed. The articles from journals presented previous studies on this topic and helped to find a gap in the studies. Web sites and web documents were used to find statistical information and the latest information on modular construction.

Semi-structured interviews were completed using video communication tools “Facetime” and “Skype”. Interviews are transcribed and analysed using a Content Analysis method. Content Analysis is a research tool used to determine the presence of certain words or concepts within the text, in this case interview [25]. This method gave a major influence for the project, because five construction professionals were interviewed, who gave a different opinion and view of the modular construction in the United Kingdom. Interviewees gave original opinions on the possible barriers of implementing this construction method. The interview consisted of five questions, asking the interviewees to express their opinion on modular construction in the UK, its’ implementation barriers and the future of it. The

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The frequency of similar answers from the participants in each question.

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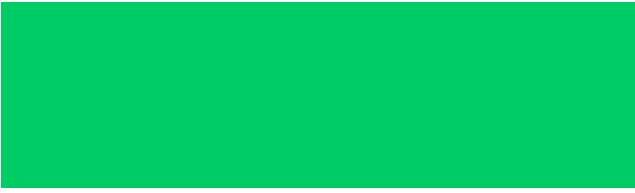
The purpose of questionnaire was to approach people who are living in UK, and to understand what are their preferences in their household regarding design are, sustainability, space, maintenance costs. Also, they were asked if they wish for a house to be built fast or slower, but to be more flexible in design. The survey included questions related to the land availability and if they agree that people should be more educated about modular construction. The aim of the questionnaire was to examine their preferences, and to analyze the differences or similarities between the construction specialist opinions.

First question asked about the importance of external and internal design of participant households. 72% of the participants stated that it is highly important for them to have great design of their houses, whereas approximately 25% of participants answered that the design is important or not important at all of this project supports the modular construction stating various existing modular houses with highly advanced design and the wide possibilities of the design (Figure 3).



Questionnaire question 1.

The bar chart indicates that 66.67% of participants list the



) L J X U Questionnaire question 7.

The land costs are high and availability of land is low in the United Kingdom. The questionnaire participants (90%) agree that the land availability is limited and costs are high, therefore the higher demand is for existing houses that are located closer to the city Centre. To