CONSTRUCTION MATTERS: INCREASING THE EFFICIENY IN DESIGN AND CONSTRUCTION PROCESS

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INTRODUCTION

In a context where new concerns such as greenhouse effect, resource shortage and economical restoration are on the spot, the optimization of construction processes is a huge and required challenge, since the construction sector is the largest consumer of raw materials and energy in the EU (25-40 per cent) and its activities account for about one third of the whole waste generated and CO2 emissions annually [1]. Besides, it has evidenced a huge lack of productivity in the last decade compared to other industries. Therefore, new strategies are needed to redefine the whole sector towards a more industrialized resource-efficient design and construction process involving, among others, material performance, stakeholder participation and digitalization. Throughout it is estimated that 42% of the final energy consumption, 35% of the greenhouse gas emissions and more than 50% of all extracted materials could be reduced [2], being both environmentally and financially beneficial.

REFORMULATING CONTRUCTION THROUGH DIGITALIZATION

The path of actions are based on three main pillars: The use of timber as main material, in order to reduce the resource intensity of construction materials, and because of its high level of prefabrication performances; the development of multi-storey buildings optimizing within the resources used in a project; and the optimization of the whole design and construction process through digitalization and industrialization, focused on lean construction principles by eliminating waste, reducing costs, increasing team productivity and creating value [3].

Taking advantage of what has been seen in other industries such as the automotive or manufacturing, construction should aim to standardize and industrialize its processes through off-site construction, digitalization and a leaner process management [4]. A “digital twin” elaborated through a BIM model and a close cooperation between all the participants of a project on a very early stage, brings a consistent and structured data management what allows a reliable monitoring of all processes. An enormous productivity improvement is achievable in terms of material performance, but also in terms of time and costs. This productivity improvement is feasable not only on the design phase, but along the total life cycle following modifications of the real building and updating itself to predict performances and their impacts in order to totally succeed with the conception. However, this approach implies bigger efforts on the design phase and consequently higher initial

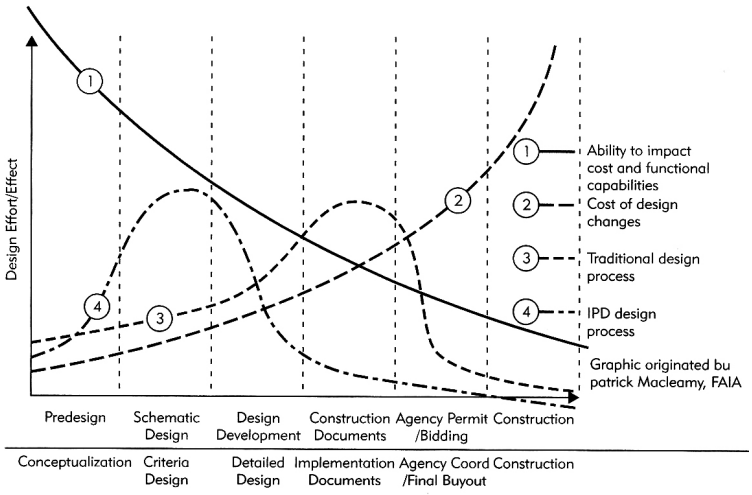

Figure 1: MacLeamy Curve. Abilities progression to control the costs and the costs of change in the traditional and IPD approaches

investment of time and costs, since every constructive element has to be firstly identified as sensitive to be part of a prefabricated system meeting all the required expectations (fire, acoustic, humidity, structural behaviour) and secondly accurately digitally modelled in a way it comes directly from design to production, avoiding the common fragmentation in traditional construction processes, where a number of different actors are participating at different stages of construction with poor levels of cooperation. This higher initial investment usually causes the rejection of the implementation of those approaches from side of many constructors, spite of the benefits they could bring later on by reducing up to 50% of the time spent on site. Nevertheless, its potential has been already proven in few pilot projects showing a large level of efficiency and productivity when combined with a leaner process management, as re-works and overlapping tasks are avoided, while quality, security and reliability are much higher.

DISCUSSION

One of these key projects, which unlock a new era of timber performance in multi-storey resource-efficient buildings, is the Life Cycle Tower One in Dornbrin, planed by the architect Hermann Kaufmann and built together with Cree by Rhomberg. All its construction elements were completely prefabricated in a factory, following the standards and modularisation defined through the system specifically developed for the project. This system was conceived in a way that its elements were prefabricated in local factories with the only need to be assembled on site like a Lego being able to raise two stores per day and with the possibility to replace them easily in the future if needed [5]. This approach brought lots of benefits in terms of CO2 emissions, costs, safety and quality, and since timber does not need the time to get dry as it is with concrete, beside its erection, works were developed parallel on site, saving up to 50 per cent of construction time. This shortness was translated to a significant reduction on the disturbances on traffic and neighbours caused throughout the construction phase. Additionally, this industrialised-based construction process allowed an quiet and clean on-site areal, where the space required for stock elements was minimal. These reasons above mentioned highlight the suitability of this kind of construction on urban areas.

CONCLUSION

Despite of these recent developments and the improvements achieved, design and construction processes on timber buildings still suffer a lack of efficiency in management. The aim of this work is to optimise these processes investigating the impact of different industrialised-based workflows and estimating improvements with the purpose to state a leaner value chain and stay competitive in the market of multi-store buildings, compared to concrete and steel, and to achieve a null-waste construction process in order to meet the expectation set by the EU, where all new buildings will be nearly zero-energy, highly material-efficient and zero construction waste sent to landfill by 2020 [2].

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