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# THE TRANSIT OF EU CONSTRUCTION BRANCH FROM CRAFT TO INDUSTRIAL PRODUCTION PROCESS USING BIM: THE CASE OF CONSTRUCTION PUBLIC WORKS IN GREECE ACCORDING TO THE ORDERS OF EU DIRECTIVES 2014/24/EU & 2014/25/EU

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**Abstract.** For years, the European Commission has focused on the production process of the construction industry, because this branch is included in the critical conditions for the European capitalism development. As such, it has focused on implementing modernization policies and increasing the productive capacity of construction companies and optimising the technical outcome for the benefit of its funds and the European society. For this reason, its benchmark has been focused on saving through the BIM practice of the unnecessary expenditure paid by funds that finance the construction of public works to meet more social needs. The author researches the transaction of the EU construction branch from craft to industrial production process using BIM. The subject of the research is approached methodologically through the examination of studies in the field of the construction branch. Announcements and Directives issued by the EU have been taken into account in comparison with national law and practices applied and used by individual Member States, especially by Hellenic public authorities, in order to identify why the EU insists on the use of digital building (3D), schedule management (4D) and cost management (5D) applying the productive process of construction public works. However, it is proven that the necessary incentive to increase BIM application usability does not seem to be perceived, since BIM applicability is not widespread compared to the executed construction volume.

***Keywords:*** *4D, 5D, BIM, Construction Projects, EU Directives.*

## INTRODUCTION

The accuracy of technical design and determination of the objective costs from project design are permanent project management objectives. Even though this practice has been applied for years in many European countries, Building Information Modelling (BIM) focuses on this particular purpose. As a concept, it valorises Intelligent Technology (IT), as it is applied to the digital construction of an infrastructure (Jrade, & Leddard, 2015). In addition, its functional structure is such that it enables the management of both the duration of each necessary work to build the project and the determination of construction costs (Willis, & Regmi, 2016). In this manner, it can be approached precisely, i.e., the objective final equivalent in money that it will cost to the customer.

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Thus, BIM use value is not only limited to its 3D application. This is not one more CAD application. Project manager is facilitated by its functional structure to accurately determine through drawings (Jrade, & Leddard, 2015):

- the elemental works to be executed for the project construction according to its technical design. Further, he is also in a position to build its work breakdown structure;
- the necessary raw materials to be incorporated into the project;
- the exact quantities of the specific works and materials;
- the necessary means of production for the work execution and the material processing.

Owing to BIM particular capabilities, an extra dimension to project design is given. The use value of BIM 4D consists of managing the schedule and planning the implementation of individual construction activities.

Thereafter, valorisation of the above-mentioned conditions (i.e., capital, labour and their management) leads to the final project cost calculation and the 5D capability use value determination of BIM (Willis, and Regmi, 2016).

Therefore, through BIM, the conditions of accurate digital management of project construction seem to be feasible (Aibinu, & Papadonikolaki, 2016). If this is confirmed in practice, the construction capacity of the branch is improved and thus the contractors' productivity is increased.

## 1. DIRECTIVES 2014/24/EU & 2014/25/EU: BIM INTRODUCTION IN THE EU PUBLIC CONSTRUCTION WORKS

For years, the European Commission has focused on the production process of the construction industry, because this branch is included in the critical conditions for the development of European capitalism. Thus, for a period of at least thirty years, a large number of studies, announcements and directives have been published. Thus, it is concluded (Commission of the E.C., 1997) that:

- the construction branch is fragmented in a large number of small and medium-sized enterprises;
- technical commodities are produced through conventional construction methods, mainly;
- conventional construction is based on craft production process;
- EU pursues cooperation enlargement between productive factors (capital and labour) in order to achieve the above-mentioned savings.

Therefore, projects cost more and their production period lasts more in comparison with what they would if they were constructed under mass production process (RICS, 2017) that is used successfully by manufacturers of automobiles, consumer goods etc. (Forbes, and Ahmed, 2010). However, craft production could not compete with the mass production (Gao, and Low, 2014). Therefore, there is a need to modernise and increase the productive capacity of constructors (RICS, 2017; Sielker, & Allmendinger, 2018), which will save money by the spent funds

on public construction works. This will result in the construction of a larger number of infrastructures, thus serving a greater number of needs (EUBIM, n. d.).

To increase the branch productivity and save the expenditures, the multitude of BIM use values and the necessary cooperation between the productive factors were set by the EU as a prerequisite (EUBIM, n. d.). Thus, Directives 2014/24 / EU & 2014/25 / EU were adopted. These acts intend to introduce the potentiality of application of digital building (3D), schedule management (4D) and cost management (5D) to the production process of technical infrastructure of the branch, mainly through the public works sector of the Member States, since the directives should be incorporated into their national law.

## 2. THE PRODUCTION FACTORS OF A TECHNICAL PROJECT: THE CASE OF THE HELLENIC PUBLIC WORKS SECTOR

### 2.1. Project Measurement by Design

According to the Hellenic practice, drawings for the selection of the necessary elemental activities, their Tender Documentation and the measurement of raw materials quantity are not used for public project construction. This is due to the fact that project finances are approved before performing a technical study. Thus, the social need equivalent in money is to be equalised with that of its financing.

This particular fact has been the cause of specific tricks, which ultimately lead to the project construction not according to tender documentation design but according to authority political needs. In practice, this is achieved either through contingencies or through increasing up to 50 % of the contractual equivalent in money. In particular, it has prevailed being counted a priori the contingencies in the public project exchange value, in the public project final equivalent in money. Thus, the design background, the design itself, the work breakdown structure, the budget and the Tender Documentation are mainly prepared and compiled to use the entire project financing. For this reason, Tender Documents do not correspond to the project that is going to be auctioned by the public agent. Instead, a designer compiles Tender Documents for a project that resembles that of the design, but for its construction the contingencies consumption will also be required. In many cases, in addition to contingencies, a supplementary contract is required at a cost up to 50 % over the original contract price (Metallinos, 2011).

The described process could not be implemented if design and construction are executed by BIM practice, because digital design (3D), schedule management (4D) and cost management (5D) cannot be violated as contractual components of the contractual agreement. Thus, what has actually been auctioned and agreed is exactly built by a project contractor and is purchased by a customer.

## 2.2. Resource Management according to Construction Project Management Principles and Contractor's Experience

After work breakdown structure compilation, the necessary resources (means of work, raw materials and employees) are determined, which are required for the design implementation. These are the necessary prerequisites for managing and planning the construction activities of a technical project. The deficient inventory and therefore incorrect measurement of project quantities makes project management difficult and an increase in the cost of construction can occur.

According to the prevailing practice, determination of the required resources is subjective for executing an object of Tender Documentation. It depends on available and performed capital structure, production capacity and technology used by the contractor. Thus, even for the same project, the required resources may vary, depending on a project contractor (Metallinos, 2011).

This empirically confirms the reality with regard to risk degree augmentation concerning successful completion of production process and technical commodity delivery to public customer (HM Treasury, 2011). Exactly at this point, the above-mentioned risk can be reduced because of BIM application contribution as Tender Documentation measurement and work breakdown structure can be compiled digitally by drawings. From now on, a contractor is capable of implementing activities, as he knows exactly what means of work are necessary, what raw materials are needed and in what quantity. Considering the prevailed particular conditions (weather, soil geomorphology, accessibility, project acceptance or not by local residents, etc.) at worksite location, it is obvious that the constructor's information is more accurate and risk uncertainties can be managed more effectively.

The consequences by BIM practice introduction are not limited to more accurate resource management. The designer should choose the implemented technology if he wants to manage the raw materials and the means of work according to his technical study. Through BIM, technology performed is a parameter that is mostly managed by the designer; even each individual constructor has his own production capacity which is dependent on his composition of capital. Undoubtedly, this does not mean that the contractor is completely bound by the applied technology of Tender Documentation, without any room for initiative. But in any case, things will not be as they are today, due to the prevailing practice. This means that the designer is able to determine and affect the conditions of contractor selection rather than the individual who pays for project construction, i.e., public agent.

Thus, in principle, the number of candidate contractors is limited. The followed technology is included in Tender Documentation and is, therefore, a contract term. If a candidate does not meet the terms of the Tender Documents, he cannot perform the contract and, therefore, does not participate in the auction. It can be concluded that this contemporary method poses the act of design in the centre of gravity of the production process, as from now on, risk can be managed before the commencement of construction process.

### 2.3. The Execution of Public Contracts according to EU Directives 2014/24/EU & 2014/25 / EU

In the case of public works, the construction technology is defined by the customer himself. Conditions for BIM form technical background, which has already been institutionalised before start-up design. Pricelists, Regulations, Tender Documentation, Auction Terms and others are only few of those Ministry factors that a BIM manager is obliged to use for the technical study production, purchased by the Hellenic public authority. However, benefits of BIM related to saving resources and timely handover of construction activities are not assured if BIM use is not institutionalised. Otherwise, the client-public agent cannot impose BIM implementation.

At the EU level, this issue is tried to be resolved by Directives 2014/24/ EU and 2014/25/ EU because the Member States are obliged to incorporate them into their national legislation. However, countries such as France and the UK have enacted its implementation since years (Sielker, & Allmendinger, 2018), mainly by instigating large construction firms, because BIM has been seen as a manner to reduce construction costs through lean management. This early integration of BIM is intended to give them a cost advantage and to be more competitive in a period of economic crisis (Davis, *et al*., 2015).

In this context, the BIM use was introduced into the national legislation by Hellenic legislator and BIM implementation was enacted by Law 4412/2016. However, so far, anything more has not been done to encourage BIM implementation by constructors, unlike some countries (e.g., Germany), which have set a roadmap for the adoption of BIM in the production process (World Economic Forum, and Boston Consulting Group, 2018; Sielker, & Allmendinger, 2018).

### 2.4. Acceptance of BIM Practice: The Hellenic Case

Until today, BIM practice has not been applied to technical project construction in Greece, either public or private.

However, the opposite is happening in countries like Sweden, whose construction structure resembles that of Greece. Specifically, in Sweden, before the mid-2000s, the BIM application was firstly adopted by small private-sector constructors and then its use was extended to big construction firms and public authorities (Swedish Transportation Administation) (Davis, *et al*., 2015; Lindblad, & Vass, 2015).

Regarding Hellenic reality, the reluctance to implement BIM may be due to the large number of small and medium-sized firms who act as independent entrepreneurs and, on the other hand, a small number of big construction firms, whose size is inferior than that of respective big firms of countries such as Sweden, France and the United Kingdom (Davis, *et al*., 2015).

The basic principle of BIM is the collaboration between contractors and designers (RICS, 2017; Willis, & Regmi, 2016). However, branch fragmentation does not contribute to this condition. The expected rate of profit/IRR has to be definitely high, so many small firms invest in BIM software, training and

employment (Willis & Regmi, 2016). It is obvious that they will prefer the derived benefit from selling smaller in size technical commodities, by employing fewer workers, even though their profit would be increased, due to more sales in the same time period.

In addition, collaboration is of great importance for the BIM method (RICS, 2017). Individual independent producers must grant their professional self-sufficiency to become members of a team of technical producers coordinated by a BIM manager (Willis, and Regmi, 2016).

In this respect, it is understandable why BIM was not used to construct projects such as Ionian Odos and parts of PATHE. These are public projects that were handover after Law 4412/2016 adoption. In addition, it is obvious that BIM use would reduce the expected rate of profit/IRR by the contractors. The reasons have already been presented: precise identification of necessary activities and therefore detailed work breakdown structure; saving recourses, so reducing the contractual money-equivalent for contingencies; timely project handover in accordance with the manufacturer's contractual obligations; elimination of reasons that lead to an increase in contract equivalent in money up to 50 %, as the causes of provocation are eliminated, etc. (Metallinos, 2011).

## 2.5. Focus on Adjusting the Necessary Conditions for the Implementation of a Public Project according to BIM Requirements

BIM practice can lead to new circumstances in the implementation of Tender Documentation of a Hellenic public project. We know that work breakdown structure activities are specific and legally institutionalised. They are chosen by a designer according to a Tender Document Invoice, which serves for budget calculation. For this reason, projects are implemented by the constructor according to their description. From this point, his obligation is to implement the regulations and to use resources, determined by the description text of each activity (Metallinos, 2011).

As a conclusion, it follows that the till today the used practice has been redefined, due to integration of BIM into the production process (Costa, & Grilo, 2015; Lindblad, & Vass, 2015). Schedule and cost management conditions are re-assessed, as many of them remain even without a practical object.

(1) Use value of Baseline Change Proposal is the first parameter that seems to be reduced. This is a useful tool, which contains the incorporated variation of activities and materials in a project. It is drawn up at intervals to illustrate:
- the activities and material quantity surplus compared to contractual budget;
- the activities and material quantity deficit compared to the contractual budget;
- the required activity implementation not contained in the contractual invoice.

The deficit of activities and materials, or even activities and materials not contained in the contractual Invoice cannot be paid by contingencies, these are paid by the money equivalent transferred surplus, as a financial account.

After BIM implementation in project construction, these deviations are missed, due to the accuracy of work breakdown structure and the measurement of activities and construction material quantity by a designer.

(2) The project budget is one more parameter. The correctness in work breakdown structure implementation and the precise measurement of construction activities and materials provide accurate technical studies.

For this reason, the contractual money equivalent for contingencies diminishes. Therefore, the final budget amount is also reduced. However, budget amount (M) is the independent variable that determines financial size of invited contractors in auction (Metallinos, 2011). Thus, due to this new reality, more bidders have the right to participate in an auction than previously, although they might be smaller size constructional enterprises. Consequently, as a result, the same project can be constructed for less money than usually costs, as competitiveness and discount size are increased.

(3)Finally, the discount size is a significant dimension because opening up competition to more bidders makes discount a powerful negotiation tool for the buyer.

Budget amount is inextricably linked only to the size of constructional enterprise and not to its ability to build a project. In contrast, discount is directly interwoven and depends on technical division of labour, productivity and available technology of each constructor. The technological level and productive ability of each candidate contractor are reported objectively and are reflected in the discount. For this reason, contractor's ability to construct and handover the project at a given discount price verifies the above-mentioned qualifications (Metallinos, 2011 & Metallinos, 2019).

## CONCLUSION

As the first conclusion, it can be said that, in general, BIM practice results in a new concept in the construction industry compared to the contemporary and still dominant craft one. Therefore, the stated goal has been reached, as the study has shown that BIM contributes to redefining craft production conditions of technical projects to corresponding mass production conditions. In this way, productivity is increased and the necessary resources are saved.

It has also been clarified whether the transition of the EU construction branch from craft to industrial production can be implemented. In such a case, it is obvious that the community objective can be achieved, in particular by reducing the thriftlessness of productive resources. The study has examined whether it is possible to redefine the conditions of the craft production of technical works under the corresponding mass production conditions. In this way, productivity is increased and the necessary resources are saved.

Nevertheless, the present research has also led to one more conclusion: the policies applied by the EU Member States as far as the reproduction and development of the construction branch are concerned, do not coincide, nor they go hand in hand with the initiatives that the EU decides concerning the application of the implemented policies by itself relating to the efficiency of financing project budgets and the saving of the resources.

Thus, although before the extensive application of BIM method it has been documented that structural characteristics of the branch make the redefining and modernisation of productive process of the construction industry difficult, today's reality shows that this fact has been overcome.

However, especially at the design stage, the cooperation between productive factors is a necessary prerequisite for the cost-effective implementation of BIM, because mainly in this manner it is possible to achieve an increase in the rate of profit that contractors expect in contrast to the traditional practice. Finally, the truth is that producers have to be convinced that their cooperation grants them a higher profit percentage (Willis, and Regmi, 2016). It is obvious that this could only happen when the entrepreneur-contractor has secured the appropriation of a higher profit percentage compared to the one he appropriates due to the currently applied craft production. However, it does not seem that this factor has been widely perceived as a presupposition for bidder entrepreneurship because BIM applicability is still not widespread compared to the volume of executed construction.

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