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DIGITAL TOOLS FOR THE CONSTRUCTION SECTOR BIM AND GIS

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Abstract

The paper deals with aspects of the digitization of the construction sector, specifically by detailing the process of adopting the Building Information Modeling (BIM) concept in Romania, in comparison with other European countries. It is based on the data obtained from specialised publications, while also integrating information about the legislative changes proposed for the adoption of BIM. Countries such as Germany, France, or Italy have taken concrete steps regarding the digitization of the construction sector by imposing the use of BIM especially in the projects financed through public funds. In this context, Romania relies on the reforms included in the National Recovery and Resilience Plan and their irreversibility to speed up the digitization of the construction sector.
In order to highlight examples of good practice, references were made to the integration of Geographic Information System (GIS) in cartography and in areas of public administration in Romania, as a component of digitization. Finally, the paper proposes a theme for a transport infrastructure project that will exclusively use digital techniques for the foundation, design, construction and monitoring of the stages related to the investment objective by combining the two tools: BIM and GIS.

Key words*: Building Information Modelling, constructions, digitization, Geographic Information System, transport infrastructure*

INTRODUCTION

In the European Union, the construction industry is an important economic sector, the turnover generated by it represents 9% of the Gross Domestic Product, contributing with more than 18 million jobs to the common labour market. Unlike other sectors, construction uses 50% of materials extracted from the ground and is responsible for 40% of greenhouse gas emissions.
One of the main disadvantages identified by the industry is the lack of efficiency manifested by unpredictable costs and delays in the delivery and in the operational process of investment objectives.
According to the European Commission, the construction sector is susceptible to be particularly hard hit by financial and economic crises. The main challenges facing construction sector refer to:

Stimulating demand: Efficiency improvements in existing buildings and renovations have the highest potential to stimulate demand.
Training: Improving specialised training and making the sector more attractive, in particular for blue-collar workers, technical colleges and universities.
Innovation: More active uptake of new technologies.
An indicator often used for measuring the performance of this sector is *the gross value added*. Data provided by Eurostat show a fluctuation of 1 percent between 2010 and 2021 in the European Union. Regarding the evolution of this sector in Romania, it can be seen in the attached graph that it has experienced much greater fluctuations compared to what happened in the EU.

Figure 1. GVA evolution of the construction sector_EU and RO

MATERIALS AND METHODS

Regarding the subject of improving efficiency and greening the sector, Building Information Modeling, or simply BIM, has emerged, a collaborative working method that integrates information from all teams connected to a project in order to obtain a single digital representation of the physical and functional characteristics of a construction objective .

BIM uses design tools and technologies that involve the creation, generation and management of information in a queryable database. It is a process that covers the entire life cycle of a construction project starting with plans, drawings (2D) in CAD (Computer Aided Design) and then going through digital 2D and 3D CAD. BIM is thus more than 3D modelling. Seen as a defined concept, BIM is structured on two levels, **dimension** and **stage**.

Dimension refers to the integration of different types of data and information, as follows:

- 3D BIM includes the digital model of the entire project
- 4D BIM includes the 3D model to which the temporal dimension is added, by integrating the execution times related to each stage
- 5D BIM includes the 3D model plus associated costs
- 6D BIM includes the 3D model to which the "facility management" component is added for an efficient management of the benefits obtained through the implementation of the project
- 7D BIM includes the 3D model and integrates sustainability elements of the construction

On the other hand, **stage** defines the level of collaboration and the flow of information between the teams involved in the development of the project.

- S0 contains 2D CAD modelling on paper, where collaboration is lacking
- S1 includes 2D and 3D CAD modelling, partial collaboration by introducing spatial coordination
- S2 includes 3D modelling along with time and cost dimensions, the data being interoperable and shared
- S3 stands for integrated BIM throughout the entire life cycle of a project

RESULTS AND DISCUSSIONS

COUNTRY	Date on which BIM became mandatory	Construction companies that use BIM (%)
UK	2016 for public funded investments	73%
Germany	2017 for projects that surpass 100 mil. EUR	70%
Poland	2030 for large construction projects financed through public funds	43%
France	January 1st, 2022	35% – real estate 50-60% of the construction companies

Croatia	not mandatory	25% of the designers 4% of the beneficiaries
Austria	2018-20 for controlling the operational costs of public buildings	20%
Russian Federation	March 1st, 2022 for all projects financed through public funds	12%

Figure 2. BIM adoption in various countries

We also refer to the study „*Integration and impact of BIM in the rehabilitation of buildings in developing countries*", whose scope is to compare the conventional and the BIM-based approaches in projects regarding the building rehabilitation. The study focused on a block of buildings containing a medico-social centre in Douala and on two other ancillary sites in Cameroon, an emerging economy, thus being in a proper position when it comes to adopting new technologies.

The methods applied for the BIM-based approach of building rehabilitation include collaborative management of the project, modelling of the building, cost estimation, development of project programme and maintenance of the building.

As seen in the diagrams below, the results revealed a gain of approximately 22% on the cost, and of approximately 14 days on the duration of the work between the classic method and the optimised BIM method.

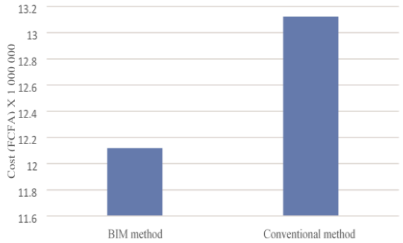

Figure 3. Comparison project cost for BIM vs. Conventional methods

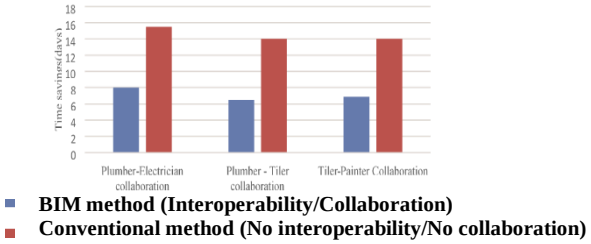

Figure 4. Time saving due to interoperability/collaboration between professionals

GIS IN ROMANIA

The GIS (Geographic Information System) is the system that allows the collection, management and analysis of data. The data that GIS manages can be of vector and raster type. Through data processing, graphic products can be obtained that facilitate the transmission of information in several fields, such as: environmental analysis, urban development and planning, telecommunications, transport and many others.

In Romania, Geographic Information Systems (GIS) have become increasingly popular among public institutions that have integrated them into their analyses. For example, GIS can be used in the spatialization and analysis of transportation systems. In the example in figure 5, GIS was used to represent a concept of a bridge-type structure designed for the railway link in the Port of Constanța .

Figure 5. Representation of the railway line from the port of Constanta using GIS

BIM IN ROMANIA

In Romania, on the national level, the strategy for digitalization of the construction sector targets the adoption of new technologies. Regarding BIM, in September 2022, a Memorandum was signed between institutional stakeholders with the subject of ”**Approval of the Roadmap regarding the implementation of the BIM methodology at the national level, in investment projects financed from public funds in the construction sector**”.

The BIM maturity stage considered as the starting level for the BIM implementation process in Romania must be at least the BIM2 maturity stage (BIM Level 2) and its adoption is part of the National Recovery and Resilience Plan, the main mechanism for accelerated reforms in all economic and administrative sectors.

According to the Memorandum, the implementation of pilot projects using BIM should start in the second half of 2024 and by 2029, BIM development and expansion will be integrated on a large scale.

In the same way, with the help of the line designed in GIS, they were transposed in Infraworks, a software that has integrated the BIM model, to realistically represent the future bridge (Figure 5).

With the help of Infraworks, the technical characteristics of the bridge were set, such as the opening of the piles, the materials used or the height in relation to the ground level

Figure 6. Representation of the railway line from the port of Constanta using Infraworks (BIM)

CONCLUSIONS

To conclude, the development of the BIM concept and its implementation represent an important step in the construction sector in Romania. The biggest advantage of BIM is that it is a digital tool that can track the progress of a project from the proposal stage to its completion. The disadvantages are given by the high costs for the purchase of the software and for the training of specialists in the field.

BIM as well as GIS are tools that require interdisciplinarity in use to maximize results. Their applicability represents an important step in the evolution of the construction system and not only in Romania, and they are the key to the development of technology and specialists.

The transport infrastructure could be one of the main beneficiaries of the BIM and GIS integration by providing an integrated approach on the various projects' entire life cycle. For example, we propose the integrated approach for the modernization of the Sinaia railway station, a project financed through European funds in the recently adopted Transport Program 2021 - 2027.

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