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Workshop: BIM4EEB: A BIM-Based Toolkit for Efficient rEnovation in Buildings †

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Abstract: On October 29th the workshop corresponding to the mid-term conference of BIM4EEB (Acronym of BIM Based Toolkit for Efficient rEnovation in Buildings, Horizon Project under grant agreement N. 820660) project was held during the Sustainable Places 2020 event. The main focus of the workshop was a general introduction of the project combined with vertical insights on the single tools that have been developed or are still in development. BIM4EEB grows from simple consideration: according to a BPIE analysis on EPC data, about 97% of building stock, currently not in A level, must be upgraded to achieve 2030 decarbonization objectives. As the biggest energy consumers, buildings consume about 40% of energy and they are responsible for 36% of CO_2—they are strategic in order to reach the set of environmental goals and subjected to renovation and refurbishment during their lifecycle according to a specific schedule. Refurbishment becomes the crucial point of sustainability not only in construction but also in the environment in general for the coming years. The BIM4EEB project focuses on implementing a complete BIM (Building Information Modelling)-based toolkit to be adopted in the renovation of existing residential buildings to make

the flow of information efficient, to enhance communication and data transfer decreasing intervention working time while improving building performances, quality, and comfort for inhabitants. The platform that controls all the tools developed for the best performance of renovation is BIMMS (Acronym of Building Information Modelling Management System platform), namely a management system linked to an operational and multifunctional toolkit for different AEC stakeholders, offering tools for increasing the adoption of BIM in renovation businesses based on an interoperable flow of information. During the workshop, six development tools have been explored in addition to the BIM Management System: BIM4EEB Fast Mapping of Buildings Toolkit, BIM4EEB BIMeaser tool, BIM4EEB BIM4Occupants tool, BIM4EEB Auteras tool, BIM4EEB BIMcpd tool, and BIM4EEB BIMPlanner tool

Keywords: BIM; toolkit; management system; renovation; Construction 4.0; models

1. The BIM4EEB Project and the BIMMS

BIM4EEB focuses on implementing a complete BIM-based toolkit to be adopted in the renovation [1] of existing residential buildings thanks to the presence in the consortium of different competences from the AEC industry to public and private researchers, SMEs (Small and Medium Enterprise), large enterprises, technology providers, end-users, inhabitants, and an umbrella organization representing all 600,000 EU architects—the group is formed by 15 partners from all over Europe.

The BIM Management System (BIMMS) in Figure 1 is the main platform that will speed up the survey, the energy modelling, the construction site management, and it will be able to support designers in the design and planning phase, construction companies to efficiently carry out the work, and service companies to provide attractive solutions for building retrofitting. It is an open integrated BIM-based collaboration environment where a set of digital tools is integrated in a web-based platform for designers, construction operators, and inhabitants aimed at easing the renovation processes through collaboration. The tools will rapidly shape 3D digital models of existing buildings and they will integrate semantic data in order to perform advanced evaluations of design options for renovations [2].

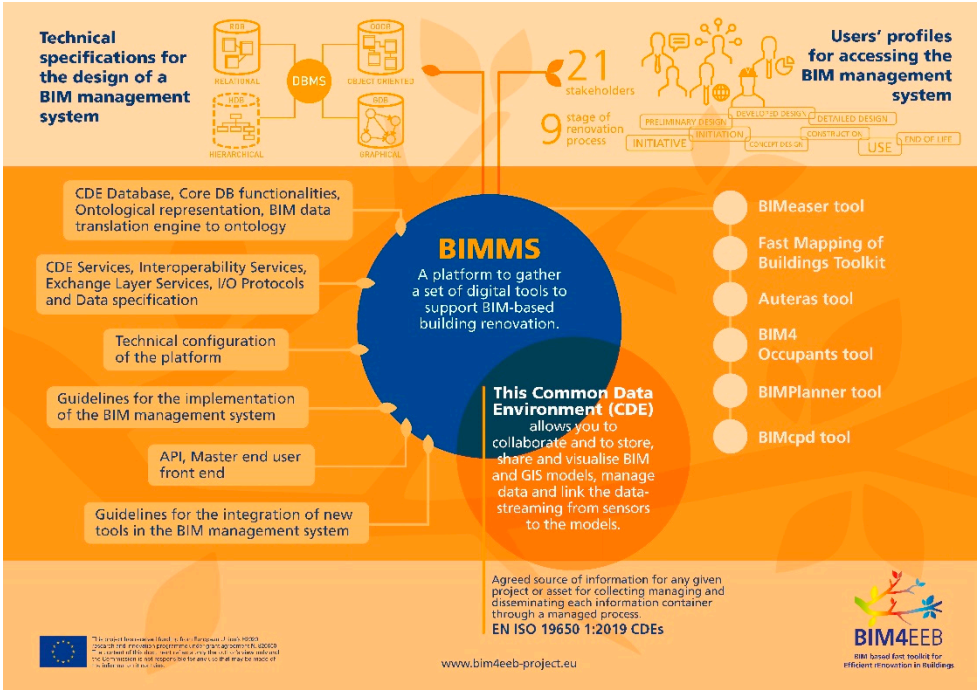

Figure 1. BIMMS general explanation and its relationship with other tools.

The BIMMS has been developed according to specific technological and procedural requirements following the indications about Common Data Environment (CDE) provided by the ISO 19650 parts 1 and 2 [3]. The main requirements defined for the BIMMS can be listed: the need to work with open format as a BIM-based collaboration environment, the need to extend model informative content through linked data, the need to guarantee the fundamental functionalities of CDEs (workflows, permissions, information states, classification, etc.), the need to effectively retrieve data (queries), the need to integrate new services and tools (API).

2. The Six Tools of the BIM Management System

The six tools included in the platform cover different stages of a renovation process.

The BIM4EEB Fast mapping tool is used at the early stage of the process, during the survey and analysis phase to gather information and quickly create BIM models of existing buildings using the latest technologies for survey (AR, laser scanning, thermo scanning, etc.) to give the opportunity to survey visible and invisible part of the building, in order to create the best model for following analysis and intervention. By scanning the walls with laser scanning equipment before, and with the help of a special developed sensor stick, then it will be possible to detect, and with an AR-(Augmented Reality) tool, visualize the walls digitally and the hidden installations inside the building. The tool consists of a hardware developed as a sensor stick and a software.

New drawings can be created by the AR-tool if those are missing in a renovation building.

The User Interface is designed to easy visualize the data in a HoloLens device. All menus and installations are showed in HoloLens2 glasses view. You can use your own hands, virtually, in front of the HoloLens while using menus.

BIMeaser and BIMcpd are introduced, respectively, as a support for decision-making and as a BIM-assisted energy refurbishment assessment tool, in the initiation and design phase.

BIMeaser uses the BIM and linked data from the BIMMS for faster initialization of the actual state resulting in more accurate building models. The tool finds solutions in accordance with the client's requirements while also aiming to minimize the energy use and maximize the occupant's indoor climate comfort.

The target of BIMeaser is to speed up the decision-making process in apartment buildings—a refurbishment project achieved by enhancing the effective informative discussion of different technical design details between experts with different backgrounds in the design team. The aim is to make a better selection of the building's refurbishment design which should meet the building owner's project requirements (OPRs). In addition, the tool should be able to enhance the building's energy performance, cost effectiveness, and the indoor climate conditions for the residents.

The BIMcpd (Constraint Checking; Performance evaluation; Data Management) toolset contains several distinct intuitive applications, that will allow the user to: find recommended positions for HVAC, lighting and other devices; analyze data from sensors, energy bills, and other sources (weather for example); manage the data that they have on the above and create new data sets that they can share with other tools. Any improvements and corrections that arise are noted, rectified, and updated to include any additional elements not previously covered for all three BIMcpd interconnected components, i.e., "c": Constraint Checking; "p": Performance evaluation; "d": Data Management.

These tools were designed to ensure minimum complications for the user while maximizing the outputs of each tool. Through a series of form wizards, the users are guided throughout each process.

For the construction and operational stages, BIMplanner and BIM4Occupants are designed.

Insufficient communication among the stakeholders of a renovation project is considered as one of the main problems behind low productivity, time delays, and cost overruns. In particular, renovation projects undertaken in occupied buildings are challenging due to the additional risks and logistical requirements caused by the presence of occupants during renovation works, which is known to raise conflicting activities between contractors and occupants. Therefore, an effective communication plan and implementation of proper health and safety procedures are required. This is the aim of these tools.

BIMPlanner is a planning and management tool for housing renovation projects–and BIM4Occupants produce a coordination tool between contractors and occupants. An information-sharing layer, based on ontologies and linked data technologies, is an essential technical enabler of these tools. The layer allows data sharing across the different components of the toolkit. The tools aim to enhance information sharing between renovation stakeholders and to enrich BIM data with links to other relevant data in renovation projects.

AUTERAS (Automated design of interoperable room automation systems) is capable of automating labor-intensive tasks during planning and design of vendor-independent, interoperable room automation systems, starting at the creation of VDI 3813-2 compliant room control schematics and followed by the selection of appropriate devices and the logical interconnections between them.

3. Conclusions

A wide audience followed the Sustainable Places conference focused on circular economy, digital twins, BIPV, local energy communities, sustainable digital infrastructure, and others. On the third day of the conference, our workshop was held with the aim of discovering the BIM4EEB project. In particular, a strong amount of success has been reached with the participation of our principal stakeholders [4]. coming from the associations world and the AECO sector so important for the development and validation of our project [5].

This validation of the developed tools and the proposed methodology will be carried out also adopting the main outcomes of the project to three Best Practice Examples in order to show their applicability, relying on actions of development, piloting, testing, and validating in relevant environments, selected due to their representativeness on the project's application target and because of the attention for selected end-users. In particular, stakeholders as designers, construction companies, and service companies will derive advantages of the implementation of BIM-based processes according to the methodology and tools developed within the project.

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