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EXECUTIVE SUMMARY

The Deliverable "D10.6 - BIMERR Living Lab Activities Evaluation Report 1" analyses the implemented Living Lab activities in the BIMERR project performed by M12. Following the design phase of Living Lab activities that was established in D10.2 – Dissemination and Communication Plan (M06), this deliverable is reporting the initial results from the implemented Living Lab activities of the BIMERR project. Moreover, the deliverable D10.6 describes the implemented Living Lab activities, the application of Living Lab methodology, a presentation of the implemented actions up to M12 and the initial evaluation of these actions.

Furthermore, the Living Lab activities involve the definition of various interaction and collaboration mechanisms and the organized targeted living lab workshops taking advantage of the input of key construction stakeholders and the pilot sites end users. Apart from the analysis and application of the Living Lab objectives, methodology and implemented actions, a very important part of this report is the evaluation of the implemented Living Lab activities. The appropriate Key Performance Indicators (KPIs) are set to measure the effectiveness and the coherence of the Living Lab actions and the appropriate tools to maximize the end-user engagement with the final BIMERR solution are thoroughly defined.

In addition, all the Living Lab actions described in this evaluation report are fully aligned with the goals and objectives of Milestones MS1 for "End-user requirements elicitation and documentation", Milestone MS7 for "Public Awareness, Dissemination and Engagement Planning" that includes the smooth operation of the Living Labs and the Milestone MS11 for the "Project website launch" for public access of the project website.

The Deliverable 10.6 -"Living Lab Activities Evaluation Report 1" of the BIMERR project, will be updated in a periodic basis in the upcoming months. The updated and enriched versions of the report will be submitted as deliverables D10.7 and D10.8 in M32 and M42.

1. INTRODUCTION

1.1 PURPOSE, CONTEXT AND SCOPE OF THIS DELIVERABLE

This deliverable presents the analysis of the establishment and implementation of Living Labs and their methodology, following their initial presentation in M06 at D10.2 - Dissemination and Communication Plan. Moreover, this report evaluates the Living Lab activities already performed under the auspices of the BIMERR implementation phase. The aim of Living Lab activities, is to establish an open innovation 4.0 and value co-creation framework, involving end-users and stakeholders either directly participating in or affected by the project and ranging from the project consortium partners to relevant end-users and stakeholders, along with scientific, technological and business communities.

The BIMERR concept has been conceived and elaborated by combining the clear need and willingness of construction companies of the consortium to further enhance/diversify their digital tool base with technology/solution provider partners. Furthermore, these aligned intentions and efforts construct a solid research and academic foundation to provide an innovative system that will be demonstrated and validated in relevant environments of real renovation activities. The BIMERR consortium is actively promoting the system using an evidence-based approach and this will be built on the use of the tools during actual renovation activities under real life conditions. The efforts from consortium partners to actively promote the BIMERR system and the value it can deliver to all stakeholders is further enhanced by the dissemination and exploitation activities of the project. The aim is to involve all the necessary AEC stakeholder value chain in the co-creation and co-design of added value solutions that respond to emerging market and sector needs.

The Living Lab operation in the BIMERR project extends from the very early stages of the project implementation (user requirements phase) up to the pilot evaluation phase, aiming at the establishment of an iteration and open collaboration process that will accelerate collaborative knowledge generation and integration, technology customization and validation against real market and user needs, as well as end-product definition and go-to-market strategy creation. The Living Lab activities involve the definition of various interaction and collaboration mechanisms. In addition, targeted living lab workshops are taking advantage of the input of key construction stakeholders and the pilot sites end-users.

The main purpose of the Living Lab activities is to provide a user-centric approach and a co-creation of the final BIMERR solution. With this new solution, the aim is to create a new product that is user-driven and to promote the adoption of the BIMERR solution as renovation-enabling

toolkit through intense dissemination and knowledge transfer of the project outcomes toward the targeted stakeholders, reaching out to audiences within and beyond the EU.

This deliverable in its first section, presents the analysis of the Living Lab general objectives, the methodology and the timeframe for the Living Lab activities. Moreover, in the second section, a detailed analysis of the actions performed in the design phase from M01-M06 and of the implementation phase (M07-M18) is presented along with the completed activities by M12. Following the presentation of the completed Living Lab activities, the estimated results, KPIs and the initial evaluation of the Living Labs activities until M12 is presented.

2. OVERVIEW OF BIMERR LIVING LABS

2.1 DEFINITION OF BIMERR LIVING LABS

The Living Lab concept is a user-centered, open-innovation environment integrating concurrent research and innovation processes within public-private-user partnerships. The concept of Living Lab is based on the user co-creation approach integrating research and innovation processes. The Living Lab activities are integrated through the co-creation, exploration, experimentation and evaluation of innovative ideas, scenarios, concepts and related technological artefacts in real life use cases. These specific use cases involve user communities, not only as passive observers but also as main source of formation of the final outcome of the project. This approach allows all involved stakeholders to concurrently consider both the global performance of the outcomes or results of the project and their potential adoption by users. Therefore, the Living Lab activities should start at a very early stage of the research and the development of all elements of the final product, in order to involve the user-centered approach to the entire lifecycle of the project. The Living Lab activities, which integrate both user-centered research and open innovation, are based on the following four main activities:

“Co-creation: bring together technology push and application pull (i.e. crowdsourcing, crowd-casting) into a diversity of views, constraints and knowledge sharing that sustains the ideation of new scenarios, concepts and related artefacts.

Exploration: engage all stakeholders, especially user communities, at the earlier stage of the co-creation process for discovering emerging scenarios, usages and behaviors through live scenarios in real or virtual environments (e.g. virtual reality, augmented reality, mixed reality).

Experimentation: implement the proper level of technological artefacts to experience live scenarios with a large number of users while collecting data which will be analyzed in their context during the evaluation activity.

Evaluation: assess new ideas and innovative concepts as well as related technological artefacts in real life situations through various dimensions such as socio-ergonomic, socio-cognitive and socio-economic aspects; make observations on the potentiality of a viral adoption of new concepts and related technological artefacts through a confrontation with users' value models.”¹

¹ Pallot M. (2009). Engaging Users into Research and Innovation: The Living Lab Approach as a User Centred Open Innovation Ecosystem. Webergence Blog. *"Archived copy"*. Retrieved 04/10/2019.

2.2 THE KEY OBJECTIVES OF LIVING LABS

A living lab rather constitutes an experiential environment, which could be compared to the concept of experimental learning, where users are immersed in a creative social space for designing and experiencing their own future product. The BIMERR Living Lab activities are oriented towards fulfilling the following objectives:

1. To disseminate widely all the results and the outcomes of the BIMERR project towards all the targeted end-users, beneficiaries and construction/renovation stakeholders.
2. Through the Living Lab activities, the goal is to generate a broad awareness, engagement and involvement throughout the BIMERR activities.
3. Receiving feedback from end-users and targeted beneficiaries during the project's lifecycle to optimize its different aspects.
4. To create new opportunities for additional exploitation and replication of the projects results after its official completion (validation phase).
5. To support all the various training activities of AEC community professionals during the BIMERR demonstration activities (validation phase).

In order to achieve all these objectives, the Living Labs need to be in direct cooperation and engagement with the end-users involved in the living lab activities. To achieve this degree of collaboration, BIMERR established a complete awareness and communication framework with all the involved stakeholders, either involved in the project, or affected by the BIMERR activities. The developed Living Lab methodology involves end-users and beneficiaries from the very beginning of a new idea, creating the motivation to share and discuss their experiences and their requirements. Furthermore, this innovative and collaborative environment where all stakeholders co-create these solutions, will lead to a natural acceptance by users who will be empowered not only to test, evaluate and report their own experiences with the BIMERR result, but mainly to use the BIMERR solution under realistic operation conditions and progressively to accept and integrate BIMERR in their daily working actions.

Therefore, up to M12, the BIMERR Living Lab activities have fulfilled the first three objectives that are enclosed in the implementation phase of the Living Labs and are analyzed further in the next sections of this report. The objectives number 4 and 5 will be eventually fulfilled in the validation phase of the BIMERR project.

During the development of the project, the Living Lab can provide an excellent environment for experience sharing and ideas exchange towards user-driven open innovation. The Living Lab activities are supported constantly by the user-driven innovation methodology and agile development of BIMERR, therefore will be thoroughly analyzed in the following chapter of this deliverable.

3. BIMERR LIVING LAB METHODOLOGICAL FRAMEWORK

3.1 METHODOLOGY

The Living Lab methodology is the main framework which supports horizontally several other aspects of the BIMERR project, and it was initially presented in the D10.2- Dissemination and Communication Plan 1 in M06. The Living Lab approach adopted by BIMERR, engages end-users from the very early stages of any new idea cultivating motivation to share and discuss experiences as well as requirements. Furthermore, one of the main novelties of BIMERR is the involvement of end-users and stakeholders in the co-creation of the BIMERR framework (user-driven approach).

As described in the Deliverable D3.1 – Stakeholders Requirements for the BIMERR system, in order to meet the BIMERR objectives, user requirements that will form the basis for the definition of the BIMERR tool architecture, need to be produced. The BIMERR solution addresses many aspects of the renovation process and at the same time involves many different stakeholders. For this reason, the aim of the Living Lab Methodology is to establish an open innovation 4.0 and value co-creation framework, involving these different end-users and stakeholders either directly participating in or offered by the project and ranging from the project consortium partners to relevant end-users and stakeholders (AEC professionals), along with scientific, technological and relevant business communities.

Moreover, the methodology of the BIMERR Living Lab is based on the User Engagement concept that aims to the constant and effective engagement of the end-users to the BIMERR project. Therefore, the end-users and main project beneficiaries are collectively placed at the center of all research, innovation, demonstration and communication activities of the BIMERR project, which adopts a User-Driven Innovation Approach towards addressing emerging end-user and market needs, critical for the successful project implementation and the realization of its anticipated impacts. The main aim of the User-Driven Innovation Approach is to involve renovation professionals and building residents/owners throughout all stages of the project life-cycle, as the key enablers of the BIMERR innovation process, towards encouraging active and collaborative contributions in the development of a BIMERR-based ICT system to accelerate energy efficiency renovation across Europe. In the overall User-Driven Innovation approach it is necessary to incorporate agile ICT implementation methodologies in conjunction with the continuous validation and verification processes. The main goal is to manage cross-



functional teams and ensure the establishment of an effective BIMERR system with the use of innovative, cross-disciplinary integrated ICT solutions.

One of the main characteristics of the User-Driven Innovation approach is the continuous interactions between different beneficiaries, end-users and project team members that will be encouraged to minimize deviations between expectations and final outcomes. In addition, the target is to divide the project final outcomes into intermediate marketable results.

Several tools such as templates and questionnaires have been produced by the partners, and subsequently used by the pilot participants in the context of the Living Labs for interviewing the targeted user groups during especially organized workshops. Details about the employed methodology are provided in the following sections.

3.2 TIMEFRAME

The main activities under the Living Lab methodology are planned to be executed in three following phases:

- The first phase of Living Labs is the **design phase**. The main scope of the activities in the first phase, is to gather the stakeholder specifications and requirements which will be used during the development of the BIMERR system. In cooperation with Task 3.1, different questionnaires for different stakeholder groups were designed and developed for the elicitation of the end user requirements. Those requirements will be then used as a core for the open-innovation design methodology of BIMERR tools and the main target will be to meet those requirements by the end of the project giving the opportunity to accelerate collaborative knowledge generation and technology integration against real market and user needs.
- The second phase of the Living Lab activities is the **Implementation phase**. The Living Labs are the live feedback loop between the stakeholders and the technology/solution providers. More in detail, the stakeholders in that phase are asked to provide feedback for the features of BIMERR tools during their development in order to establish the co-creation framework and maximize their effect on the characteristics of BIMERR tools. To achieve that, various interaction and collaboration mechanisms are used during that phase, including workshops that might contain demonstration of beta versions of tools, or direct demonstration of features by the technology providers to specified user groups, or online demonstration of BIMERR tools to specific user groups with the scope to receive their feedback and implement their needs in the BIMERR tools.
- The third phase is the **Validation phase**. Thus, the evaluation of BIMERR tools is performed in accordance with the successful meeting of the end user requirements. Moreover, the stakeholders shall be actively participating in the end-product definition and go-to-market strategy creation, during that phase by involving them through the final workshops in the pilot sites, but also by involving the participants in the training activities and other dissemination activities of the project. These activities aim to establish an iteration and open collaboration process that will accelerate collaborative knowledge generation and integration, technology customization and validation against real market and user needs, as well as end-product definition and go-to-market strategy creation.

3.3 MAIN USER GROUPS

During the design phase, building upon the user-driven approach of Living Labs, the first step was the definition of BIMERR end-users. After extensive internal discussions with the BIMERR pilot partners², the total number of BIMERR tools end-users was identified. The characteristics of this group of end-users were rather diverse and their potential interaction with BIMERR tools differed significantly. Hence, two of the earlier decisions for targeting the complexity of such a problem, were a) grouping the end-users into main user groups and b) choosing the design thinking method for the early interactions of the Living Lab members in the context of Workshops. These 2 approaches are described in detail in the Deliverable 3.1 in the relevant chapters.

The 17 user groups identified in the use cases are grouped to 7 main user groups according to their role in the use cases and the BIMERR component (tool) they will use. The remaining user groups are allocated to (or represented by) one of the seven main user groups since their role is considered either complementary or derivative for the use cases. Figure 1 depicts the users' classification to main and secondary user groups.

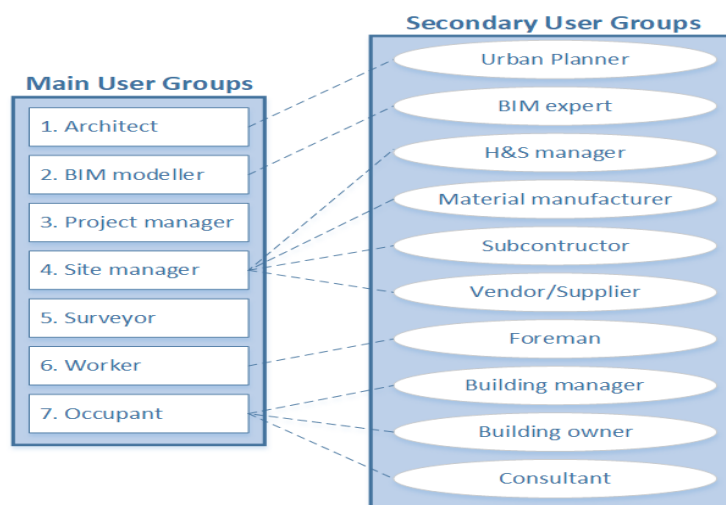


Figure 1: User groups and categorization to main and secondary groups

² For further details see D3.1- "Stakeholder requirements for the BIMERR system" page 15.

4. LIVING LAB ACTIVITIES ENGAGEMENT

The concept of user engagement is incorporated in the Living Lab Methodology for co-creation follows an approach to involve different perspectives and collaboratively design tools, materials, processes, tools and activities. Another essential part of the Living Lab methodology is engagement of the users. One important factor of the engagement is that all possible types of user's engagement require continuous information of the users about the project and various information tools and activities. Thus, all types of engagement require some tools and activities. In this context, the early planning of Living Lab activities as well as possible engagement tools of end-users shall be described and thoroughly analyzed from the beginning of the BIMERR project.

The following table is a useful mechanism to structure the types of engagement in Living Lab activities with the goals for the users, key messages and relevant engagement tools:

Type of engagement	Living Lab goal for participation	Engagement Tools
CONTINUOUS INFORMATION	<ul style="list-style-type: none"> Continuous information of participants in Living Labs in every stage of the project. The end-users and the stakeholders shall be informed about the goals and objectives of the BIMERR project. In this type of engagement is really important, the participants in the Living Labs to understand that their continuous input and feedback are very crucial for the development of the project. 	<ul style="list-style-type: none"> Website/ Social Media Brochure Fact Sheet Workshop Questionnaires Newsletter Press Releases Articles
CONSULTATION	<ul style="list-style-type: none"> Constant gathering of information and feedback from end users through the project The feedback that is received from the Living Labs is valuable for the project and they will be informed about how their input influenced BIMERR. 	<ul style="list-style-type: none"> Living Lab Workshops Questionnaires Templates
COLLABORATION	<ul style="list-style-type: none"> The creation of a collaborative relation with the Living Lab participants is very important. The identification of problems and the recommendations of possible solutions will be included in BIMERR. The collaboration with the users and stakeholders will ensure that their concerns will be incorporated 	<ul style="list-style-type: none"> Living Lab workshops Interaction with participants Open questions in Questionnaires

	in the final outcome alongside with solutions and recommendations that they proposed.	<ul style="list-style-type: none"> • Dedicated space on project website
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Table 1: Type of engagement in Living Labs

4.1 DEDICATED SPACE

For the implementation and the support of the actions included in the Living Lab activities, a dedicated space was designed in M03 and presented in M04 inside the project website. The dedicated space increased the interaction between the Living Lab participants and the consortium and promoted the engagement of the users with the completion of the questionnaires. Moreover, in the dedicated space for Living Labs on the BIMERR website, the end-users are invited to complete the end-user requirement Questionnaires, offered in 4 different languages.

4.2 LIVING LAB DATABASE

Overall, one of the main tools for the end-user's engagement is the establishment of a Living Lab database, which includes the personal data of the participants in Living Lab activities. With this tool the BIMERR consortium creates a pool of interested end-users that can formulate the final product during the development of the BIMERR project. End-users and stakeholders stem from the networks of the BIMERR consortium partners. All partners are responsible to provide contact details and to obtain the consent from end-users and stakeholders that are participating in the project Living Lab activities. The participants are categorized in target groups per user group (e.g. Architects, Engineers, BIM-modelers etc.). The Living Lab database is used as the pool for future dissemination activities and the list will be continuously updated though the development of the project.

5. PLANNED AND IMPLEMENTED LIVING LAB ACTIVITIES

5.1 DESIGN PHASE OF LIVING LAB ACTIVITIES (M01-M06)

As already presented in D10.2 Dissemination and Communication Plan, the design phase of the Living Lab activities of the BIMERR project outlined the concept and the activities that shall be included in the Living Labs. In detail, as described in D10.2, during this period, the methodology, the timeframe, the activities and the specific means for the implementation phase of the living lab activities were rigorously designed and presented in M06.

5.2 IMPLEMENTATION PHASE OF LIVING LAB ACTIVITIES (M07-M12)

Following the design phase of the BIMERR Living Lab activities in M07 the implementation phase had started. During this phase, the Consortium has implemented and set in place many of the foreseen tools and activities presented in the design phase. Moreover, in the following sections, the performed Living Lab activities by M12, are presented in detail.

5.2.1 QUESTIONNAIRES

As described in the Description of Actions of the BIMERR consortium, as part of the Living Lab activities had released a questionnaire in a dedicated space of the BIMERR website. This questionnaire is targeting specific end-user groups to capture their preferences. The methodology that is followed, in order to attract end-users was decided in Kosice at the BIMERR plenary meeting that took place at 11-12 of September 2019. In the plenary meeting, all partners agreed to invite at least 5 end-users to complete successfully the questionnaire. As a first step the partner shall identify the suitable end-users and they shall send a template email that had been created by the Dissemination, Exploitation Manager (DEM) to invite them to complete the Questionnaire anonymously. At the beginning of the questionnaire, there is a consent form that the participants shall agree in order to proceed. By accepting the terms of the questionnaire, the user provides the necessary consent, and therefore his contact details are added in the Living Lab database. In a second step, once the partner has received an email from the end-user that the questionnaire was completed, the partner shall send an email to DEM with the names of the end-users that have completed the questionnaires, in order to add them in the Living Lab database.

Furthermore, the questionnaire is online in a secured dedicated space at the BIMERR website at the following link – <https://bimerr.eu/questionnaire-language-selector/> and is divided in five parts. The first part is the language selection, that the user can choose the language of the questionnaire, among English, Greek, Spanish and Polish as presented in Figure 2.



Figure 2: BIMERR Questionnaire language selection

The second part is the “Welcome page” of the Questionnaire that provides a short description of the BIMERR overarching story / vision. The brief abstract is presented in Figure 3..



Figure 3: BIMERR Questionnaire Abstract

The third part of the questionnaire is presenting the consent form that the user needs to accept to proceed into the questionnaire (see Figure 4).

Consent Form for BIMERR Online Questionnaire

You are invited to participate in a web-based online questionnaire for the Living Lab Activities of BIMERR Horizon 2020 project. This is a research project being conducted by the BIMERR consortium of partners. Your participation in this questionnaire is voluntary. You may refuse to take part in the research or exit the questionnaire at any time without penalty. You are free to decline to answer any particular question you do not wish to answer for any reason.

You will receive no direct benefits from participating in this research study. However, your responses may help us for the development of the BIMERR solution. There are no foreseeable risks involved in participating in this questionnaire other than those encountered in day-to-day life. BIMERR does not collect identifying information such as your IP address. However, BIMERR Consortium will store in internal database some personal information such as Name, Surname and contact details for use in the future versions of Questionnaires and other Living Lab Activities. This database will be strictly accessible only by members of the BIMERR Consortium and only for the lifecycle of the project until its end in July 2022.

For that reason, in the next page of the questionnaire you will be asked for your function and your personal information so you can be contacted in future Living Lab Activities. If you do not choose to provide personal information you cannot proceed to the next page of the questionnaire. In addition, no names or identifying information would be included in any publications or presentations based on these data, and your responses to this questionnaire will remain confidential.

If you have questions at any time about the questionnaire, Living Lab workshops or the procedures, you may contact the Project Coordinator Dr Erion Elmasllari in the following email address: erion.elmasllari@fit.fraunhofer.de

Thank you in advance for your participation!

Consent Terms

- Agree and Consent on the Questionnaires Consent Form and its Privacy Policy
- You have read and agree the above information and you agree to be contacted on future BIMERR Living Lab activities such as Workshops and new versions of the Questionnaire
- Specifically, and expressly consent to the use of your personal information to be circulated strictly inside the BIMERR Consortium

☒ Click here to indicate that you have read and agree to the terms and conditions of this questionnaire.

Agree and Continue

Figure 4: BIMERR Questionnaire Consent Form

In the fourth part of the Questionnaire the user fills the form with its role and contact details for the future Living Lab activities (see Figure 5). The questionnaire responses are completely anonymized and protected, the contact details will be used only to invite the users in future Living Lab activities and will be stored in the Living Lab Database during the project lifetime.



Choose your category

What is your role?

- ☒ Architect
- ☐ BIM modeller
- ☐ Building Surveyor
- ☐ Occupant
- ☐ Project Manager
- ☐ Site manager
- ☐ Worker

Last

Email

Proceed

Figure 5: BIMERR Questionnaire - Role and Contact Details

In the fifth part of the questionnaire, the user is redirected to the relevant questionnaire (depending on his role) and is invited to complete the questionnaire that was presented in the Deliverable 3.1 - Stakeholder requirements for the BIMERR system. For the visual presentation of the online questionnaires and questions for the User Groups, see Annex 1.

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5.2.2 LIVING LAB WORKSHOPS

5.2.2.1 LIVING LAB WORKSHOPS IN SPAIN:

According to the DOA, the first workshop within the Living Lab activities involves end users in the requirements definition activities of the project. This workshop was organized in the context of the Living Labs. On the 19th of June, in Ferrovial Agroman's offices in Madrid, and on the 12th of July in the IVE's offices (Instituto Valenciano de la Edificación), Ferrovial Agroman's Urban rehabilitation Area and its R&D Department organized two different requirements workshops in the framework of the BIMERR project.



The aim of the workshops was to lead debates and conversations about the state and need of the renovation industry. In the early stages of the project, it is indeed fundamental to gather concrete and clear information about how things are done nowadays and how the new tool should be developed to meet the requirements and needs of the end users, so that BIMERR's effectiveness and future impact is as big as possible.

The workshops included participants from all the main user groups apart from the occupants. The occupants will be targeted at a later stage during the pilots. The below presented companies, institutions and organizations were represented in these workshops:

- **CONCOVI:** The Confederación de Cooperativas de Viviendas de España is an institution that aims at protecting, coordinating and assessing all affiliated housing cooperatives.
- **CNC:** The Confederación Nacional de la Construcción (CNC) is an association that preserves the interests of all major companies from the construction sector.
- **ITeC:** Instituto de Tecnología de la Construcción, representing BIM experts and modellers.

- **Colegio Oficial de Aparejadores y Arquitectos Técnicos de Madrid** (Institute of Architects) which represents and defends the interests of the quantity surveyors, technical architects and building construction engineers.
- **IVE (Instituto valenciano de la edificación)**, governed by a Board of Trustees that brings together the group of professionals involved in the edificatory and urbanization process: (administration, professional associations, associations of manufacturers, developers, builders, users and teachers and technology centers).
- **AECO estudio**, architects and BIM managers.
- **Efitres**, architects and energy consultants.
- **Building Smart Spanish Chapter**, BIM experts.
- **Ferrovial Agroman**, one of Spain's largest construction company.

In the workshops, the following topics, which are essential to the project and its future success, were discussed: methodologies, processes, communication and information systems, used devices, technologies, digital brandification, relations between stakeholders, cost/benefit assessment, etc. Furthermore, many participants to this second workshop are involved in another EU-financed BIM-related R&D Project, the BIMplement (Grant Agreement No 745510). This workshop was a good opportunity to exchange information and talk about possible shared opportunities.

In order to structure the workshops, the following steps were followed:

1. General introduction to the BIMERR project.
2. Moderation of general discussions with the participants from the different user groups based on the questions in the questionnaires.
3. Realization of activities similar to the design thinking approach.



During the exercises, the participants were asked to work on large charts and models that were prepared by FERROVIAL, based on questionnaires elaborated by UoP partner. This enabled the participants to describe tools and technologies currently available for renovation such as laser scanning, thermal imaging and building leak tests. They also engaged in discussions on

possible process modifications that could make them feel more satisfied with their work. The participants mentioned for instance the need for easier and faster decision-making processes along with a more structured building certification process.

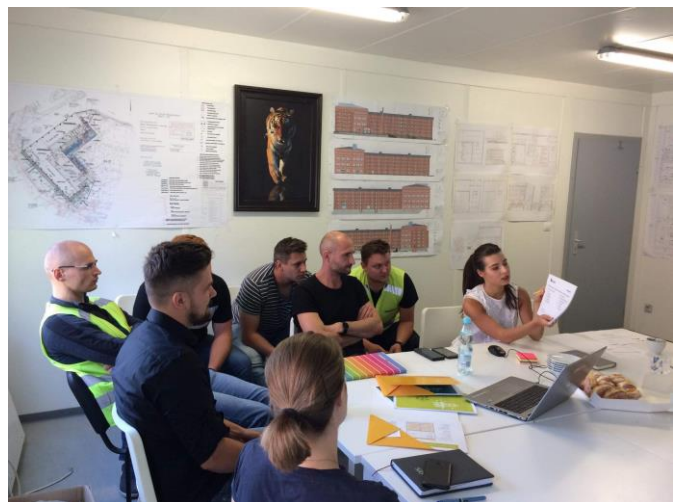
Additionally, the participants provided feedback for the planned BIMERR tools that were presented to them. Specifically, they described what is useful, and what will make these tools more effective for their work. Participants expressed concerns about safety issues related to using smart glasses, tablets and smartphones at the construction site. They really liked the way how the planned BIMERR tools make surveying and decision-making process easier and detailed.



Figure 6: Living Lab Workshop material in Spain

5.2.2.2 LIVING LAB WORKSHOPS IN POLAND

In May 2019, BIMERR project workshops were held in Warsaw, Poland by BUDIMEX. The meetings were attended by representatives of selected organizations, focused around the construction industry, as well as BIM experts and construction supervision employees.

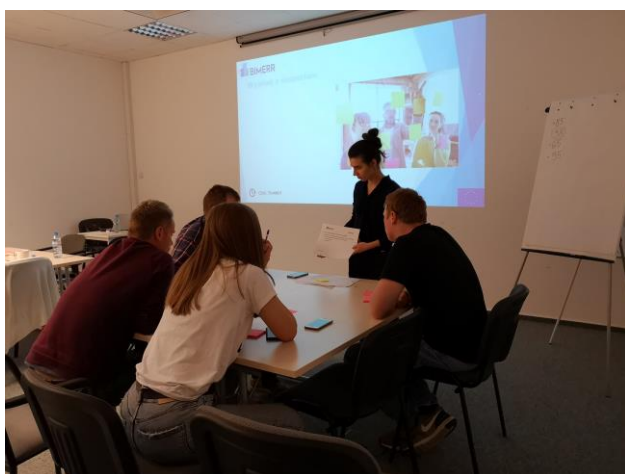


Information on the methods, tools and technologies currently used in the process of planning, implementation, as well as research on the effectiveness of thermal modernization of residential buildings are crucial for the success of the project. The aim of the workshops was to determine the expectations and needs of potential users and recipients of innovative tools, which will be the result of BIMERR's design work.

During the workshops, participants determined the most important elements of the process of energy renovation of buildings, such as: methodologies, processes, communication and information systems, currently used devices, technologies, relations between stakeholders, as well as budget for potential benefits, etc.



In Warsaw, the workshop meeting, was conducted according to the methodology of Design Thinking, which allowed for a more creative approach to the discussed issues. The participants identified the archetype of the BIMERR client, identifying the site manager as a potential, exemplary user of innovative solutions. They also defined his hypothetical expectations towards technologies and tools supporting thermal upgrading works, but also fears related to them. They created a list of expected features and benefits, such as: digitalization of tasks and saving time, the ability to automatically record collisions and errors, efficient and quick exchange of information, effective management and risk prevention, and the ability to order materials.



The second workshop which was held in August 2019 had totally different approach. This time Budimex focused on feedback from the construction site in Bydgoszcz, Poland. The construction site was related to the renovation and construction works of the building Rother Mill and Granary, which was covered in multifunctional facility. The discussion with participants were moderated based on questions

from the Questionnaires. All the participants have working experience, most of them are familiar with BIM models and renovation technology. In total 17 participants attended workshops in Poland.

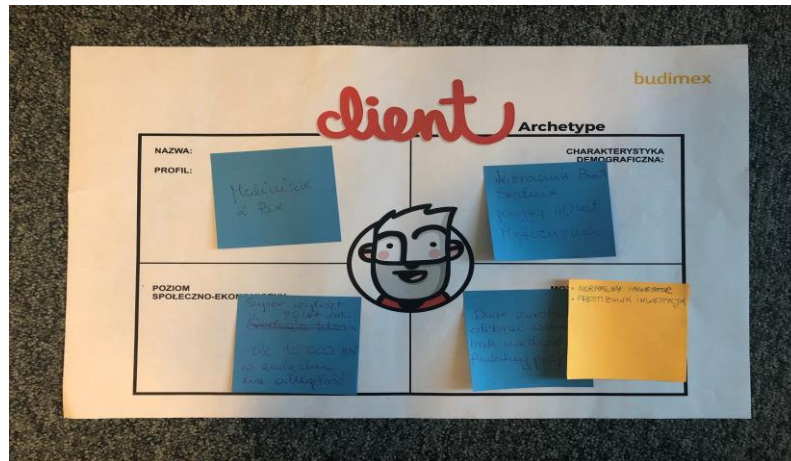


Figure 7: Living Lab Workshop material in Poland

5.2.3 TRAINING SEMINARS

According to DoA, the training seminars and working groups with standardization bodies will be organized at a later stage of the BIMERR project under Task 9.2. More specifically the process and the methodology that will be followed in these seminars will be specified in the D9.2 – “Report and Associated Material on BIMERR stakeholder’s engagement and training activities” in Month 32 by Budimex. In addition, these activities will be presented under the scope of Living Lab activities in the D10.7 – “BIMERR Living Lab activities evaluation Report 2” in month 32.

6. EVALUATION OF LIVING LAB ACTIVITIES

The Living Lab activities of the BIMERR project as described in this report are completed by M12 of the project's lifecycle. At this stage, it is essential to review the main Key Performance indicators (KPIs) to measure the effectiveness of the Living Lab activities. The main KPIs that will be used to measure the effectiveness of the Living Lab Activities at this stage are the successful realization of project milestones, key indicators and quantified targets as set in the BIMERR DoA (Task 9.2).

Firstly, main quantified targets are the milestones as described in the DoA of the BIMERR project. The first target already achieved is the successful realization of Milestone MS1- "Project website launch" and the successful realization of Milestone MS7 "Public Awareness, Dissemination & Engagement Planning" for the smooth operation of the Living Labs. In that sense, the respective milestones to the Living Lab activities are already achieved.

Secondly, another quantified target to evaluate the success of the Living Lab activities is the number of end-users in the Living Lab database. As suggested from the Task 3.1 leader (UoP) in M05, in order to conclude on a good result for the end-user requirements, the questionnaire is expected to be responded by approximately 100 participants. The estimated total number of end-users in the Living Lab database is 100. The end-users provide their names, roles and contact details before they complete the Questionnaire. The contact details of the end-users will be used by the consortium for future Living Lab activities such as seminars, trainings etc.

Hence, up to November 2019 (M11) a total number of 41 participants entered the questionnaire, 29 end-users have completed it in total and 12 participants were reached but didn't complete the questionnaire. Figure 8 shows the percentage of the different participant roles:

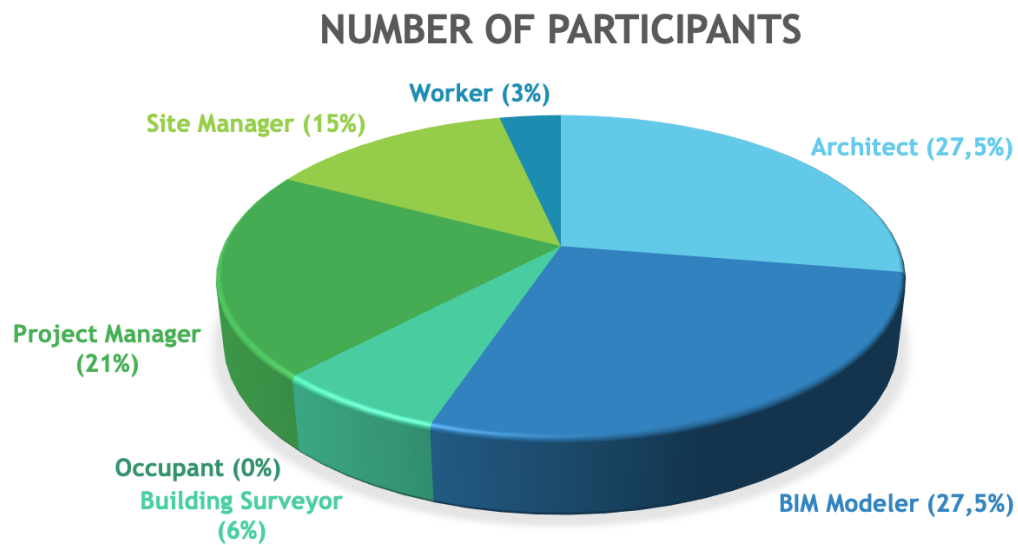


Figure 8: Living Lab Questionnaire role statistics

Another metric that shows the impact of the online questionnaires is that 41 people were reached / entered the Questionnaire and 29 of them replied to all the questions of the questionnaire. Therefore, 72% of the users that entered the Questionnaire have completed it as well. The following figure shows the total number of end-users that just entered or completed the questionnaires:

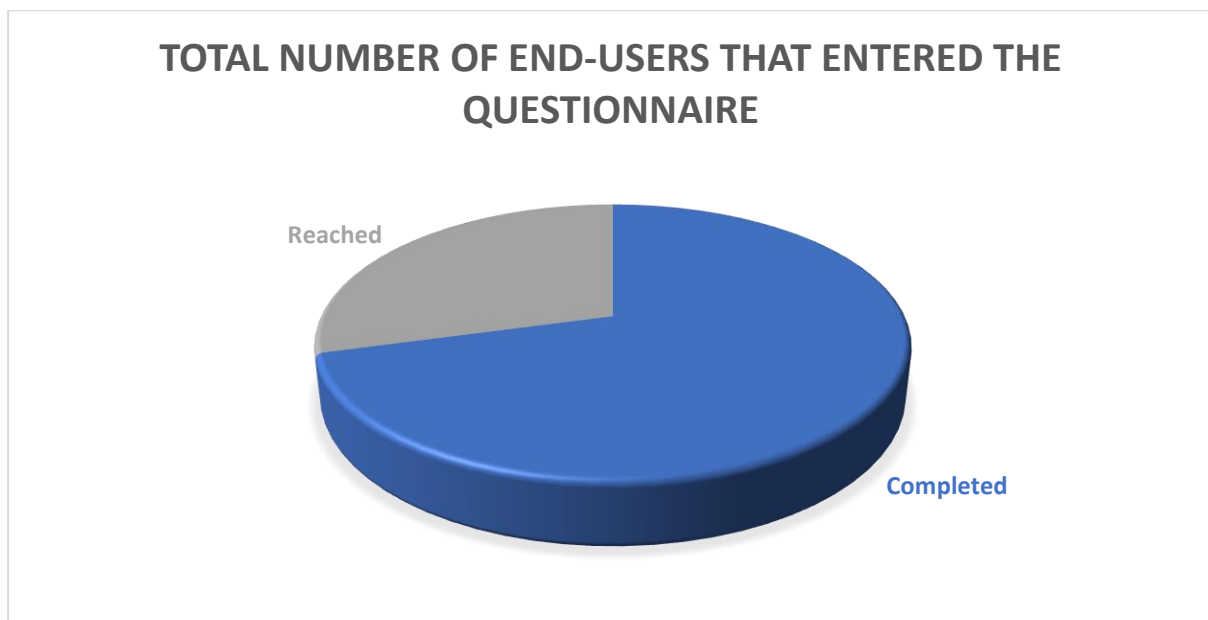


Figure 9: Total Number of End-users that entered the Questionnaire

During the BIMERR Plenary Meeting that took place at 02-04 of December in Athens, the Dissemination and Exploitation Manager urged all the partners to share with more end-users the questionnaire to reach the goal set by the Leader of Task 3.1 of 100 end-users by M15.

Thirdly, another key indicator to evaluate the Living Lab activities is the number of realized Living Lab workshops. Up to M12, 4 Living Lab workshops have been organized in the premises of BX and FER. The number of participants was approximately 30 in total and that fulfills the target set by the DoA.

At this stage there are not yet organized working groups with standardization bodies nor training seminars with the participation of end-users since it is foreseen to start Task 9.2 in M22.

As described in D10.2 “Dissemination and Communication Plan” several quantified targets are set to measure the Living Lab activities boosting reach and dissemination of project outcomes. During the development of the project, specific key messages will be created in order to attract more end-users to the Living Lab activities. These messages will be specialized and elaborated in the next version of the Dissemination and Communication Plan that will be presented as deliverable D10.3 – “BIMERR dissemination and communication plan and associated material 2” by M18. All the results from future Living Lab Activities, will be thoroughly analyzed and presented with specific and targeted messages for the engagement of more potential end-users in the updated version of D10.7 – “Living Lab Activities Evaluation Report 2”, to show the effectiveness and the coherence of the dissemination and exploitation actions implemented through the Living Lab activities.

CONCLUSIONS

In conclusion, the deliverable D10.6 – “Living lab Activities Evaluation report” aims to describe all the implemented actions designed and performed in the BIMERR project until M12. Based on the design phase of Living Lab activities, analyzed in the D10.2 – Dissemination and Communication Plan, this deliverable attempted to report all the Living Lab activities. As described in detail in the deliverable, the Living Labs activities are the core of the BIMERR dissemination and exploitation strategy. Therefore, the consortium, in order to maximize the impact and the promotion of the BIMERR project, uses a user-centric approach to incorporate all the user’s needs and preferences to the final BIMERR result. Through this approach the use of Living Lab activities sets the end-user in the middle of the project’s development. BIMERR Living Lab activities extend from the very first stages of project implementation (user requirements phase) up to the pilot evaluation phase, aiming at the establishment of an iteration and open collaboration process that will accelerate collaborative knowledge generation and integration, technology customization and validation against real market and user needs, as well as end-product definition and go-to-market strategy creation.

The Living Lab activities, as described in this deliverable, are the main horizontal actions that establish an open innovation 4.0 and value co-creation framework. The objectives and the targets of the Living Lab activities, the methodology, the timeframe, the target groups as well as the implemented action by Month 12 of the project’s lifecycle were described. The questionnaire for the end-user’s requirements and Living Lab workshops were presented in detail.

Following the presentation of the performed activities, an analysis of the targets of the key performance indicators (KPIs) was presented to establish the advantages and the shortcomings of the implemented activities. Based on the findings of the KPI analysis of the Living Lab activities, in the plenary meeting in Athens between 2-4 December 2019, the Dissemination and Exploitation Manager urged all the partners to step up their efforts and share the Questionnaire for the end-user’s requirements with more contacts to reach the target of 100 completed Questionnaires by M14. D10.6 is the initial version that describes in detail the design phase as well as the implementation phase (up to M12) for the Living Lab activities. Following the extraction of the results and the analysis of the findings under the T3.1, an updated version of this deliverable under the name D10.7 – “BIMERR Living Lab activities evaluation report 2” will be submitted to describe and analyze the specific results of the implementation phase of the Living Lab activities in M32.

ANNEX 1

1. QUESTIONNAIRE FOR ARCHITECTS



Questionnaire (online version) for Architects

The Questionnaire focuses on specific aspects of architects' role in the framework of building renovation projects. We would like to know information about the software tools and applications you use, the professionals you need to communicate with in the context of their work, as well as obtain some valuable insight on your methods and techniques.

The Questionnaire consists mainly of multiple-choice, "multiple-answer" type questions where you can check off all the choices that apply to you. When none of the choices is applicable, you can tick off the "Other" option and then a free-text box will be made available for further elaborating your response.

In the Questionnaire there are also a few free-form questions, where some typical answers are provided underneath the text box for guidance.

Estimated Time: 15 min

S1

Which devices do you use for work?

- ☐ Laptop
- ☐ Phone
- ☐ Smartphone
- ☐ Tablet
- ☐ Other

S2

What Operating Systems do these devices use?

- ☐ Windows
- ☐ Linux
- ☐ Android
- ☐ Other

S3

Which applications and information systems do you typically use in your everyday job?

- ☐ ArchiCAD
- ☐ AutoCAD Architecture
- ☐ Autodesk Revit
- ☐ FreeCAD
- ☐ Other

S4

What import functionality do they support?

- ☐ Through APIs
- ☐ As files
- ☐ Other

S5

What data formats are supported for importing data to these applications?

eg. IFC, DGN, DWX, XML, JSON, CSV, ASCII, GML

S6

What export functionality do they support?

- ☐ Through APIs
- ☐ As files
- ☐ Other

S7

What data formats are supported for exporting data from these applications?

(e.g. IFC, DGN, DWX, XML, JSON, CSV, ASCII, GML)

S8

Which tools/systems do you use for handling Building Information Modelling (BIM) models and 3D architectural design?

- ☐ AutoCAD
- ☐ Revit
- ☐ ArchiCAD
- ☐ Other
- ☐ I don't use BIM models

S9

What are the main data formats that you use to import BIM models to these systems?

S10

Which formats do you export to your BIM models, when using these systems?

(e.g. IFC, gbXML, etc.)

S11

For your work, you exchange information with other stakeholders. Who are these stakeholders?

(e.g. project manager, BIM expert, client, etc.)

S12

How do you exchange information with other stakeholders?

- ☐ Via email
- ☐ Using a cloud content management and file sharing service (e.g. Box, Confluence, etc.)
- ☐ Using a mobile and web-based project management software
- ☐ With printed documents
- ☐ Other

S13

How frequently do you exchange information with them?

S14

What type of information do you exchange?

- ☐ Drawings (2D/3D)
- ☐ Documents/notes/text
- ☐ Annotated photos
- ☐ Other

S15

Which are the stakeholders with whom it is most critical to exchange data/information at real-time?

(e.g. project manager, client, etc.)

S16

What type of data do you need from other stakeholders in order to properly complete your work?

- ☐ Construction drawings
- ☐ Specifications
- ☐ Information from surveys
- ☐ Pre-existing BIM model
- ☐ Other

S17

How do you find data that you need and do not have electronically in your information system?

- ☐ I request the data from another stakeholder
- ☐ I try to work without it, trusting my working experience
- ☐ I access the official project documents
- ☐ I search for it online in Open BIM libraries at manufacturer's libraries.
- ☐ Other

S18

How do you acquire building information?

- ☐ From existing drawings
- ☐ From surveys
- ☐ From existing BIM model
- ☐ From project plans and documents
- ☐ Other

S19

In what format is this building information retrieved?

- ☐ PDF
- ☐ AutoCad files (dwg, dxf, etc.)
- ☐ Images (jpeg, tiff, etc.)
- ☐ Spreadsheets (xls, etc.)
- ☐ Other

S20

What are the security and privacy requirements for the building data / information that you manage?

- ☐ Open data (available to all involved parties)
- ☐ Protected data (access restricted to certain stakeholders)
- ☐ Fully encrypted data (intended for internal use)

S21

Do you use any online databases or tools for your design material selection?

- ☐ No
- ☐ Yes

S22

Which tools do you use to model energy performance?

- ☐ Energy Plus (or Energy Plus based platforms e.g. Open Studio)
- ☐ TRACE 700
- ☐ IES VE
- ☐ DesignBuilder
- ☐ eQUEST
- ☐ TRNSYS
- ☐ Other

S23

What data do you see as of high interest during the energy performance modelling?

- ☐ Energy consumption
- ☐ Orientation
- ☐ Materials
- ☐ Other

S24

Which renovation measures do you consider at renovation scenarios?

- ☐ Insulation
- ☐ Heating system
- ☐ Cooling system
- ☐ Hot water production
- ☐ Other

S25

If you consider the Life Cycle Cost (LCC) of renovation projects, what data or databases do you use as input? (e.g. BKI building cost database)

- ☐ Cost database
- ☐ I don't consider the LCC of renovation projects.

S26

If you take into account operational energy data during the design phase, what data do you consider?

- ☐ Energy inertia
- ☐ Number of occupants
- ☐ Occupants patterns and habits
- ☐ Other
- ☐ I don't take into account operational energy data.

S27

If you consider the occupants' comfort in your calculations, how do you quantify (or measure) occupants' comfort?

- ☐ With user profiles
- ☐ Other
- ☐ I don't consider occupants' comfort in my calculations.

S28

You are asked to deliver a proposal design for an energy renovation project. Suppose that smart IoT solutions (i.e. sensors) were utilized to monitor indoor comfort and energy consumption. Do you think that evaluating the energy performance of the building based on actual operational data would be beneficial for your work?

- ☐ Yes
- ☐ No
- ☐ Not sure

S29

If you want to assess the impact of a single building renovation project on the surrounding buildings and/or the district, what data do you use as input?

- ☐ Energy consumption of surrounding buildings
- ☐ Energy production of surrounding buildings
- ☐ Energy network data
- ☐ Energy load profiles of surrounding buildings
- ☐ Energy productions profiles of surrounding buildings
- ☐ Other
- ☐ I don't make this kind of assessment

S30

Do you get this data from the utility company?

- ☐ Yes
- ☐ No

Submit

2. QUESTIONNAIRE FOR BIM MODELERS



Questionnaire (online version) for BIM Modellers

The Questionnaire focuses on the data that BIM modellers' use for their BIM models (type, format, software tools).

The Questionnaire consists mainly of

- multiple-choice ("multiple-answer" type) questions where you can check off all the choices that apply to you. When none of the choices is applicable you can tick off the "Other" option and then a free-text box will be made available for further elaborating your response.
- and simple yes/no questions.

Estimated Time: 5-10 min

S1

Which data do you need to effectively generate BIM models, i.e. conduct a Scan-to-BIM (S2B) process?

- ☐ Point clouds
☐ Geo-referencing data
☐ 2D drawings
☐ 3D models
☐ Other

S2

Do you use other auxiliary data while producing a BIM model with a view on energy refurbishment?

S3

Do you employ (or are you required to adhere to) Level of Accuracy (LOA) and Level of Detail (LOD) specifications for your data?

- ☐ No ☐ Yes

S4

Which software platform do you use for the generation of BIM/S2B process?

- ☐ Commercial software (e.g. REVIT)
☐ In-house built software
☐ Other

S5

Do you have any automated task in the BIM/S2B process?

- ☐ No ☐ Yes

(e.g. structural components detection)

S6

Which storage formats do you usually use for handling point clouds?

- ☐ Basic formats (e.g. XYZ, PTS...)
☐ Enriched data formats (e.g. PTX, E57...)
☐ Other

S7

Do you use/require open formats for storing and sharing your data?

- ☐ Yes ☐ No

S8

Are you aware of the existence of the E57 open format for point cloud data storage and exchange?

- ☐ Yes ☐ No

S7

Do you use/require open formats for storing and sharing your data?

☐ Yes ☐ No

S8

Are you aware of the existence of the E57 open format for point cloud data storage and exchange?

☐ Yes ☐ No

S9

In which format are you normally required to deliver the BIM model in?

- ☐ Proprietary format (e.g. RVT)
☐ Open formats (e.g. IFC)
☐ Other

S10

Do you produce/export the final BIM models in IFC format?

☐ Yes ☐ No

S11

If not, are you aware of the existence of the IFC format?

☐ Yes ☐ No

S12

Do you produce/export the final BIM models in energy-oriented formats, such as gbXML?

☐ No ☐ Yes

Submit

3. QUESTIONNAIRE FOR BUILDING SURVEYOR



Questionnaire (online version) for Building Surveyor

The Questionnaire focuses on specific aspects of Building Surveyors' role in the framework of building renovation projects. We would like to know information about the software tools and equipment you use, the professionals you need to communicate with in the context of your work, as well as obtain some valuable insight on your methods and techniques.

The Questionnaire consists mainly of multiple-choice, "multiple-answer" type questions where you can check off all the choices that apply to you. When none of the choices is applicable, you can tick off the "Other" option and then a free-text box will be made available for further elaborating your response.

In the Questionnaire there are also a few free-form questions, where some typical answers are provided underneath the text box for guidance.

Estimated Time: 10-15 min

S1

What kind of internet connectivity do you have when working in the field?

- ☐ None
- ☐ WiFi
- ☐ Cellular (2G, 3G, 4G)
- ☐ Other

S6

Suppose you have the option to ask residents/workers additional information about the building you are surveying. How would you like them to provide input?

- ☐ Email
- ☐ SMS
- ☐ Mobile data collection app
- ☐ Web based survey
- ☐ Other

S7

What kind of information would you require from the residents/workers?

- ☐ Photos
- ☐ Notes
- ☐ Markups on existing drawings
- ☐ Other

S8

Should the input from residents/workers...

- ☐ ...be added directly in existing surveying reports
- ☐ ...be annotated onto existing drawings with exact locations
- ☐ Other

S9

Have you used laser scanning to validate a design model?

- ☐ Yes
- ☐ No

(e.g. in CAD or BIM)

S10

Do you use terrestrial laser scanners

- ☐ No
- ☐ Yes

S11

Which field tools do you use to assist your tasks?

- ☐ BIM 360 Field
- ☐ PointLayout
- ☐ Other
- ☐ I don't use any field tools

S12

What data do you (or are you required to) acquire?

- ☐ 3D
- ☐ Colour
- ☐ Laser Intensity
- ☐ Thermal
- ☐ Other

S13

For acquiring dense 3D data, do you use

- ☐ Terrestrial laser scanning (TLS)
- ☐ Photogrammetry (PG)
- ☐ Other

S14

If you use PG, do you scale your data?

- ☐ Yes
- ☐ No

S15

Do you geo-reference your data?

- ☐ Yes
- ☐ No

S16

Do you employ (or are you required to adhere to) Level of Accuracy (LOA) and Level of Detail (LOD) specifications for your data?

☐ No ☐ Yes

S17

What is the cost breakdown of producing as-is data?

Euros per 100 m2

S18

What is the time breakdown of producing the as-is data?

Hours per 100 m2

S19

What are the formats that you usually use for handling/delivering as-is data?

- ☐ TLS proprietary formats (e.g. PTX, FLS)
☐ Open formats (e.g. PLY, E57)
☐ Other

S20

Have you ever used an AR device or an AR Application running on a Phone/Tablet?

☐ Yes ☐ No

S21

Do you think it is useful to wear a pair of AR glasses in order to be able to work hands-free?

Useful Somewhat useful Not very useful Not useful at all

☐ ☐ ☐ ☐

S22

Do you wear safety helmets during building survey?

☐ Yes ☐ No

S23

How often do you work in a well-lit environment?

Always Usually Sometimes Rarely

☐ ☐ ☐ ☐

S24

How often do surveys take place in day-light?

Always Usually Sometimes Rarely

☐ ☐ ☐ ☐

S25

How often is it possible to use the right equipment in order to provide indoor navigation?

Always Usually Sometimes Rarely Never

☐ ☐ ☐ ☐ ☐

Submit

4. QUESTIONNAIRE FOR OCCUPANTS



Questionnaire (online version) for Occupants

The Questionnaire is addressed to building occupants and/or owners that had their premises renovated in the past or they are thinking of doing so in the future. We would like to know your priorities regarding renovation choices as well as your preferences during the renovation works.

The Questionnaire consists mainly of

- multiple-choice ("multiple-answer" type) questions where you can check off all the choices that apply to you. When none of the choices is applicable you can tick off the "Other" option and then a free-text box will be made available in case you wish to elaborate further on the response, and
- simple yes/no questions. Please note that in a couple of these questions, the response may render some of the following questions non-applicable, i.e. the questions will be automatically omitted.

Estimated Time: 10-15 min

S1

What kind of wireless technology devices do you normally use?

- ☐ Smartphone
- ☐ Tablet
- ☐ Desktop/Laptop
- ☐ Other

S2

What kind of internet connectivity is there at your home?

- ☐ Fixed line
- ☐ Wi-Fi
- ☐ Cellular (2G, 3G, 4G)
- ☐ Other

S3

If your building/premises is to be renovated, would you be interested in providing input?

- ☐ Yes ☐ No

(i.e. upload information for aspects of your building/premises, give feedback on the renovation activities, report Health and Safety issues, etc.)?

S4

What kind of information are you willing to provide in regard to your building/premises?

- ☐ Photos
- ☐ Available drawings
- ☐ Notes/short text
- ☐ Other

S5

When we need information from you, how would you like to contact you?

- ☐ Email
- ☐ SMS
- ☐ Mobile application
- ☐ Other

S6

Assume that you want to send us information. How would you like to send it?

- ☐ Mobile application
- ☐ Desktop application
- ☐ Web based platform
- ☐ Other

S7

Your building is going to be renovated, and you are asked to indicate which walls have mould due to high humidity. How would you prefer to provide this information?

- ☐ Using a mobile application enabling text comments on drawings?
- ☐ Using a mobile application for annotating directly on photos?

S8

Your building is being renovated and construction works are under go. You would like to visit the construction site, but you don't know if this is safe. How often would you like to receive alerts/instructions about construction site safety?

- ☐ Daily
- ☐ Weekly
- ☐ Monthly
- ☐ Only when visiting the site
- ☐ Only when visiting a specific area of the site where safety issues exist.

S9

Would you be interested in being informed about the renovation process activities when performed?

- ☐ Yes
- ☐ No

S10

Your house is being renovated. The construction crew would like to know your opinion about a new radiator they are trying to install. You probably have to schedule a visit to the construction site. Would you be willing to offer your opinion after watching a video describing the radiator issue, instead of visiting the construction site?

- ☐ Yes
- ☐ No

S11

You decide to renovate your house to improve the living conditions inside it but you cannot decide what is best for you and your family. How much are you willing to pay for sensors to be installed inside your house to measure your living preferences (room temperature, light levels, etc.) and finally help you decide on what renovation changes best address your needs?

- ☐ Nothing
- ☐ No more than 100 Euros
- ☐ No more than 500 Euros

S12

Have you ever been involved in a project that assessed your living comfort and/or indoor air quality?

- ☐ Yes
- ☐ No

S13

Please rate the following preferences regarding your living comfort:

	Not important	Somewhat important	Important	Very Important
Temperature	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Humidity	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Luminance	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Air quality	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

S14

Have you been asked about your preferences when renovating your property? Did you have a choice between several alternatives?

- ☐ Yes
- ☐ No

S15

Which of the following information was presented to you in order to decide?

- ☐ Cost of the renovation works
- ☐ Cost savings after the renovation works have been completed
- ☐ Operational and maintenance cost of the renovated premises
- ☐ Improvement of the living conditions
- ☐ Other

S16

Is there any information that was not presented to you but it would have helped you decide?

Please specify

S17

In order to determine the best renovation option for your particular needs, we need to use sensors. Can we leave some sensors at your property for long periods of time, e.g. a year?

- ☐ Yes ☐ No

S18

Your property is being renovated. What information would you like to know at any given time?

- ☐ Current number of people working on the premises
- ☐ Type of activities performed
- ☐ Noise levels
- ☐ Progress level on planned work
- ☐ Other

S19

Are any financial incentives in your country that support renovations that improve the energy efficiency of buildings?

- ☐ Yes ☐ No

Submit

5. PROJECT MANAGER



Questionnaire (online version) for Project Managers

The Questionnaire focuses on specific aspects of project managers' role in the framework of building renovation projects. We would like to know information about the software tools and applications you use, the professionals you need to communicate with in the context of your work, as well as obtain some valuable insight on your methods and techniques.

The Questionnaire consists mainly of multiple-choice, "multiple-answer" type questions where you can check off all the choices that apply to you. When none of the choices is applicable you can tick off the "Other" option and then a free-text box will be made available for further elaborating your response.

In the Questionnaire there are also a few free-form questions, where some typical answers are provided underneath the text box for guidance.

Estimated Time: 10-15 min

S1

What kind of internet connectivity do you have in your office?

- ☐ None
- ☐ Fixed
- ☐ Wi-Fi
- ☐ Cellular (2G, 3G, 4G)?
- ☐ Other

S2

Which devices do you use for work?

- ☐ Laptop
- ☐ Phone
- ☐ Smartphone
- ☐ Tablet
- ☐ Other

S3

What Operating Systems do these devices use?

- ☐ Windows
- ☐ Linux
- ☐ Android
- ☐ iOS
- ☐ Other

S4

For your work, you exchange information with other stakeholders. Who are these stakeholders?

S5

How do you exchange information with other stakeholders?

- ☐ Via email
- ☐ Using a cloud content management and file sharing service (e.g. Box, Confluence, etc.)
- ☐ Using a mobile and web-based project management software
- ☐ With printed documents
- ☐ Other

S6

How frequently do you exchange information with them?

Please specify time span

Please select frequency within the time span (how many times in the selected time span):

- ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9 ☐ 10

S7

What type of information do you exchange?

- ☐ Drawings (2D/3D)
- ☐ Documents/notes/text
- ☐ Annotated photos
- ☐ Other

S8

Which are the stakeholders with whom it is most critical to exchange data/information at real-time?

S9

What type of data do you need from other stakeholders in order to properly complete your work?

- ☐ Construction drawings
- ☐ Specifications
- ☐ Information from surveys
- ☐ Pre-existing BIM model
- ☐ Other

S10

How do you find data that you need and do not have electronically in your information system?

- ☐ I request the data from another stakeholder
- ☐ I try to work without it, trusting my working experience
- ☐ I access the official project documents
- ☐ I search for it online in Open BIM libraries at manufacturer's libraries.
- ☐ Other

S11

How do you currently acquire building information?

- ☐ With printed existing drawing
- ☐ Using the existing BIM model
- ☐ By performing surveys

S12

In what format is this information retrieved?

- ☐ PDF
- ☐ AutoCad files (dwg, dxf, etc.)
- ☐ Images (jpeg, tiff, etc.)
- ☐ Spreadsheets (xls, etc.)
- ☐ Other

S13

Which applications and information systems do you typically use in your everyday job?

- ☐ Microsoft Project
- ☐ JIRA
- ☐ Redmine
- ☐ Basecamp
- ☐ Primavera
- ☐ OpenProject
- ☐ Aconex
- ☐ Other

S14

What import functionality do they support?

- ☐ Through APIs
- ☐ As files
- ☐ Other

S15

What data formats are supported for importing data to these applications?

e.g. IFC, DGN, DWX, XML, JSON, CSV, ASCII, GML)

S16

What export functionality do they support?

- ☐ Through APIs
- ☐ As files
- ☐ Other

S17

What data formats are supported for exporting data from these applications?

e.g. IFC, DGN, DWX, XML, JSON, CSV, ASCII, GML)

S18

What are the security and privacy requirements for the building data / information that you manage?

- ☐ Open data (available to all involved parties)
- ☐ Protected data (access restricted to certain stakeholders)
- ☐ Fully encrypted data (intended for internal use)

S19

Which are the typical issues causing re-scheduling of the project?

- ☐ Weather
- ☐ Wrong planning of work
- ☐ Undereducated workers
- ☐ Unexpected/hidden construction problems
- ☐ Late delivery of construction materials
- ☐ Other

S20

Which stakeholders are affected by the re-schedules?

- ☐ Site manager
- ☐ Working crews
- ☐ Occupants
- ☐ Other

S21

What is the expected time-delay for a change made by the Project Manager to be reflected in the information provided to the stakeholders?

- ☐ Hours
- ☐ Days
- ☐ Weeks

S22

When changes to the plan are made, what type of automated notifications do you find beneficial?

- ☐ Email sending
- ☐ SMS alert
- ☐ API call
- ☐ Other

S23

What processes you think it would be interested to be automated?

- ☐ Ordering materials
- ☐ Ordering final acceptance of work
- ☐ Following deadlines
- ☐ Other

S24

Which labels are useful to categorize possible types of processes relevant to building renovation?

- ☐ Manual
- ☐ Automated
- ☐ Imparting
- ☐ Aggregated
- ☐ Other

Submit

6. SITE MANAGERS



Questionnaire (online version) for Site Managers

The Questionnaire focuses on specific aspects of site managers' role in the framework of building renovation projects. We would like to know information about the software tools and applications you use, the professionals you need to communicate with in the context of their work, your methods and techniques, as well as obtain some valuable insight on your preferences regarding any future tools.

The Questionnaire consists mainly of multiple-choice, "multiple-answer" type questions where you can check off all the choices that apply to you. When none of the choices is applicable you can tick off the "Other" option and then a free-text box will be made available for further elaborating your response.

In the Questionnaire there are also a few free-form questions, where some typical answers are provided underneath the text box for guidance.

Estimated Time: 10-15 min

S1

What kind of internet connectivity do you have when working in the field?

- ☐ None
- ☐ Fixed
- ☐ WiFi
- ☐ Cellular (2G, 3G, 4G)?
- ☐ Other

S2

Which devices do you use for work?

- ☐ Laptop
- ☐ Phone
- ☐ Smartphone
- ☐ Tablet
- ☐ Other

S3

What Operating Systems do these devices use?

- ☐ Windows
- ☐ Linux
- ☐ Android
- ☐ Other

S4

Do you identify any issues in carrying a tablet on-site?

- ☐ Yes
- ☐ No

S5

How would you prefer the changes at the construction site to be reported back to you?

- ☐ With pictures
- ☐ With video
- ☐ Other

S6

Which applications and information systems do you typically use in your everyday job?

- ☐ ArchiCAD
- ☐ AutoCAD Architecture
- ☐ Autodesk Revit
- ☐ FreeCAD
- ☐ Microsoft Project
- ☐ JIRA
- ☐ Redmine
- ☐ Basecamp
- ☐ Primavera
- ☐ OpenProject
- ☐ Other

S7

What import functionality do they support?

- ☐ Through APIs
- ☐ As files
- ☐ Other

S8

What data formats are supported for importing data to these applications?

e.g. IFC, DGN, DWX, XML, JSON, CSV, ASCII, GML

S9

What export functionality do they support?

- ☐ Through APIs
- ☐ As files
- ☐ Other

S10

What data formats are supported for exporting data from these applications?

(e.g. IFC, DGN, DWX, XML, JSON, CSV, ASCII, GML)

S11

For your work, you exchange information with other stakeholders. Who are these stakeholders?

Please specify

(e.g. project manager, foreman, worker, etc.)

S12

How do you exchange information with other stakeholders?

- ☐ Via email
- ☐ Using a cloud content management and file sharing service (e.g. Box, Confluence, etc.)
- ☐ Using a mobile and web-based project management software
- ☐ With printed documents
- ☐ Other

S13

How frequently do you exchange information with them?

Please specify time span

Please select frequency within the time span (how many times in the selected time span):

- ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9 ☐ 10

S14

What type of information do you exchange?

- ☐ Drawings (2D/3D)
- ☐ Documents/notes/text
- ☐ Annotated photos
- ☐ Other

S15

Which are the stakeholders with whom it is most critical to exchange data/information at real-time?

S16

What type of data do you need from other stakeholders in order to properly complete your work?

- ☐ Construction drawings
- ☐ Specifications
- ☐ Information from surveys
- ☐ Pre-existing BIM model
- ☐ Other

S17

How do you currently find data that you need and do not have electronically in your information system?

- ☐ I request the data from another stakeholder
- ☐ I try to work without it, trusting my working experience
- ☐ I access the official project documents
- ☐ I get online and search for it in Open BIM libraries on manufacturer's libraries.
- ☐ Other

S18

How do you currently acquire building information?

- ☐ From existing drawings
- ☐ From surveys
- ☐ From existing BIM model
- ☐ From project plans and documents
- ☐ Other

S19

In what format is this building information retrieved?

- ☐ PDF
- ☐ AutoCad files (dwg, dxf, etc.)
- ☐ Images (jpeg, tiff, etc.)
- ☐ Spreadsheets (xls, etc.)
- ☐ Other

S20

What are the security and privacy requirements for the building data / information that you manage?

- ☐ Open data (available to all involved parties)
- ☐ Protected data (access restricted to certain stakeholders)
- ☐ Fully encrypted data (intended for internal use)

S21

How would you like to send out Health & Safety alerts, observations, etc.?

- ☐ Mobile app
- ☐ Tablet app
- ☐ Smart glasses app
- ☐ Other

S22

When would you like to send Health & Safety (H&S) alerts/instructions?

- ☐ When H&S events occurred/identified
- ☐ Location based alerts/notifications
- ☐ Prior to day-shift to all site team
- ☐ Other

S23

What kind of Health & Safety alerts/notifications would you like to send?

- ☐ Photos with text comments
- ☐ Notes
- ☐ Annotated drawings
- ☐ Other

S24

Do you use a database for energy efficient materials/equipment?

- ☐ Yes
- ☐ No

S25

Would you require integration of such data into your procurement system?

- ☐ Yes
- ☐ No

S26

If you could have 3D visualisations on-site what data do you need access to?

- ☐ Workers' location
- ☐ Location of activities to be performed
- ☐ BIM overlays
- ☐ Other

S27

If you had the capability for indoor localisation what accuracy would you consider enough for BIM overlaid data on top of the actual building?

Submit

7. WORKERS



Questionnaire (online version) for Workers

The Questionnaire is addressed to construction site crews that have participated in building renovation projects. We would like to know your communications needs during work as well as your preferences regarding any future tool or applications supporting these needs.

The Questionnaire consists mainly of

- simple yes/no questions and
- multiple-choice ("multiple-answer" type) questions where you can check off all the choices that apply to you. In some of these questions, when none of the choices are applicable you can tick off the "Other" option and then a free-text box will be made available in case you wish to elaborate further on the response.

Estimated Time: 5-10 min

S1

What kind of internet connectivity do you have at the construction site?

- ☐ None
- ☐ Wi-Fi
- ☐ Cellular (2G, 3G, 4G)

S2

What devices do you have with you?

- ☐ Smartphone
- ☐ Tablet
- ☐ Other

S3

Do you identify any issues in carrying a tablet on-site?

- ☐ Yes ☐ No

S4

Do you use any software applications in your every day job?

- ☐ No ☐ Yes

(e.g. BIM 360 Field or BIM360 Docs)?

S5

Please rate how important to your work is to be able to exchange information (e.g. photos, notes, etc.) real-time with:

	Not important	Somewhat important	Important	Very Important
Other workers	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Site manager	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Foreman	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
H&S manager	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

H&S: Health and Safety

S6

You work in a construction site where a building is being renovated. You see that the owners have installed air conditioning equipment. Are you allowed to share this information with your friends who are not working at your company?

- ☐ Yes ☐ No ☐ I don't know

S7

Would you prefer to receive on-site guidance for the technologies you can use at the construction site?

- ☐ Yes ☐ No

S8

You walk around the construction site and you notice that a protection from falling is not fixed properly. Do you think it would be useful to be able to communicate this directly to the Site Manager (or the Health and Safety Manager) in real time?

- ☐ Yes ☐ No

S9

You want to describe a construction defect to the site manager who is currently in his office. Which from the following do you find easier to do?

- ☐ A. Use an application installed in my phone (or tablet) that allows me to
- ☐ A1. describe the issue by filling in pre-defined fields.
- ☐ A2. shows me construction drawings and allows me to annotate them.
- ☐ A3. allows me to take a photo and write a short text about it.
- ☐ B. Use my smart glasses.

S10

How would you like to receive Health and Safety alerts, observations, etc. ?

- ☐ At my phone using a mobile app
- ☐ At my tablet using a tablet app
- ☐ At my smart glasses

S11

When would you like to receive Health and Safety (H&S) alerts/instructions?

- ☐ When H&S events occur or when they are identified
- ☐ When I am approaching a location where a H&S event has been identified
- ☐ Every day, before I start my day-shift

S12

How would you prefer to operate the Augmented Reality Glasses with?

- ☐ Voice commands ☐ Gestures

S13

How noisy is your work environment?

- ☐ Low ☐ Medium ☐ High ☐ Intolerable

S14

The site manager schedules the daily activities and you get a task that you have never performed in the past. Apart from the instructions you get from the foreman on how to complete this task, would you like to receive instructions on-demand both visually and by audio streams to your smart glasses?

- ☐ Yes ☐ No

S15

There is camera mounted to your Augmented Reality Glasses. Would it be helpful if the site engineer could "see" what you see in order to receive real-time help for your job tasks?

- ☐ Yes ☐ No

S16

Do you think that a thermal camera would be useful during your daily operations?

- ☐ Yes ☐ No ☐ I don't know what a thermal camera is.

S17

If you could have 3D visualisations on-site what data do you need access to?

- ☐ Other workers' locations
- ☐ Location of activities to be performed
- ☐ BIM overlays
- ☐ Other

Submit