BIM4EEB

BIM based fast toolkit for
Efficient rEnovation in Buildings

D2.5 List of owners' and inhabitants' needs and requirements for BIM-based renovation processes

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D2.5 List of owners' and inhabitants' needs and requirements for BIM-based renovation processes

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EXECUTIVE SUMMARY

The scope of this document is to blueprint the list of building owners' and inhabitants' (as main stakeholders in the BIM4EEB project) needs and requirements associated with building renovation interventions. A key point of this task is that the scope is not only to address these end-user requirements related to the management and control of the renovation intervention processes; but to further extend the analysis and incorporate their needs and requirements associated with everyday building conditions (e.g. comfort and building quality), control of working times, economic sustainability etc...

Towards this direction, a detailed methodology was established at the early phase of the project in order to ensure the proper extraction of end-user's feedback. The definition of the target groups and further elaboration of them in task activities was the preliminary step performed in the project. Along with the definition of the key user groups, the main use cases associated with the roles are specified in the document.

Furthermore, the tools and mechanisms utilized for the extraction of end-user requirements were defined. A hybrid approach has been adopted for acquiring the required information, including both questionnaires and (in a limited scale) semi-structured interviews in the requirements extraction process. In such a way, we ensure that accurate and to the point feedback is provided on the way to extract the list of their requirements.

As a next step of work, further analysis of the end-users' feedback is performed to extract the final list of Owners' and Inhabitants' needs and requirements. A hierarchy/taxonomy of requirements is also performed to facilitate the development process in the project period. At the end of this task, the final list of requirements associated with the role of Owners and Inhabitants in the BIM4EEB project is defined.

This activity complements the work performed in Work Package 2 (WP2), which details the definition of requirements for an efficient renovation process, through the utilisation of the BIM4EEB platform.

The results of these activities, which are presented in this document, form the basis for the design and development of the work packages of the project. Therefore, this document, acts as a guideline for the development of the BIM4EEB platform. The Usage Scenarios and requirements definition will enable the definition of BIM4EEB architecture and further guide the development and evaluation phase of the project in the predefined pilot sites.

PUBLISHING SUMMARY

The scope of deliverable D2.5 is to identify the needs and requirements of the building owners and inhabitants in respect to renovation interventions, considering them as stakeholders of the BIM4EEB project and end-users of the proposed toolkits. This deliverable supplement the activities undertaken in Work Package 2, which details the definition of requirements for an efficient renovation process, through the utilisation of the BIM4EEB platform.

The extraction of the building owners and inhabitants requirements is based on a "hybrid" engagement approach; driven by the feedback received from questionnaires circulated in the preselected pilot sites of Italy, Poland and Finland, along with engagement of the pilot site representative partners in semi-structured interviews (ALER & Reg Lomb being responsible for the Italian site, Prochem being responsible for the Polish site and Caverion being responsible for the Finnish site).

The outcome of this document resulted in the documentation of the building owners and inhabitants requirements including some technical and non-functional requirements, as well as pilot specific requirements and ethical, legal barriers as identified from the pilot site representative partners. The final list of the extracted requirements will form the basis for the design and development of the work packages of the BIM4EEB project, as well as provide the required inputs for the definition of the BIM4EEB technology framework architecture and specifications.

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Glossary

Acronym	Full name
AEC	Architecture, Engineering and Construction
AR	Augmented Reality
BACS	Building Automation Control Systems
BIM	Building Information Modelling
BIM4EEB	BIM-based fast toolkit for Efficient rEnovation in Buildings
DoA	Description of Action
DoW	Description of Work
EC	European Commission
EU	European Union
H&S	Health and Safety
HVAC	Heating Ventilation and Air-conditioning
IAQ	Indoor Air Quality
IEC	Indoor Environmental Comfort
UI/UX	User Interface/User Experience
US	Usage Scenarios
WP	Work Package

1 Introduction

1.1 Scope of the Document

The main scope of this document is to contribute to the BIM4EEB project foundations definition that will further enable the implementation of technical activities in the project. As defined in T2.5 in the Description of Actions (DoA), the end-user's requirements should be defined in order to create the necessary inputs for individualizing the functional components of the BIM4EEB platform. More specifically, the focus in the context of T2.5 is about the definition of requirements of the building owners and inhabitants (i.e. BIM4EEB end-users), considering their active engagement in BIM4EEB activities.

Initially, the project Usage Scenarios (US) are defined, derived from the projects' main objectives and upon consultation with WP2 partners, to drive the whole definition process for the BIM4EEB framework. This will allow the relevant stakeholders to easily grasp the intention, functionality and use of BIM4EEB platform which ultimate scope is to result in an efficient renovation process.

An important and difficult step in designing a software product is determining what the end-user expectations of the software will be; such as what activities the user will be able to perform once the platform is operational. This is because the users are often not able to communicate entirely their needs, or the information they provide may be incomplete, inaccurate and/or self-conflicting. To overcome this missing information, the end user of the system (i.e. owners and inhabitants) should express their needs in a form of requirements, generally documented in a User Requirements Document (URD) using narrative text, signed off by the user. For that reason, dedicated to the building owners and inhabitants questionnaires, as well as the pilot's representative partners semi-structured interviews were defined, towards co-creating a shared value and directly addressing the owners and inhabitants needs.

The work results in a thorough analysis and further extraction of these end-users' requirements creating the necessary inputs for the definition of the BIM4EEB technology framework architecture and specifications.

In general, by engaging the Owners and Inhabitants of a building, enables them to participate as active players in the renovation process, which in turn increases their awareness about their influence on the way a building function. As such, their input during the whole process will ensure that their requirements and needs in relation to the renovation's outcome will be considered; additionally, it will increase the chances of a successful renovation design outcome achieved through the BIM4EEB platform utilisation.

1.2 Relevance to other deliverables

The main concept of BIM4EEB is to propose a solution for connecting the end-users and stakeholders involved in the renovation value chain, by ensuring clear communication paths and collaboration along the whole renovation process (from field survey, initiation and design to construction and management).

Considering the building Owners and Inhabitants as actors in the renovation process and as the final end-users of the renovation interventions in their building, identification of their needs and requirements will contribute further in the definition of BIM4EEB architecture and further feed information for the definition of ontologies and the development of the BIM management system carried out in WP3 and WP4 activities respectively.

In order to get a commonly shared understanding of the goals and scope of BIM4EEB project, discussions and agreement between the partners have been undertaken to identify mutually the project's scope, identify suitable Usage Scenarios and finally the definition of end-users needs and requirements.

Towards this direction the results presented in this document will form the basis for the design and development of the BIM4EEB platform. As presented in Figure 1, D2.5 -''List of owners' and inhabitants' needs and requirements'' complements the overall work performed in WP2 towards the definition of the requirements for an efficient renovation process. More specifically, it complements the renovation workflow and definition of the renovation's stakeholders presented in D2.1, the Designers' needs and requirements definition in D2.2, Construction companies' needs and requirements definition in D2.3 and the definition of building service companies' needs and requirements in D2.4.

The combined result of all these activities, (namely D2.1 - D2.5), will provide input from all the intended BIM4EEB actors, namely the Architecture, Engineering and Construction (AEC) stakeholders involved actively in the renovation interventions of a building, as well as the final end-users of the renovation itself and BIM4EEB platform, i.e. the Building Owners and Inhabitants.

The identified requirements will drive the following tasks and especially T4.1, where the technical specifications for the design of the BIM management system are defined. Additionally, the informative requirements for satisfying the identified needs will be set out and associated to Linked Data and Ontologies ensuring semantic interoperability (WP3).

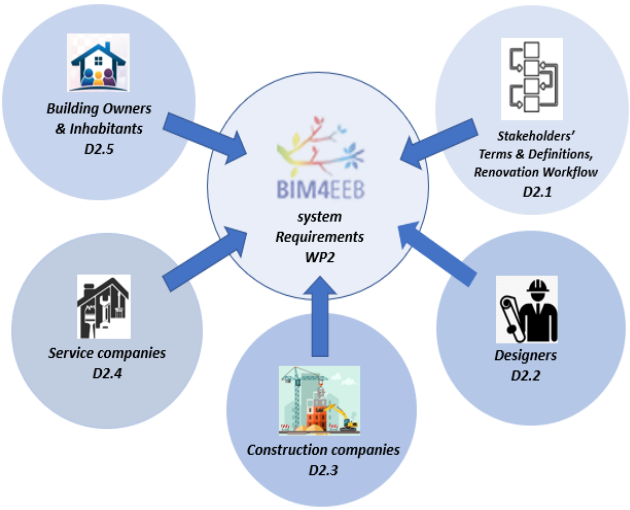


Figure 1: BIM4EEB stakeholder's requirements

1.3 Structure of the Document

To address all the aspects relevant to the scope of T2.5, this deliverable has been structured to include the following contents:

- In chapter 1, an introductory section is provided highlighting the scope and objectives of this deliverable.
- In chapter 2, the methodology for the extraction of the building owners and inhabitants use cases and requirements is defined.
- In chapter 3, the definition of BIM4EEB Usage Scenarios (US) is presented in order to screen the landscape for the requirements.
- In chapter 4, the actions followed for the active engagement of the key target groups (building owners and inhabitants) is presented; additionally, the different activities performed towards their engagement in the project's activities are reported.
- In chapter 5, the questionnaires and interviews analysis results are presented.
- In chapter 6, we present the list of building owners' and inhabitants' requirements.

In the last chapter of this deliverable, the main conclusions of the work are reported, along with the next steps focusing on the interconnection of the requirements extraction phase with BIM4EEB specifications definition.

Annex I, II and Annex III contain all the supportive information towards the definition of the project foundations, namely: Annex I: 9.1 Building owners questionnaire template, 9.2 Building inhabitants questionnaire template, 9.3 Semi-structured interview template, Annex II: 10.1 Building owners questionnaire analysis results & 10.2 Building inhabitants analysis results, Annex II: Questionnaire results

2 Methodological Framework and key target group definition

To define the list of key end-users and extract the list of the project's foundations the main objectives of BIM4EEB framework are taken into consideration along with the description of task T2.5, as explicitly stated in the description of work (DoA):

"The task will define how to satisfy needs of owner and inhabitants to ensure comfort (e.g., from a thermal, hygrometric and acoustical point of view) and building quality (e.g., compliance of as-built performances with designed ones) with the possibility to exploit an updated digital logbook. Owners' needs will be considered not only for the management and control of the renovation interventions, but also for the control of working times and economic sustainability using digital tools and BIM. The output will describe owners' and inhabitants' needs and requirements for BIM-based renovation processes (D2.5)".

Following T2.5 scope a number of requirements should be extracted, setting the baseline for the definition of the BIM4EEB framework. Based on the methodology proposed below, several tools have been provided towards the extraction of the owners' and inhabitants' needs and requirements. These tools (templates, questionnaires, semi-structured interviews etc.) have been created upon consultation with the WP2 partners and have been disseminated to the pilot site representatives, to ensure that their valuable feedback is taken into account. The applied methodology is described in detail in the following section.

Subsequently, the scope of this section is twofold:

- To define the methodological framework that will ensure the active participation and collaboration of buildings owners and buildings inhabitants on the way to extract their specific needs and requirements.
- As building owners and inhabitants set a broader and rather generic group, we have to define specific targets/segments in order to better organize the requirements extraction process in this task.

2.1 Methodology

The basis for decisions within a renovation project is addressed with research questions on how decisions are developed, who is involved and what is their contribution in the different stages of a renovation project. The feedback from the building's end-users, namely the building owners and inhabitants during each phase of the requirement analysis phase will be sought along with contribution from the WP2 partners.

This is the 1st step of the work towards the definition of the methodology that will ensure the active contribution of the identified BIM4EEB end-users (i.e. building owners and inhabitants) and the successful extraction of their requirements.

As shown in Figure 2 below, the proposed methodology is composed by three steps through which the requirements coming from the building owners and inhabitants can be captured.

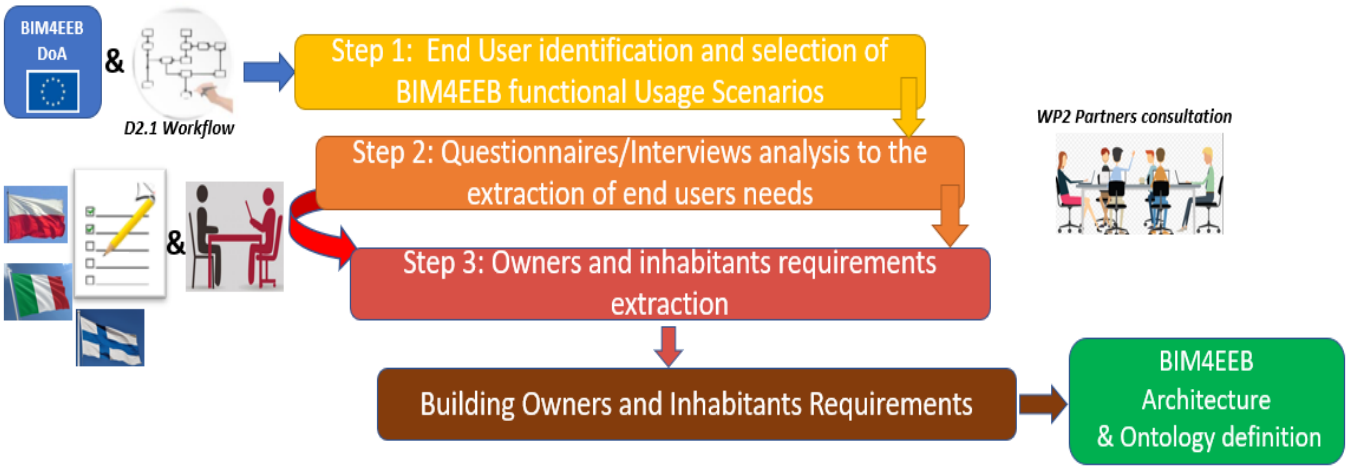


Figure 2: Requirements Extraction Methodological Framework

The different steps shown in Figure 2 above are detailed in the following text:

Step 1: Selection of BIM4EEB functional Usage Scenarios

The starting point for this analysis, is the identification of the end-users (namely the building owners and inhabitants in this document); as well as the 'incorporation' of the BIM4EEB objectives, as defined in the DoA. These objectives will be used as a guidance for the identification and selection of appropriate Usage Scenarios (US). Definition of the Usage Scenarios is performed on the basis of D2.1 about the extraction of the workflow for the renovation process; with the specific focus on owners and inhabitants activities/roles during the various renovation stages (both for public and private works); considered and contributed into the selection of appropriate Usage Scenarios. The refinement and final list of BIM4EEB Usage Scenarios is performed after consultation with the projects partners and pilot site stakeholders, actively participating on BIM4EEB activities and early engaged in the project's activities.

Step 2: Questionnaires/Interviews analysis to the extraction of the end-users needs

Following the definition of the BIM4EEB Usage Scenarios, a set of questionnaires and semi-structured interviews were prepared to address the needs of the building owners and inhabitants (as end-users of the BIM4EEB project). The scope was to engage these end-users in the project's activities and further retrieve their valuable feedback towards the extraction of their needs and requirements related to BIM4EEB project. Besides identifying their needs, building owners' and inhabitants' views on opportunities for improving intended tools and processes of the proposed renovation interventions on their building will be elicited through the questionnaires and through the contribution of the Pilot site representative partners in semi-structures interviews. We have to point out that compared to the other target groups (reported in WP2 deliverables), the opinion (requirements extraction) from building owners/inhabitants can be retrieved only through a direct communication as presented above.

Step 3: Owners and Inhabitants requirements extraction

Finally, in step 3 we take into account the questionnaires/interviews analysis results which are transformed to BIM4EEB's building owners and inhabitants requirements. These are further complemented by additional requirements mainly related to ethical and any legislation constrains imposed

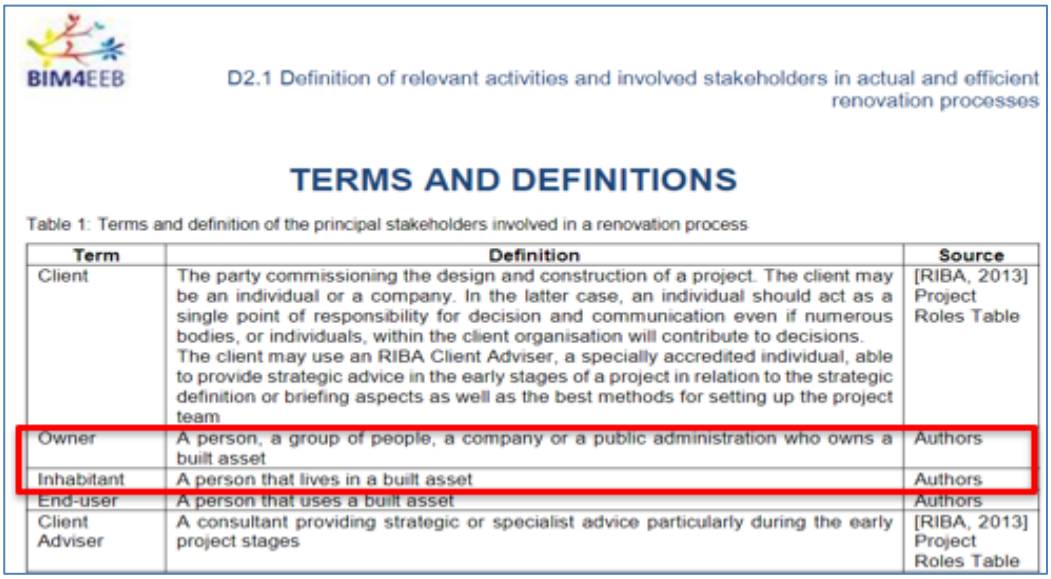
in the pilot regions of the BIM4EEB project, as identified by each responsible pilot partner. The prioritization of the end-user's requirements is also a critical ask performed at this phase, setting the guidelines for the design and development of the BIM4EEB platform.

The three-step methodological approach detailed above, clearly defines the work required for this deliverable. The next sections focus on the definition of the key target groups and thereafter the selected engagement processes, towards the extraction of the intended BIM4EEB end-users' requirements.

2.2 Key target groups definition

For the purpose of D2.5, the focus is given on the **Building Owners and Inhabitants** identified in the preselected BIM4EEB demonstration sites of Italy, Poland and Finland. The building owners and inhabitants are considered as main end-users of the intended BIM4EEB platform, since they will be directly interacting with the BIM4EEB tools and services, as well as with the proposed renovation interventions undertaken in their building. In addition, a main innovation of the BIM4EEB is to provide personalized services for the owners/inhabitants in order preserve or enhance further the occupant's comfort and the building's efficiency in terms of energy performance. In general, the role of the Owners and Inhabitants is to act as major stakeholders in the project, by setting preferences and further define the operational parameters for the building conditions.

Therefore, both these groups will be engaged, in order to understand their needs and requirements regarding the renovation interventions of their building and their required functions of the BIM4EEB platform. A short description of the identified BIM4EEB end users is provided in the following, complementing the definition of these two target groups as reported in D2.1 (see Figure 3).



BIM4EEB

D2.1 Definition of relevant activities and involved stakeholders in actual and efficient renovation processes

TERMS AND DEFINITIONS

Table 1: Terms and definition of the principal stakeholders involved in a renovation process

Term	Definition	Source
Client	The party commissioning the design and construction of a project. The client may be an individual or a company. In the latter case, an individual should act as a single point of responsibility for decision and communication even if numerous bodies, or individuals, within the client organisation will contribute to decisions. The client may use an RIBA Client Adviser, a specially accredited individual, able to provide strategic advice in the early stages of a project in relation to the strategic definition or briefing aspects as well as the best methods for setting up the project team	[RIBA, 2013] Project Roles Table
Owner	A person, a group of people, a company or a public administration who owns a built asset	Authors
Inhabitant	A person that lives in a built asset	Authors
End-user	A person that uses a built asset	Authors
Client Adviser	A consultant providing strategic or specialist advice particularly during the early project stages	[RIBA, 2013] Project Roles Table

Figure 3: Owner and Inhabitant definition (extract from Table 1, D2.1)

2.2.1 Building owner

Following the definition as presented in Table 1 of D2.1; the **building owner** is considered as a person, a group of people, a company or a public administration who owns a built asset.

Overall, the owner is responsible for the payment of any rates and taxes that arise due to his/her ownership of a built asset. The building owner has the largest interest in a successful renovation project since he/she will usually fund it and experience the outcomes/benefits. The owner is typically the actor deciding and commissioning the design and construction of the renovation and any investment in their building/asset must result in a monetary benefit, increasing profitability by reducing operating expenses and maintenance costs; this can lead to an increased net operating income and quicker returns on investment.

For the purpose of this project, it is considered that the building owner may/may not live within the building, however he/she uses the built asset and is the person responsible for the renovation scenario selection and intended building facilities. Additionally, the building owner is responsible and/or directly engaged in the building management, thus this actor should have a key input in the renovation decision making of their asset. In addition, as stated in the description of this task, within BIM4EEB project, the building owner's needs will be considered not only towards the management and control of the renovation from an energy performance viewpoint, but also for the control of working times and economic sustainability using digital tools and enhanced BIM services.

2.2.2 Building inhabitant

This end-user is the person who lives in a built asset (such as a flat/commercial unit) and typically rents it from an owner, for an agreed period in return for paying a rent. He/she has (usually) a written agreement (i.e. tenancy agreement) with the landlord, which sets down the duties, rights and responsibilities of each party for the duration of the tenancy.

Within BIM4EEB, we address the role of the Inhabitant as one of the major BIM4EEB stakeholders, since one of the main objectives of the project is to establish an energy efficient environment fully preserving end users' needs and preferences. Towards this direction, BIM4EEB tools and applications will be available for the building inhabitants to further address the high-level needs and requirements as active stakeholders of the BIM4EEB project.

Note: Regarding the BIM4EEB pilot buildings, the inhabitants of the Italian and Finnish buildings are found to occupy residential properties only, while in the Polish demonstration site we identify inhabitants both in residential and commercial properties. Therefore, BIM4EEB is addressing a diversity of building inhabitants.

Following the definition of the D2.5 end users, the BIM4EEB Usage Scenarios are described in the next section. The extraction of the Usage Scenarios is following the Description of Work, project's main objectives and consultation with pilot partners towards the definition of meaningful scenarios.

3 BIM4EEB Usage Scenarios

In this chapter, an initial list of Usage Scenarios (US) is defined, in order to screen the landscape for the definition of BIM4EEB owners and inhabitants requirements. The criteria used to select these US are:

- Defined according to the main objectives of BIM4EEB project, as detailed in the DoA;
- Defined according to the renovation process in WP2, selecting Usage Scenarios that incorporate the needs of the owners and inhabitants during the different stages of the renovation, as presented in D2.1 renovation workflow (both for private and public works);
- Defined following consultation with the relevant target group in order to individualise the way the end-users (i.e. owners and inhabitants) are actively engaged and interact with the BIM4EEB platform.

As part of the specifications extraction process, the BIM4EEB Usage Scenarios will be described in order to capture the entire process, identify the involved stakeholders and put their requirements in perspective. The extracted requirements will feed the following Work Packages and especially WP3, where stakeholders' requirements will be associated to Linked Data and Ontologies developed for ensuring semantic interoperability.

Towards the definition of the core functionalities to be supported by the BIM4EEB platform in regard to the owners and inhabitants perspective, 6 Usage Scenarios have been identified; following the review of the project foundations and following consultation with the pilot stakeholders and end-users towards their involvement in the various renovation phases as identified in D2.1 workflows:

- **US-01: Establishment of a comfort and IAQ preserving framework for inhabitants during the renovation period.**
- **US-02: Establishment of a comfort and IAQ preserving framework for inhabitants post renovation phase.**
- **US-03: A continuous interaction framework for comfort status monitoring and report for inhabitants**
- **US-04: An alerts and notification framework during the renovation process for owners and inhabitants**.
- **US-05: Management and control of renovation interventions for owners.**
- **US-06: Control of working times and economic sustainability for owners - tracking tool for renovation operations for owners**

The definition of the different Usage Scenarios highlights the key differentiation among the stakeholders (owners vs. inhabitants) examined in this document, A detailed description of the BIM4EEB Usage Scenarios is provided in the following tables, focusing mainly on the definition of functionalities as requested by the system end-users.

Table 1 US-01: Establishment of comfort and IAQ preserving framework for inhabitants during the renovation interventions

BIM4EEB Usage Scenario - 01	
US ID	US-01
US Name	Establishment of a comfort and IAQ preserving framework for inhabitants during the renovation interventions
Pilot site	Italy, Poland, Finland
Involved End-User	Building inhabitants
Description	The ultimate scope when considering undertaking a renovation in a building is to enhance the building's energy performance; this in turn will result in enhanced living comfort conditions for its occupants and users. Nevertheless, during the actual renovation works it is anticipated that the physically invasive processes of the renovation will impact the Inhabitants' comfort conditions and the building's Indoor Air Quality (IAQ). Considering also that people spend 60–90% of their life indoors (houses, offices, etc.) preserving appropriate comfort levels and satisfactory IAQ is critical for their health and particularly for the health of vulnerable groups (children and elderly people), especially if they continue to live inside the building during the renovation works (small scale renovation). In addition, research has clearly recognized that problems with indoor environmental quality (i.e. thermal, acoustic, visual and IAQ) of a building has a direct effect on the comfort, health and productivity of its Inhabitants. Consequently, establishment of built environments that can preserve high levels of human comfort and IAQ is a key requirement for the renovation process, since these aspects are tightly connected to the real estate value of a building directly affecting the economics and contractual terms for the implementation of such projects. Considering all the above; US-01 focuses on the actual renovation period and its objective is threefold: • to establish the building's realistic indoor environmental conditions in terms of physical and measurable parameters; • to identify the personal perceptions and attitudes of the building's inhabitants with respect to those same ambient parameters, including comfort IAQ zones, acoustic and visual comfort; • to provide a mechanism for preserving the inhabitants comfort conditions during the period of the renovation works. The overall renovation approach should identify the requirements for the establishment and preservation of the Inhabitants' comfort zones with the focus given to their thermal comfort preferences, perceived and actual IAQ, acoustics and visual

	comfort preferences associated with indoor environmental conditions; as well as inhabitants' activity-related comfort preferences associated with the operational conditions in the building premises.
US Key Aspects	BIM4EEB should introduce a comprehensive approach that can holistically infer user preferences on several ambience parameters (e.g. temperature, lighting quality, etc.) through the development of a set of user comfort models that can recognise and infer comfort preferences of occupants. This should be realised by introducing a continuous adaptive framework for accurate extraction of building conditions, addressing also inhabitants as a critical parameter affecting the overall building's performance. As such, US-01 relies on the availability of Indoor Environmental Comfort (IEC) data from sensors and utilisation of a Building Energy Management System (BEMS) with centralisation and treatment of the gathered data from the installed smart equipment, responsible for real-time monitoring of different comfort related parameters (IAQ, Temperature, Acoustics, etc.).The availability of sensing and metering data will enable the extraction of accurate inhabitants' comfort zone and context conditions in real-time; to be further modelled in order to create inhabitants' preferences. Moreover, key prerequisite towards the realisation of this scenario, is to capture the inhabitants' perception regarding the quality of their indoor environment conditions; through a feedback mechanism will allow for the definition of accurate behavioural/ comfort profiles of the inhabitants during the phase of the renovation works. Overall, the establishment and preservation of the inhabitant's optimum comfort, requires also direct input from the inhabitants (i.e. qualitative feedback); to establish advanced control strategies access to real-time - device level – is also needed to obtain quantitative feedback based on sensor and meter readings, along with the associated user related parameters. Extraction of the behavioural profiles will enable identification of occupants' actual comfort preferences in terms for example of HVAC (i.e. thermal comfort) and Lighting operation (i.e. visual comfort), considering also any health constraints imposed during the building's operation. The extraction of these (dis)comfort profiles will further facilitate the design of a livable building during the renovation phase, with a high degree of satisfaction among the final building occupants.

Table 2 US-02: Establishment of a comfort and IAQ preserving framework for inhabitants, post-renovation

BIM4EEB Usage Scenario - 02	
US ID	US-02
US Name	Establishment of a comfort and IAQ preserving framework for inhabitants, post renovation interventions

Pilot site	Italy, Poland, Finland
Involved End-User	Building inhabitant
Description	Similar to US-01 this proposed framework should identify the requirements for the establishment of the building Inhabitants' comfort zones (e.g. Temperature, Acoustics, Lighting, etc.), as well as preservation of the building's IAQ once the renovation works are completed (i.e. post renovation) As explicitly stated in the DoA, BIM4EEB should include inhabitants in a variety of activities (engaging them as target group), establishing a strong link with the occupants at the demonstration cases, towards monitoring energy consumptions and indoor air quality parameters after the renovation period. The inhabitants' comfort profiling framework will enable a user-centric continuous monitoring of ambient conditions and interact with the inhabitants in an ambient manner (facilitated by appropriate user-friendly interfaces) to extract context-aware user preferences and understand comfort (dis)satisfaction zones. As such, inhabitants post occupancy evaluation of their comfort zones should be sought and defined, in order to (a) ensure a comfort and IAQ preserving framework during the operational phase of the building and (b) enable a direct comparison of the comfort zones and IAQ needs of the inhabitants, during and after the renovation period.
US Key Aspects	This Usage Scenario depends on the preservation of the pre-installed smart equipment and sensors responsible for real-time monitoring of different comfort related parameters (IAQ, Temperature, etc.) after the renovation period. Real time data from the sensors and / or feedback from the end users will be also required in order to set the mechanisms that will enable the establishment and preservation of the Inhabitants comfort zones and building's IAQ. Additionally, US-02 will provide a direct comparison of the inhabitant's comfort zones preference during the actual renovation operations and post renovation phase.

Table 3 US-03: Continuous comfort status monitoring and report interaction framework for inhabitants

BIM4EEB Usage Scenario - 03	
US ID	US-03
US Name	Continuous interaction framework for comfort status monitoring and report for inhabitants

Pilot site	Italy, Poland, Finland
Involved End-User	Building inhabitant
Description	As explicitly stated in the DoA, one of BIM4EEB's objectives (Obj 3.4) is to enhance user involvement. Towards the enhanced user involvement, a continuous interaction framework about comfort status should be established, enabling users (i.e. Inhabitants) to continuously update their comfort preferences during and post renovation. The proposed framework should ensure that the inhabitants' perception of various comfort related parameters is taken into consideration during the initial renovation design scenario; as well as during the actual operation minimising any impact on their comfort zones during the works. Inhabitants comfort needs will be considered through their interaction with the proposed BIM4EEB tool and data captured by sensors in the demonstration buildings. Overall, detailed and accurate dynamic visual and thermal comfort models of occupants that allow the correlation between ambient conditions and usage metrics will enable the definition of accurate comfort-based energy behaviour profiles of Inhabitants within a building. Inhabitants profiles will incorporate all personalised and contextual (environmental, temporal) aspects of (energy-related) behaviours, focusing on thermal and visual comfort preferences of consumers, hygienic and health boundaries that need to be applied in the indoor environment.
US Key Aspects	US-03 stands on top of the specification defined in US-01 & US-02 and relies on a user-centric and participatory approach of the inhabitants; as key aspect for the realisation of this scenario is the inhabitants' willingness to provide feedback regarding their comfort preferences. Towards this direction, a specific tool (e.g. a mobile application) should be considered, enabling interaction with the inhabitants for collecting their feedback on their perceived comfort conditions. The proposed tool should allow continuous analysis of inhabitants' comfort status and behavioural dynamics, towards providing quick but comprehensive snapshot of their daily activities and correlated energy consumption in their premises. Moreover, it should allow user-specific continuous & correlated monitoring of ambient comfort conditions and inhabitants' actions in order to extract context-aware user preferences and understand their comfort (dis)satisfaction zones. Overall, the definition of a user centered behavioural profiling framework is defined in US-01 & US-02. By further processing and dynamically analyzing information from building premises in US-03, the user will be able to have a snapshot of inhabitants' comfort preferences in an adaptive/progressive way and identify their perception towards building's operation.

Table 4 US-04: Alerts and notification framework during the renovation process for owners and inhabitants

BIM4EEB Usage Scenario - 04	
US ID	US-04
US Name	An alerts and notification framework during the renovation process for owners and inhabitants
Pilot site	Italy, Poland, Finland
Involved End User	Building owner & inhabitant
Description	As referred in the DoA and highlighted also in the list of scenarios in D2.1, BIM4EEB should focus at the development of a suitable BIM-based framework allowing building Inhabitants & owners to receive information on on-going works, safety hints and information, e.g. to avoid specific areas where works have not yet been finished. Avoiding accidents on-site and preserving the H&S of the building's occupants is critical to any renovation project; not only for efficiency but also for other legally related reasons. Any relevant issue that may have a negative impact to onsite H&S needs to be promptly reported, documented and transparently communicated to all involved actors, to increase their awareness and cautiousness when they are on-site and enable proper actions to tackle it. The proposed framework aims to keep owners and inhabitants of a building informed of the renovation activities by sending security and safety recommendations and/or Health and Safety (H&S) instructions regarding the ongoing and programmed renovation works; owners and Inhabitants should be made aware of any changes done on the site, without the need to be informed by an individual. Before entering the site, they should be able to access the proposed application in order to get access to the relevant H&S instructions that should be followed when they are on site. Additionally, potential risks could be available for each floor of the building, as identified in the project's risk assessment. The objective of this framework is to provide building inhabitants & owners with guidance of the on-site renovation works, enhancing security and safety on-site thus resulting in reduction of accidents or near misses, which in turn will provide an accident-free renovation progress, avoiding delays related to H&S events.
US Key Aspects	US-04 relies on the development of a web application which will enable bi-directional communication and information exchange among the building stakeholders during the renovation phase. End-users will have to subscribe to the proposed web application in order to receive alerts and notifications related to the renovation process. The alert/notification mechanism should identify the phase of the works, as defined in the original

	renovation schedule and further trigger the appropriate messages/notifications in several ways through the available communication channels.

Table 5 US-05: Management and control of renovation interventions for owners

BIM4EEB Usage Scenario - 05	
US ID	US-05
US Name	Management and control of renovation interventions for building owners
Pilot site	Italy, Poland, Finland
Involved End-User	Building owner
Description	As explicitly stated in the DoA and highlighted also in the list of scenarios in D2.1, the building owners should be always aware and conscious about the management and control of the renovation interventions. BIM4EEB should provide owners with a tool to control the renovation interventions, enabling them to also provide their input into the building renovation simulation; enabling them to actively participate (jointly with contractor) in the management of the intended renovation interventions. More specifically, the tool is about reporting of various building structures/elements within a building. For example, as the owners have a better knowledge of their building/asset they are able to identify critical information about the building geometry and existing systems (e.g., heating, pipes, cables) not included in existing drawings. Moreover, as the owners have a better knowledge of the building's usage, they can provide valuable information (e.g. occupancy schedules, comfort requirements or preferences and energy use) to adapt the design of the proposed renovation interventions to the actual building use. This enhanced information will enable BIM modelers to significantly accelerate the creation of accurate and semantically-rich building models, resulting in more precise renovation simulations. Furthermore, this will result in reduction of time and cost of the renovation project design procedures. On the other hand, the building owners will be able to continuously track the renovation activities and thus be able to have a better understanding about the progress of the work.
US Key Aspects	US-05 relies on the active participation of building owners from the initial stages of the renovation design to the actual renovation works. Key requirement for the realisation of US-05 is the establishment of a tool enabling owners to update the results of the renovation simulations. The end user will be able to upload information in a structured way that is required in order to proceed with the fine-grained modeling of the building.

	On the other hand, information about the renovation process; the anticipated cost of the renovation, the duration and resulting energy performance of the renovation scenario should be accessible to the owners, so they can get access to information about the optimum scenario as per their needs.

Table 6 US-06: Control of working times and economic sustainability for owners - tracking tool for renovation operations for owners

BIM4EEB Usage Scenario - 06	
US ID	US-06
US Name	Control of working times and economic sustainability for owners - tracking tool for renovation operations for owners
Pilot site	Italy, Poland, Finland
Involved End-User	Building owner
Description	As explicitly stated in the DoA and complementing US-05, owners' needs will be considered not only for the management and control of the renovation interventions but also for the control of the working times and economic sustainability using digital tools and BIM. The proposed framework should provide 24/7 situational awareness of the statuses of the renovation activities, providing unprecedented transparency of the project progress, thus informing building owners of the scheduled activities and of any deviations from the original renovation plan. In addition, they will be able to receive information about on-site work planning and schedules, "negotiate" with contractors based on their individual needs and jointly decide on the optimal schedules without affecting the overall duration of project. Use of this tool by the owners will enable bidirectional communication and information exchange between the renovation contractors and the building owners, thus achieving optimised operational planning and fine-grained works scheduling, resulting in minimum disruption both to the scheduled activities as well as to the buildings occupants. By keeping track of every onsite detail including, but not limited to labor, communication, equipment, materials, and recording daily job site events, the proposed toolset will provide transparency on all jobsite activities enabling tracking and control of the renovation activities from the owners' perspective.
US Key Aspects	Key aspect for the realisation of US-06, is the development of BIME4EEB's fast tracking tool for renovation operations. The proposed tool should allow scheduling of the site activities with shorter lead times resulting in reduction of the overall

	construction duration while on the same time allowing owners to immediately take control of any possible deviations in implementation and informing the construction team to rectify these deviations. Overall this usage scenario complements US-05 with the focus to be on expanding the list of KPIs to monitor with focus on working times and economic sustainability for the renovation process.

In summary, the list of the selected US defines the design principles for the BIM4EEB platform considering the owners and inhabitants perspective. Moving beyond the definition of the Usage Scenarios, the next step focuses on the extraction of the end-user's requirements following the methodology detailed in the following chapter.

We have to point out that, the definition of the usage scenarios (on the basis of the renovation process principles as defined in D2.1) will also enable the design of the system's components as part of the BIM4EEB framework (WP4-WP5-WP6-WP7).

4 End-user's engagement approach

The building owners' and inhabitants' engagement in the project's activities is a necessary starting point to identify their needs and requirements for the development of BIM4EEB's tools and methodologies.

In contrary to the work performed in the previous requirement extraction tasks in WP2 (namely D2.2 - D2.4) where the AEC business stakeholders (i.e. Construction companies, Service companies, Designers) with deep knowledge about their needs and requirements were engaged in this process; building owners and inhabitants are not familiar with the renovation process and its specificities. Therefore, a different approach should be established in this task, to ensure their active participation and useful contribution.

Several participatory processes are considered to collect each piece of information from the end users. Depending on the type of information, how specific it is, the complexity, the need of a contextualization, the importance of the details and accuracy in the response, topics or questions are assigned to the most suitable participatory process. The requirements definition derives through the owners and inhabitants participation in appropriate questionnaires and at a later stage in semi structured interviews with the pilot site representative partners. As such, the participation of the building owners & inhabitants is deemed of primary importance for collecting the end-users' needs and identify the usability of the developed tools, especially with respect to fragile inhabitants of social housing.

Specifically, the input from the owners and inhabitants of the BIM4EEB pilot sites in Italy, Finland and Poland, will be used to fulfil D2.5 and further serve as inputs to the specifications extraction of the BIM4EEB system architecture.

Figure 4: Buildings owners and inhabitants engagement methodology

The details about the stakeholder's engagement methodology are presented:

4.1 Tools for owners/inhabitants' stakeholder's engagement

Two engagement methodologies and associated tools were considered for the building owners and inhabitants engagement, undertaken in two different phases:

4.1.1 Phase 1: Questionnaires

At first, focused questionnaires are considered for gathering feedback from a large pool of end users. The proposed questionnaires are compiled in such a way to engage the targeted end-users in the project's activities and further retrieve their valuable feedback towards the extraction of their needs and

requirements, while considering the type of end user, location of the pilot site and applied BIM4EEB toolkits.

Two different questionnaires were compiled for each target group (i.e. building owners and inhabitants). The questions asked, were filtered and polished to avoid too technical questions and confusion of the participants that are not familiar with the BIM concept and the various renovation stages. Questionnaires are mainly formed of multiple-choice questions, which narrow down the amount and quality of the information to a limited number of options in each question. An additional field is available in each question for other choices with comments, allowing flexibility for personal comments or options. This way, the survey is faster to respond, and the analysis is also facilitated.

A draft version of the questionnaire was initially circulated among the Pilot site representative partners to test the acceptability of the questions and help refine the wording and layout. Once feedback was received from the questionnaires were reformed and updated according to the partners' comments and thereafter translated to each pilot site language, prior to being circulated in the proposed sites.

The questionnaires also include a short introduction about the project's concept as well as a non-disclosure statement regarding the collection, storage and processing of data the questionnaires. The intended type of information to be gathered from the end users is classified into the following groups:

- Profile information: such as personal profile data, household composition and building characteristics. This information is useful for segmentation and statistical analysis.

- General knowledge and familiarity with concepts such as BIM (Building Information Modeling), BACS (Building Automation and Control systems), etc., and questions trying to capture the current knowledge of the Owners and Inhabitants, in regards to how their building/premises operates.

- Owners & Inhabitants required BIM4EEB tools and attitude towards participation in the usage scenarios. This information will gather the intended tools and aspects of BIM4EEB platform as identified from the Owners and Inhabitants considering their own needs, as the final end-user of the BIM4EEB toolkits.

The templates of the questionnaires can be found in Annex I.

4.1.2 Phase 2: Semi-structured Interviews

Further to the use of questionnaires for extracting the owners' and inhabitants' needs and requirements, the Pilot site representative partners were also engaged in semi-structured interviews to extract further pilot specific requirements. In addition to the questions included in the circulated template (see Annex I); the use of these semi-structured interviews allowed new ideas/concepts to be examined, as well as further technical requirements to be identified in regard to ethical/legal barriers imposed in the different pilot sites.

Having defined the engagement tools for the owners and inhabitants, the next section provides an overview of the schedule for the implementation of activities towards end users engagement and feedback gathering.

4.2 Timeline Framework for Questionnaire Analysis

Two main types of questionnaires have been created and circulated to the BIM4EEB's end-users. One for the building owners and one for building inhabitants. Customized versions of the questionnaire were available to address the specific needs of each pilot site (e.g. translation, pilot specific remarks etc.). On the other hand, the template for the semi structured interviews was structured in order to complement questionnaire analysis.

Considering the role of the pilot site representative partners and their contribution in this deliverable, the following work-allocation was performed:

- Suite5 compiled the questionnaires for owners and inhabitants in English along with the template for the semi structured interviews and was responsible for the questionnaire and interview analysis. One questionnaire was compiled for the building inhabitants and one for the building owners, being a company/ group of companies or a public administration.
- Caverion was the partner responsible to translate the questionnaires in Finnish and circulate the questionnaires in the Finish pilot site to the tentative end users of the project. Also, for contribution at the interviews.
- ALER and RegLomb were the partners responsible to translate the questionnaires in Italian and circulate the questionnaires in the Italian pilot site to the tentative end users of the project. Also, for contribution at the interviews.
- Prochem was the partner responsible to translate the questionnaires in Polish, circulate the questionnaires in the Polish pilot site to the tentative end users of the project. Also, for contribution at the interviews.

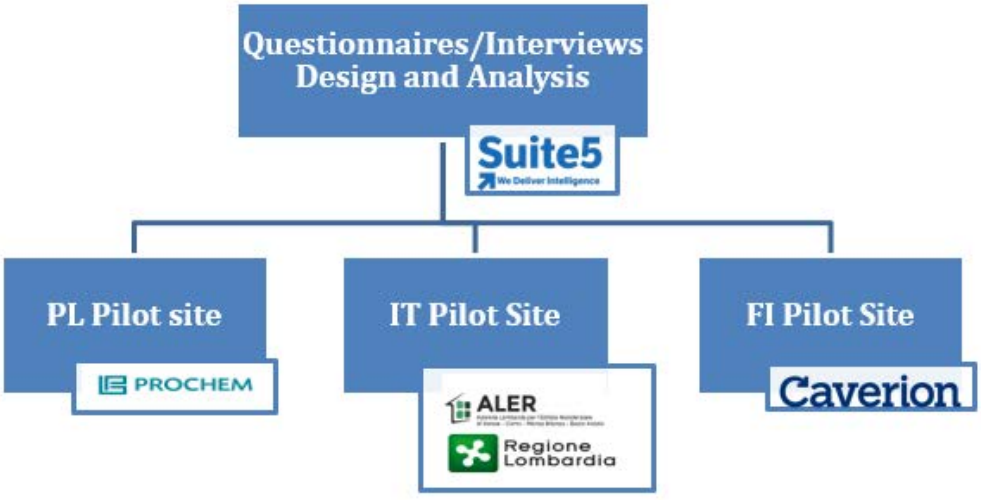


Figure 5: Questionnaires work allocation

Following the work allocation among the involved partners, an action plan for the building owners and inhabitants engagement was defined and agreed with the Pilot sites representative partners. The details of this action plan are presented in the following figure.

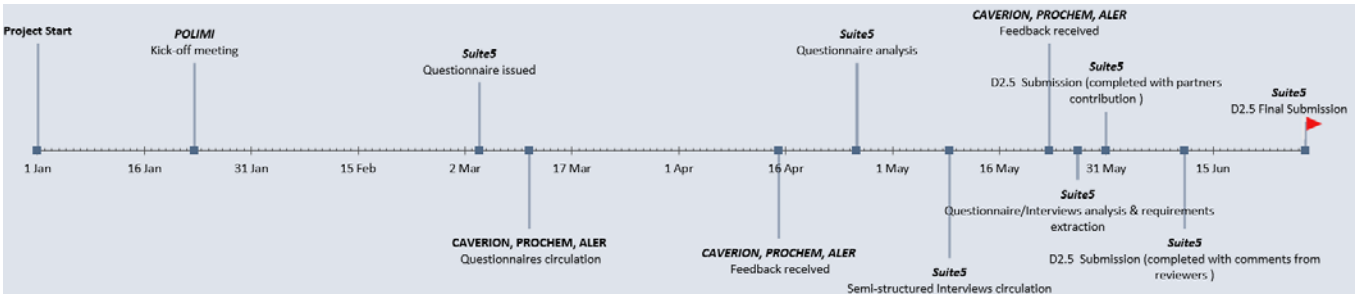


Figure 6: Building Inhabitants and Owners engagement action plan

We presented in brief the overall methodology for end users engagement and feedback gathering from building occupants and inhabitants. The following section presents the results from the Questionnaires & Interviews analysis per pilot site and semi-structured interview, that will further lead us to the extraction of the list of owners' and inhabitants' requirements in relation to the proposed Usage Scenarios of the BIM4EEEB platform.

5 Questionnaires & Interviews Analysis

By defining the list of BIM4EEB Usage Scenarios and presenting the methodology for end users' engagement, the next step is the extraction of the Owners and Inhabitants needs and requirements.

As explicitly stated in the DoA, *"a participatory perspective will be even considered as a measure for public and societal engagement, ensuring an active participation of different stakeholders (as end-users in demonstration buildings and standardization bodies in the AB (Advisory Board)) ".* Furthermore, *"The participation will be of primary importance for collecting users' needs and testing the usability of developed tools, especially with respect to fragile inhabitants of social housing"*

From the above statement, it is clear that interaction with the pilot end-users (i.e. owners and inhabitants) at this point is a main prerequisite for the extraction of their needs and requirements. As mentioned previously and towards this direction, the pilot site's owners and inhabitants were engaged to provide feedback in suitable questionnaires, in order to ensure their active involvement. The results from this questionnaire analysis are presented in the following.

5.1 Summary of Questionnaires Analysis results

Six different translated versions of the questionnaires (three for the building owners and three for the building inhabitants per pilot site) were circulated to gather end users' feedback in the preselected pilot sites of Italy, Poland and Finland.

In total, 102 questionnaires were answered (45 for building Owners & 57 for building Inhabitants) and the most important insights are presented per pilot site; a detailed presentation of the questionnaire results can be found in Annex II.

5.1.1 Italian Pilot Site Analysis

The results from the questionnaire analysis are available below for both the building owners and Inhabitants. The outcomes are first presented for the **Building owners**:

ALER, a public administration is the owner of the entire Italian pilot site solely responsible for deciding to undertake (or not) a renovation in their assets. ALER reported to have a previous experience in undertaking a renovation in their asset, while the Italian pilot site is identified as an old building with no previously undertaken renovation and no building automation system installed.

According to the responses, the buildings' inhabitants have not requested any energy upgrades in their premises and the communication with the inhabitants is undertaken through email, telephone conversation or face to face meeting.

The Italian pilot site owner reported to understand the concepts and benefits of Building Information Modelling (BIM) and Building Automation and Control systems (BACS) (closely related to the BIM4EEB project) except for some details/concept; has a good knowledge on how heating, fresh air, cooling, and lighting is provided in their asset and is aware of all the existing equipment in their building. Moreover, ALER holds information about the inhabitant's heating equipment and lighting conditions in their premises;

however, no information/data is available regarding the inhabitants' comfort conditions (such as Temperature, IAQ, etc.)

Overall, the Italian pilot owner showed a high interest to be involved in the proposed framework by:

- Participating (jointly with contractors) in the renovation scenario selection;
- Monitor and select the results of the building renovation simulation;
- Participate (jointly with contractors) in the planning of the renovation operations;
- Monitor the ongoing renovation activities;
- Upload information of the building when requested by contractors;
- Participate (jointly with contractors) in the management and control of the renovation works;
- Control the renovation working times;
- Monitor the building's energy performance (near real time);
- Control the economic sustainability of the renovation process.

Towards the owner's needs and requirements regarding the BIM4EEB toolkits and integrated capabilities of the proposed platform; the incorporation of safety alerts and notifications on the ongoing works, as well as the capability to control the renovation working times is main requirements for the overall framework.

Enabling a) transmission of data/info/drawings, when requested by contractors, b) communication and information exchange with other stakeholders (i.e. Project leader, Contractors etc.) and c) monitoring the building's energy performance, are also very interesting features to be examined. As least important capabilities the owner reported to be: the provision of automated progress tracking of on-site operations and enabling control of the economic sustainability of the renovation process. The Italian Owner identified as very important opportunities for considering undertaking a renovation in their building the possibility to a) comply with building regulations, legislative requirements, b) decrease the building's operational costs and c) increase of the building's energy performance and sustainability. As equally important opportunities for considering undertaking a renovation in their asset, the Italian pilot site owner identified the possibilities to: a) retain/increase value of their building in the long run, b) maintain a high level building quality, c) enhance inhabitants comfort conditions d) increase building's aesthetic and e) increased rental rates, as a result of the renovation interventions.

The lack of funding, high upfront costs and long payback time are the main drawbacks (main reasons for not considering undertaking a renovation in their asset. As equally important barriers are considered: the inhabitants' discomfort (complaints) during the renovation works and the uncertainty of economic consequences of the renovation. As least important barriers for not considering undertaking a renovation are: the owner's lack of knowledge/experience on renovation works, the fragmented nature of the building sector and the difficulty to monitor progress and site activities since several separated disciplines are working onsite simultaneously during the renovation works.

A similar analysis is undertaken for the Italian **Building inhabitants**, starting with some generic profiling information.

A total number of 26 respondents filled in the questionnaire from the Italian pilot site, out of which the majority (65.4%) are females. Most of the respondents are 70 years old or older (34.6%), followed by 50-

59-year-old (26.9%), 40-49 years old (23.1%) and 60-69 years old (11.5%). Most of the Italian pilot flats are occupied by 2 persons (53.8%) or by 1 person (30.8%), followed by 3-4 persons occupancy (11.5%). Most of the respondents live in their current flat for 10 years or more (88.5%) and only 7.7% live less than a year in their current premises. The majority of the respondents reported that they spend 9 hour or more in their flat (76.9%) and the rest spend 5-8 hours per day (23.1%). Most of the respondents reported that they have no digital skills at all (53.8%), while only 34.6% own a PC and only 30.8% a smartphone. According to the inhabitant's perception, the pilot building is identified as an old building with no renovation undertaken in the past (73.1%), however only 46.2% of the respondents' have requested an energy upgrade of their flats/building from their property owner.

The analysis of the next section of the questionnaire provides insights of the inhabitants' knowledge on concepts relevant to the project; their understanding on how their building operates, as well as preferred features to be incorporated into the BIM4EEB platform.

Most of the respondents do not understand at all concepts such as BIM (38.5%) and BACS (42.5%) and its capabilities in renovation interventions. Only 23.1% fully understand the concept of BIM and only 4% fully understand the concept of BACS. The inhabitants reported to have a limited knowledge on how the building's heating, fresh air, cooling and lighting is provided (53.8%) to no knowledge at all (30.8%). Only 15.4% of the respondents reported to have a good knowledge of it. In addition, 50% of the respondents are not satisfied at all with their building, while only 11.5% reported to be very satisfied.

The most critical parameters regarding the inhabitants comfort zones is the Indoor Air Quality (69.2%), followed by Temperature (53.8%), Acoustics (42.3%) and Lighting quality (15.4%); Only 7.7% of the respondents consider all of the above parameters critical. As part of the work in BIM4EEB, the IAQ, Temperature, Acoustics and Lighting are the main comfort parameters to be considered in the project. Currently most of the respondents reported to have no control within their flats of the IAQ (21 votes) and noise (18 votes) in their premises followed by Lighting conditions (10 votes) and Temperature (9 votes).

The last section of the inhabitant's questionnaire aims to define the inhabitants needs and requirements regarding their preferred BIM4EEB toolkits and integrated capabilities.

The most preferred functionality is enabling inhabitants to receive information on the work-planning/schedule of the renovation activities both during and post renovation period (18 votes), which is a key point to be addressed by the project through the Human Interface tool. Additional important feature to be provided is an "interaction" mechanism enabling inhabitants to upload maintenance issues/faults and H&S issues (16 votes), provide information about their comfort conditions (during and post renovation period (15 votes), receive safety alerts and notifications about the ongoing renovation works (14 votes) and lastly enable communication and information exchange with the renovation stakeholders.(11 votes). As least important capabilities, inhabitants identified the provision of a tool enabling them to transmit data/info/drawings when requested by contractors for the renovation process and providing them access to the building's documentation (e.g. operation and maintenance manual, structural drawings, etc.).

Towards defining the favorite feedback mechanism for the inhabitants', the respondents expressed a high interest to provide feedback on their comfort zones, both during the renovation (84.6%) and post renovation period (96.2%) on a monthly basis (92%) through communication with the building

Owner/Facility manager (65.4%), followed by Email (32%) and through a Mobile application (24%). This is most likely because the majority of the Italian pilot site inhabitants reported to have no digital skills at all (56%).

Provision of a notification/alerts mechanism regarding the renovation progress/schedule is the most interesting feature for most of the respondents (76.9%). The inhabitants expressed also their preference to receive notification messages through a mobile (47.6%), by Email (42.9%) or through a dedicated mobile application (38.1%), when there is a change in the work progress/schedule (69.6%) and on monthly intervals (26.1%). The inhabitants showed also a great interest to receive security and safety recommendations/alerts about the ongoing activities in their building (84.6%). Their most preferable way to receive the safety alerts is by Email (10 votes) or SMS (10 votes) and through a mobile application (9 votes); as previously they would like to receive the safety alerts mostly when there is change in the in the works schedule (70.8%), followed by monthly (16.7%) and weekly intervals (12.5%).

The last two questions of the questionnaire provide the means to identify the opinion of the inhabitants regarding opportunities and barriers for requesting a renovation of their assets from the building/asset owner. The answers will be utilized to extract further requirements for the inhabitants.

As very important opportunities for requesting from their building owner a renovation in their building, is the potential of energy savings (22 votes), followed by the potential enhanced indoor environmental conditions (20 votes) and increased inhabitants' health and well-being (20 votes). On the other hand, as very important barriers for not considering requesting a renovation in their building is the poor communication/ with their landlord/owner (18 votes) and the possibility of an extended duration of the renovation works (18 votes).

As further important barriers, the respondents identified the lack of information about the economic and environmental benefits of the renovation works, the lack of inhabitants' input/control over the renovation scenario selection and the difficulty to foresee the renovation's benefits.

5.1.2 Polish Pilot Site Analysis

The results from the questionnaire analysis are available for both the building inhabitants & owners. The outcomes are first presented for the **Building owners.** A total number of 15 owners from the Polish pilot site filled answers in the appropriate questionnaire.

As identified by the respondents of the building owners questionnaire, the Polish pilot site is co-owned by multiple owners, where the majority of the respondents own 1 apartment/flat (66.7%). The pilot site is identified as a new building by 60% of the respondents; while 26.7% identify their building as old, but recently renovated. Regarding the profile of the Polish building owners who filled in the questionnaire: the majority are involved in property management (73.3%), property owners (26.7%) and Municipal Real Estate (20%). Most of the respondents reported that they have previous experience in undertaking a renovation of their building (73.3%) and only 26.7% reported to have limited experience.

The Polish owners reported that their building's inhabitants have not requested any energy upgrades of their properties (40%) or have made some requests for energy improvements to the building owners. Only 20% of the owners reported that their building inhabitants are frequent, vocal advocates for energy

efficiency improvements. The communication between the building owners and the inhabitants is currently undertaken through Email or Telephone conversation (14 votes), followed by Face to Face meetings (12 votes) and lastly via SMS or Mail correspondence (8 votes).

Most of the Polish owners reported to partially understand the concepts and benefits of BIM (46.7%) and BACS (40%) and only 13.3% and 20% respectively reported to fully understand these concepts. The owners reported to have some knowledge but not fully aware on how heating, fresh air, cooling, and lighting is provided in their asset (60%), however most of them are aware of all the existing equipment installations in their building (86.7%). Moreover, the owners reported to hold information about the inhabitant's heating equipment and lighting conditions in their premises; however, no information/data is available regarding the inhabitants' comfort conditions (such as Temperature, IAQ, etc.).

Towards the Polish owner's needs and requirements regarding their preferred BIM4EEB toolkits and integrated capabilities of the proposed platform; the most important aspect is enabling owners to control the renovation working times. Moreover, enabling communication and information exchange with the renovation's stakeholders (i.e. Contractors, Project leader, etc.) is an important feature to be examined (10 votes). Further equally important tools to be integrated are: enable owners to transmit data/info/drawings, when requested by the contractors as well as to monitor the building's energy performance (8 votes). The incorporation of safety alerts and notifications for the ongoing works, as well as enabling automated progress tracking of the on-site operations are also considered as important (7 votes) tools. As a slightly important capability is to enable owners to control the economic sustainability of the renovation process (3 votes).

Overall, the Polish owners showed a high interest to be involved in the proposed framework and should a renovation in their building takes place they would like to be involved in the following renovation activities (results are presented in a descending order of preference votes):

- Control the renovation working times (13 votes);
- Monitor the ongoing renovation activities (12 votes);
- Upload information of the building when requested by contractors (11 votes);
- Participate (jointly with contractors) in the planning of the renovation operations (11 votes);
- Participate (jointly with contractors) in the management and control of the renovation works (10 votes);
- Control the economic sustainability of the renovation process (9 votes);
- Participate (jointly with contractors) in the renovation scenario selection (8 votes);
- Monitor and select the results of the building renovation simulation (7 votes);
- Monitor the building's energy performance - near real time (3 votes).

The last two questions of the questionnaire provide the means to identify the opinion of the Polish owners regarding opportunities and barriers for undertaking (or not) a renovation of their assets in the future. The answers will be utilized to extract further requirements for the building owners. As very important opportunities are considered the possibilities to a) provide enhanced Inhabitants' comfort conditions and b) decrease the building's operational costs; reduce maintenance (8 votes).

As important opportunities are identified the possibility to maintain a high-level building quality (10 votes) and increase the building's aesthetics (10 votes). Additional important opportunities reported to be the

possibility of improving the building's energy efficiency and reduce its environmental impact (9 votes); followed by the opportunity to comply with building regulations, legislative requirements (8 votes).

As least important opportunities for undertaking a renovation, is considered the increased rental rates, as a result of the renovation interventions (7 votes) and retain/increase the value of their building in the long run (5 votes).

On the other hand, the most important barrier for not considering undertaking a renovation in their asset is considered the lack of funding, high upfront costs and long payback time for most of the owners (8 votes). As important barriers are considered: a) the owner's lack of knowledge/experience on renovation works (9 votes), b) the possibility of an extended duration of the renovation works (6 votes), c) the difficulty owners face in monitoring the renovation progress and site activities (6 votes) and d) Owner's difficulty to foresee the renovation's benefits. As least important barriers, owners consider the inhabitants' discomfort (complaints) during the renovation works (5 votes); the fragmented nature of the building sector (4 votes) and the uncertainty of the economic consequences of the renovation (2 votes).

A similar analysis is undertaken for the **Building inhabitants**, starting with some generic profiling information. A total number of 15 respondents filled in the questionnaire from the Polish pilot site, out of which the majority (73.3%) are females. Most of the respondents are between 30-39 years old (60%), followed by 40-49 years old (33.1%) and 50-59-year-old (6.7%). Most of the Polish pilot flats are occupied by 3-4 persons (60%) followed by single person occupancy (26.7%) and two-person occupancy (13.3%).

The majority of the respondents live in their current flat for 3-5 years (53.3%), followed by 5-10 years (20%) and less than a year (13.3%). Only 6.7% reported to live in their current building for more than 10 years. Most of the respondents reported that they spend 9 hour or more in their flat (93.3%) and the rest (6.7%) spend 5-8 hours per day. Most of the respondents reported to own a PC (93.9%), a tablet (60%) and a smartphone (33.3%).

According to most of the inhabitant's, the pilot building is an old building with no renovation undertaken in the past (93.3%) and many of the respondents have already requested an energy upgrade of their flats/building from their property Owner (73.3%).

The next section of the questionnaire provides insights of the Polish inhabitants' knowledge on concepts relevant to the project, their understanding on how their building operates, as well as preferred features to be incorporated into the BIM4EEB platform.

Most of the respondents understand BIM (46.7%) and BACS (53.3%) except for some concepts. Only 20% of the respondents reported to fully understand the concept of BIM, while 20% partially understand the concept of BACS. The inhabitants of the Polish site reported to have a good knowledge on how their building's heating, fresh air, cooling and lighting is provided (46.7%) and the majority of the respondents are satisfied with their building (60%).

The Polish inhabitants consider as equally critical: Indoor Air Quality, Temperature, Acoustics and Lighting quality. However, most of the respondents reported to have no control on the IAQ and noise in their premises. As mentioned previously, IAQ, Temperature, Acoustics and Lighting are the main comfort parameters to be considered as part of the work in BIM4EEB project.

The last section of the inhabitant's questionnaire aims to define the inhabitants needs and requirements regarding their preferred BIM4EEB functionalities and integrated capabilities of the proposed platform. As very important capabilities to be incorporated in the BIM4EEB framework according to the respondents are: a) the provision of safety alerts & notifications of ongoing works (9 votes), b) enabling inhabitants to receive information on the work-planning/schedule of the renovation activities during and post-renovation period (9 votes) and c) enabling them to upload information about their comfort conditions during and post-renovation period. As important capabilities for inhabitants are reported: enabling them to communicate and exchange information with the various stakeholders of the renovation (12 votes), enabling them to communicate with the contractors regarding the renovation work planning (11 votes) and provide Inhabitants with a tool for reporting maintenance issues/faults and H&S issues (9 votes).

As least important capabilities are identified the provision of a tool enabling transmission of data/info/drawings when requested by contractors for the renovation process (6 votes) and providing inhabitants access to the building's documentation (e.g.: Operation and maintenance manual, structural drawings, etc.) (4 votes).

Towards defining the inhabitants favorite feedback mechanism, the respondents expressed a high interest to provide feedback on their comfort zones both during the renovation (60%) and post renovation period (66%). During the actual renovation period and post renovation period the inhabitants indicated their preference to provide feedback on a monthly basis (92% and 83.3% respectively) through a Mobile application (9 votes), by Email (8 votes), via a Web Based Survey tool (6 votes) and lastly with notifications messages through a mobile (3 votes).

Provision of a notification/alert mechanism is also an interesting feature for most of the inhabitants, who expressed their willingness to receive notifications and alerts regarding the renovation progress/schedule (93.9%). Their most favorable way to be notified is by Email (10 votes), through a dedicated mobile application (7 votes) and with notification messages through a mobile (4 votes). The Polish inhabitants indicated also their preference to receive these notifications/alerts only when there is a change in the work progress/schedule (78.6%) and at weekly intervals (14.3%).

The inhabitants expressed also a great interest to receive security/ safety recommendations and alerts about the ongoing activities in their building (93.3%), by Email (10/14 votes), through a mobile application (6/14votes), or by SMS (2/14 votes); mostly when there is change in the in the works schedule (78.6%), followed by weekly (14.3 %) and monthly intervals (7.1%).

The last two questions of the questionnaire provide the means to identify the opinion of the inhabitants regarding opportunities and barriers for requesting a renovation of their assets from the building/asset Owner. As a very important opportunity for requesting from their building owner a renovation in their building, is the potential enhanced health and well-being (11 votes). As important opportunities are reported: the potential energy savings, as a result of building's energy upgrade (10 votes), the potential enhanced indoor environmental conditions and increased building sustainability; reduced environmental impact (9 votes) and a potential improved building quality (8 votes).

On the other hand, as important barriers for not considering requesting a renovation in their building is: the possibility of an extended duration of the renovation works (11 votes), the poor communication with

their landlord/owner (9 votes), the possible increased rental rates after the renovation interventions and the lack of inhabitants' input/control over the renovation scenario selection (9 votes).
As least important barriers, inhabitants reported the lack of information about the economic and environmental benefits of the renovation (7 votes) and as not important barrier at all the inhabitants' difficulty to foresee the renovation's benefits (10 votes).

5.1.3 Finnish Pilot Site Analysis

The results from the questionnaire analysis are available for both the Building inhabitants & owners. The outcomes are first presented for the **Building owners** of the Finnish site, where a total number of 16 Owners filled answers in the questionnaire.

The Finnish pilot site is identified as a co-owned building (81.3%) which is old but has been recently renovated and the majority of the owners possess 1 property (80%). Most of the Owners identified themselves as Property owners (81.3%) and Property Managers (12.5%), who reported to have previous experience in undertaking a renovation in their asset (75%). The inhabitants of the Finnish site are identified as frequent, vocal advocates for energy efficiency improvements (68.8%), from the building's owners and the current way of communication between owners and inhabitants is mostly by Email (15 votes) and not so often by face to face meetings (2 votes) or by mail correspondence (2 votes).

The Finnish pilot site owners reported to understand the concepts and benefits of BIM (50%) and BACS (62.5%) except from some details/concepts. A 43.8% fully understands the concept of BIM and only 31.1% reported to fully understand the concept of BACS. Most of the respondents do not have a good knowledge on how heating, fresh air, cooling and lighting is provided in their asset (43.8%) and only half of the respondents reported to be aware of all existing equipment in their building. According to the building owners, most of them do not hold any information/data at all about the inhabitant's electrical devices and equipment and in their premises (56.3%). A 31.3% reported to hold information regarding the inhabitants' heating equipment, 18.3% hold data for the inhabitants lighting conditions and only 6.3% hold data for the cooling equipment.

Overall, the Finnish owners showed a high interest to be involved in the proposed framework and in the following renovation activities, should a renovation in their building takes place: (results are presented in a descending order of preference votes):

- Control the renovation working times (16 votes);
- Participate (jointly with contractors) in the management and control of the renovation works (12 votes);
- Upload information of the building when requested by contractors (10 votes);
- Monitor the ongoing renovation activities (8 votes);
- Participate (jointly with contractors) in the planning of the renovation operations (5 votes);
- Participating (jointly with contractors) in the renovation scenario selection (5 votes);
- Monitor the building's energy performance - near real time (3 votes);
- Monitor and select the results of the building renovation simulation (1 vote).

Towards the owner's needs and requirements regarding the BIM4EEB toolkits and integrated capabilities of the proposed platform; the incorporation of safety alerts and notifications of the ongoing works (16

votes), as well as the capability to control the renovation working times (15 votes) are considered as very important requirements from the owner perspective. Further, very important capabilities to be incorporated into the platform are: a) enabling owners to communicate and exchange information with other stakeholders (Client/Owner, Contractors, Project leader, etc.) (12 votes), b) provision of automated progress tracking of on-site operations (7 votes), c) enable owners to transmit data/info/drawings, when requested by contractors (5 votes) and d) provide owners with the means to monitor the building's energy performance (3 votes). As a least important capability, is enabling Owners to control the economic sustainability of the renovation process.

The Finnish owners identified as very important for considering undertaking a renovation in their building the opportunity to a) comply with building regulations, legislative requirements, b) decrease building operational costs and c) increase of the building's energy performance and sustainability.

The last two questions of the questionnaire provide the means to identify the opinion of the owners regarding opportunities and barriers for considering undertaking a renovation of their assets in the future. The answers will be utilized to extract further requirements for the building owners.

On the other hand, owners reported as the most important barrier for not considering to undertake a renovation: the inhabitants discomfort (complaints) during the renovation works (12 votes), followed by the difficulty to monitor the renovation's progress and site activities, as several separated disciplines work onsite simultaneously (11 votes) and the possibility of an extended duration of the renovation works, resulting in loss of income for the owners (9 votes). The lack of funding, high upfront costs and long payback time are considered as slightly important barriers (7 votes). Lastly, as not at all important barriers for not considering undertaking a renovation is: the owner's lack of knowledge/experience on renovation works (9 votes), the difficulty to foresee the renovation's benefits (6 votes), the uncertainty of the economic consequences of renovation (6 votes) and the fragmented nature of the building sector (6 votes).

Most of the respondents specified that complying with the building regulations, legislative requirements is the most important opportunity (15 votes) for considering undertaking a renovation. Additionally, as very important opportunities are considered: a) the enhanced inhabitants comfort conditions (14 votes), b) decreased building operational costs; reduced maintenance (11 votes), c) Improved building energy efficiency, reduced environmental impact and d) the opportunity to retain/increase the value of their building in the long run (8 votes). Further important opportunities for considering undertaken a renovation is the potential to maintain a high-level building quality (7 votes), the increased rental rates, as a result of the renovation interventions (5 votes) and lastly the increased building's aesthetics (3 votes).

A similar analysis is undertaken for the **Building inhabitants** of the Finnish pilot site, where a total number of 16 respondents filled in the questionnaire, out of which the majority (62.5%) are males. Most of the respondents are 40-49 years-old (62.5%), followed by 50-59 years-old (18.8%) and 60-69 years-old (18.8%).

The majority of the Finnish pilot flats are occupied by 3-4 persons (62.5%), 2 persons (31.1%) and 1 person (6.3%), while most of the respondents live in the building for 5-10 years (81.3%), 3-5 years (12.5%) and 2-3 years (6.3%). Most of the respondents reported that they spend daily 9 hours or more in their flat (87.5%) and the rest spend 5-8 hours per day (12.5%). Regarding the inhabitants' digital skills, most of

them reported that they own a Smartphone (15 votes), a PC (10 votes) and a Tablet (2 votes). According to the inhabitant's perception, the pilot building is as an old building with no renovation undertaken in the past (100%), where the majority of the respondents have requested an energy upgrade of their flats/building from their property owner (81.3%).

The analysis of the next section of the questionnaire provides insights of the inhabitants' knowledge on concepts relevant to the project, their understanding on how their building operates, as well as preferred features to be incorporated into the BIM4EEB platform.

While most of the respondents reported to fully understand the concept of BIM (62.5%) only 25% fully understands the concept of BACS and the benefits it can offer in building management and control. The Finish pilot site inhabitants reported to have limited knowledge on how the building's heating, fresh air, cooling and lighting is provided (56.3%). Only 37.5% of the respondents reported to have a good knowledge of it. In addition, 56.3% of the respondents are not satisfied at all with their building.

Most of the respondents identified Indoor Air Quality Temperature Acoustics and Lighting quality as equally critical parameters in regard to their comfort zones (87.5%). However, most of the respondents have no control of the IAQ (16 votes) and noise (16 votes) in their premises, followed by almost no control of the Temperature (13 votes) and little control of the Lighting conditions (13 votes).

The last section of the inhabitant's questionnaire aims to define their needs and requirements regarding the preferred BIM4EEB toolkits and integrated capabilities of the proposed platform.

As very important functionalities to be incorporated in the BIM4EEB platform for the inhabitants is the provision of safety alerts and notifications about the ongoing renovation works (16 votes), followed by provision of a tool enabling inhabitants to report maintenance issues/faults and H&S issues (16 votes) and receive information on work-planning/schedule of the renovation activities during and post renovation (14 votes). Further very important capabilities to be incorporated into the BIM4EEB platform are considered: a tool for inhabitants to upload information about their comfort conditions during and post-renovation period (9 votes) and enabling communication and information exchange with the renovation's stakeholders (6 votes). As an important capability is reported the provision of a tool enabling inhabitants to transmit data/info/drawings when requested by contractors for the renovation process, while as slightly important is considered enabling Inhabitants to access the building's documentation (e.g.: Operation and maintenance manual, structural drawings, etc.).

Towards defining the favorite feedback mechanism for the inhabitants; the respondents expressed a high interest to provide feedback on their comfort zones both during the renovation (100%) and post renovation period (100%). During the renovation period they indicated their preference to provide feedback every 15 days (13 votes) or on a monthly basis (6 votes) and after the renovation period on a monthly basis (15 votes). The most preferred way for providing their feedback is through a mobile application (16 votes) or by Email (14 votes).

Provision of a notification/alerts mechanism regarding the renovation progress/schedule is also an interesting feature for all the respondents (100%). The most favorable way to notify the inhabitants is through a mobile application (16 votes) and by Email (10 votes), only when there is a change in the work

progress/schedule (100%). The inhabitants showed also a great interest to receive security and safety recommendations/alerts about the ongoing activities in their building (93.8%). The most favorable way to notify the inhabitants is through a mobile application (15 votes) and by e-mail (9 votes), only when there is a change in the work progress/schedule (100%).

The last two questions of the questionnaire provide the means to identify the Finnish pilot inhabitants, perception on opportunities and barriers for requesting (or not) a renovation of their assets from their building/asset owner. The answers will be utilized to extract further requirements for the inhabitants.

As equally very important opportunities for requesting from their building owner a renovation in their building is: the potential enhanced indoor environmental conditions (16 votes) and increased Inhabitant's health and well-being (16 votes). A further very important opportunity is considered the potential of energy savings, as a result of the building's energy upgrade (8 votes). Important opportunities are considered the provision of an improved building quality (16 votes) and increased building sustainability/reduced environmental impact (15 votes). As slightly important to no important at all is considered the opportunity of increased building aesthetics (14 votes) as a result of the renovation works.

On the other hand, as a very important barrier for not requesting a renovation in their building, inhabitants consider the poor communication with their landlord /owner (16 votes).

As important barriers the respondents identified: the possibility of an extended duration of the renovation works (13 votes), the lack of information about the economic and environmental benefits of the renovation (12 votes), the lack of inhabitants' input/control over the renovation scenario selection and the potential increased rental rates after the renovation (10 votes). As a least important barrier is considered the inhabitants difficulty to foresee the renovation's benefits (5 votes).

5.2 Summary of semi-structured interviews

Along with the questionnaire analysis, short semi-structured interviews with the pilot representatives took place in order to extract further technical requirements, as well as any pilot specific requirements along with ethical and legislation requirements.

The goal of these semi-structured interviews was threefold:

- To shape the final list of Usage Scenarios addressing the owners and inhabitants needs;
- To cross check the results from questionnaire analysis towards the extraction of the final list of owners and Inhabitants requirements;
- To gather any regulatory and legal requirements as part of the overall requirements definition phase at the different pilot sites.

As a summary of the work, we highlight the main outcomes from the semi-structured interviews, per pilot site as identified from the pilot site representative partners (ALER & RegLomb, Caverion, Prochem)

Italian pilot site

The pilot site special interest (in regards to the owners perspective) is about the provision of a communication feature for building owners and renovation stakeholders, as well as provision of the

means/tools for planning an effective renovation, maintenance works and management of the works in a more effective manner resulting in resources and time savings enhancing owners involvement in the project's activities. In regard to the inhabitants' perspective the pilot site's main interest is on the provision of a feedback and notification mechanism for Inhabitants which will enhance their involvement during the actual renovation works as well as in the project's activities.

As ALER & RegLomb further indicated through their feedback in the semi-structured interview, the main challenges to be tackled through the utilization of the BIM4EEB framework in the Italian pilot are:

- Enable a clear and unobstructed exchange of information;
- Provide means to track/monitor the works progress;
- Provide the means to identify any problems during the works and notify the anticipated duration of the works.

Overall, the main interest is about the bilateral communication with the user through the establishment of the associated channels. As a secondary interest for the local administration is testing the innovative services developed by the project within the context of comfort preservation.

Polish pilot site

Due to excessive Outdoor Air pollution identified in the area of the pilot site, special interest (in regards to the owners perspective) is based on the integration of environmentally friendly solutions during the renovation planning process, with incorporation of cost analysis for the different renovation scenarios.

As Prochem indicated through its feedback in the semi-structured interview, further challenges to be tackled in the Polish pilot are:

- Existing air quality in the area of the pilot site influencing in inhabitants' living comfort, health, and wellbeing;
- Legal restrictions owners face in respect to the renovation process/renovation scenario selection, due to legal regulations imposed by the environmental protection policy;
- Regulatory requirements and additional cost owners face in renovation processes of old buildings, indicated in the register of monuments;
- Restrictions of renovation activities on historical buildings.

Finish pilot site

The pilot site's special interest is on the provision of a communication feature for building owners and inhabitants, as well as the provision of a fluent construction process management.

As Caverion further indicated through its' feedback in the semi-structured interview, the main challenges to be tackled through the BIM4EEB framework in the Finnish pilot are:

- Control/monitor energy consumption and indoor climate (before and after energy upgrade);
- Economic evaluation of energy upgrade and thus create know-how for ESCO type of project in future;

- Enable BIM based energy analysis for residential renovation projects; results available for the end users;
- Connect BIM with building automation system and enable close to real time indoor climate and energy monitoring/control.

Further input and feedback from the semi-structured interviews with the Pilot sites representative partners will be utilized in the requirements extraction phase detailed in the following section.

6 BIM4EEB owners and inhabitants requirements

In this section, the building Owners and Inhabitants needs and requirements are defined. A non-exhaustive list of requirements has been derived following the methodology explained in Chapter 2, following Usage Scenarios definition in Chapter 4 and the analysis of the questionnaires and semi-structured interviews as described in Chapter 5. Before presenting the list of requirements, the description of the methodological framework for the taxonomy of the requirements is also presented below in order to set a structured way for requirements management.

6.1 BIM4EEB Requirements management framework

6.1.1 Requirements Elicitation Phase

The 1st step of the work as mentioned above is the requirements extraction following analysis of the questionnaires and semi-structured interviews. As a next step, the requirements elicitation phase follows. During this phase the needs, conditions, as well as the constraints of BIM4EEB are considered and clarified in order to focus only at meaningful and to the point requirements.

Undoubtedly, the most reliable method of requirements elicitation effort is the one that gets information directly from the proposed end-users of the system. Therefore, by considering the questionnaire review phase and further analyzing the different viewpoints of the Owners and Inhabitants of the pilot sites, a non-exhaustive list of end-users' requirements is derived by taking into account the results of the questionnaires.

6.1.2 Requirements Prioritization Phase

Following the requirement elicitation phase and once an initial list of end-user's requirements is defined, a hierarchy and prioritization is performed. The prioritization phase is achieved by considering the Owners and Inhabitants responses on the questionnaires and by using the following priority scale to define the most "critical" requirements.

1. High: Requirements in this category as defined are a key innovation of the project. These requirements are essential in order to achieve the goals of the project and fulfil the end-users' needs.

2. Medium: These requirements are necessary or very helpful in order to set the application prototypes, but not crucial one for the whole system operation.

3. Low: Requirements in this class are not necessary for the BIM4EEB system. However, they may be considering as important for the fine-tuned operation of the system examined.

Identifying the requirements with high priority is crucial in order to define the core aspects of the BIM4EEB system from the Owners and Inhabitants perspective. Moreover, in order to provide a thorough support for the development of the solution, it is important to identify the requirements with medium priority. The low priority requirements are not that crucial for the operation of the whole system; however, they may provide additional features for applications that could provide an added value to the proposed framework.

Having defined the requirements analysis methodology, the following step comprises of the extraction of Owners and Inhabitants requirements as seen in the following sections.

6.2 BIM4EEB owners and inhabitants list of requirements

In this section, the final list of owners and inhabitants (i.e. end-users) requirements for the BIM4EEB project is presented. Since, a multidimensional analysis has been performed, a taxonomy is considered. Initially, the high-level segmentation of the functional requirements to the different type of end-users. In this analysis, we consider also the applicable phase of a renovation project, as identified in D2.1" List of owners' and inhabitants' needs and requirements for BIM-based renovation processes". Moreover, specific segments of requirements are identified (technical requirements, pilot specific - legal requirements) in order to complement the list of fictional requirements in this section.

The template for requirements presentation is presented below.

Table 7 Requirements template

Requirement ID	A unique ID for requirements taxonomy
Description	A Short description of requirements
Type	(Functional, Non-functional, Technical, Pilot Specific)
Renovation Phase	(Initiation, Design, Procurement, Construction, Use, End Life)
Priority	Requirements Prioritization Level

Note: In tables 8 and 9 below, we specify in **bold** the information flows/data associated with the definition of the owners/inhabitants functional requirements.

6.2.1 BIM4EEB owners requirements

A non-exhaustive list of requirements as identified from the building Owners questionnaire analysis is presented in this section. This is the list of functional requirements, where the focus of the analysis is on the way the building Owners are going to experience the core functionalities provided by BIM4EEB platform and associated toolkits available to their use.

Table 8 List of owners functional requirements

Req. ID	Description	Renovation Phase	Priority
O.01	Owner should be able to get insights on the Inhabitants' **(dis)comfort conditions** prior to a renovation.	Initiation	High
O.02	Owner should be able via an app to upload information when requested from contractors for the renovation process. **(building documents, operation schedules, photos)**	Initiation	High
O.03	Owner should be able to participate (jointly with contractors) in the renovation scenario selection.	Initiation	Medium
O.04	Owner should be able to participate (jointly with contractors) in the planning of the renovation operations for the optimal schedules/ time plan of the process.	Initiation	Medium
O.06	Owner should via an app receive info and/or remotely monitor the **work planning/schedules**.	Initiation	High
O.07	Owner should be able via an app to remotely negotiate with contractors/ set constrains about the work planning/ schedules.	Initiation	High
O.08	Owner should be able via a web app to receive **security and safety alerts** about the construction programming.	Initiation	High
O.09	Owner should be able to monitor and provide input on the **building renovation simulation scenarios.**	Initiation	High
O.10	Owner should be able to remotely monitor the **building's energy performance/ Indoor Air Quality (IEQ)** via an app.	Initiation	Medium
O.11	Owner should be able to control or provide input in the **scheduling of the renovation working times**.	Initiation	High
O.12	Owner should be able, via an app to upload information requested from contractors if necessary.	Initiation	High
O.13	Owner should be able to provide enhanced information about **BIM structure, drawings, device operation** etc... in order to facilitate the overall intervention process.	Initiation	High

O.14	Owner should be able via an app to provide information about the **inhabitants' comfort conditions** prior to the renovation.	Initiation	High
O.15	Owner should be able to remotely monitor **building's energy performance**/ special interest about **HVAC/lighting systems device performance**	Commissioning/ Operation	Medium
O.16	Owner should be able via an app to negotiate with contractors about the work planning/schedules during the renovation works.	Commissioning	Medium
O.17	Owner should be able to receive **safety alerts and notifications** regarding the ongoing works via a mobile app.	Commissioning	High
O.18	Owner should be able to receive security and safety alerts about the construction programming during the renovation works via a mobile app.	Commissioning	High
O.19	Owner should be able to provide information about **(dis) comfort conditions** post renovation process.	Operation	Medium
O.20	Owner should be able to upload ad hoc information related to the operational processes that may be useful for the renovation process. **(Photos, Notes, Annotated drawings**)	Commissioning/ Operation	High
O.21	Owner should be able to control the economic sustainability of the renovation process.	Commissioning/ Operation	Low
O.22	Owner requires an **automated progress tracking** tool for the on-site operations.	Commissioning/ Operation	Medium
O.23	Owner should be able to **communicate** with the renovation stakeholders (Project leader, Contractors, etc.).	Commissioning/ Operation	High
O.24	Owner should be able to provide/upload **maintenance issues** via a web app.	Commissioning/ Operation	High
O.25	Owner should be able to receive information about **abnormal conditions/IEQ** during the operation phase of the building.	Operation	High
O.26	Owner should be able to receive information about the impact **(economic/ energy/ wellbeing)** of the renovation process in building premises.	Operation	High

O.27	Owner should be able to receive information about the overall impact of the renovation in an intuitive and understandable way.	Operation	High

6.2.2 BIM4EEB inhabitants requirements

The list of requirements as identified from the building inhabitants questionnaire analysis is presented in this section. Table 9 below presented the list of functional requirements, where the focus of the analysis is on the way the building Inhabitants are going to experience the core functionalities provided by BIM4EEB platform and associated toolkits available to their use.

Table 9 List of inhabitants functional requirements

Req. ID	Description	Renovation Phase	Priority
I.01	Inhabitants are interested to get **energy updates** in building premises with focus also on **indoor environmental conditions**; increased **building sustainability** and reduced energy impact.	Initiation/ Operation	High
I.02	Inhabitants are interested to have a better understanding about BIM/BACS related information from building premises.	Initiation/ Operation	High
I.03	Inhabitant are interested to have a better understanding about the operation of heating/lighting systems in building premises.	Initiation/ Commissioning/ Operation	Medium
I.04	Inhabitants are interested to have a deep knowledge about **indoor environmental conditions** in premises.	Initiation/ Commissioning/ Operation	High
I.05	Inhabitants interest is high for the establishment of a healthy and wellbeing environment in building premises.	Initiation/ Commissioning/ Operation	High
I.06	Inhabitant- are interested to have a knowledge about **temperature, humidity, IAQ** with lower interest about **acoustics**.	Initiation/ Commissioning/ Operation	High
I.07	Inhabitants are interested to get updates and have control over indoor environmental conditions in building premises.	Initiation/ Commissioning/ Operation	High

I.08	Communication channels via a web app should be established among inhabitants, owners and other stakeholders involved in the renovation.	Initiation	High
I.09	Inhabitants should be able to upload their **(dis)comfort preferences** regarding **IAQ, Temperature, Lighting, Acoustics**.	Initiation	High
I.10	Inhabitants should be able via an app to upload information when requested from the contractors for the renovation process. **(building documents, photos, drawings)**	Initiation	High
I.11	Inhabitant would like to have the option to participate in the renovation scenario selection.	Initiation	Medium
I.12	Inhabitant should be able to communicate with and exchange information with the renovation stakeholders.	Initiation	High
I.13	Inhabitants should be able via an app to remotely transmit **data/info/drawings,** when requested by contractors for the renovation process.	Initiation/ Commissioning	Medium
I.14	Inhabitants should be able to receive information about the implementation of renovation activities, major renovation events, etc..	Initiation/ Commissioning	Medium
I.15	Inhabitants would like to have remote access to the building's documentation.	Initiation/ Commissioning/ Operation	Low
I.16	Inhabitants should be able via an app to transmit/upload data and drawings, when requested by contractors during the renovation process.	Commissioning/ Operation	Medium
I.17	Inhabitants should via an app receive **safety alerts and notifications** about the ongoing renovation works.	Commissioning/ Operation	High
I.18	Inhabitants should be able to remotely report **maintenance issues/faults.**	Commissioning/ Operation	High
I.19	Inhabitants should be able to receive **notifications and report issues** at the exact time of the event.	Commissioning/ Operation	Low
I.20	Inhabitants should be able to provide feedback on their (dis)comfort conditions during the renovation.	Commissioning/ Operation	High

I.21	Inhabitants should be able via an app to upload **H&S issues** during the renovation works.	Commissioning/ Operation	High
I.22	Inhabitants should be able provide feedback via an app regarding their (dis)comfort conditions (IAQ, Temperature, Lighting, Acoustics) post renovation.	Operation	High
I.23	Inhabitants should be able to easily track the impact of renovation in terms of **energy consumption and IEQ.**	Operation	High

6.3 List of non-functional requirements

In addition to the list of functional requirements (i.e. owners and inhabitants requirements on what the system and proposed toolkit should do) we further extract the list of non-functional requirements as derived through internal consultation with the pilot representatives during their engagement in semi-structured interviews. These are mainly about the look and feel and the design (i.e. quality characteristics) of the applications along with some technical limitations that have to apply during the renovation process in a building.

We slightly modify the template for requirements presentation in order to address the different criteria considered for the presentation of nonfunctional requirements.

Table 10 List of non-functional User Interface/User Experience (UI/UX) requirements

Req. ID	Description	Priority
NF.01	The development of user-friendly apps is a main prerequisite, allowing users to identify all the available features.	High
NF.02	The graphic design of the proposed apps is very important; thus, apps should be developed to be visually appealing resulting in an enhanced user experience.	Medium
NF.03	In order to increase end-users' awareness and their active participation in the project's activities, user interfaces should be tailored/ personalized to the specified end-user needs (Owners vs. Inhabitants).	High
NF.04	A non-exhaustive list of relevant metrics and KPIs should be visualized in a transparent and easy to understand way.	Medium
NF.05	Localization of the apps is main requirement to ensure the active enrolment of end-users in the project activities.	High

NF.06	The design of the app should be non-intrusive; update rate and notifications should be triggered on a way to ensure the minimum of end-users' intrusiveness.	High
NF.07	Any feedback requested by the users should be performed with the minimum of effort from the user – an easy and understandable way to request feedback.	Medium
NF.08	In order to increase end-users' awareness and their active participation in the project's activities, the activities related to the different phases of the renovation process should be clear and transparent.	High
NF.09	Responsive design of the proposed apps is required, enabling end-users to access the apps through different means (Smartphone, Web browser, Tablet etc.).	Medium

The list of technical requirements follows in order to set the basis for the development of the BIM4EEB framework.

Table 11 List of technical requirements

Req. ID	Description	Priority
T.01	An internet connection should be available in all pilot premises to ensure the interconnection of the pilot site and access of the users to the relevant information.	High
T.02	A wireless sensor network should be available to set the data gathering framework of BIM4EEB.	Medium
T.03	Low-cost sensors should be available to monitor building's indoor environment, Inhabitants' comfort conditions and buildings' energy consumption.	Medium
T.04	Low cost actuators should be available enabling control of various climate control systems (e.g. HVAC, etc.).	Medium
T.05	A training phase is required for the extraction of accurate occupancy and inhabitants preferences/comfort profiles.	Medium
T.06	An authentication mechanism is required at the web app development for accessing pilot user specific data.	High

T.07	The overall solution should be scalable and extendable in order to address the requirements of owners with a big portfolio of buildings.	Medium
T.08	Security measures should take place at the BIM platform in order to ensure the secure of data gathered by the users in premises.	High

Along with the non-functional requirements, pilot specific, legal & regulatory barriers are considered as part of the analysis addressing the specific perspective of interest in this document. These are presented in the following section.

6.4 Pilot specific legal & regulatory barriers

Further to the building owners and inhabitants' requirements as these are extracted from the questionnaire analysis, we have to thoroughly identify the market and any regulatory and legal barriers imposed at the pilot sites of the project. This pilot specific analysis was performed as part of the work in this task (semi-structured interviews with pilot stakeholders) and the results are presented per pilot site.

6.4.1 Italian Pilot site

The Italian pilot site is located in via della Birona, Monza, an urban center placed in the northeast of Milan. It is a building managed by the BIM4EEB consortium partner ALER. This 8-storey building is a representative example of the residential public housing in Italy consisting of 65 apartments, with a central heating and no previous renovations or energy refurbishments.

Considering the pilot site specificities, the business interest of the company and the legal and regulatory framework in Italy, the following list of requirements is derived following an interview with ALER and RegLomb stakeholders.

Table 12 Italian pilot site requirements

Req. ID	Description	Priority
IT.01	The minimum of modifications in building infrastructures and new installations should be ensured.	High
IT.02	Due to the type of pilot building premises, plug and play installation of equipment (if required) should be considered.	Medium
IT.03	The minimum of intrusiveness from installations (if required) is a main requirement especially for residential premises.	High
IT.04	An internet connection should be available in the pilot premises to ensure the interconnection with the rest of the framework.	Medium

IT.05	Due to the type of occupants in the pilot site the design of the User Interface (UI) tool should consider the lack of end-user's experience/knowledge in the domain.	High
IT.06	Installation of sensors/equipment (if required) in residential buildings/ flats / private areas needs to be approved by all flat owners.	High
IT.07	The proposed sensors/equipment (if installed) in residential buildings flats / private areas should be CE certified.	High
IT.08	Owners and Inhabitants will test/use the proposed system functionalities: • monitoring and control of working times. • Upload data/info when requested by contractors • Provide feedback on (dis)comfort zones during/post renovation	Low
IT.09	The Italian Pilot site's special interest is about the provision of communication tools for owner and renovation stakeholders.	High
IT.10	Due to the type of occupants in the pilot site, the alert/notification messages should be understandable by everyone as end-users are not experts and thus the messages should be very simple.	High
IT.11	The implementation of project activities should take into account the current legislation, Regulation (EU) 2016/679 of the European about the protection of individuals with regard to the processing of personal data and on the free movement of such data (General Data Protection Regulation).	High

6.4.2 Polish Pilot site

The Polish pilot site is a residential building located in the center of the Chorzow (near Katowice) Town, in the Silesian Region and owned by the consortium partner Prochem. It was built in 1902 and has 5 floors with a total area of 1330 m^2, consisting of 12 apartments and 3 commercial areas.
Considering the pilot site specificities, the business interest of the company and the legal and regulatory framework in Poland, the following list of requirements is derived following the interviews with Solintel and Prochem stakeholders.

Table 13 Polish pilot site requirements

Req. ID	Description	Priority
PL.01	The minimum of intrusiveness from installations is a main requirement especially for residential premises.	High

PL.02	The minimum of installations should take place in residential premises. The users should be aware about any installations to take place in premises.	Medium
PL.03	Due to the pilot site specificities, monitoring of the Air Quality is of high importance.	High
PL.04	Installation of sensors/equipment (if required) in residential buildings/ flats / private areas needs to be approved by all owners.	High
PL.05	Due to the type of pilot buildings, plug and play installation of equipment should be examined. Also, certification on the equipment installation is required. (CE certified)	High
PL.06	A close consultation with the pilot users is required during the project period as they are not familiar with the activities performed in the project	High
PL.07	The alert/notification messages should be understandable by everyone; the end users are not experts and thus the messages should be very simple.	High
PL.08	A demo account for the different owners/inhabitants' apps is required in order to get familiar with the project concepts.	Medium
PL.09	The implementation of project activities should take into account the current legislation about data privacy.	High
PL.10	The implementation of project activities should take into account the current legislation, Regulation (EU) 2016/679 of the European about the protection of individuals with regard to the processing of personal data and on the free movement (General Data Protection Regulation).	High

6.4.3 Finnish Pilot site

The Finnish pilot site is located in the city of Tampere and presents the most common building type in Finland. The site is built in 1998 and includes 52 apartments with a total volume of 12700 m3. According to the pilot site representative partner, the main challenges to be tackled in the Finish pilot are:

- Control/monitor energy consumption and indoor climate (before and after energy upgrade)
- Economic evaluation of energy upgrade and thus create know-how for ESCO type of project in future
- Enable BIM based energy analysis for residential renovation projects
- Connect BIM with building automation system and enable close to real time indoor climate and energy monitoring/control

Considering the pilot site specificities, the business interest of the company and the legal and regulatory framework in Finland, the following list of requirements is derived following the interview with Caverion stakeholders.

Table 14 Finnish pilot site requirements

Req. ID	Description	Priority
FI.01	Due to cost effectiveness, the minimum of modifications in building infrastructures and new installations should be ensured.	High
FI.02	Due to the type of pilot buildings, plug and play installation of equipment should be examined. Also, certification on the equipment installation is required. (CE certified).	High
FI.03	The minimum of intrusiveness from installations is a main requirement especially for residential premises.	High
FI.04	Due to the type of occupants in the pilot site the design of the User Interface (UI) tool should consider the lack of end-users' experience/knowledge in the domain.	High
FI.05	Due to the type of pilot site specifics, usage of environment friendly solutions in the renovation process should be ensured.	High
FI.06	Installation of sensors/equipment (if required) in residential buildings/ flats / private areas needs to be approved by all owners.	High
FI.07	Due to the type of occupants in the pilot site, the alert/notification messages should be understandable by everyone as end-users are not experts and thus the messages should be very simple.	Medium
FI.08	The Finnish Pilot site's special interest is on the provision of a communication feature and fluent construction process management.	High
FI.09	The implementation of project activities should take into account the current legislation, Regulation (EU) 2016/679 of the European about the protection of individuals with regard to the processing of personal data and on the free movement of such data (General Data Protection Regulation).	High

Overall, a total number of 97 requirements derived from the analysis of the building owners and inhabitants' questionnaires, as well as by taking into consideration the contribution of the pilot sites' representatives in semi-structured interviews. The definition of requirements will further facilitate the design of the BIM4EEB platform and the associated toolkits required for the demonstration of BIM4EEB functionalities.

7 Conclusions

As a preliminary activity towards the definition of BIM4EEB foundations, the focus in this document is to extract the list of requirements for building owners and inhabitants. This document is the outcome of the work performed in task 2.5 providing the definition of high-level Usage Scenarios from the building owners and inhabitants perspective, along with the elicitation of their requirements in order to address BIM4EEB stakeholder's specific perspective.

A list of six Usage Scenarios (use cases from the building owners and inhabitant's viewpoint) have been defined, addressing the main objectives of the project (as highlighted in the DoA and in line with the definition of renovation workflow in D2.1) which will further enable the design of the platform. The identified Usage Scenarios are presented below.

- **US-01**: Establishment of a comfort and IAQ preserving framework for inhabitants during the renovation period.
- **US-02**: Establishment of a comfort and IAQ preserving framework for inhabitants during the renovation period post renovation phase.
- **US-03**: A continuous interaction framework for comfort status monitoring and report for inhabitants
- **US-04**: An alerts and notification framework during the renovation process for owners and inhabitants.
- **US-05**: Management and control of renovation interventions for owners.
- **US-06**: Control of working times and economic sustainability for owners - tracking tool for renovation operations for owners

Following the definition of the usage scenarios, the next step is consultation with the relevant stakeholder's in order to extract the list of requirements. As stated above, building occupants and inhabitants is a very special target group in the BIM4EEB project, with limited knowledge about the renovation activities, and thus a very specific approach was considered for their engagement in the project. Targeted questionnaires and semi structure interviews were constructed in order to get their targeted feedback. Moreover, the pilot representatives were enrolled in this task in order to (a) engage the end users (pilot users) in the project activities and (b) act as the support partner to the circulation of questionnaires and feedback gathering.

A total number of 102 questionnaires were responded by building owners and inhabitants. Also, a limited number of semi-structured interviews was answered by the pilot representatives (Italy, Poland and Finland) to express their needs and main expectations from BIM4EEB project. Following questionnaires feedback gathering, analysis was performed in order to extract owners/inhabitants list of requirements.

A total number of 97 end-user's requirements were extracted incorporating also some technical constrains. The list of the extracted requirements derived from the active participation of the pilot sites. In addition to the owners and inhabitants (i.e. BIM4EEB end-users) requirements, regulatory and legal barriers imposed in the different pilot sites of the project were examined to define the BIM4EEB requirements by engaging the pilot site's stakeholders in the semi-structured interviews.

In total, 30 pilot specific requirements are to be considered at the instantiation/configuration of the BIM4EEB framework at the different pilot sites. Further to the above work and the elicitation of the non-exhaustive list the requirements, we categorized them considering the hierarchy and the project's objectives. This hierarchy will further facilitate the design of the BIM4EEB platform in the following tasks.

It should be mentioned that, while the detailed analysis of the end users (inhabitants / owners) requirements was performed in the document with the focus on BIM4EEB pilot sites and activities, we consider this task as a continuously evolving work. The non-exhaustive list of requirements will be further elaborated following consultation with other (out of the pilot demonstrations) end users and following discussions with similar projects in the domain towards defining a broader list of end users needs that will be incorporated in the BIM4EEB platform during the development phase (- M15). This collaborative work will further enable the provision of a punch list that should be followed in other similar BIM based renovation demonstrations activities in the building domain.

Overall, the outcome of this deliverable is (a) the definition of the relevant for the building owners/inhabitant's usage scenarios in order to further enable the (b) extraction of the user specific requirements for this target group of the BIM4EEB project. The extraction of the requirements will further facilitate the design and development of the BIM4EEB core in WP3 and WP4 along with the associated tools and services in WP5, WP6, WP7.

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8 Bibliography

[BIM4EEB, 2018] BIM4EEB 2018, DoA, 820660, European Commission

[BIM4EEB, 2019] D2.1 Definition of relevant activities and involved stakeholders in actual and efficient renovation processes

[G. Kotonya & I. Sommerville, 2017] Requirements Engineering, John Wiley & Sons, 1997

[Health & Consumer Protection Directorate-General, 2011] Promoting actions for healthy indoor air (IAIAQ)

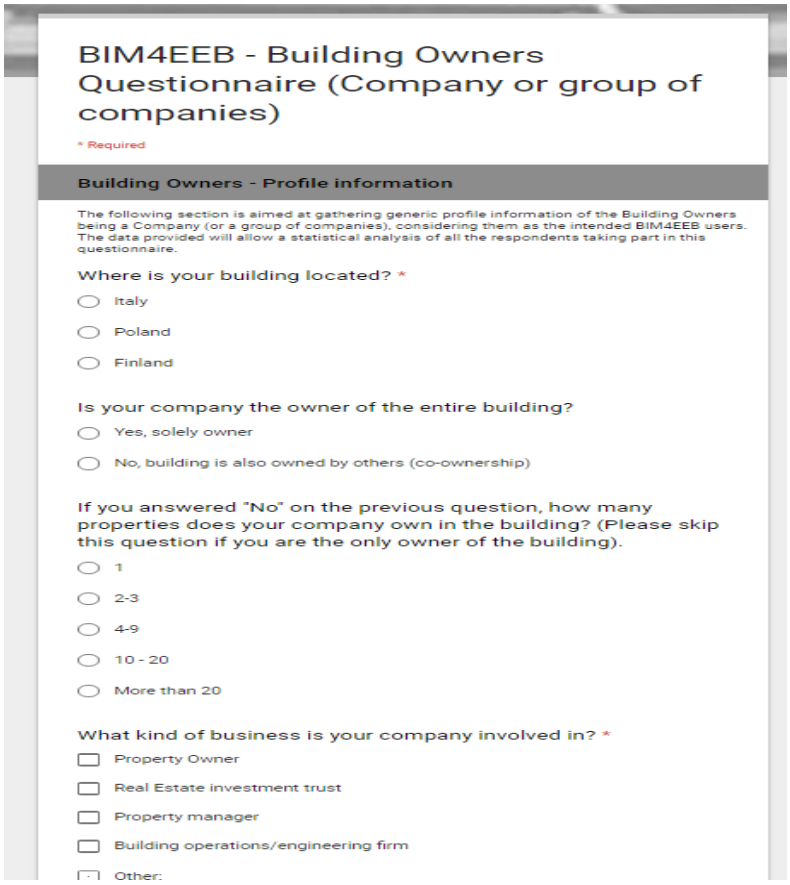
9 Annex I

Two different questionnaires were prepared to gather feedback from the intended BIM4EEB stakeholders/end-users, namely the building owners and inhabitants.

Upon preparation of the questionnaires, they were translated in each pilot country's language (i.e. Italian, Polish and Finnish) and circulated accordingly by the partner responsible for each pilot site. The templates of the different versions of questionnaires prepared are provided as follows.

9.1 Building owners questionnaire template

This questionnaire focuses on the specific role of the building owners in the project. The main objective is to gather their requirements for the proposed BIM4EEB toolkits. A screenshot of the questionnaire is presented below.



BIM4EEB - Building Owners Questionnaire (Company or group of companies)

* Required

Building Owners - Profile information

The following section is aimed at gathering generic profile information of the Building Owners being a Company (or a group of companies), considering them as the intended BIM4EEB users. The data provided will allow a statistical analysis of all the respondents taking part in this questionnaire.

Where is your building located? *

- ◯ Italy
- ◯ Poland
- ◯ Finland

Is your company the owner of the entire building?

- ◯ Yes, solely owner
- ◯ No, building is also owned by others (co-ownership)

If you answered "No" on the previous question, how many properties does your company own in the building? (Please skip this question if you are the only owner of the building).

- ◯ 1
- ◯ 2-3
- ◯ 4-9
- ◯ 10 - 20
- ◯ More than 20

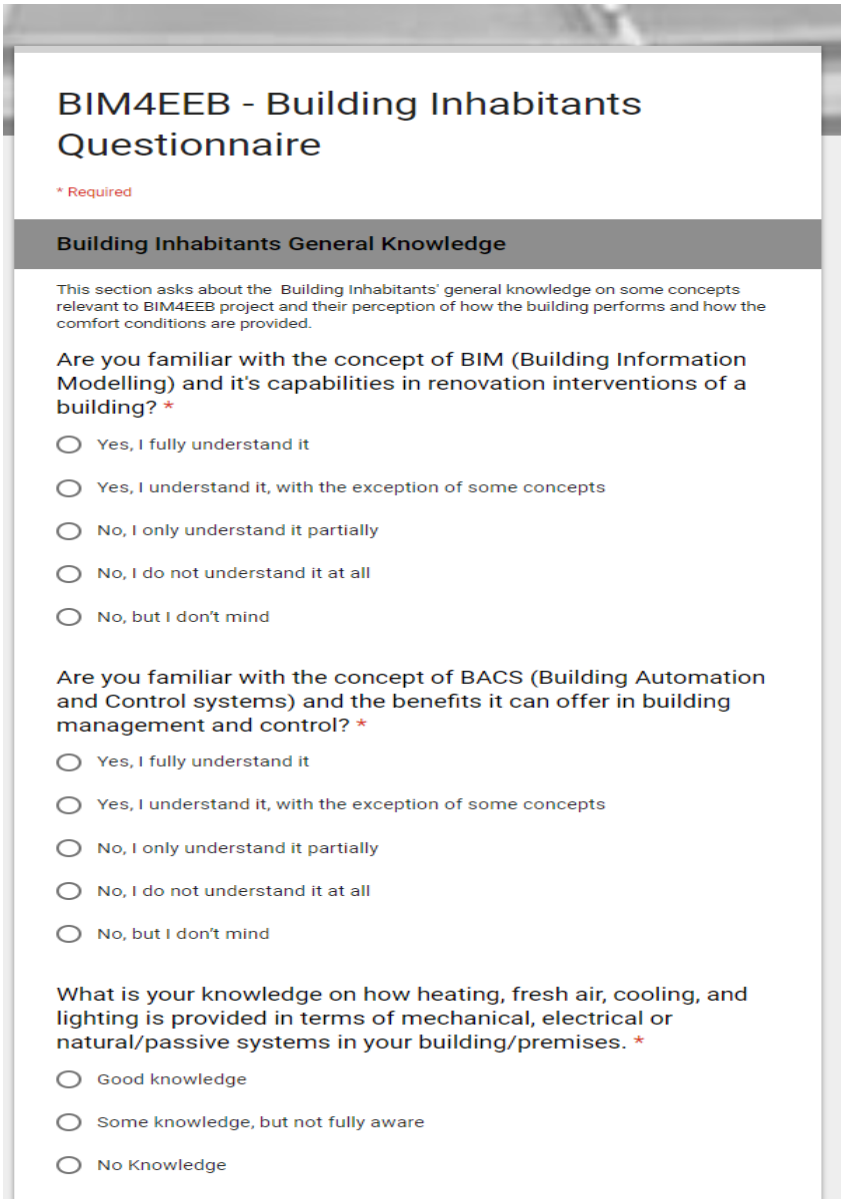
What kind of business is your company involved in? *

- ☐ Property Owner
- ☐ Real Estate investment trust
- ☐ Property manager
- ☐ Building operations/engineering firm
- ☐ Other:

Figure 7: Building owners questionnaire

9.2 Inhabitants questionnaire template

This questionnaire focuses on the specific role of the building inhabitants in the project. The main objective is to gather their requirements for the proposed BIM4EEB toolkits. A screenshot of the questionnaire is presented below.



BIM4EEB - Building Inhabitants Questionnaire

* Required

Building Inhabitants General Knowledge

This section asks about the Building Inhabitants' general knowledge on some concepts relevant to BIM4EEB project and their perception of how the building performs and how the comfort conditions are provided.

Are you familiar with the concept of BIM (Building Information Modelling) and it's capabilities in renovation interventions of a building? *

- ◯ Yes, I fully understand it
- ◯ Yes, I understand it, with the exception of some concepts
- ◯ No, I only understand it partially
- ◯ No, I do not understand it at all
- ◯ No, but I don't mind

Are you familiar with the concept of BACS (Building Automation and Control systems) and the benefits it can offer in building management and control? *

- ◯ Yes, I fully understand it
- ◯ Yes, I understand it, with the exception of some concepts
- ◯ No, I only understand it partially
- ◯ No, I do not understand it at all
- ◯ No, but I don't mind

What is your knowledge on how heating, fresh air, cooling, and lighting is provided in terms of mechanical, electrical or natural/passive systems in your building/premises. *

- ◯ Good knowledge
- ◯ Some knowledge, but not fully aware
- ◯ No Knowledge

Figure 8: Building inhabitants questionnaire

9.3 Semi-structured interview template

The template for the semi-structured interviews was prepared and circulated among the pilot site representative partners. The aim of this semi-structured interview is to create an open discussion and identify further needs of the pilot sites. The template of the semi-structured interviews can be seen as follows.

PILOT SPECIFIC LEGAL & REGULATORY BARRIERS

Pilot site short description:	
Usage Scenarios: - Please provide your feedback about the definition of the Usage Scenarios in the project. (please review D2.5 v0.2, chapter 3) - How BIM4EEB toolkits are expected to enhance Owners and Inhabitants role and in the project? - What is the current problem/ specific needs in your pilot site which BIM4EEB framework should tackle (in regard to the Owners and Inhabitants perspective)? - What should we further take into account?	
Answer:	
Pilot site specific characteristics: As part of the analysis in the project, we have to thoroughly examine your regulatory and legal requirements. Select which requirement fits to your case and further extend the list with additional requirements; in addition, please specify the requirements priority (High, Medium or Low)	
Indicative List of Requirements:	**Priority**
Regarding the Owners and Inhabitants perspective, the main interest for the Polish, Italian , Finnish (please select) pilot site is on……(Please specify)	High Medium Low
Due to the type of pilot building premises (e.g. cultural building), the minimum of modifications in building infrastructures and new installations should be ensured.	High Medium Low
Due to the type of pilot building premises, plug and play installation of equipment should be considered.	High Medium Low
The minimum of intrusiveness from installations is a main requirement especially for residential premises	High Medium Low
An internet connection should be available in the pilot premises to ensure the interconnection with the rest of the framework	High Medium Low
Due to the type of occupants in the pilot site the design of the User Interface (UI) tool should take into account the lack of end-user's experience/knowledge in the domain	High Medium Low
Installation of sensors/equipment (if required) in residential buildings/ flats / private areas needs to be approved by all flat owners and/or by the Owners	High Medium Low
The proposed sensors/equipment (if installed) in residential buildings flats / private areas should be CE certified	High Medium Low
Owners and Inhabitants will test/use the proposed system functionalities: • monitoring and control of working times. • Upload data/info when requested by contractors • Provide feedback on (dis)comfort zones during/post renovation • Provision of communication tools with Owner and renovation stakeholders Pilot site's special interest about the …… feature	High Medium Low
Due to the type of occupants in the pilot site, the alert/notification messages should be understandable by everyone as end-users are not experts and thus the messages should be very simple.	High Medium Low
The implementation of the project activities should take into account current ethics regulatory/legal constraints imposed in the pilot regions with regard to: e.g.: - the processing of personal data, namely……(Please specify) - the installation (if required) of sensors/equipment……	High Medium Low
Additional Requirements: (Please add as many as required, according to the pilot site needs and peculiarities)	High Medium Low

Figure 9: Semi-structured interview template

10 Annex II

The detailed results of the questionnaire analysis are presented in this section according to each type of end-user and per pilot site. The latest snapshot of the questionnaire responses presented below was taken on the 27h June 2019. The main aim of the questionnaires is to identify the end user's (building owners & inhabitants) requirements addressing their role in the project. A total number of 102 questionnaires were answered; 40 questionnaires from the Italian pilot, 30 questionnaires from the Polish pilot site and 32 questionnaires from the Finnish pilot site.

10.1 Italian Pilot site

10.1.1 Building owners

Starting from the definition of use cases, the role of building owners is to act as major stakeholders in the project, by setting context preferences and further defining the operational parameters for building conditions. The building owner is considered as an active element of the proposed framework, directly interacting with the BIM4EEB tools and services. Having this in mind, the building owner questionnaire is designed to cover the owner's role in the project and provide them with a tool to express their preferences, needs and requirements.

The introductory section of the questionnaire starts aims at defining the generic profile of the building Owner; for the Italian pilot site a solely owner is identified (ALER), being in possession of all the flats/properties in the pilot building.

Question: Is your company the owner of the entire building?

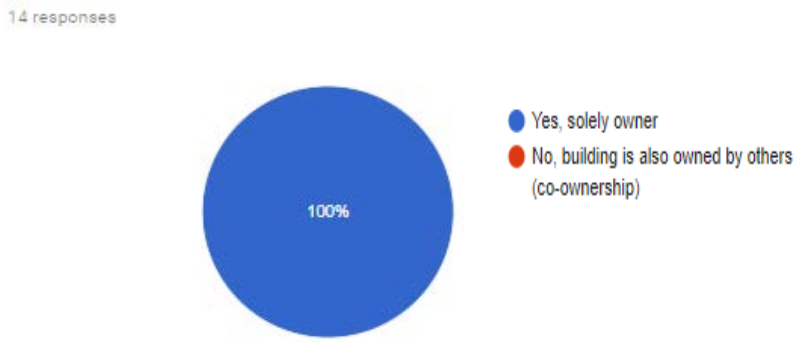


Figure 10: Italian site - Ownership of the pilot building

Question: What kind of business is your company involved in?

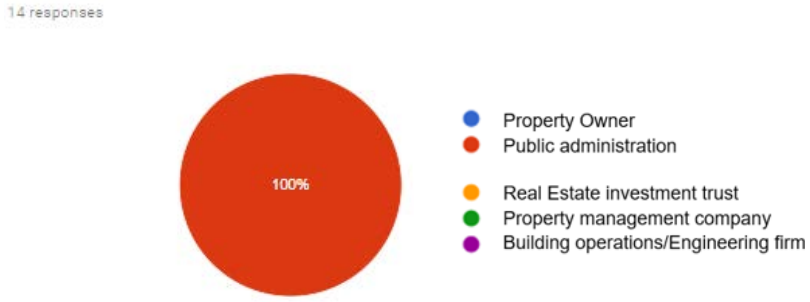


Figure 11: Italian site - Owner's business sector

Question: How would you describe the status of your building?

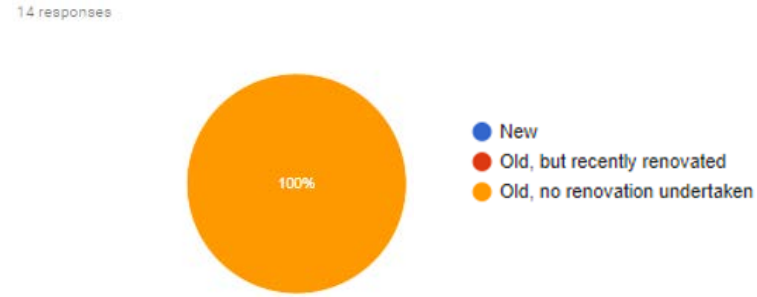


Figure 12: Italian Site – Owner's perception of its building condition

Question: Have your building's inhabitants requested energy efficiency improvements to properties?

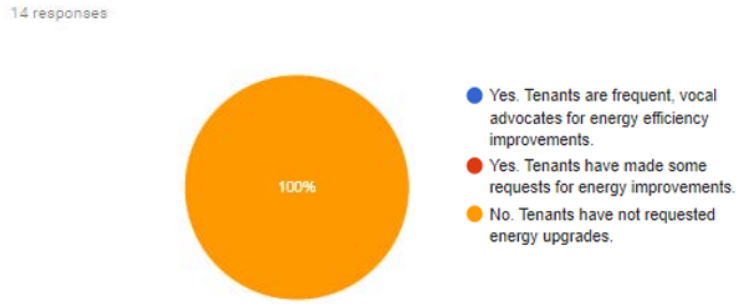


Figure 13: Italian site - Inhabitants energy improvements requests to the building owner

Question: Has you company previous experience in undertaking a renovation in their building/assets?

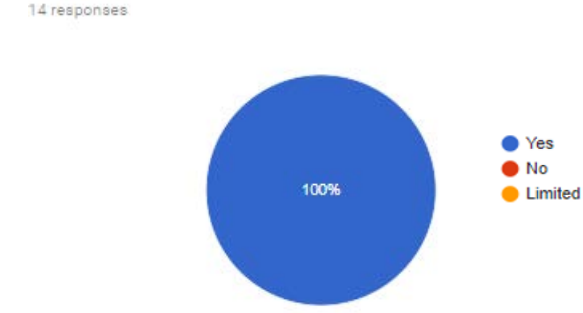


Figure 14: Italian site - Owner's experience in renovation

Question: What is your company's current process for contacting with the inhabitants of your building?

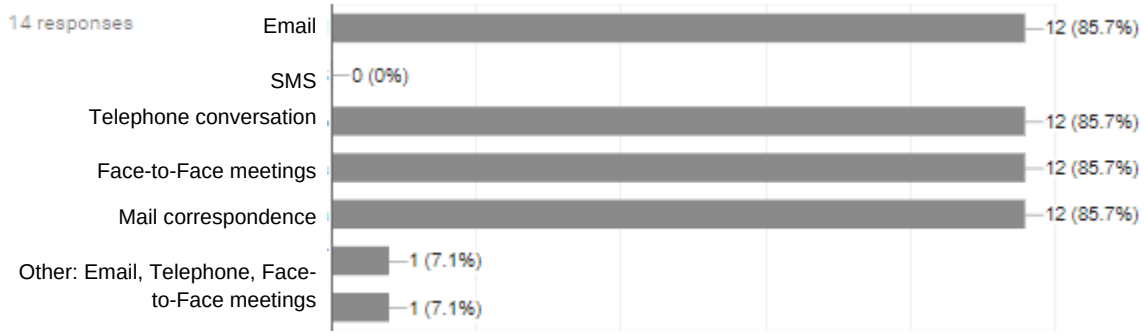


Figure 15: Italian site - Owner's communication tools with the pilot's inhabitants

Question: Are you familiar with the concept of BIM (Building Information Modelling) and its capabilities in renovation interventions of a building?

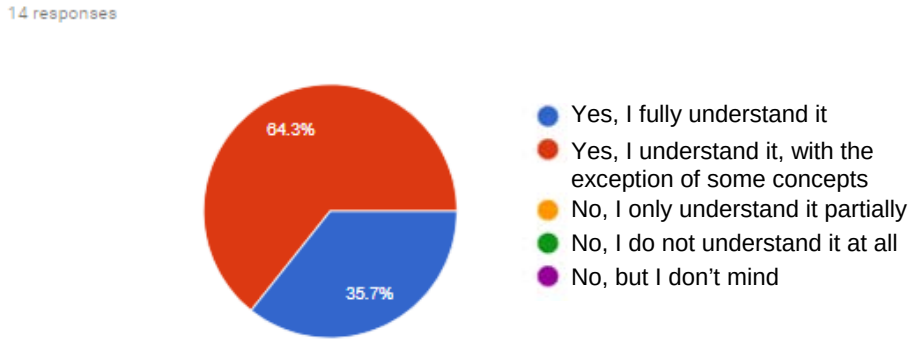


Figure 16: Italian site - Owner's awareness about Building Information Modelling (BIM)

Question: Are you familiar with the concept of BACS (Building Automation and Control systems) and the benefits it can offer in building management and control?

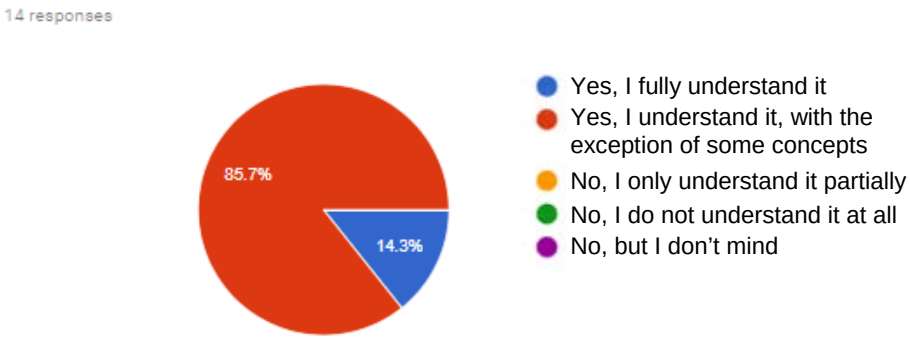


Figure 17: Italian site - Owner's awareness about Building Automation and Control Systems (BACS).

Question: Is your company responsible, when it comes to deciding to undertake a renovation in your building/assets?

14 responses

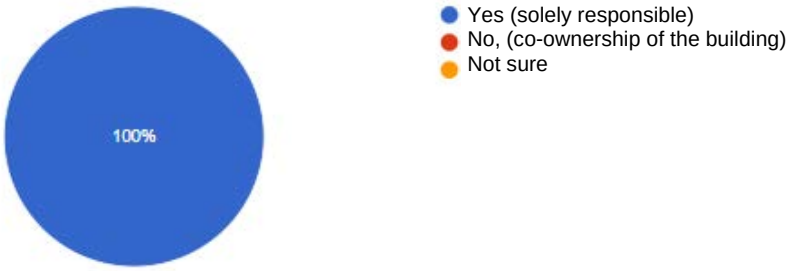


Figure 18: Italian site - Owner's responsibility for renovation decision making

Question: What is your knowledge on how heating, fresh air, cooling, and lighting is provided in terms of mechanical, electrical or natural/passive systems in your building/asset?

14 responses

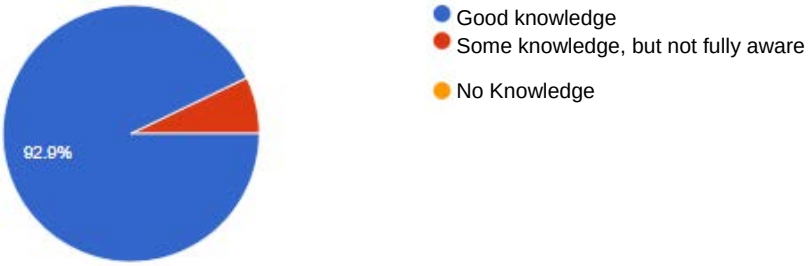


Figure 19: Italian site - Owner's knowledge on how heating, fresh air, cooling, and lighting is provided in the pilot building

Question: Is your company aware of all the equipment installations in your building/assets?

14 responses

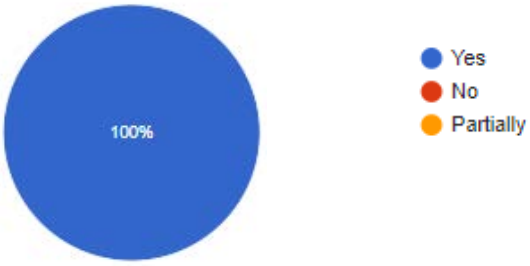


Figure 20: Italian site - Owner's knowledge on the existing building's installations

Question: Does your building have a building automation system with direct digital controls? (e.g.: detailed zone condition controls, scheduled lighting controls, monitors system performance)

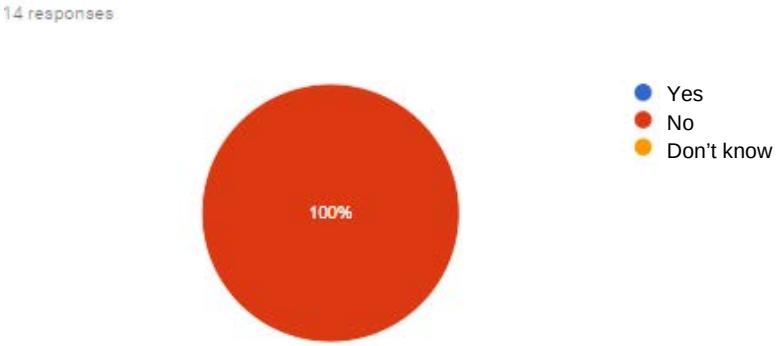


Figure 21: Italian site - Owner's knowledge on building's automation systems

Question: For which of the following does your company hold information/data about the building's inhabitants' electrical devices and equipment in their premises?

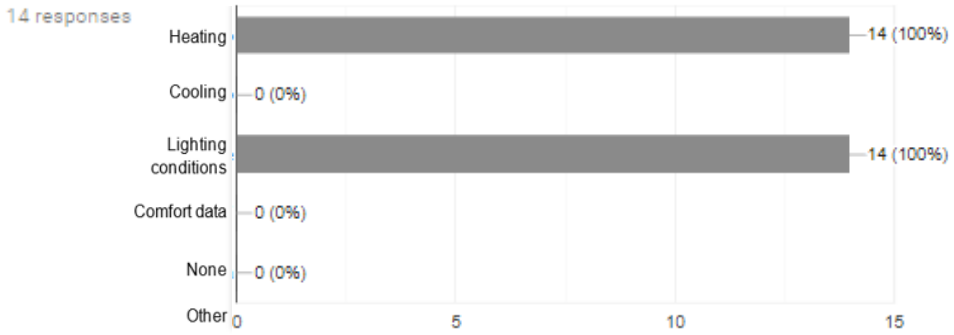


Figure 22: Italian site - Owner's available information on inhabitant's electrical devices

Question: Please, rate each of the following capabilities that the BIM4EEB tools for Building Owners should integrate.

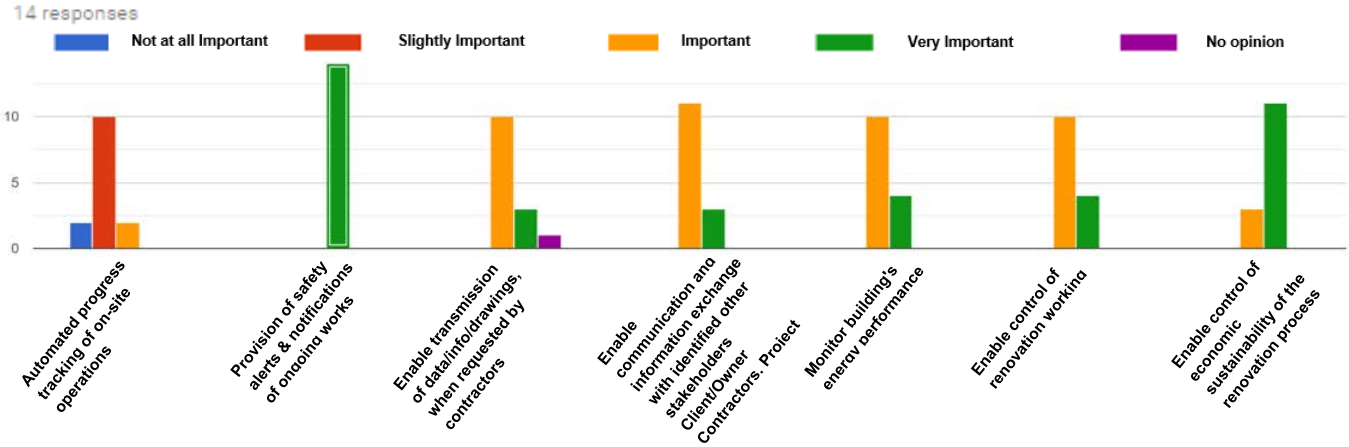


Figure 23: Italian site - Owner's preference on BIM4EEB integrated tools

Question: As the building Owner; for which of the following activities are you currently in control?

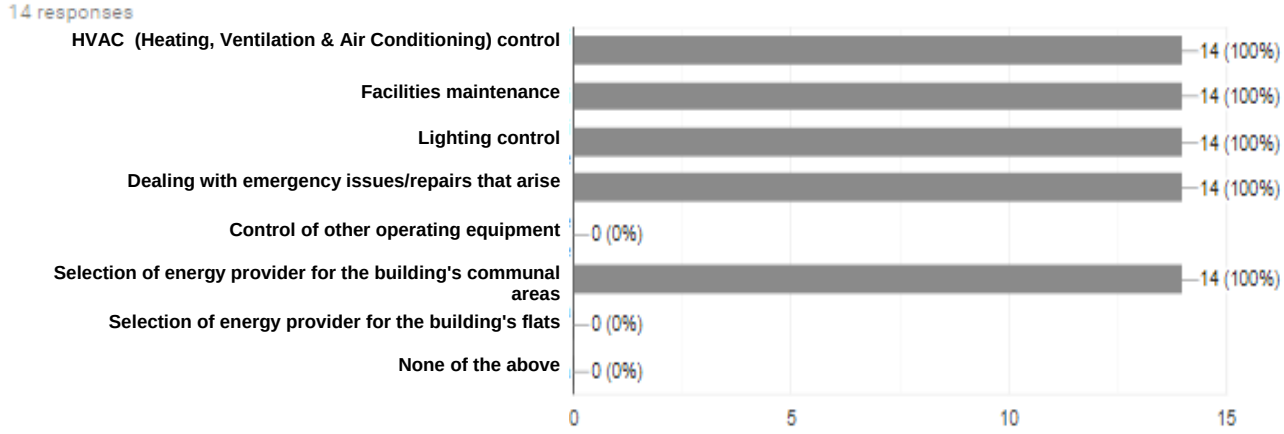


Figure 24: Italian site - Owner's control of existing equipment

Question: In which of the following activities would you like to get involved; regarding the renovation activities in your building in the near future?

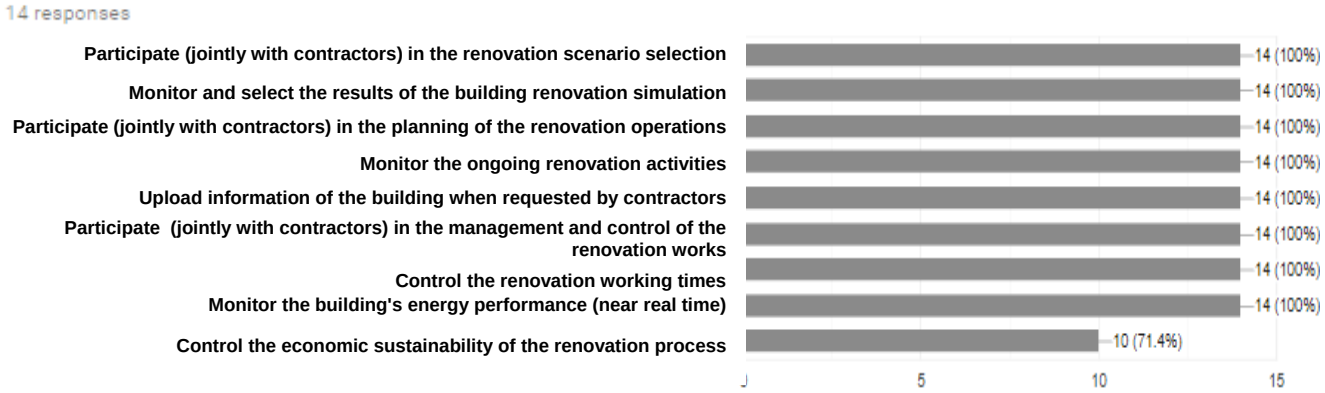


Figure 25: Italian site - Owner's involvement preference in future renovation activities

Question: Please, rate each of the following aspects considered as opportunities for your company as an Owner in undertaking a potential renovation in your building.

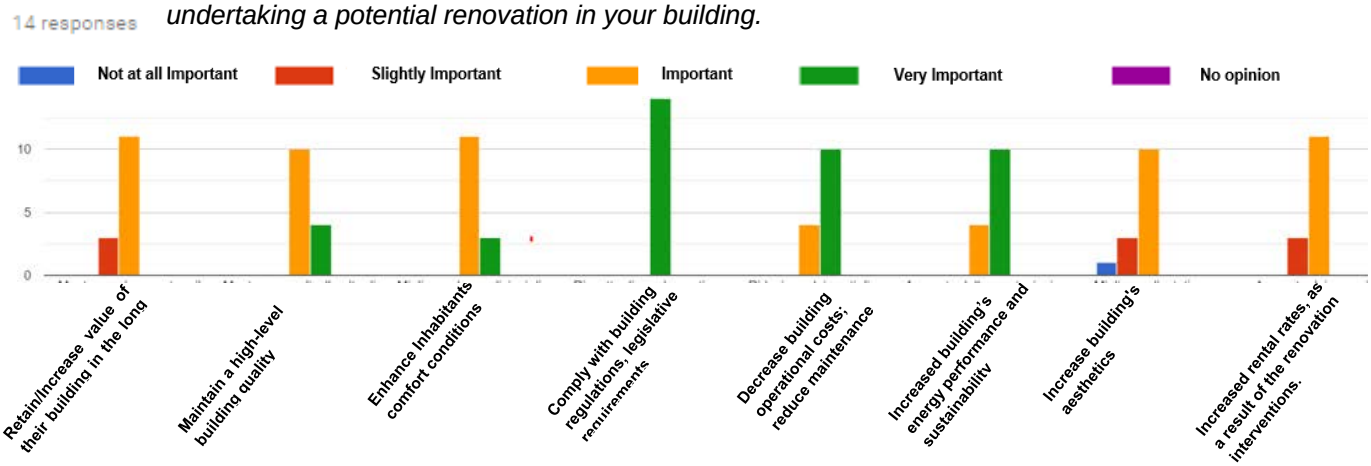


Figure 26: Italian site - Owner's views on opportunities for considering undertaking a renovation

Question: Please, rate each of the following aspects considered as barriers for your company as an Owner in undertaking a potential renovation in your building.

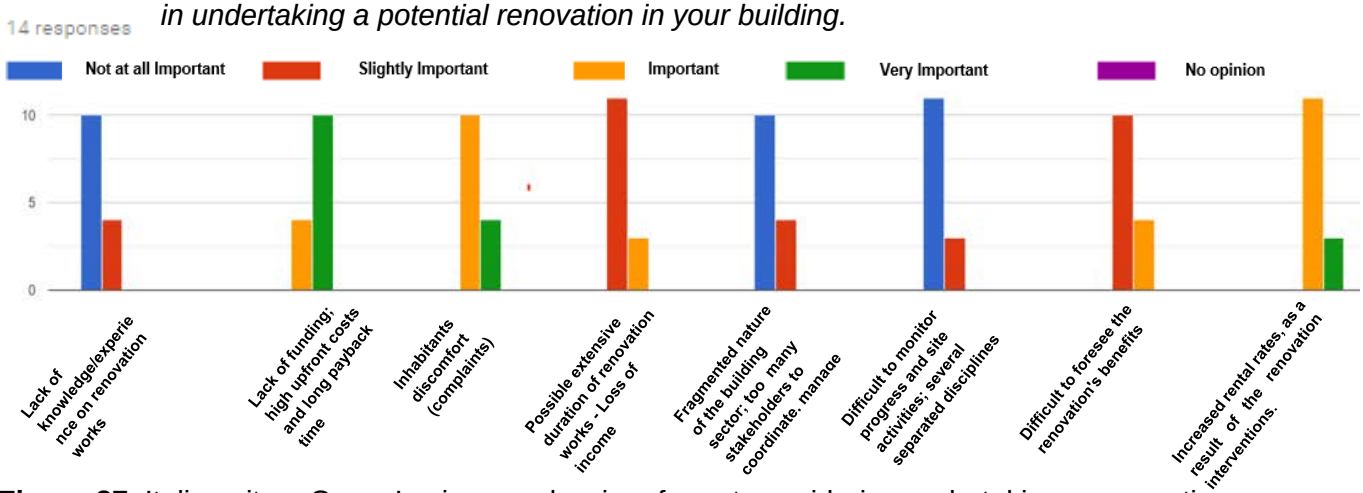


Figure 27: Italian site – Owner's views on barriers for not considering undertaking a renovation

10.1.2 Building inhabitants

The building inhabitants are also considered as active elements of the proposed framework, who will be directly interacting with the BIM4EEB tools and services. Having this in mind, the building inhabitant's questionnaire is designed to cover their role in the project and provide them with a tool to express their preferences, needs and requirements. A total number of 26 inhabitants from the Italian pilot site completed the questionnaire.

Question: What is your gender?

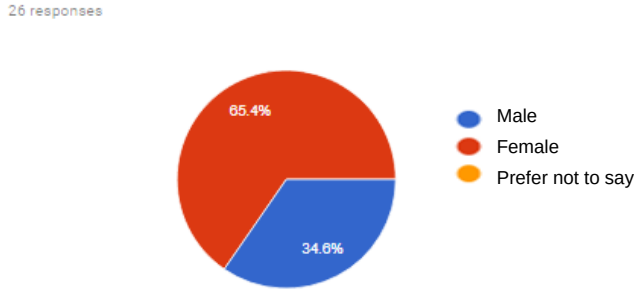


Figure 28: Italian site – Inhabitants gender

Question: What is your age group?

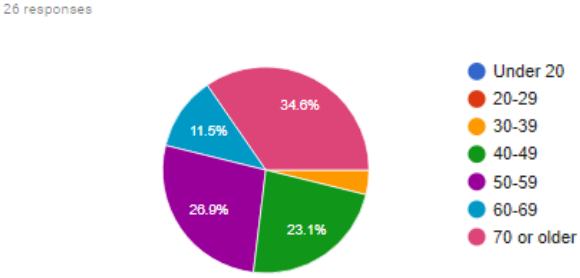


Figure 29: Italian site - Inhabitants age group

Question: How many people live in your flat, including yourself?

26 responses

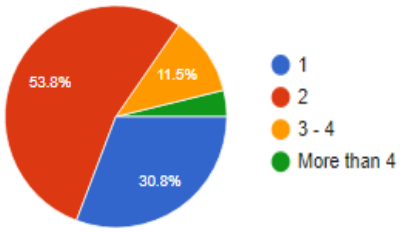


Figure 30: Italian site - Inhabitants household composition

Question: How long have you lived in your current flat?

26 responses

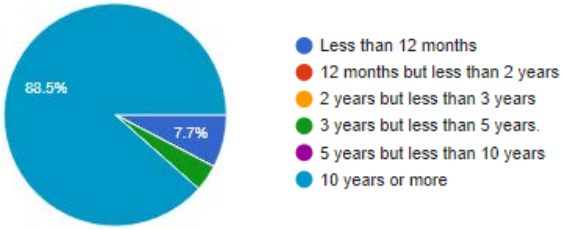


Figure 31: Italian site - Inhabitants length of stay in their flat

Question: How many hours do you spend in your flat daily?

26 responses

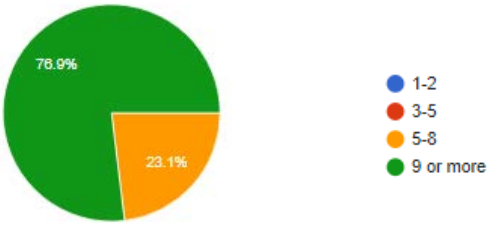


Figure 32: Italian site - Inhabitants daily length of stay in their premises

Question: How would you describe the status of your property/flat?

26 responses

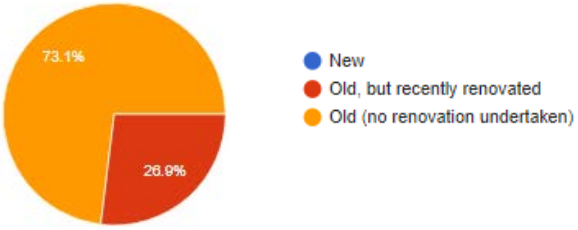


Figure 33: Italian site - Inhabitants perception of their property/flat condition.

Question: Have you ever requested from your property owner, energy efficiency improvements to your building and/or flat?

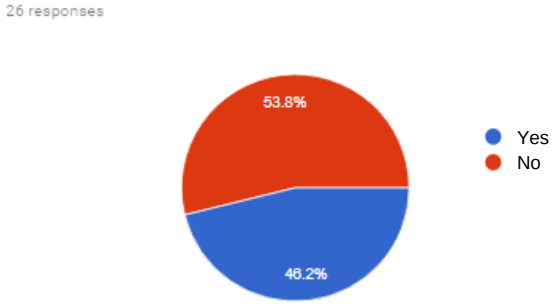


Figure 34: Italian site - Inhabitants requests to owner for energy improvement of their building and/or flat

Question: Digital Skills: Please check all the answer/answers that apply to you.

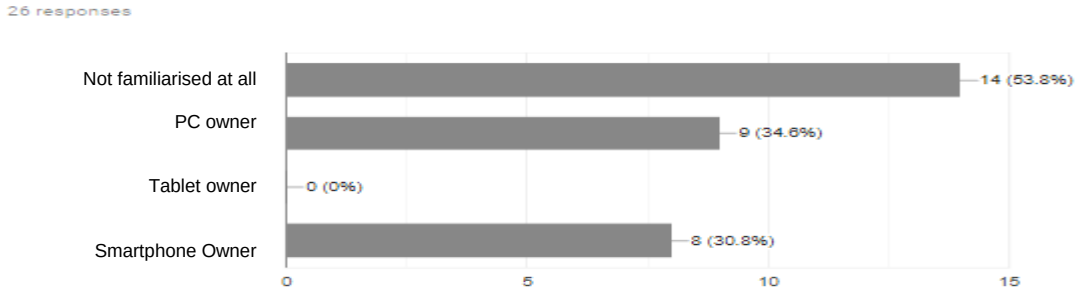


Figure 35: Italian site - Inhabitants digital skills

Question: Are you familiar with the concept of BIM (Building Information Modelling) and its capabilities in renovation interventions of a building?

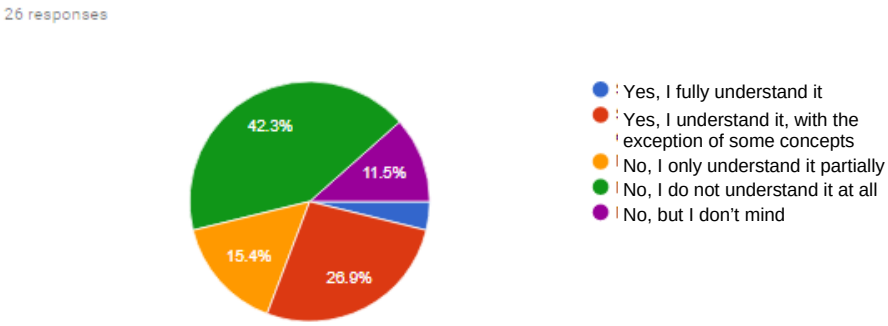


Figure 36: Italian site - Awareness about Building Information Modelling (BIM)

Question: Are you familiar with the concept of BACS (Building Automation and Control systems) and the benefits it can offer in building management and control?

26 responses

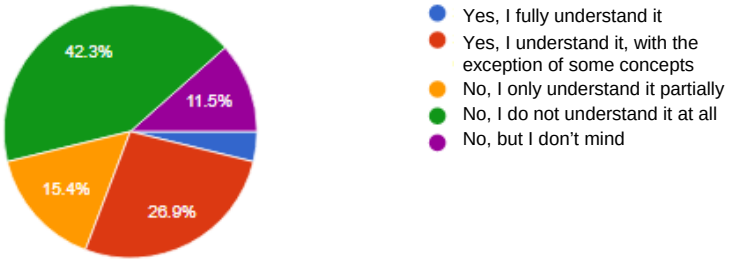


Figure 37: Italian site - Awareness about Building Automation and Control Systems (BACS).

Question: What is your knowledge on how heating, fresh air, cooling, and lighting is provided in terms of mechanical, electrical or natural/passive systems in your building/premises.

26 responses

Figure 38: Italian site – Awareness on how heating, fresh air, cooling, and lighting is provided

Question: Overall, how satisfied are you on how the building meets your needs ? (with 1 "Not at all Satisfied" to 5 being "Very Satisfied"):

26 responses

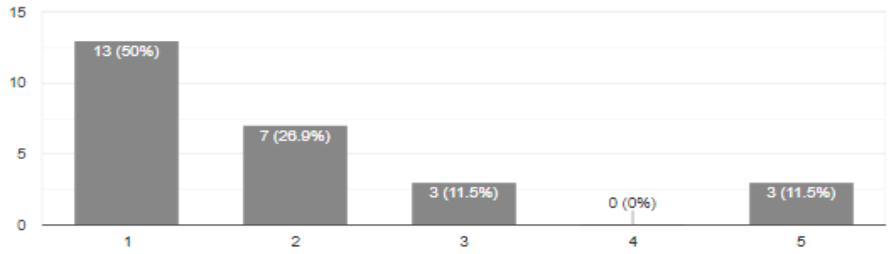


Figure 39: Italian site - Inhabitants satisfaction on their building

Question: Which of the following parameters do you consider as the most critical, in regard to your comfort zone in your premises ?

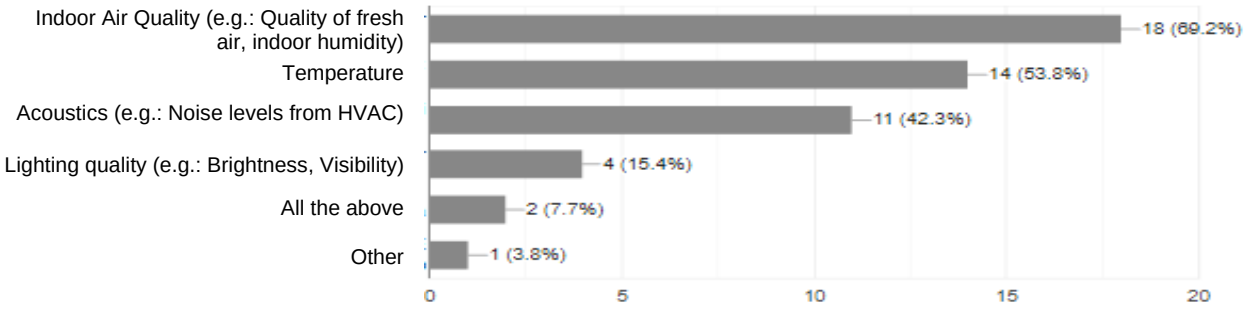


Figure 40:Italian site - inhabitants views on the most critical comfort parameters

Question: How much control do you have over the following aspects within your premises/flat?

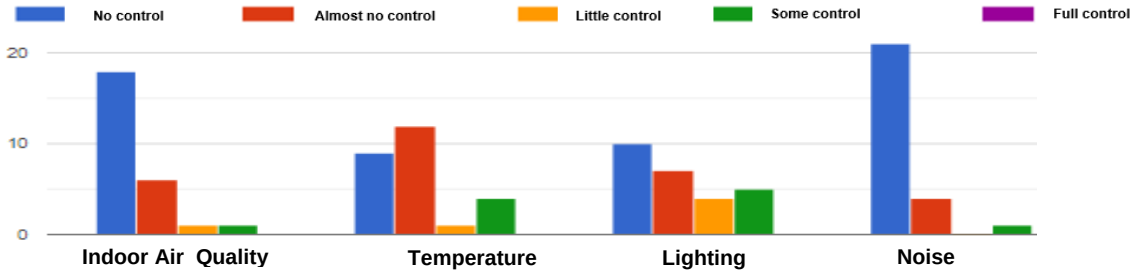


Figure 41: Italian site - Inhabitant's available control in their premises/flat

Question: Please, rate each of the following capabilities that the BIM4EEB tools for Building Inhabitants should integrate.

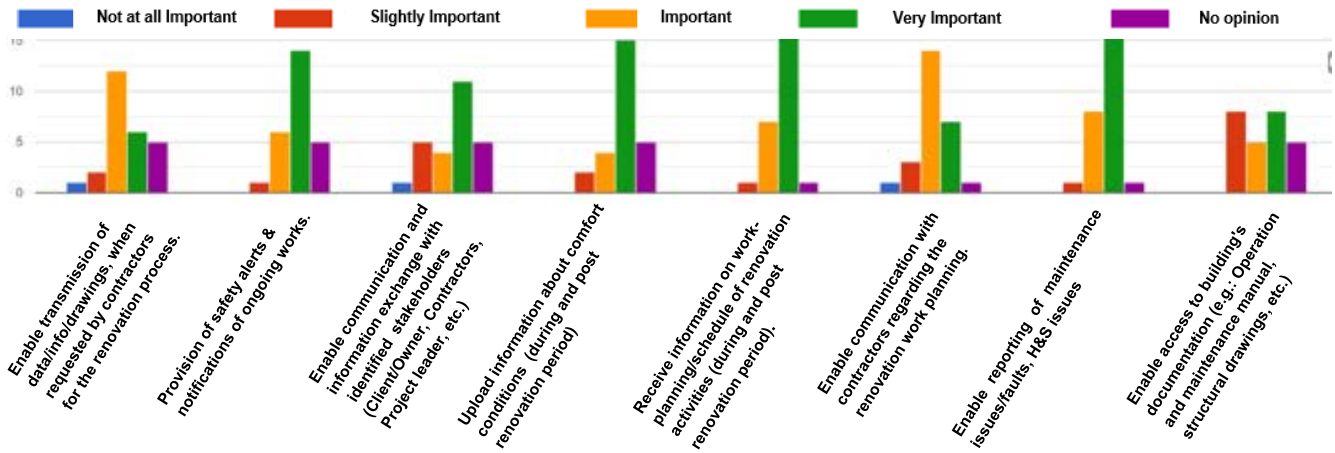


Figure 42: Italian site - Inhabitant's rating on BIM4EEB integrated tools

Question: Would you be interested in providing feedback on your comfort zones within your premises/flat, during the renovation period?

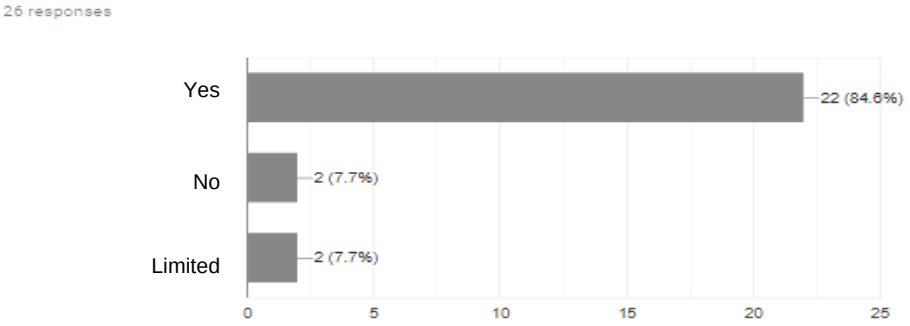


Figure 43: Italian site - Inhabitants willingness to provide feedback on their comfort zones during the renovation

Question: How often would you like to provide your feedback?

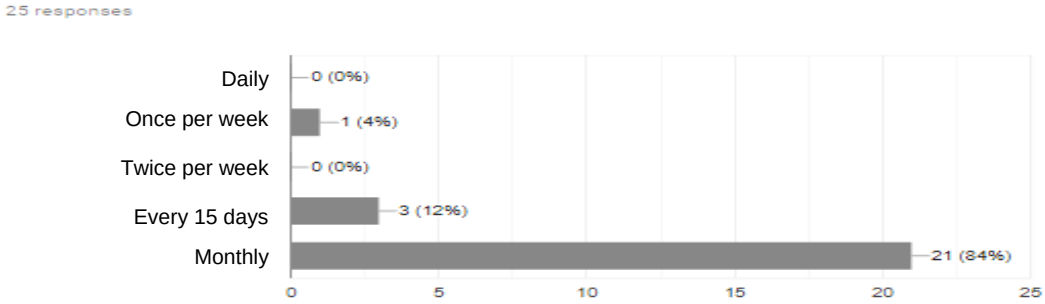


Figure 44: Italian site - Inhabitants preferred intervals for giving feedback on their comfort zones during the renovation

Question: Would you be interested in providing feedback on your comfort zones within your premises/flat, after the renovation (post renovation period)?

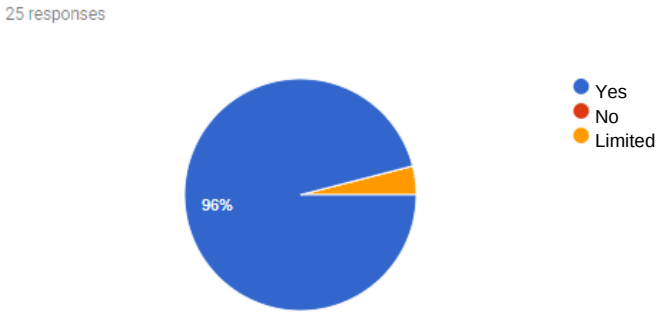


Figure 45: Italian site - Inhabitant's willingness to provide their comfort zones after the renovation period

Question: If you answered Yes in the above question; how often would you like to provide your feedback?

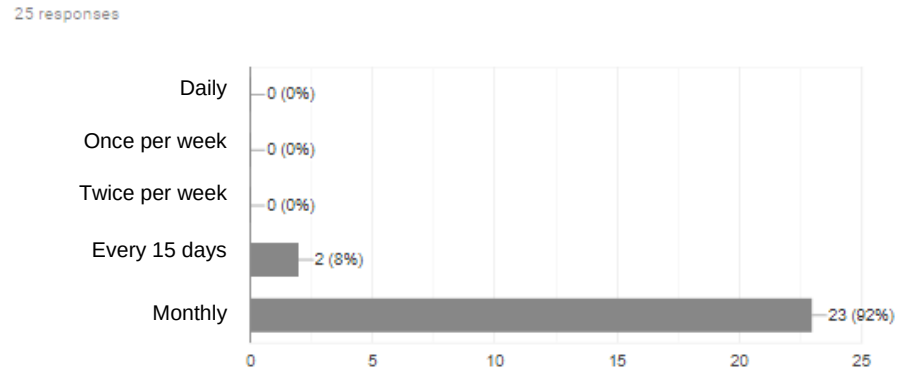


Figure 46: Italian site - Inhabitants preferred tool for providing their comfort zones.

Question: Through which of the following means, would you prefer to provide your feedback regarding your comfort zones?

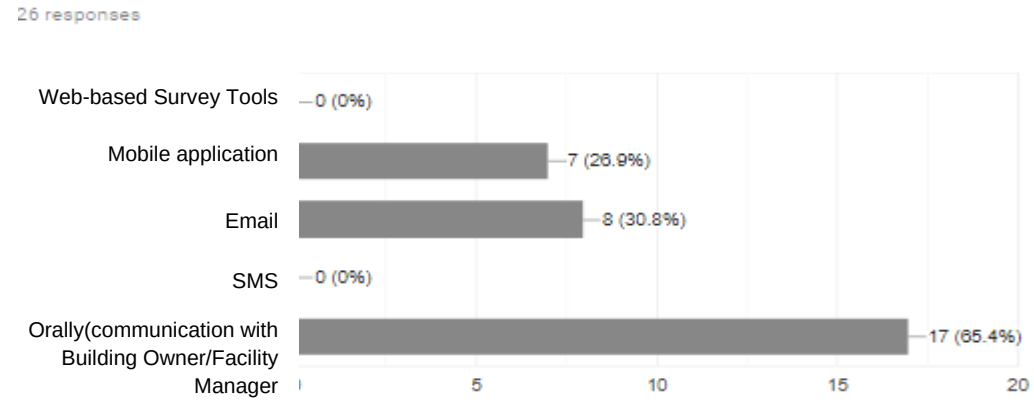


Figure 47: Italian site: Inhabitants' preferred tool for receiving notifications/alerts regarding the renovation progress

Question: Do you want to receive notifications/alerts regarding the renovation progress / schedule in your building?

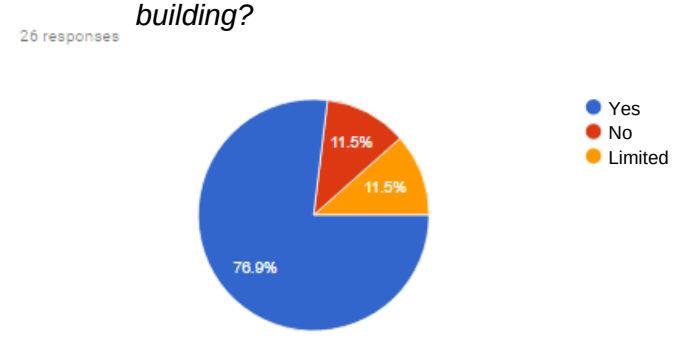


Figure 48: Italian site - Inhabitants willingness to receive notifications/alerts on the renovation progress

Question: If you answered "Yes" on the above question, through which of the following means would you like to receive notifications/alerts etc.?

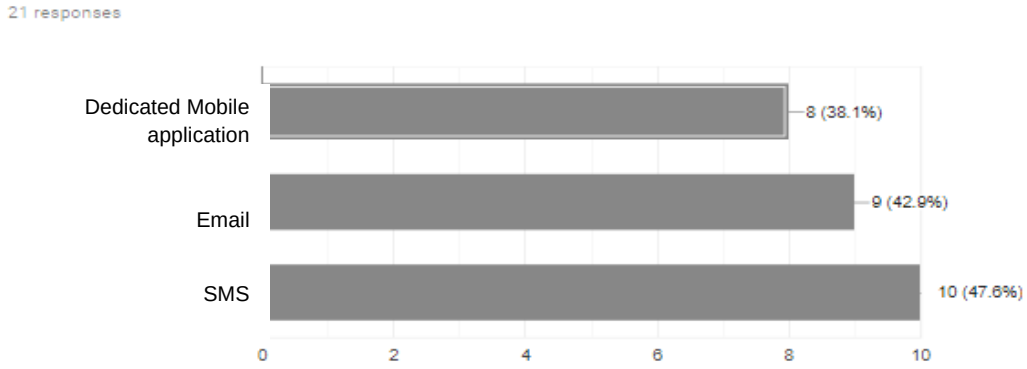


Figure 49: Italian site - Inhabitants' preferred mean for receiving notifications/alerts

Question: How often would you like to receive notifications/alerts?

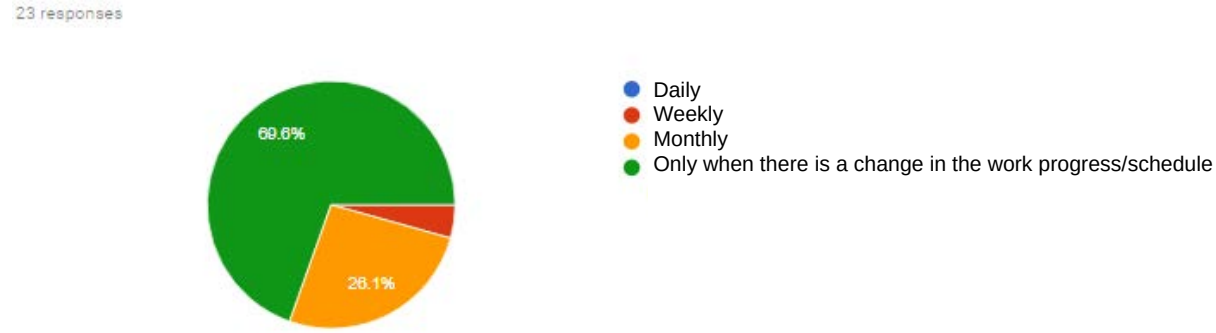


Figure 50: Italian site – Inhabitants preferred intervals for receiving notifications/alerts

Question: Would you be interested to receive security and safety recommendations/alerts about the construction programming and ongoing activities in your building?

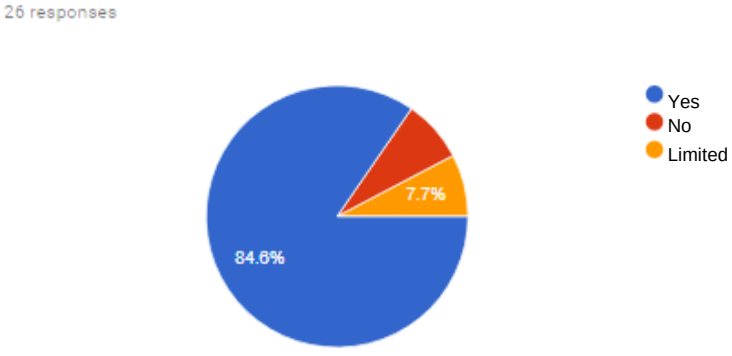


Figure 51: Italian site – Inhabitants' willingness to receive security and safety recommendations /alerts about the construction programming and ongoing activities.

Question: If you answered "Yes" on the above question, through which of the following means would you like to receive notifications/alerts etc.?

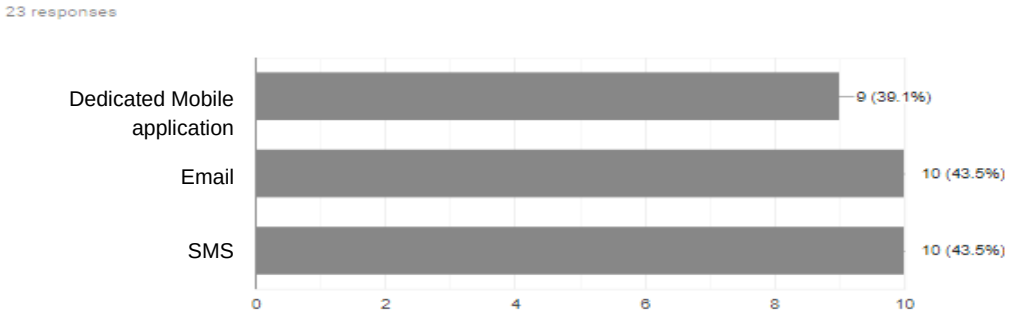


Figure 52: Italian site - Inhabitants preferred tool for receiving notifications/alerts.

Question: How often would you like to receive notifications/alerts?

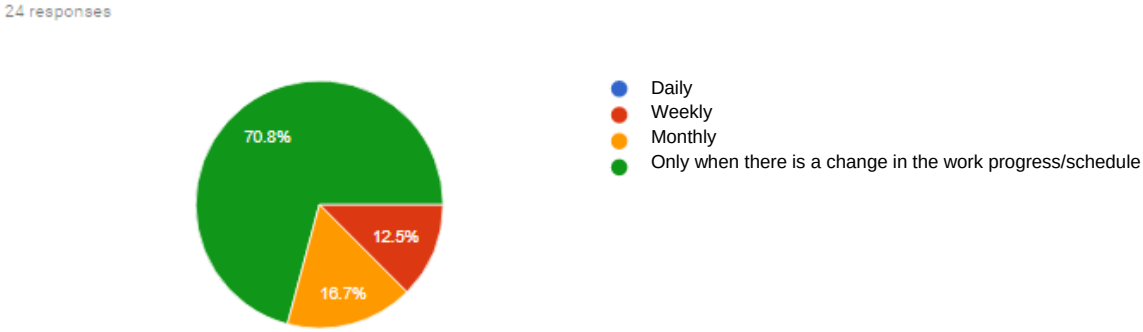


Figure 53: Italian site - Inhabitants preferred interval for receiving notifications/alerts

Question: Please, rate each of the following aspects considered as opportunities for you as an Inhabitant in requesting from the building Owner a potential renovation in your building/flat.

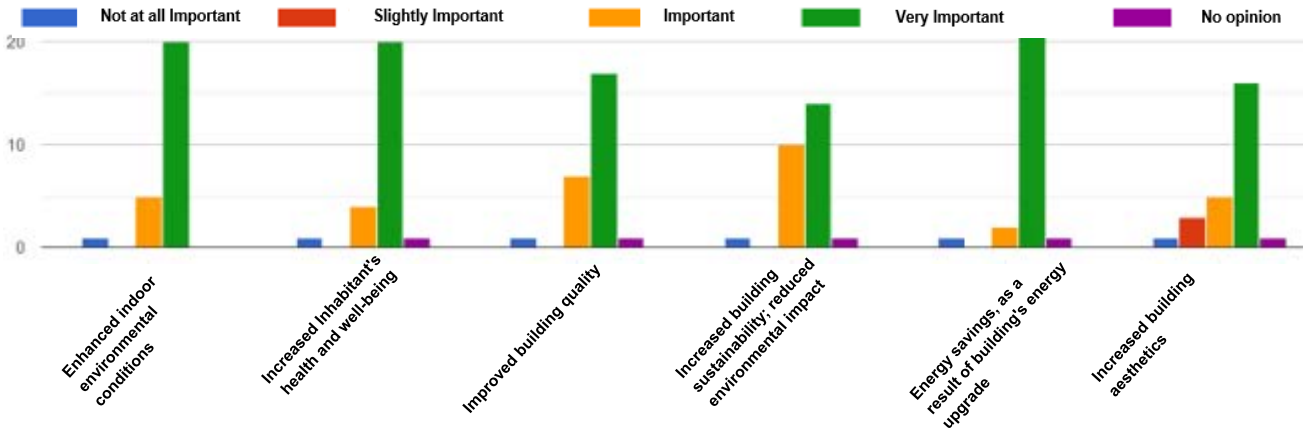


Figure 54: Italian site - Opportunities for requesting from the Owner to undertake a renovation

Question: Please, rate each of the following aspects considered as barriers for you as an Inhabitant in requesting from the building owner a potential renovation in your building/flat:

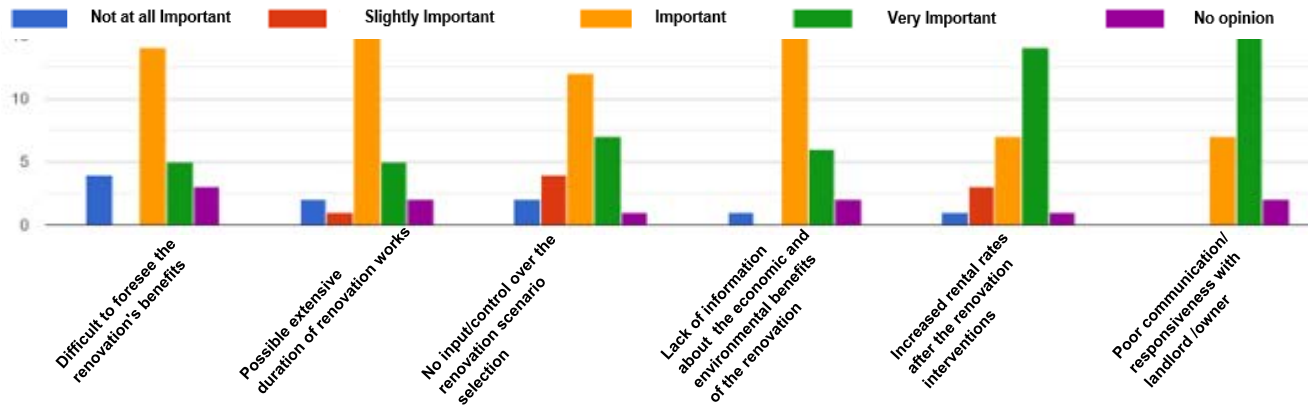


Figure 55: Italian site - Barriers for requesting from the Owner to undertake a renovation

10.2 Polish Pilot site

As before, the results of the questionnaires filled in by the Owners and Inhabitants of the Polish pilot site are presented below.

10.2.1 Building owners

Starting from the definition of use cases, the role of building owners is to act as major stakeholders in the project, by setting context preferences and further defining the operational parameters for building conditions. The building owner is considered as an active element of the proposed framework, directly interacting with the BIM4EEB tools and services. Having this in mind, the building owners questionnaire is designed to cover the owner's role in the project and provide them with a tool to express their preferences, needs and requirements. The introductory section of the questionnaire starts aims at defining the generic profile of the building owners; from the Polish pilot 15 owners completed the questionnaire.

Question: Is your company the owner of the entire building/flats?

15 responses

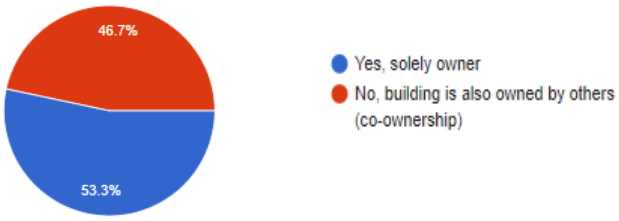


Figure 56: Polish site - Ownership of the pilot building

Question: If you answered "No" on the previous question, how many properties does your company own in the building? (Please skip this question if you are the only owner of the building).

9 responses

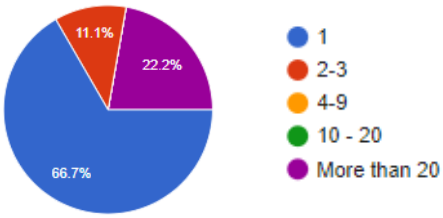


Figure 57: Polish site - Ownership of the pilot building

Question: What kind of business is your company involved in?

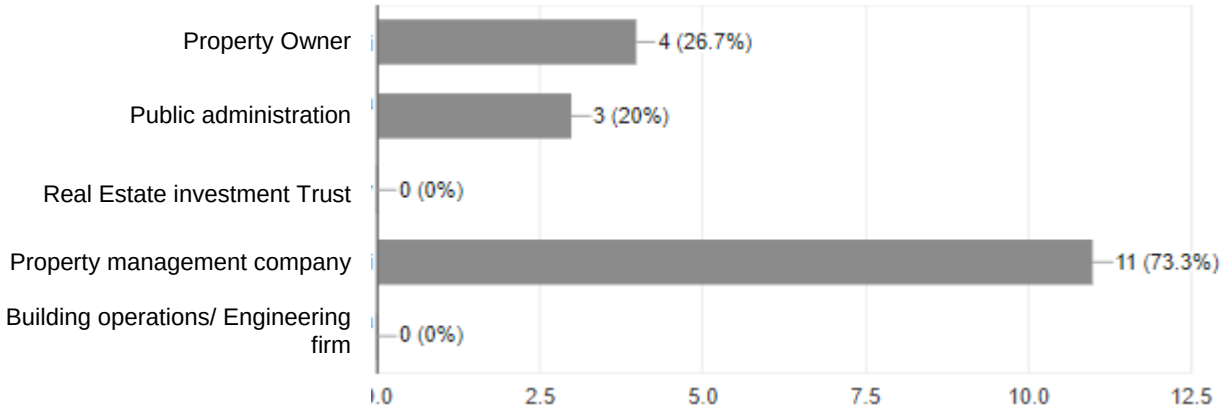


Figure 58: Polish site - Owner's business sector

Question: How would you describe the status of your building?

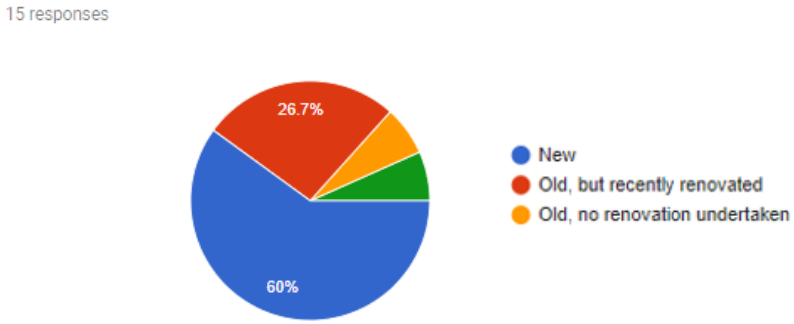


Figure 59: Polish site - Owner's perception of its building condition

Question: Have your building's inhabitants requested energy efficiency improvements to properties?

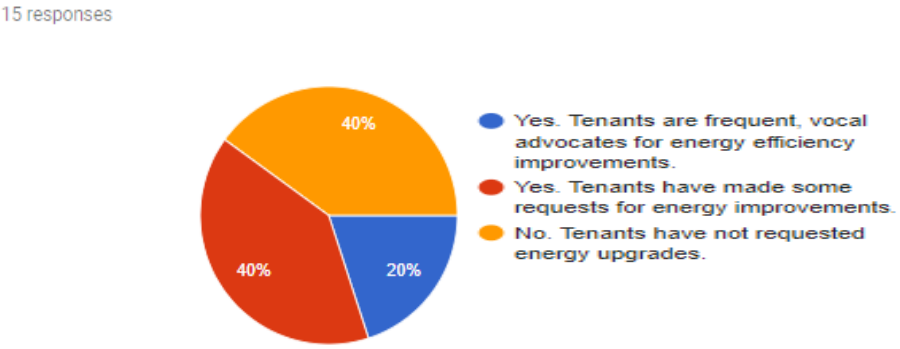


Figure 60: Polish site - Inhabitants energy improvements requests to the building owner

Question: Has you company previous experience in undertaking a renovation in their building/assets?

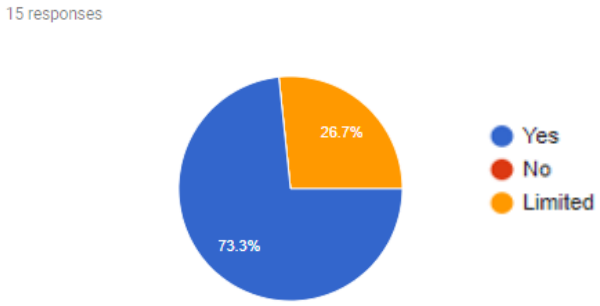


Figure 61: Polish site - Owner's experience in renovation

Question: What is your company's current process for contacting with the inhabitants of your building?

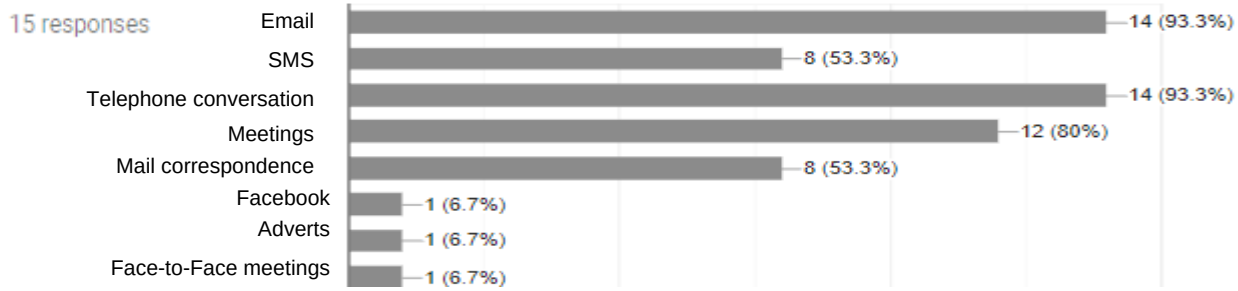


Figure 62: Polish site - Owners communication means with the pilot's inhabitants

Question: Are you familiar with the concept of BIM (Building Information Modelling) and its capabilities in renovation interventions of a building?

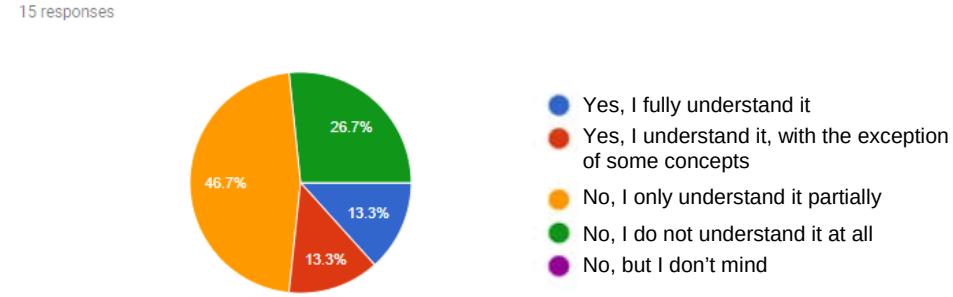


Figure 63: Polish site – Owners' awareness about Building Information Modelling (BIM)

Question: Are you familiar with the concept of BACS (Building Automation and Control systems) and the benefits it can offer in building management and control?

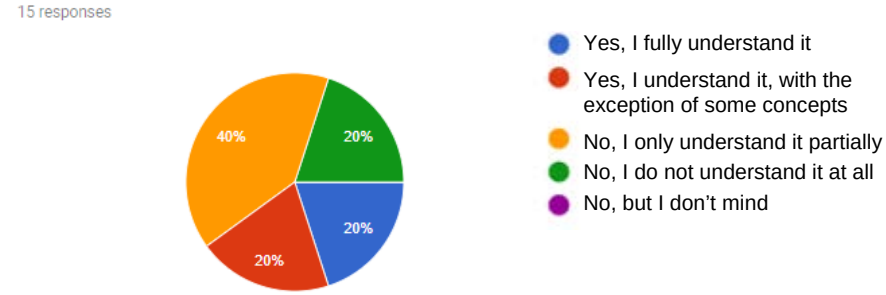


Figure 64: Polish site - Owners' awareness about Building Automation and Control Systems (BACS).

Question: Is your company responsible, when it comes to deciding to undertake a renovation in your building/assets?

15 responses

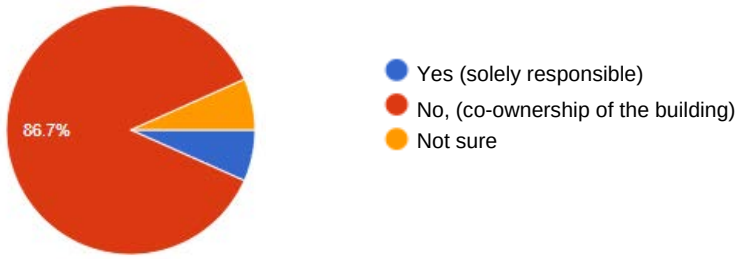


Figure 65: Polish site - Owner's responsibility for renovation decision making.

Question: What is your knowledge on how heating, fresh air, cooling, and lighting is provided in terms of mechanical, electrical or natural/passive systems in your building/asset?

15 responses

Figure 66: Polish site - Owner's knowledge on provision of heating, fresh air, cooling, and lighting in the pilot building

Question: Is your company aware of all the equipment installations in your building/assets?

15 responses

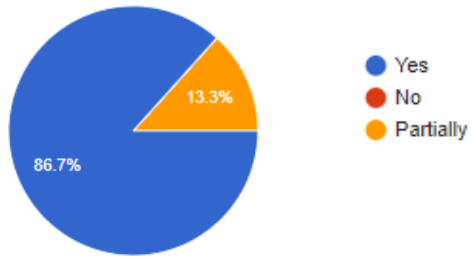


Figure 67: Polish site - Owner's knowledge on the existing building's installations

Question: Does your building have a building automation system with direct digital controls? (e.g.: detailed zone condition controls, scheduled lighting controls, monitors system performance

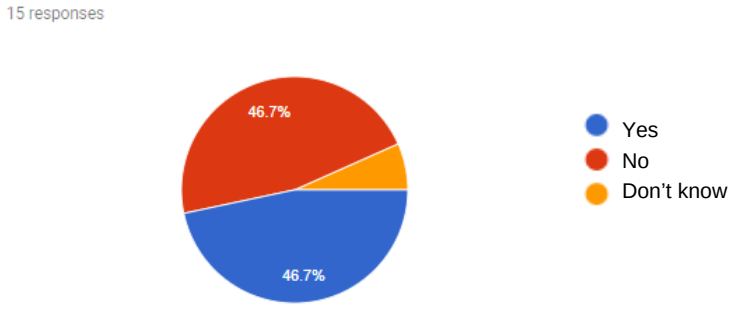


Figure 68: Polish site - Owner's knowledge on building's automation system

Question: For which of the following does your company hold information/data about the building's inhabitants' electrical devices and equipment in their premises?

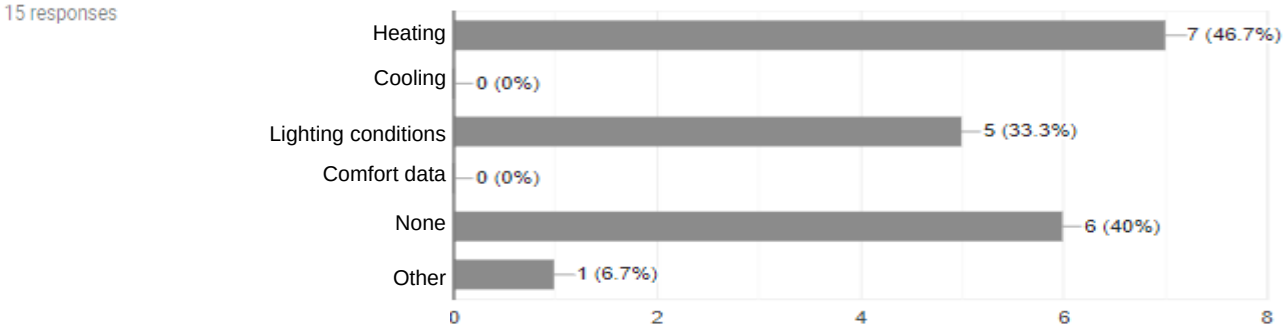


Figure 69: Polish site - Owner's available information on inhabitant's electrical devices

Question: Please, rate each of the following capabilities that the BIM4EEB tools for Building Owners should integrate

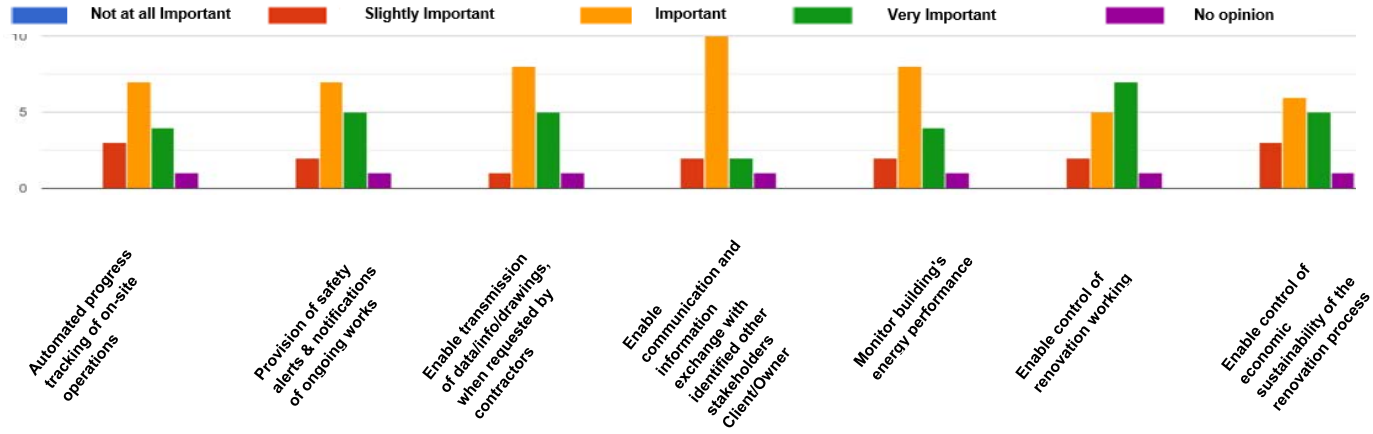


Figure 70: Polish site - Owner's preference on BIM4EEB integrated tools

Question: As the building Owner; for which of the following activities are you currently in control?

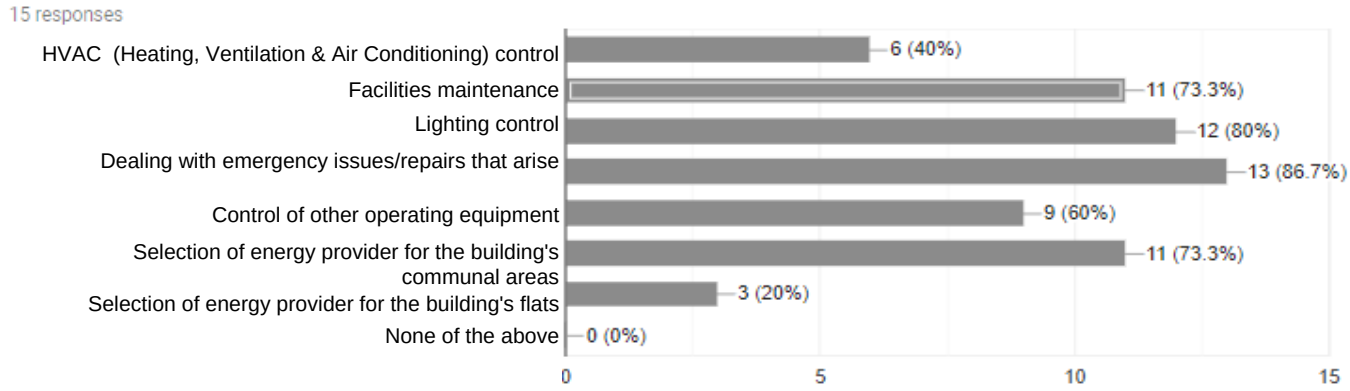


Figure 71: Polish site - Owner's control of existing equipment

Question: In which of the following activities would you like to get involved; in regard to the renovation activities in your building in the near future?

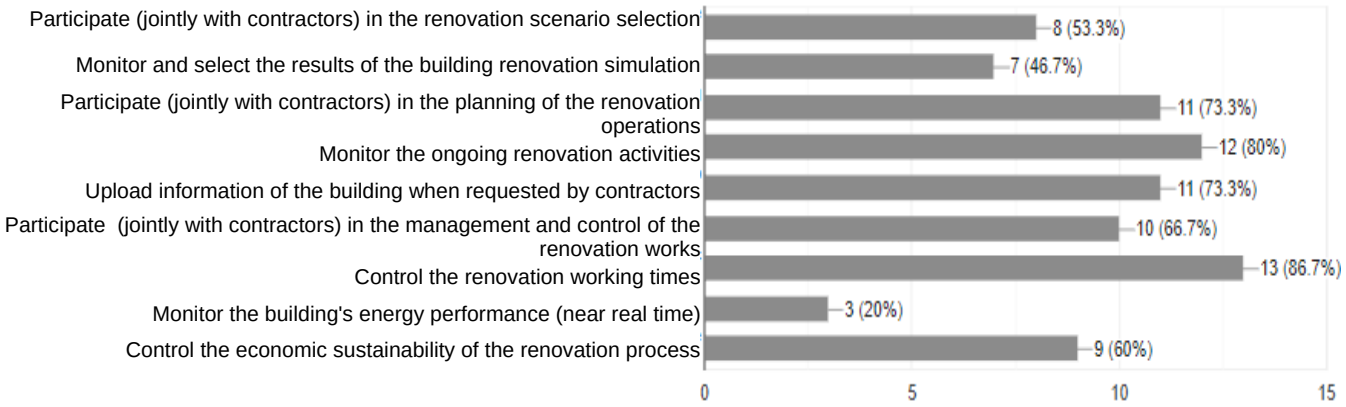


Figure 72: Polish site - Owner's involvement preference in future renovation activities

Question: Please, rate each of the following aspects considered as opportunities for your company as an Owner in undertaking a potential renovation in your building.

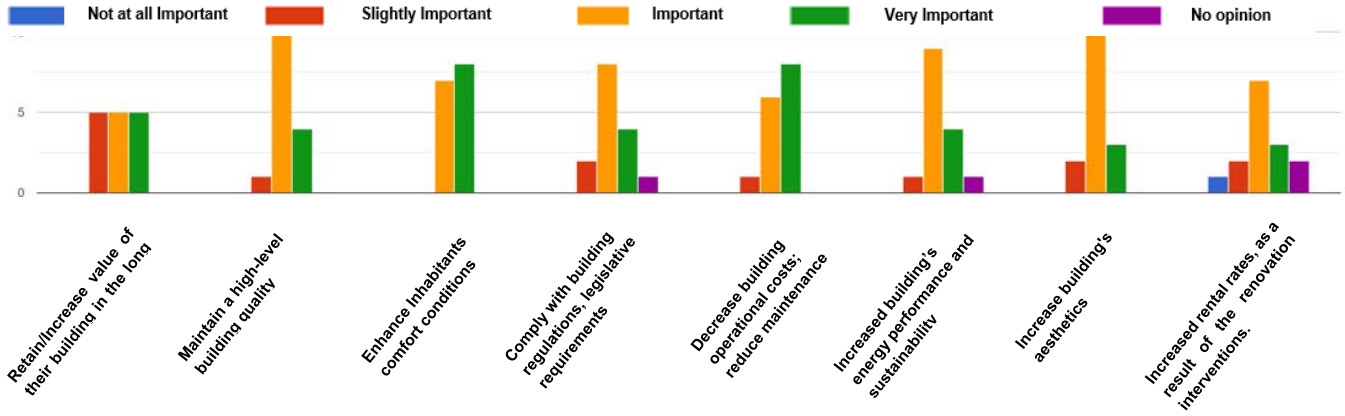


Figure 73: Polish site - Owner's views on opportunities for considering undertaking a renovation

Question: Please, rate each of the following aspects considered as barriers for your company as an Owner in undertaking a potential renovation in your building.

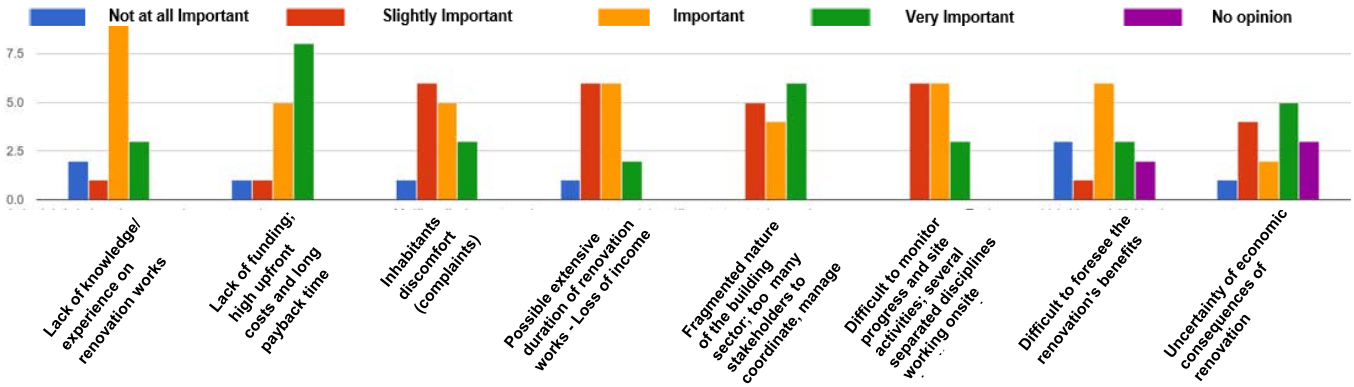


Figure 74: Polish site – Owner's views on barriers for not considering undertaking a renovation

10.2.2 Building inhabitants

As mentioned previously, the building inhabitant's questionnaire is designed to cover their role in the project and provide them with a tool to express their preferences, needs and requirements. A total number of 15 inhabitants from the Polish pilot site completed the questionnaire.

Question: What is your gender?

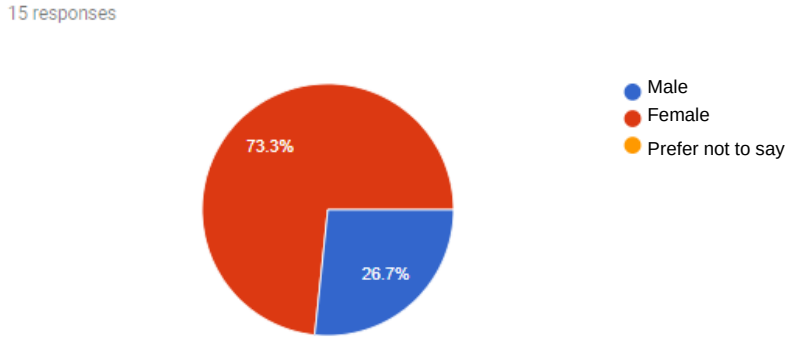


Figure 75: Polish site - Inhabitants gender

Question: What is your age group?

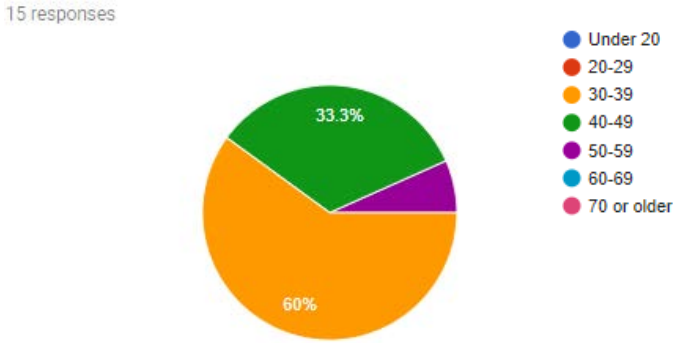


Figure 76: Polish site - Inhabitants age group

Question: How many people live in your flat, including yourself?

15 responses

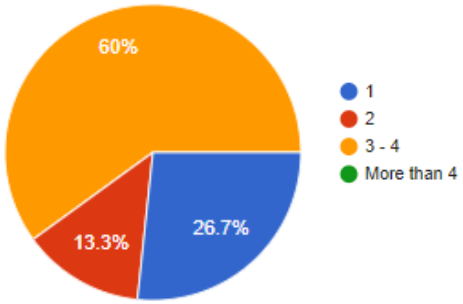


Figure 77: Polish site - Inhabitants household composition

Question: How long have you lived in your current flat?

15 responses

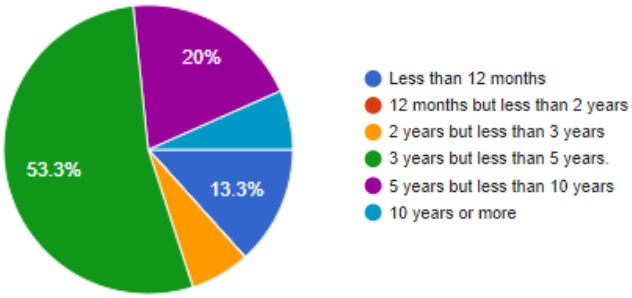


Figure 78: Polish site - Inhabitants length of stay in their flat

Question: How many hours do you spend in your flat daily?

15 responses

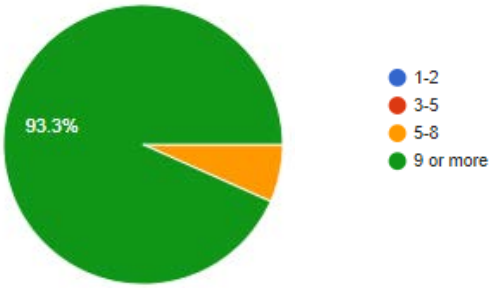


Figure 79: Polish site - Inhabitants daily length of stay in their premises

Question: How would you describe the status of your property/flat?

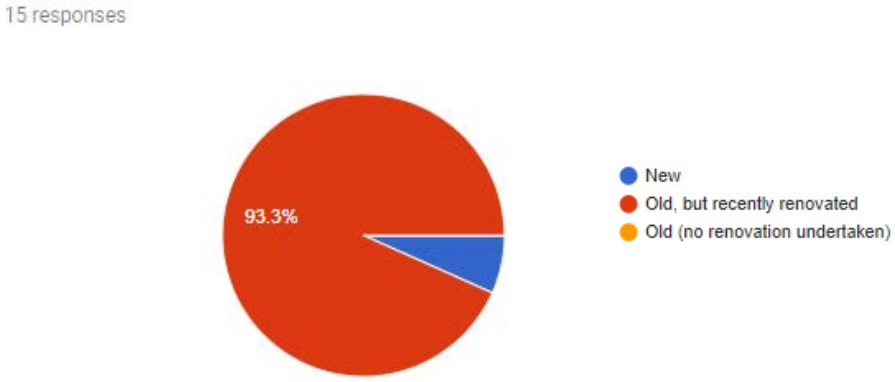


Figure 80: Polish site - Inhabitants perception of their property/flat condition.

Question: Have you ever requested from your property owner, energy efficiency improvements to your building and/or flat?

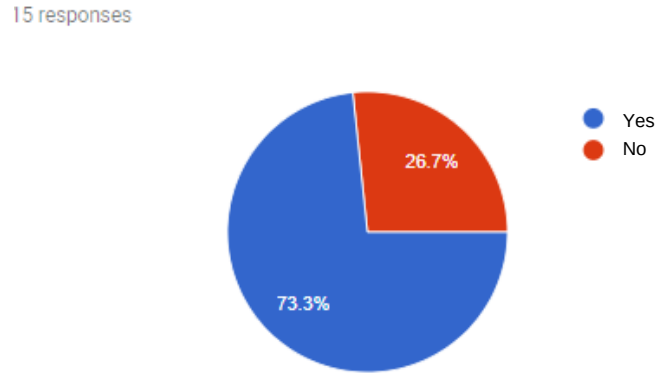


Figure 81: Polish site - Inhabitants requests for energy improvement of their building and/or flat

Question: Digital Skills: Please check all the answer/answers that apply to you.

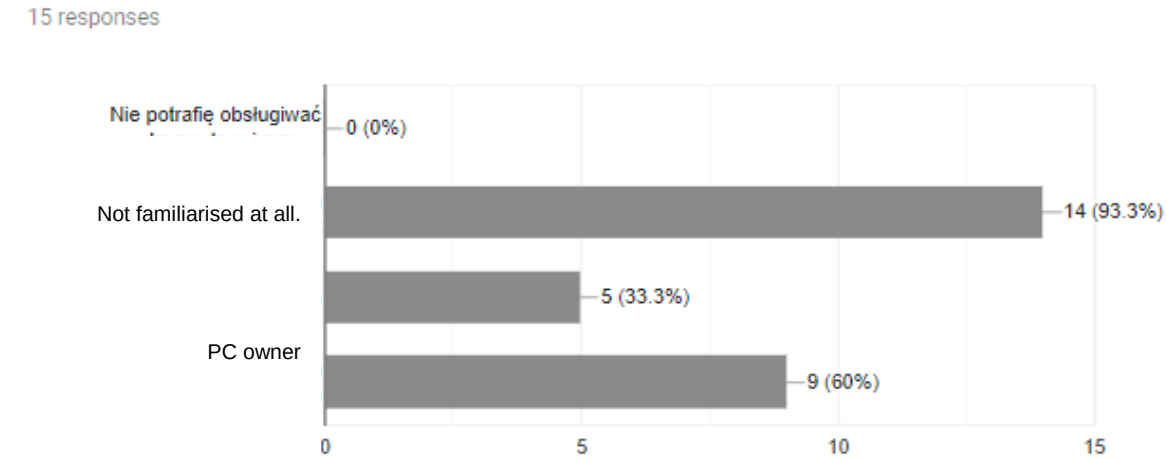


Figure 82: Polish site - Inhabitants digital skills

Question: Are you familiar with the concept of BIM (Building Information Modelling) and its capabilities in renovation interventions of a building?

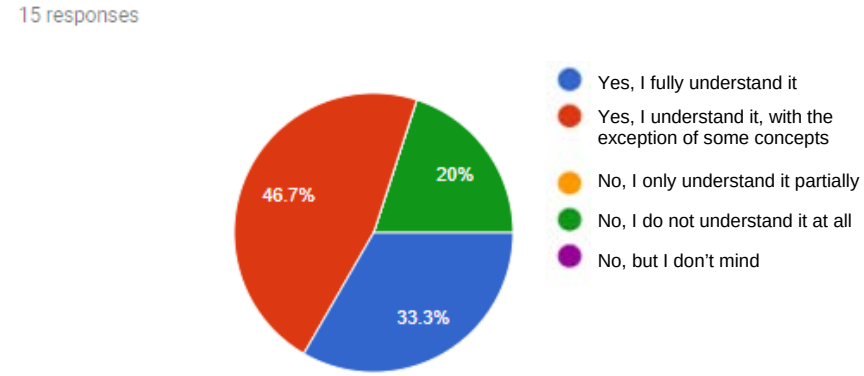


Figure 83: Polish site - Awareness about Building Information Modelling (BIM)

Question: Are you familiar with the concept of BACS (Building Automation and Control systems) and the benefits it can offer in building management and control?

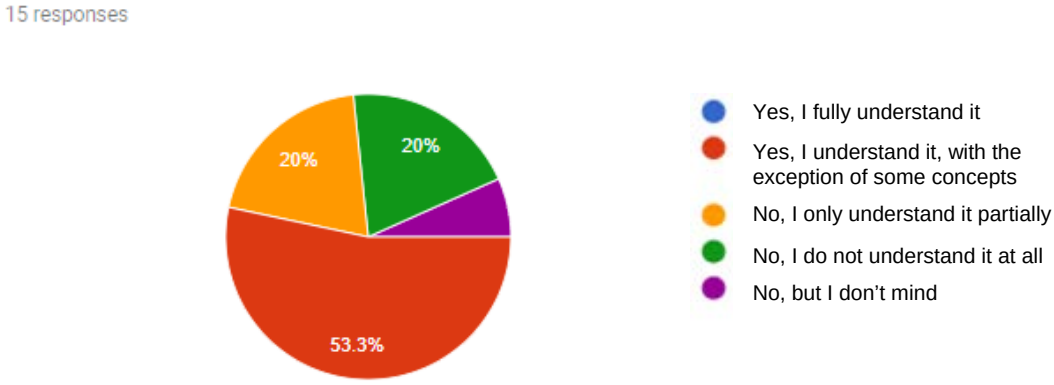


Figure 84: Polish site - Awareness about Building Automation and Control Systems (BACS).

Question: What is your knowledge on how heating, fresh air, cooling, and lighting is provided in terms of mechanical, electrical or natural/passive systems in your building/premises.

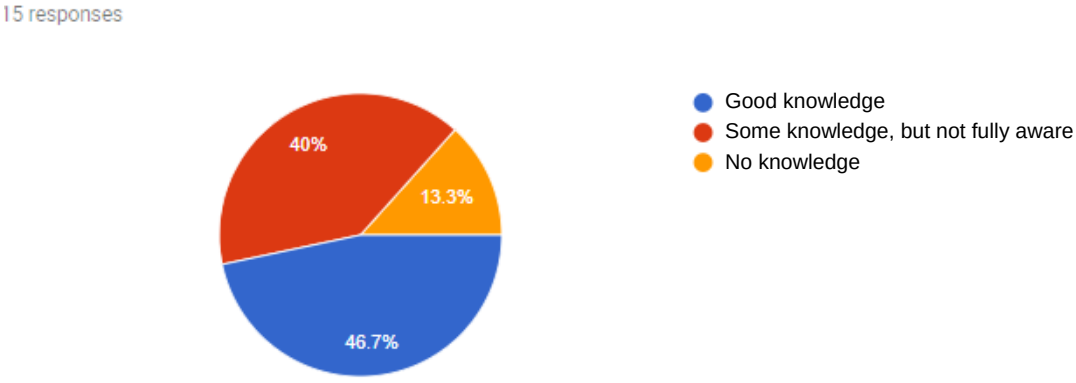


Figure 85: Polish site – Awareness on how heating, fresh air, cooling, and lighting is provided

Question: Overall, how satisfied are you on how the building meets your needs ? (with 1 "Not at all Satisfied" to 5 being "Very Satisfied"):

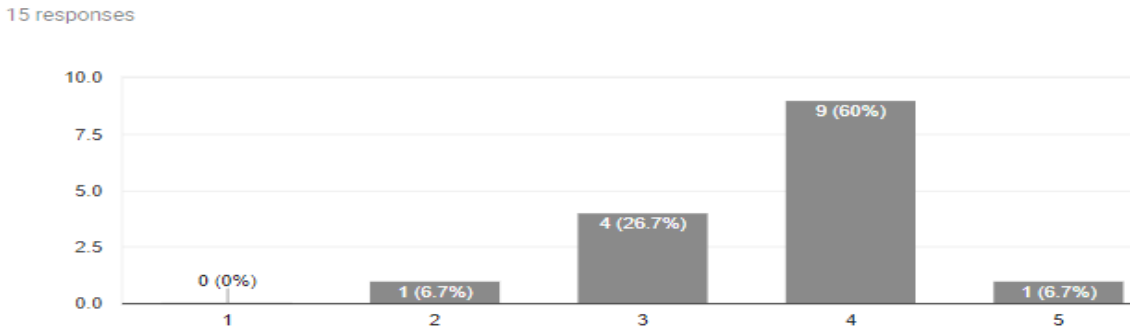


Figure 86: Polish site - Inhabitants satisfaction on their building

Question: Which of the following parameters do you consider as the most critical, in regard to your comfort zone in your premises ?

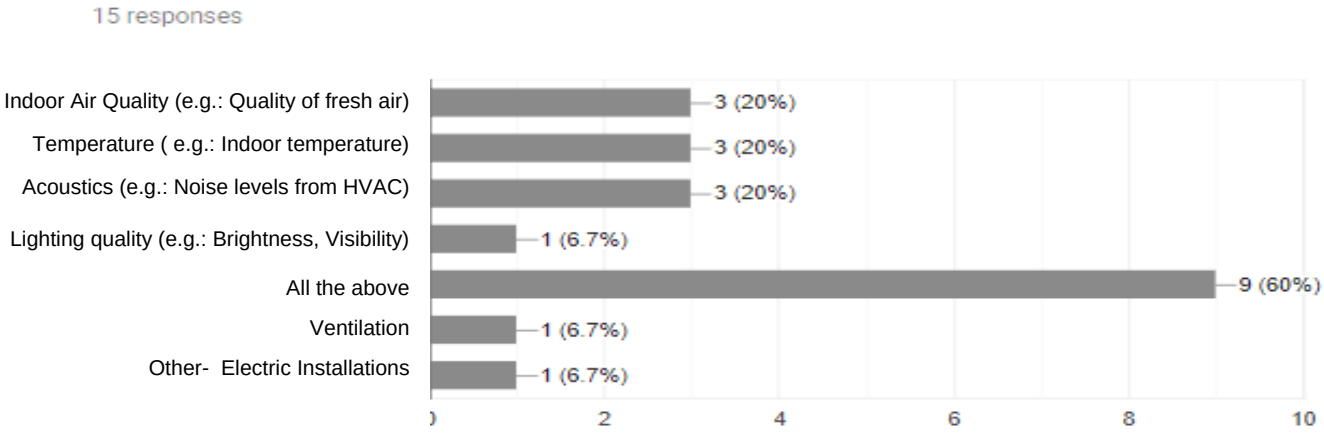


Figure 87: Polish site - Inhabitants views on the most critical comfort parameter

Question: How much control do you have over the following aspects within your premises/flat?

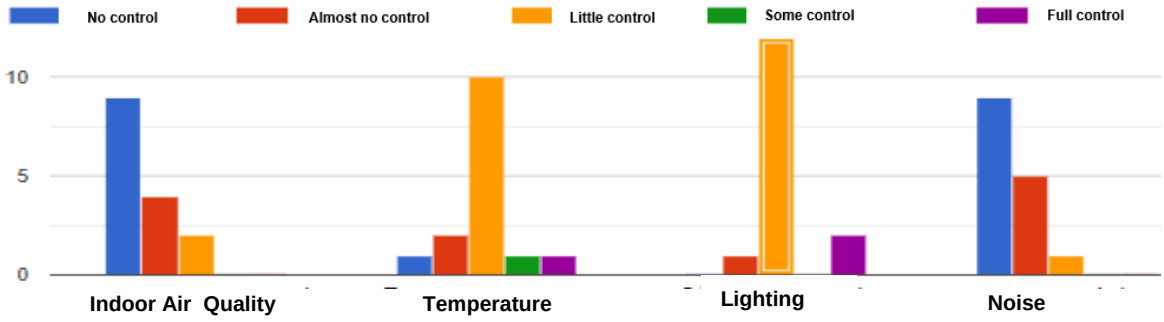


Figure 88: Polish site - Inhabitant's available control in their premises/flat

Question: Please, rate each of the following capabilities that the BIM4EEB tools for Building Inhabitants should integrate.

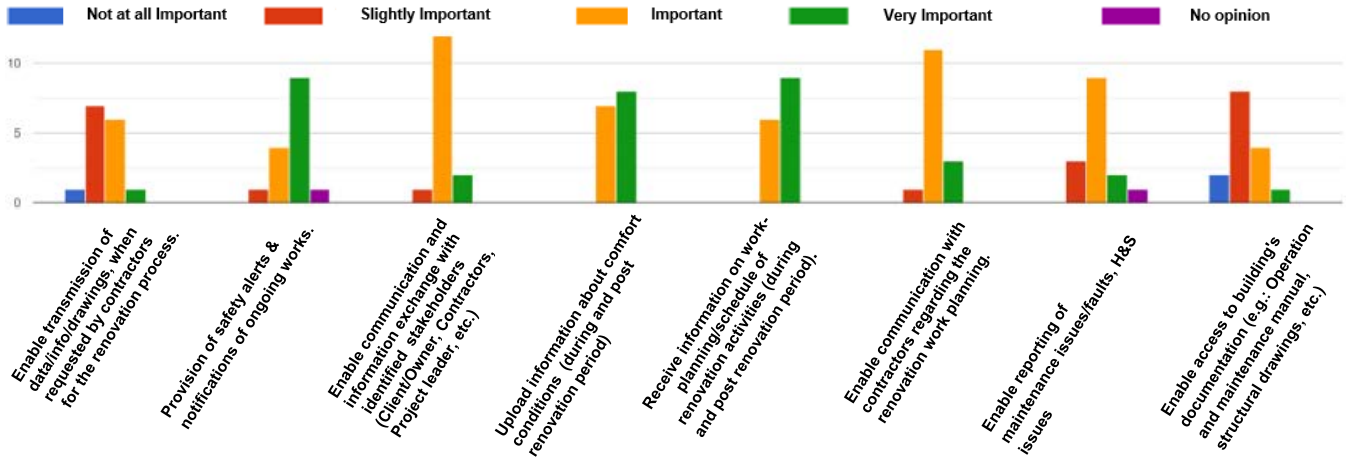


Figure 89: Polish site - Inhabitant's rating on BIM4EEB integrated tools

Question: Would you be interested in providing feedback on your comfort zones within your premises/flat, during the renovation period?

15 responses

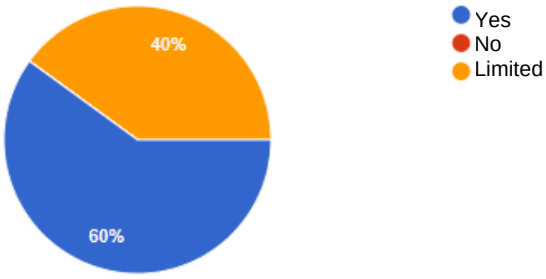


Figure 90: Polish site - Inhabitants willingness to provide feedback on their comfort zones during the renovation

Question: How often would you like to provide your feedback?

11 responses

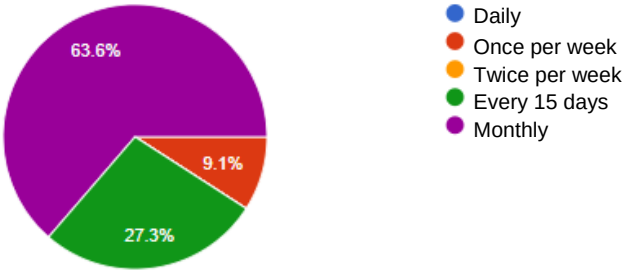


Figure 91: Polish site - Inhabitants preferred means for providing feedback on their comfort zones during the renovation

Question: Would you be interested in providing feedback on your comfort zones within your premises/flat, after the renovation (post renovation period)?

15 responses

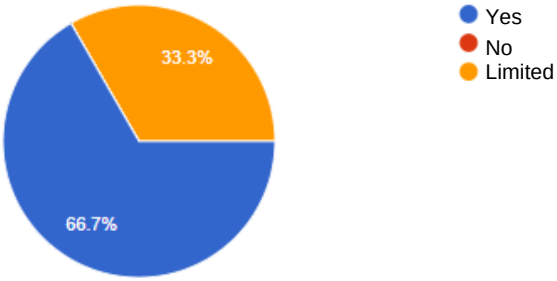


Figure 92: Polish site: Inhabitant's willingness towards providing their comfort zones after the renovation

Question: If you answered Yes in the above question; how often would you like to provide your feedback?

12 responses

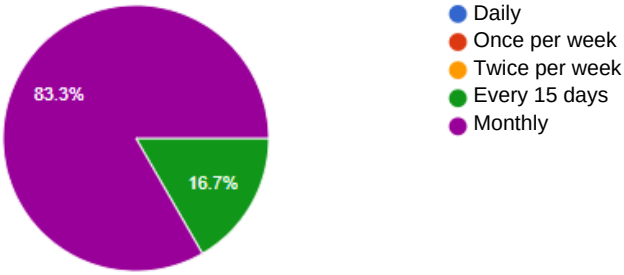


Figure 93: Polish site: Inhabitants preferred intervals for providing their comfort zones.

Question: Through which of the following means, would you prefer to provide your feedback regarding our comfort zones?

15 responses

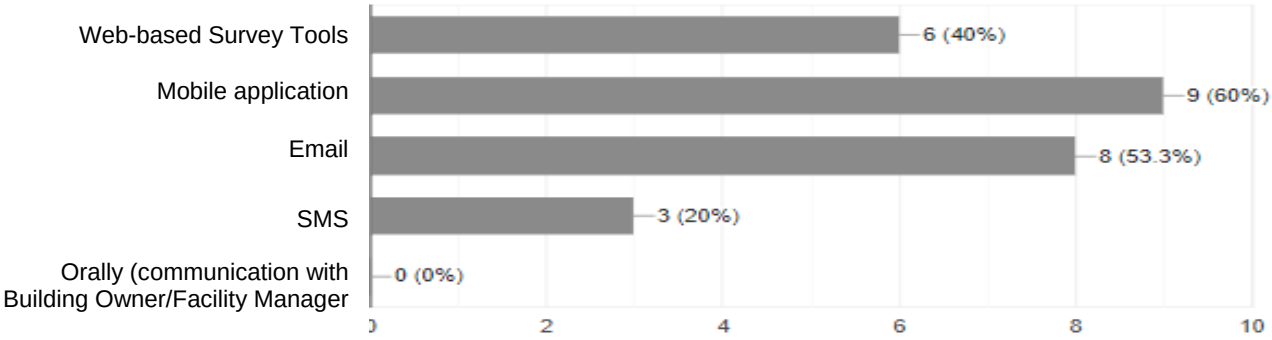


Figure 94: Polish site - Inhabitants' preferred tools for receiving notifications/alerts regarding the renovation progress

Question: Do you want to receive notifications/alerts regarding the renovation progress / schedule in your building?

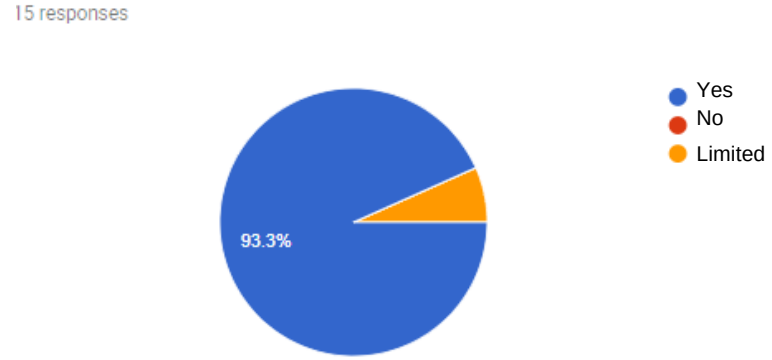


Figure 95: Polish site - Inhabitants willingness to receive notifications/alerts regarding the renovation progress

Question: If you answered "Yes" on the above question, through which of the following means would you like to receive notifications/alerts etc.?

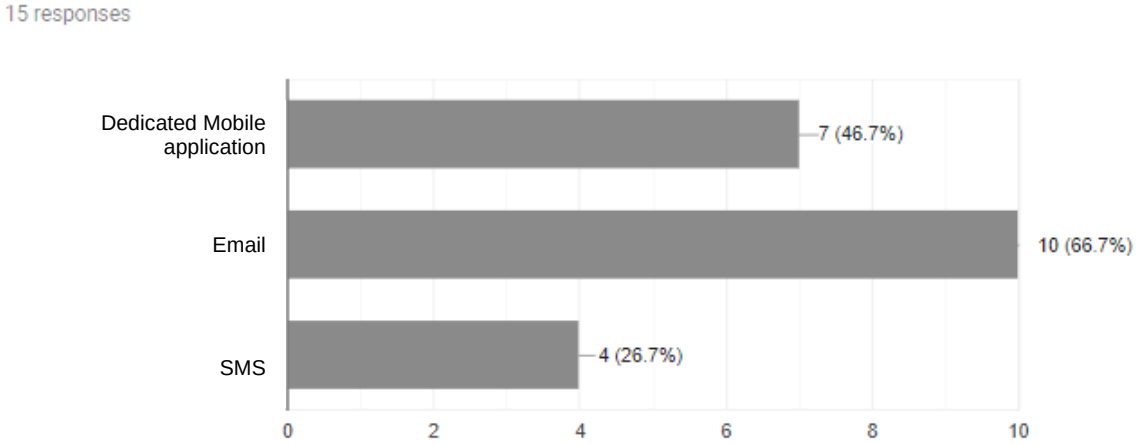


Figure 96: Polish site: Inhabitants' preferred tools for receiving notifications/alerts

Question: How often would you like to receive notifications/alerts?

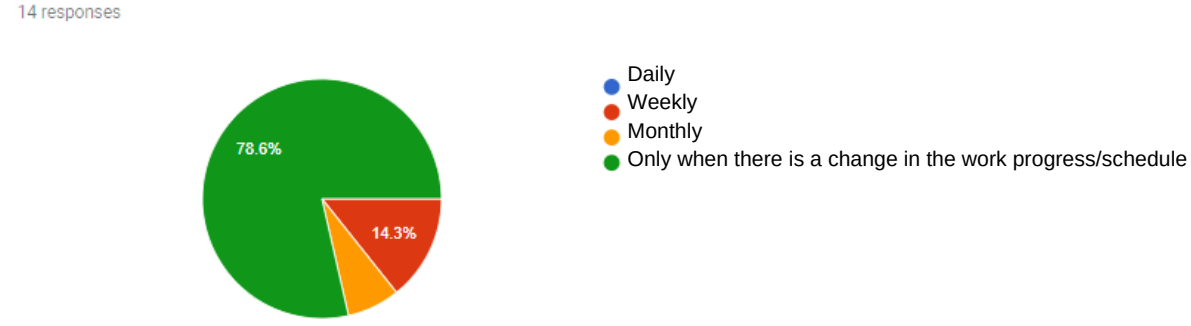


Figure 97: Polish site – Inhabitants preferred intervals for receiving notifications/alerts

Question: Would you be interested to receive security and safety recommendations /alerts about the construction programming and ongoing activities in your building?

15 responses

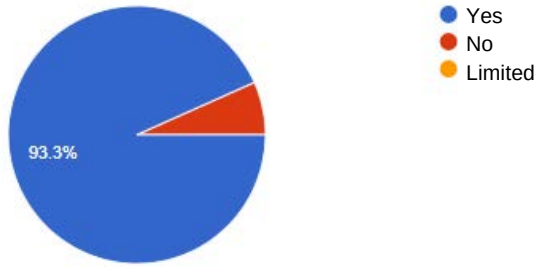


Figure 98: Polish site - Inhabitants willingness to receive security and safety recommendations /alerts about the construction programming and ongoing activities

Question: If you answered "Yes" on the above question, through which of the following means would you like to receive notifications/alerts etc.?

14 responses

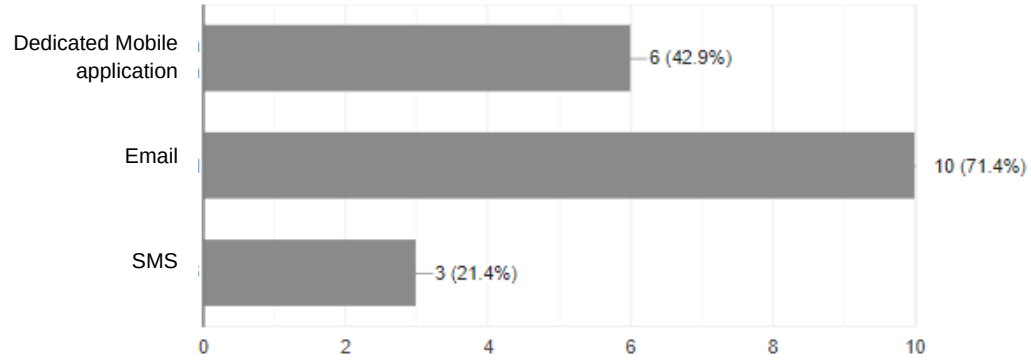


Figure 99: Polish site - Inhabitants preferred tools for receiving notifications/alerts.

Question: How often would you like to receive notifications/alerts?

14 responses

Figure 100: Polish site - Inhabitants preferred intervals for receiving notifications/alerts.

Question: Please, rate each of the following aspects considered as opportunities for you as an Inhabitant in requesting from the building Owner a potential renovation in your building/flat.

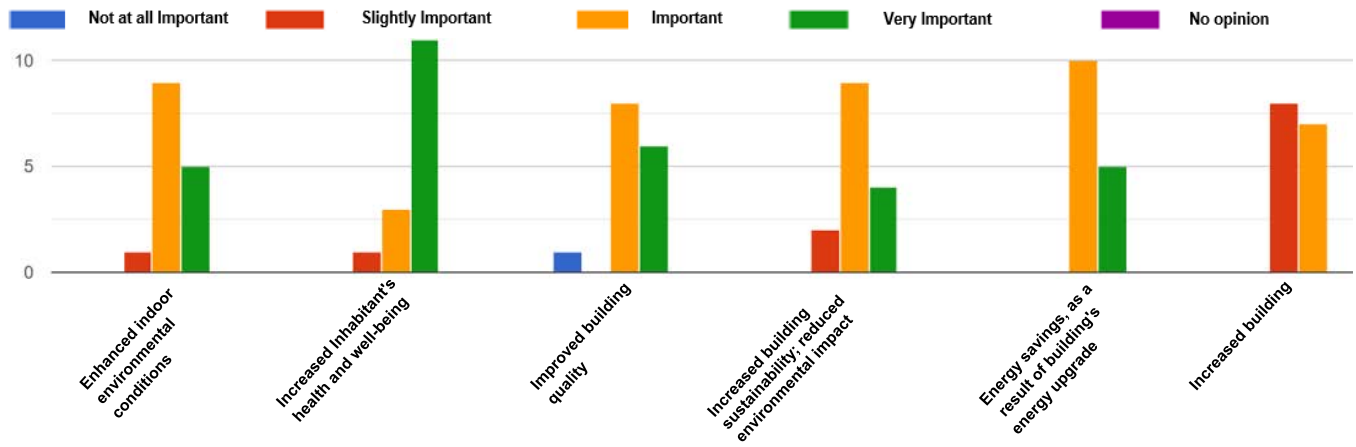


Figure 101: Polish site - Opportunities for requesting from the Owner to undertake a renovation

Question: Please, rate each of the following aspects considered as barriers for you as an Inhabitant in requesting from the building owner a potential renovation in your building/flat:

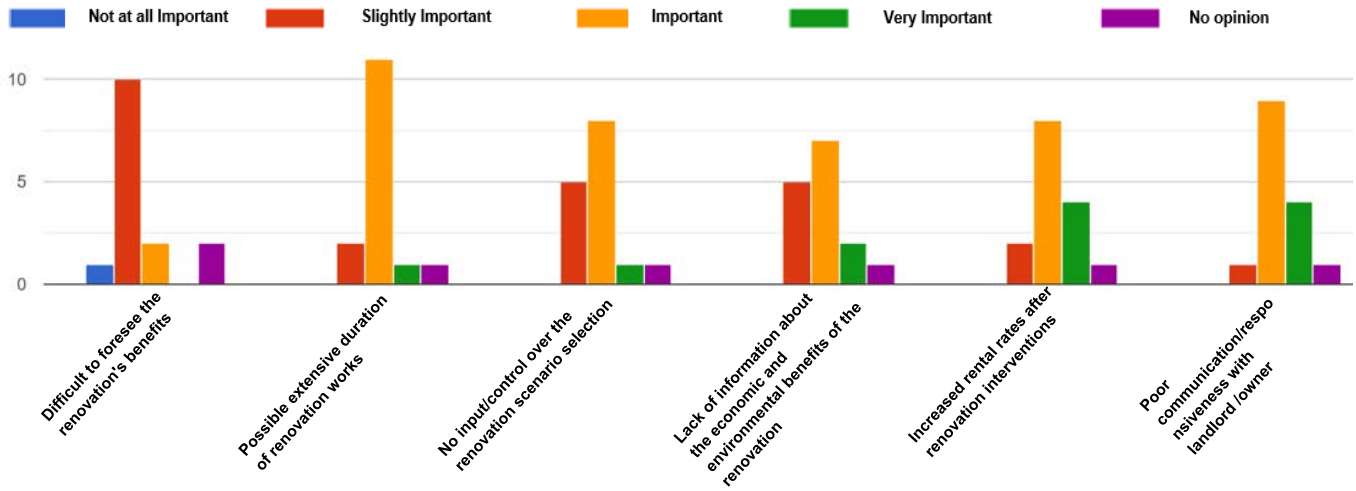


Figure 102: Polish site - Barriers for not requesting from the Owner to undertake a renovation

10.3 Finnish Pilot site

10.3.1 Building owners

Starting from the definition of use cases, the role of the building owners is to act as major stakeholders in the project, by setting context preferences and further defining the operational parameters for building conditions. The building owners are considered as active elements of the proposed framework, who will be directly interacting with the BIM4EEB tools and services. Having this in mind, the building owners questionnaire is designed to cover their role in the project and provide them with a tool to express their preferences, needs and requirements. From the Finnish pilot 16 owners completed the questionnaire.

The introductory section of the questionnaire starts aims at defining the generic profile of the building Owners:

Question: Is your company the owner of the entire building?

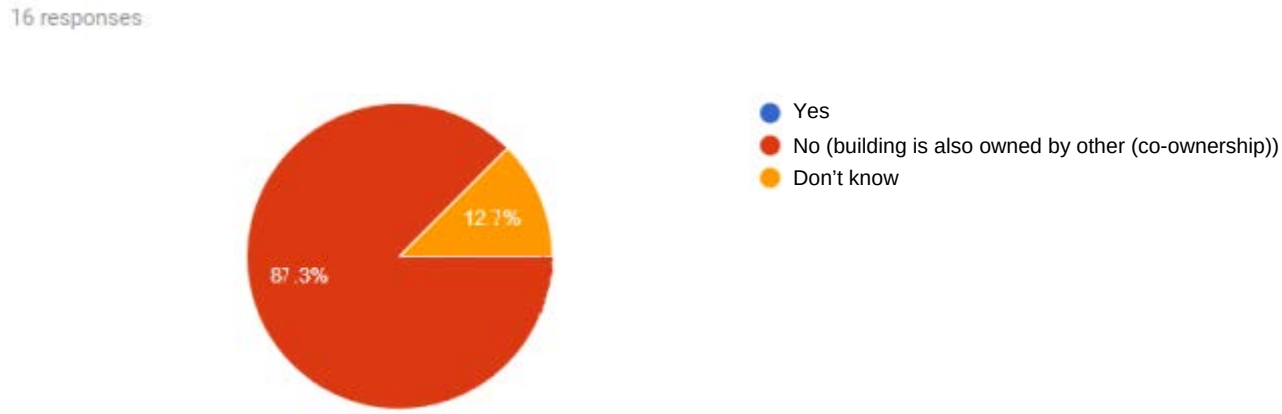


Figure 103: Finnish site - Ownership of the pilot building

Question: How many apartments does your company own in the building?

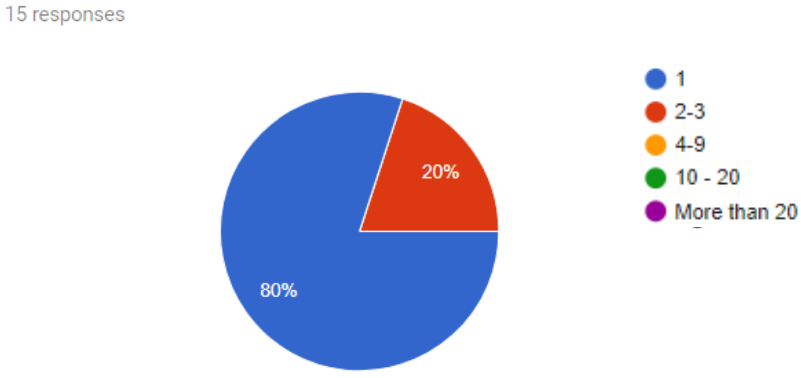


Figure 104: Finnish site - Ownership of the pilot building

Question: What kind of business is your company involved in?

16 responses

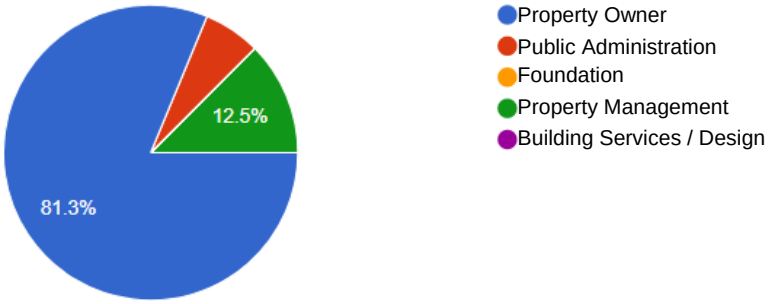


Figure 105: Finnish site – Owners' business sector

Question: How would you describe the status of your building?

16 responses

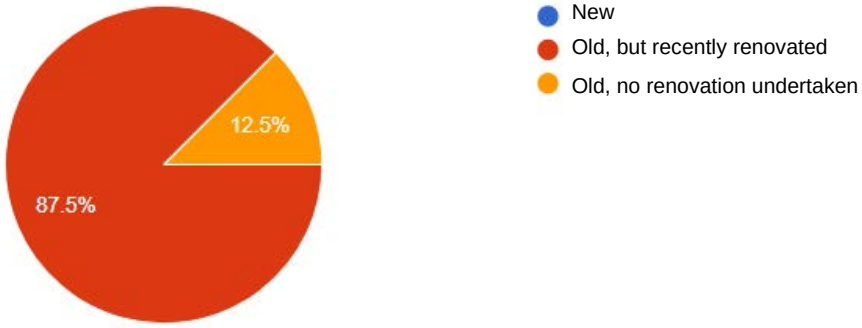


Figure 106: Finnish Site – Owner's perception of its building condition

Question: Have your building's inhabitants requested energy efficiency improvements to properties?

16 responses

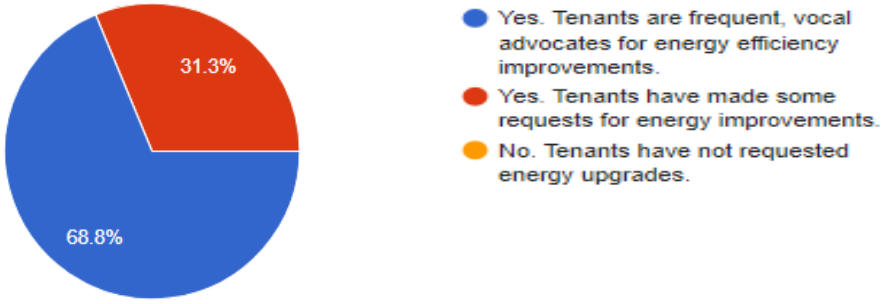


Figure 107: Finnish site - Inhabitants requests to the building owner for energy improvements

Question: Has you company previous experience in undertaking a renovation in their building/assets?

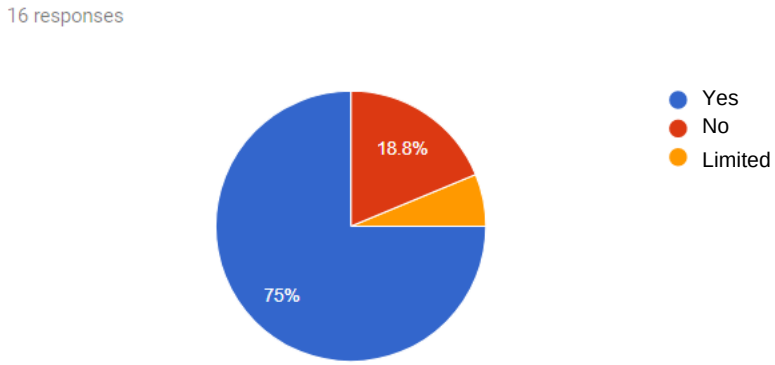


Figure 108: Finnish site - Owner's experience in renovation

Question: What is your company's current process for contacting with the inhabitants of your building?

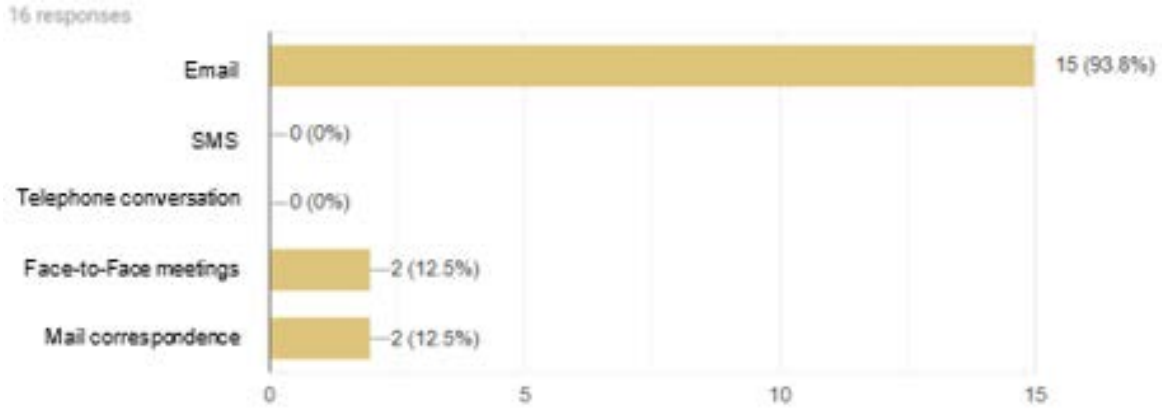


Figure 109: Finnish site - Owner's communication tools with the pilot's inhabitants

Question: Are you familiar with the concept of BIM (Building Information Modelling) and its capabilities in renovation interventions of a building?

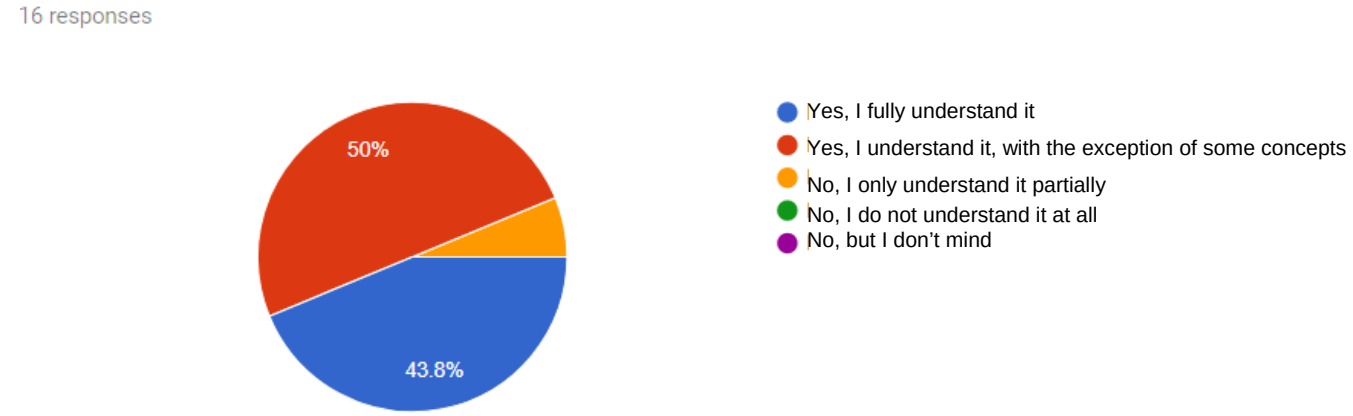


Figure 110: Finnish site - Owner's awareness about Building Information Modelling (BIM) concept

Question: Are you familiar with the concept of BACS (Building Automation and Control systems) and the benefits it can offer in building management and control?

16 responses

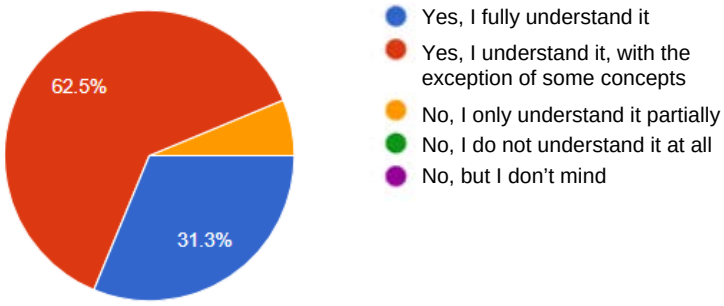


Figure 111: Finnish site - Owner's awareness about Building Automation and Control Systems (BACS).

Question: Is your company responsible, when it comes to deciding to undertake a renovation in your building/assets?

16 responses

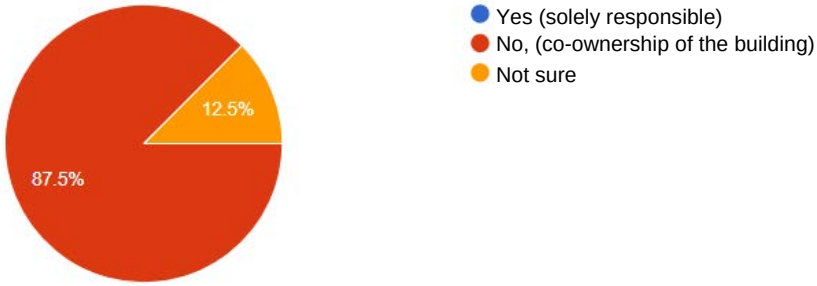


Figure 112: Finnish site - Owner's responsibility for renovation decision making

Question: Is your company aware of all the equipment installations in your building/assets?

16 responses

Figure 113: Finnish site - Owner's knowledge on the existing building's installations

Question: Does your building have a building automation system with direct digital controls? (e.g.: detailed zone condition controls, scheduled lighting controls, monitors system performance)

16 responses

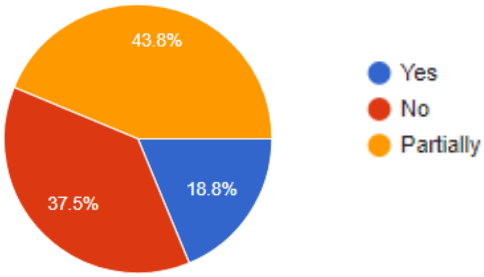


Figure 114: Finnish site - Owner's knowledge on building's automation system

Question: For which of the following does your company hold information/data about the building's

16 responses

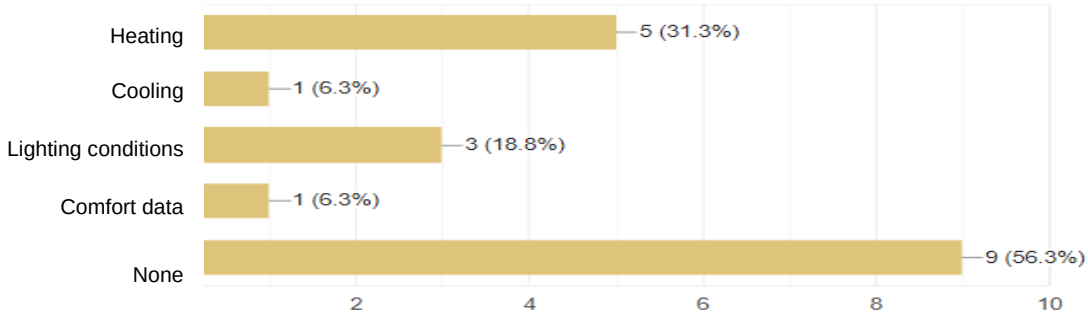


Figure 115: Finnish site - Owner's available information on inhabitant's electrical devices

Question: Please, rate each of the following capabilities that the BIM4EEB tools for Building Owners should integrate

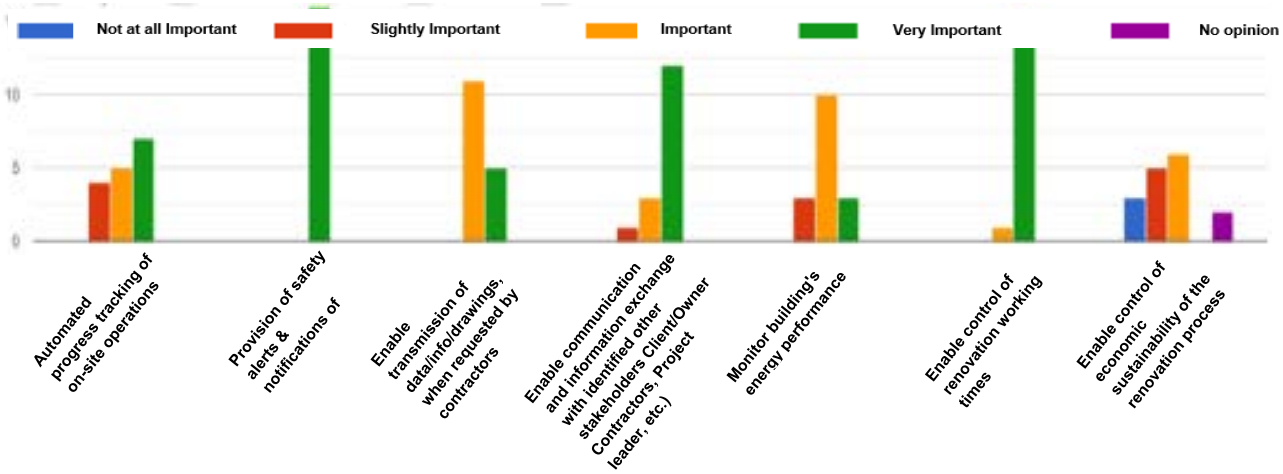


Figure 116: Finnish site - Owner's preference on BIM4EEB integrated tools

Question: As the building Owner; for which of the following activities are you currently in control?

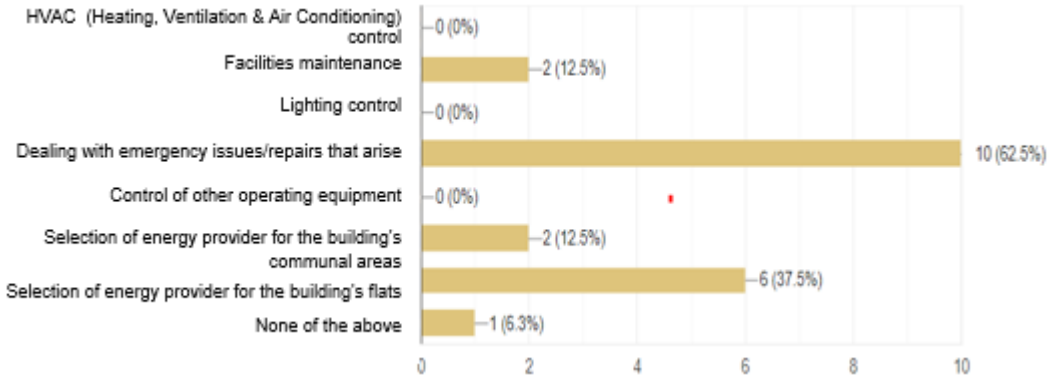


Figure 117: Finnish site - Owner's control of existing equipment

Question: In which of the following activities would you like to get involved; in regard to the renovation activities in your building in the near future?

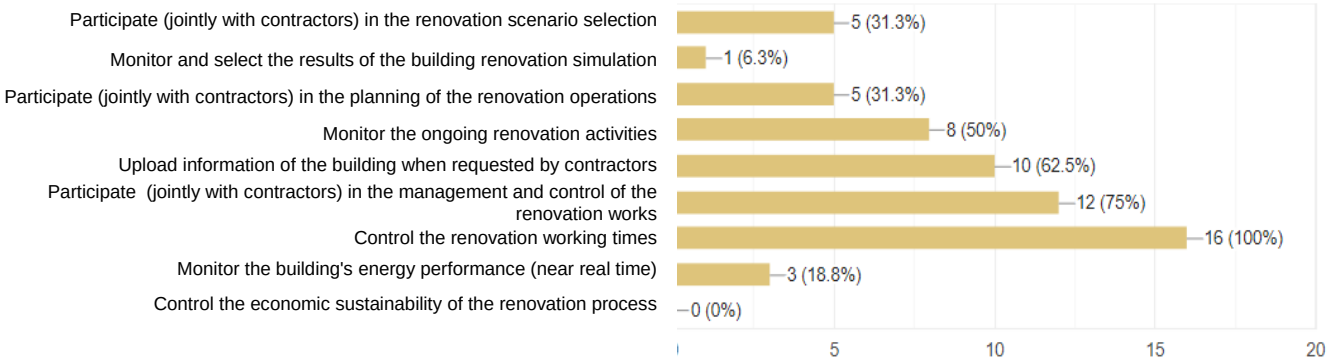


Figure 118: Finnish site - Owner's involvement preference in future renovation activities

Question: Please, rate each of the following aspects considered as opportunities for your company as an Owner in undertaking a potential renovation in your building.

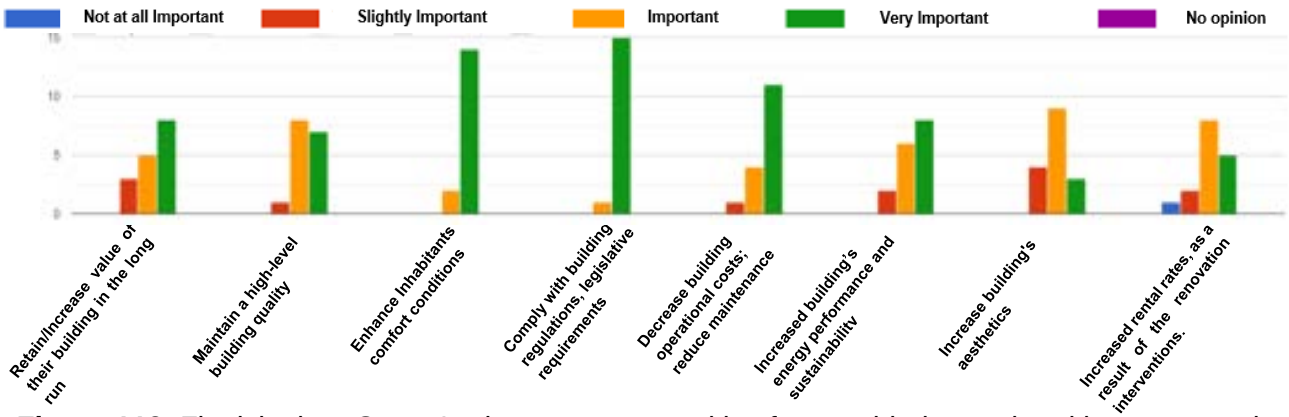


Figure 119: Finnish site - Owner's views on opportunities for considering undertaking a renovation

Question: Please, rate each of the following aspects considered as barriers for your company as an Owner in undertaking a potential renovation in your building.

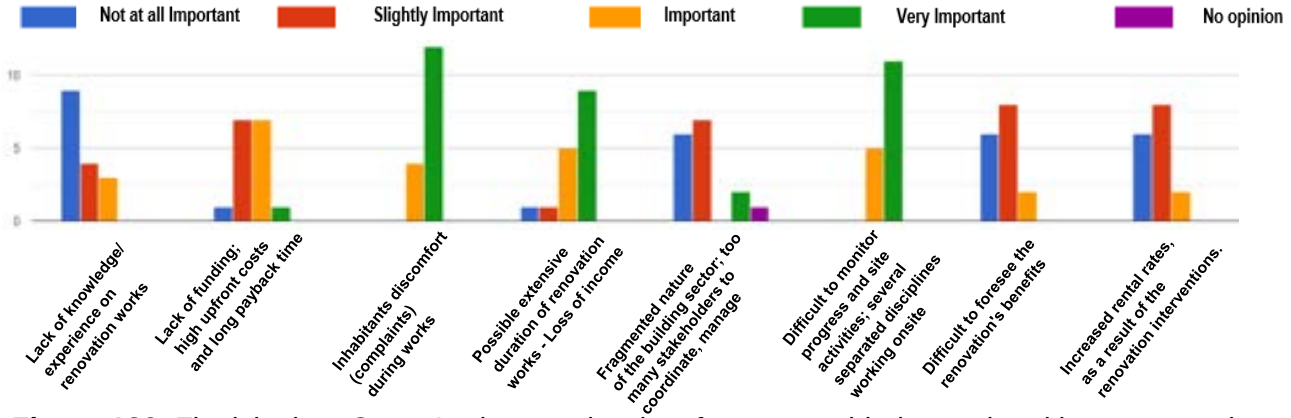


Figure 120: Finnish site - Owner's views on barriers for not considering undertaking a renovation

10.3.2 Building Inhabitants

The building inhabitants are considered as active elements of the proposed framework, who will be directly interacting with the BIM4EEB tools and services. Having this in mind, the inhabitant's questionnaire is designed to cover their role in the project and provide them with a tool to express their preferences, needs and requirements. A total number of 16 inhabitants from the Finnish pilot site completed the questionnaire.

Question: What is your gender?

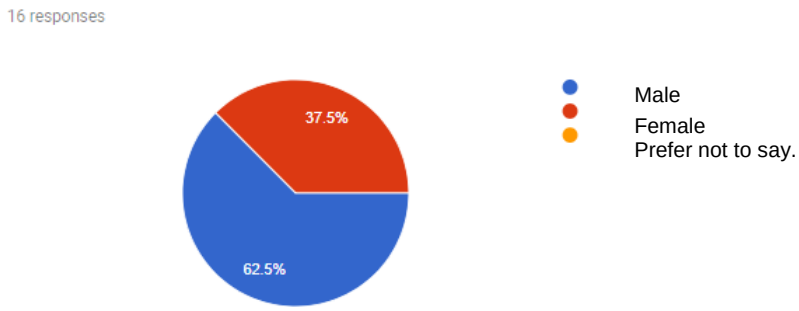


Figure 121: Finnish site - Inhabitants gender

Question: What is your age group?

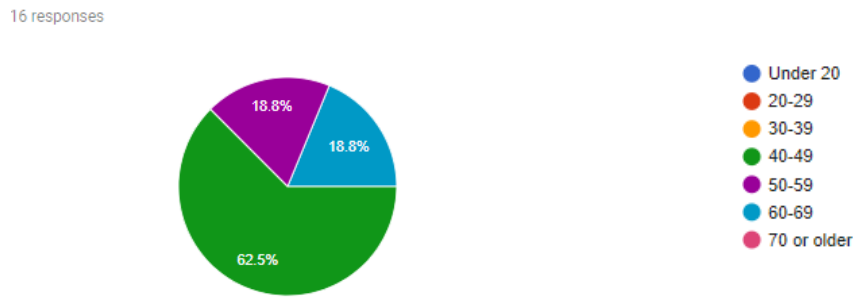


Figure 122: Finnish site - Inhabitants age groups

Question: How many people live in your flat, including yourself?

16 responses

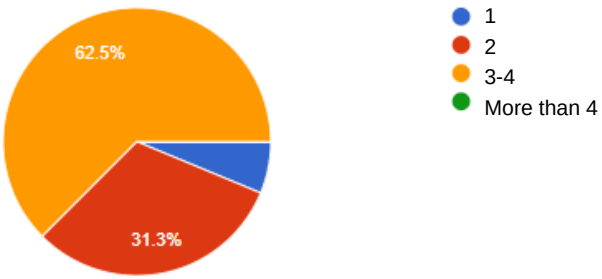


Figure 123: Finnish site - Inhabitants household composition

Question: How long have you lived in your current flat?

16 responses

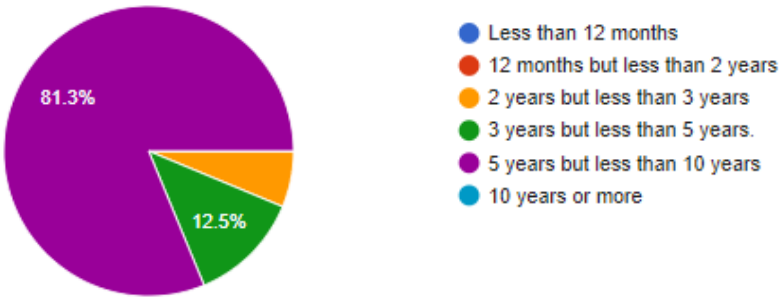


Figure 124: Finnish site - Inhabitants length of stay in their flat

Question: How many hours do you spend in your flat daily?

16 responses

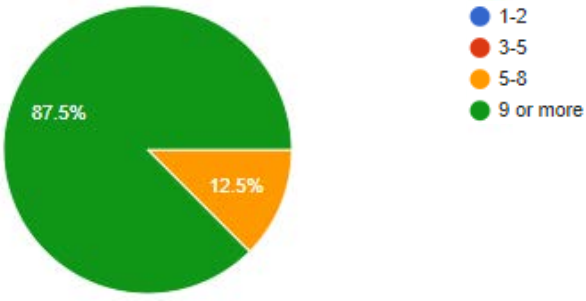


Figure 125: Finnish site - Inhabitants daily length of stay in their premises

Question: How would you describe the status of your property/flat?

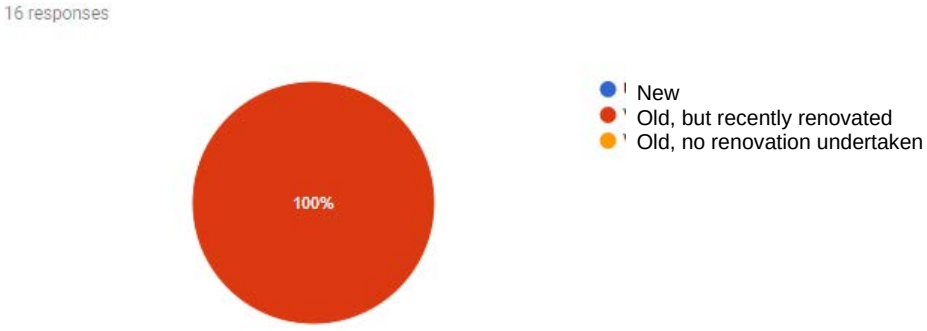


Figure 126: Finnish site - Inhabitants perception of their property/flat condition

Question: Have you ever requested from your property owner, energy efficiency improvements to your building and/or flat?

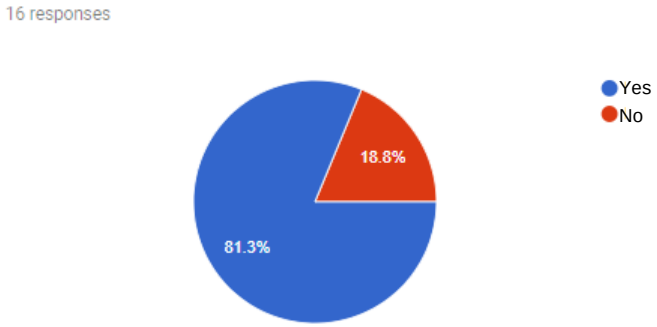


Figure 127: Finnish site - Inhabitants requests to owner for energy improvement of their building or flat

Question: Digital Skills: Please check all the answer/answers that apply to you.

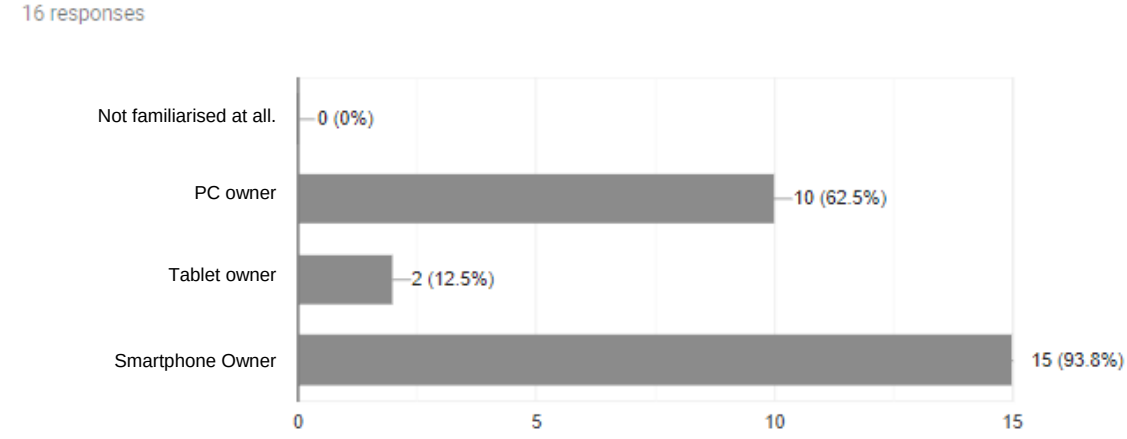


Figure 128: Finnish site - Inhabitants digital skills

Question: Are you familiar with the concept of BIM (Building Information Modelling) and its capabilities in renovation interventions of a building?

16 responses

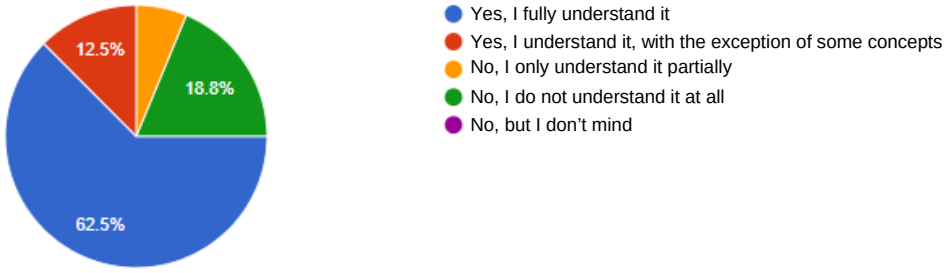


Figure 129: Finnish site - Awareness about Building Information Modelling (BIM); Right graph: Building Automation and Control Systems (BACS)

Question: Are you familiar with the concept of BACS (Building Automation and Control systems) and the benefits it can offer in building management and control?

16 responses

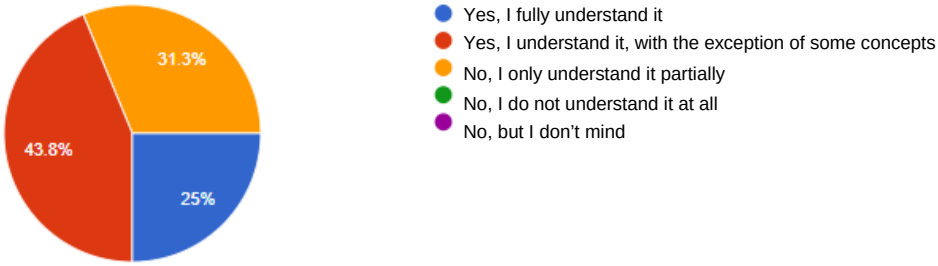


Figure 130: Finnish site - Awareness about Building Automation and Control Systems (BACS)

Question: What is your knowledge on how heating, fresh air, cooling, and lighting is provided in terms of mechanical, electrical or natural/passive systems in your building/premises.

16 responses

Figure 131: Finnish site - Awareness on how heating, fresh air, cooling, and lighting is provided

Question: Overall, how satisfied are you on how the building meets your needs ? (with 1 "Not at all Satisfied" to 5 being "Very Satisfied"):

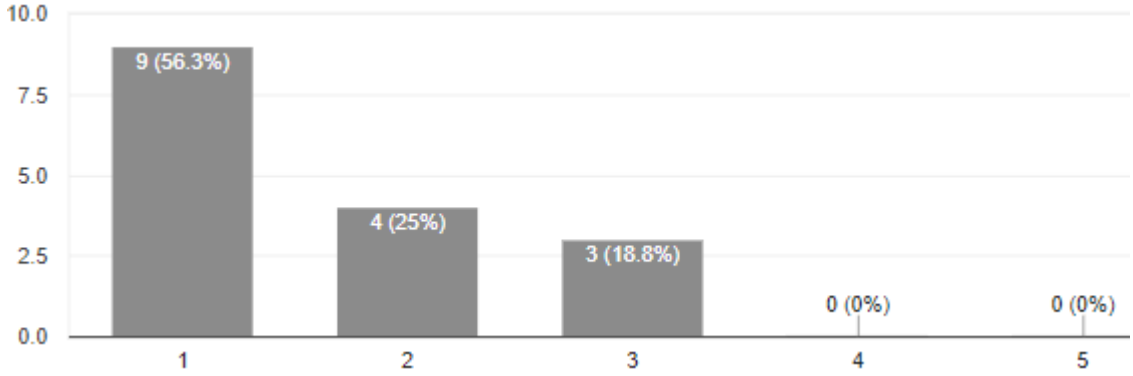


Figure 132: Finnish site - Inhabitants satisfaction of their building

Question: Which of the following parameters do you consider as the most critical, in regard to your comfort zone in your premises ?

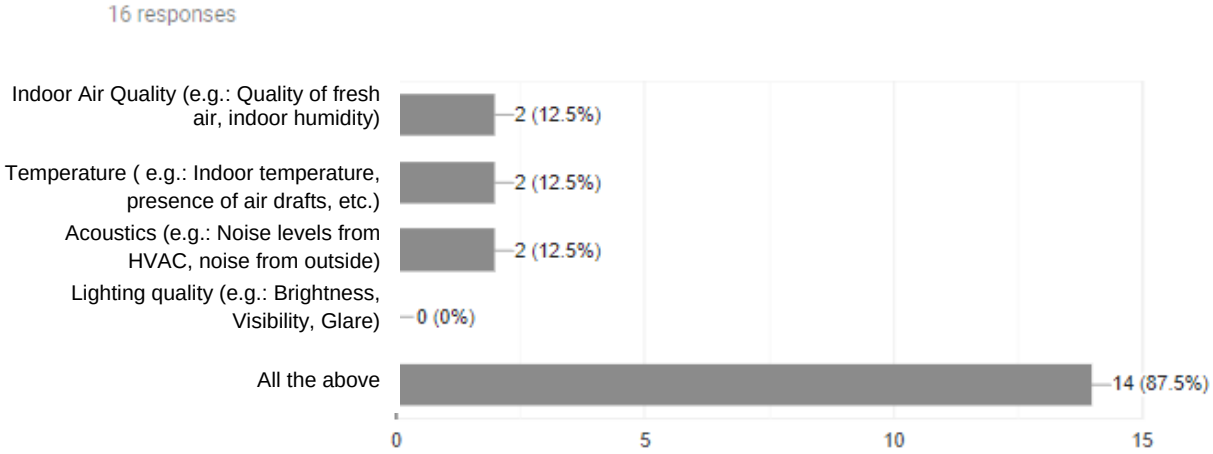


Figure 133: Finnish site - Inhabitants views on the most critical comfort parameters

Question: How much control do you have over the following aspects within your premises/flat?

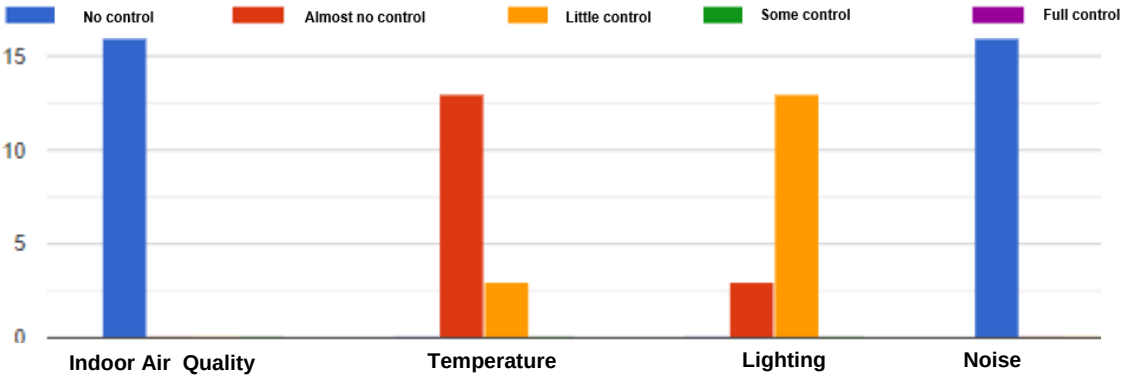


Figure 134: Finnish site - Inhabitant's available control in their premises/flat

Question: Please, rate each of the following capabilities that the BIM4EEB tools for Building Inhabitants should integrate.

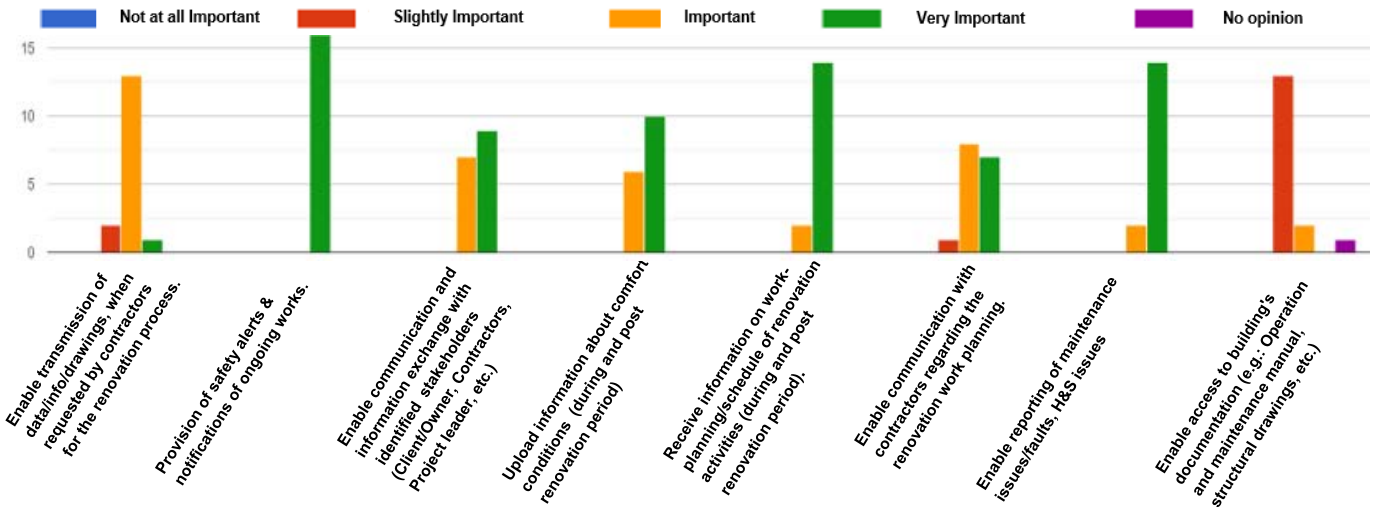


Figure 135: Finnish site - Inhabitant's rating on BIM4EEB integrated tools

Question: Would you be interested in providing feedback on your comfort zones within your premises/flat, during the renovation period?

16 responses

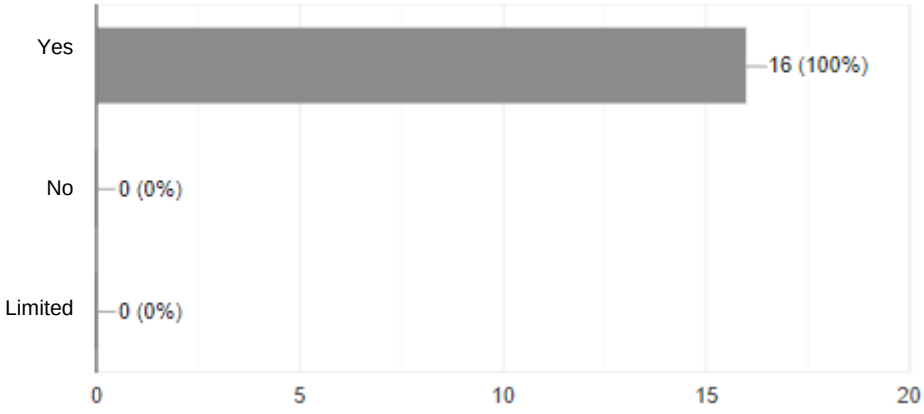


Figure 136: Finnish site - Inhabitants willingness to provide feedback on their comfort zones during the renovation

Question: How often would you like to provide your feedback during the renovation*?*

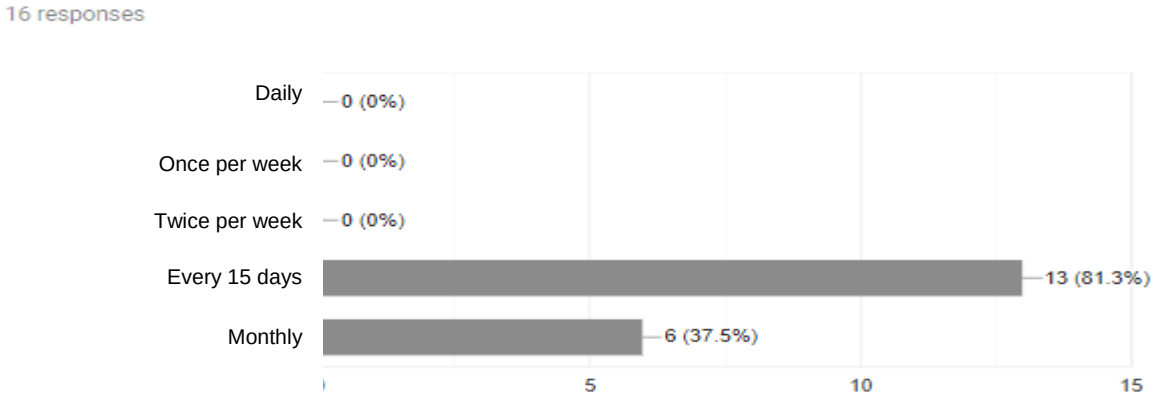


Figure 137: Finnish site - Inhabitants preferred to provide feedback on their comfort zones during the renovation

Question: Would you be interested in providing feedback on your comfort zones within your premises/flat, after the renovation (post renovation period)?

Figure 138: Finnish site - Inhabitant's willingness towards providing their comfort zones after the renovation period

Question: If you answered Yes in the above question; how often would you like to provide your feedback?

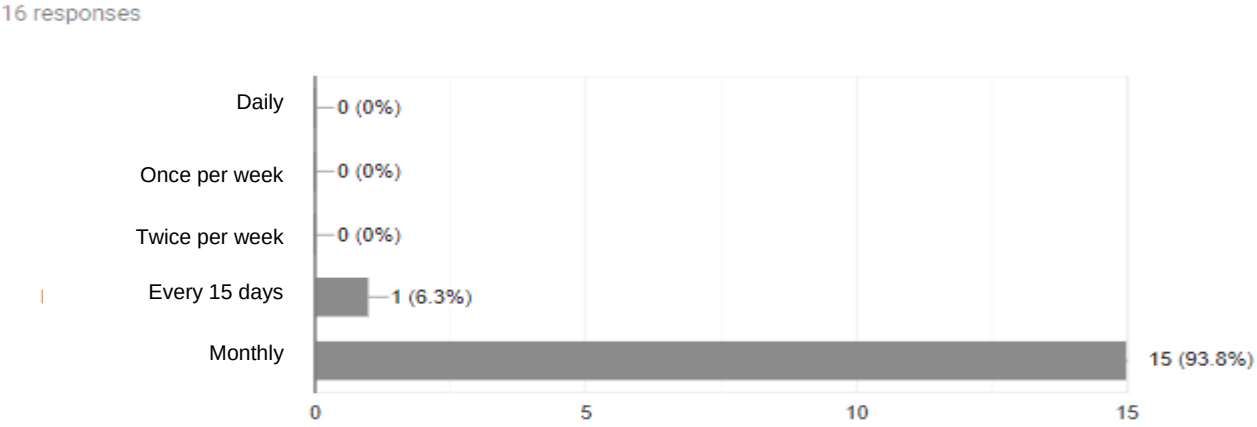


Figure 139: Finnish site - Inhabitants preferred tool for providing their comfort zones.

Question: Through which of the following means, would you prefer to provide your feedback regarding your comfort zones?

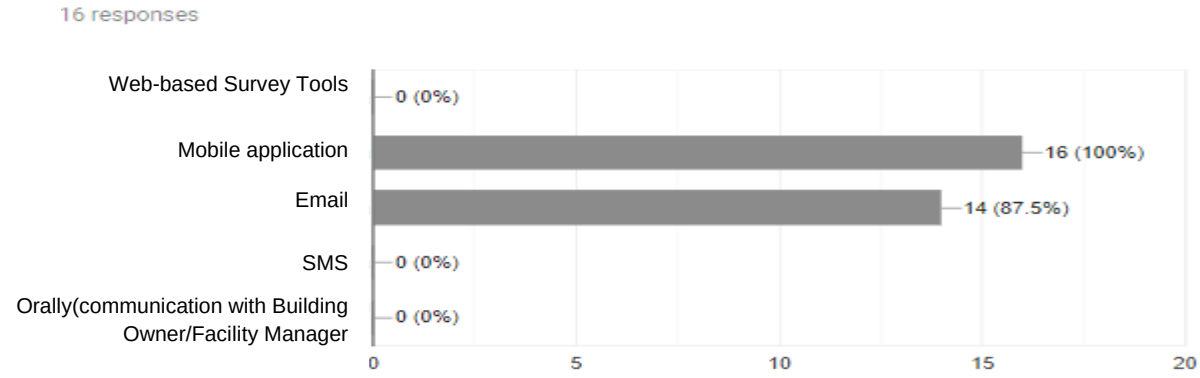


Figure 140: Finnish site - Inhabitants' preferred tool for receiving notifications/alerts regarding the renovation progress

Question: Do you want to receive notifications/alerts regarding the renovation progress / schedule in your building?

Figure 141: Finnish site - Inhabitants willingness to receive notifications/alerts regarding the renovation progress

Question: If you answered "Yes" on the above question, through which of the following means would you like to receive notifications/alerts etc.?

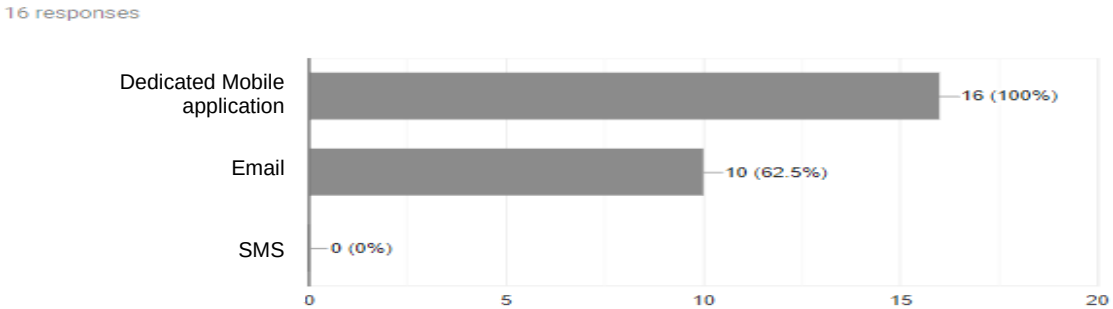


Figure 142: Finnish site - Inhabitants' preferred tool for receiving notifications/alerts regarding the renovation progress

Question: How often would you like to receive notifications/alerts?

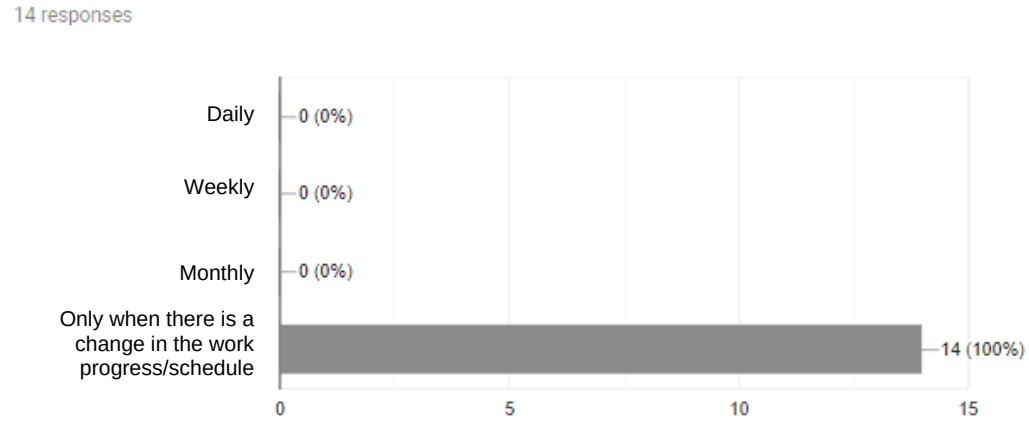


Figure 143: Finnish site - Inhabitants preferred intervals for receiving notifications/alerts

Question: Would you be interested to receive security and safety recommendations /alerts about the construction programming and ongoing activities in your building?

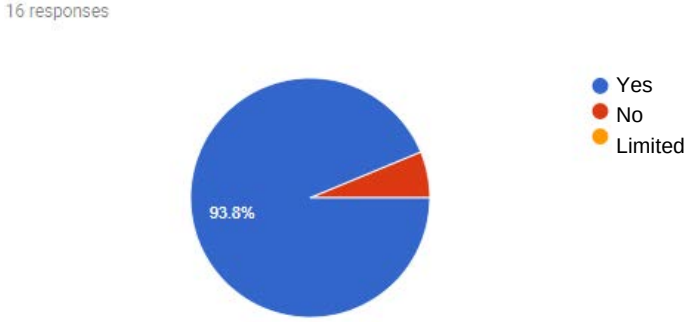


Figure 144: Finnish site - Inhabitants willingness to receive security and safety recommendations /alerts about the construction programming and ongoing activities

Question: If you answered "Yes" on the above question, through which of the following means would you like to receive notifications/alerts etc.?

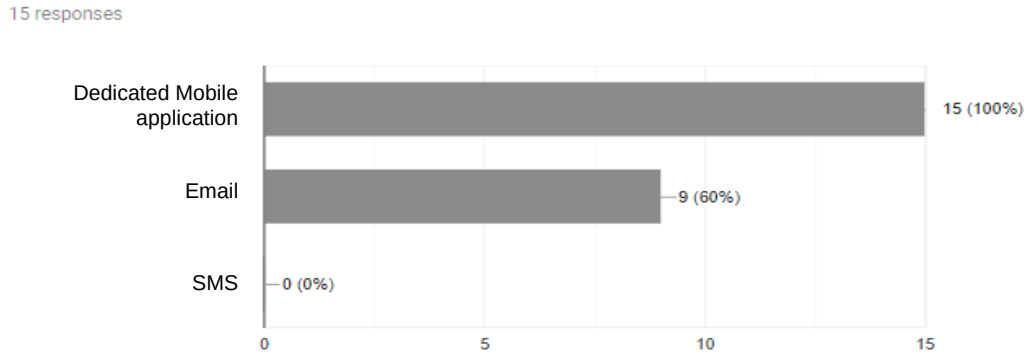


Figure 145: Finnish site - Inhabitants preferred tool for receiving notifications/alerts.

Question: How often would you like to receive notifications/alerts?

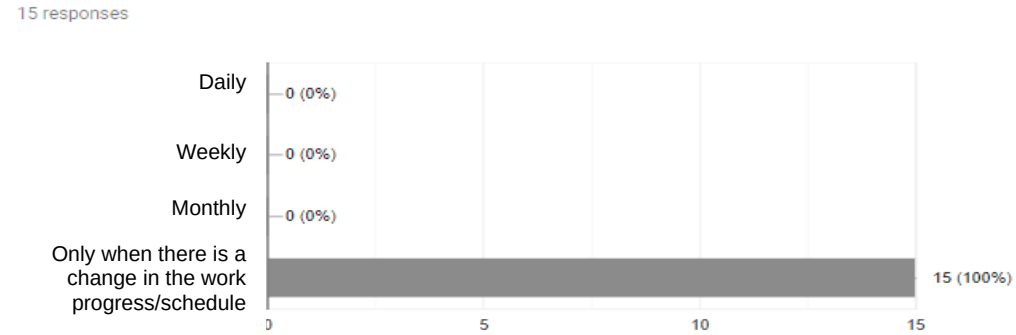


Figure 146: Finnish site - Inhabitants preferred intervals for receiving notifications/alerts

Question: Please, rate each of the following aspects considered as opportunities for you as an Inhabitant in requesting from the building Owner a potential renovation in your building/flat.

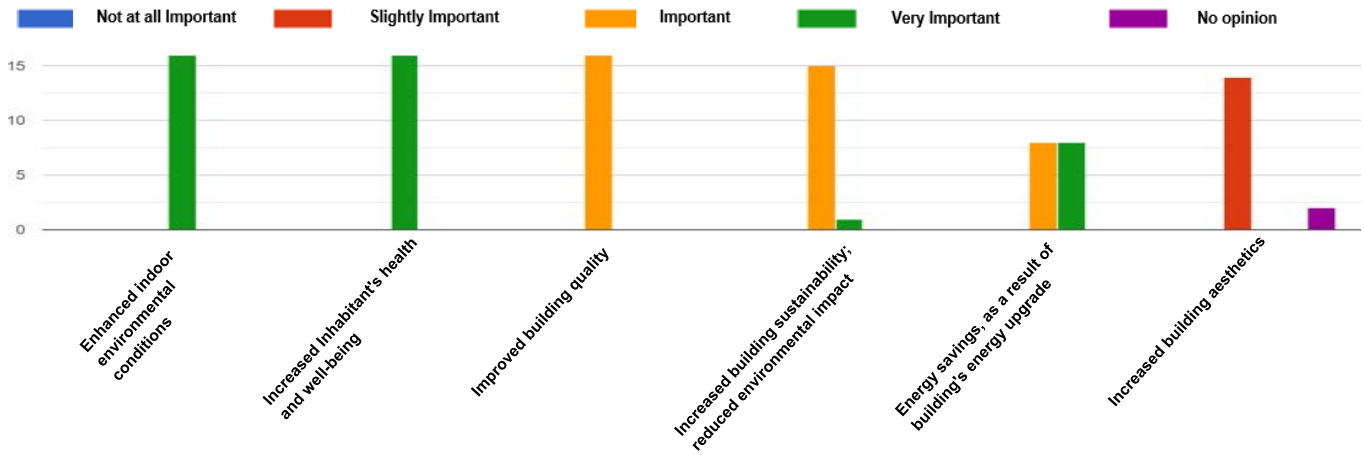


Figure 147: Finnish site - Opportunities for requesting from the Owner to undertake a renovation

Question: Please, rate each of the following aspects considered as barriers for you as an Inhabitant in requesting from the building owner a potential renovation in your building/flat:

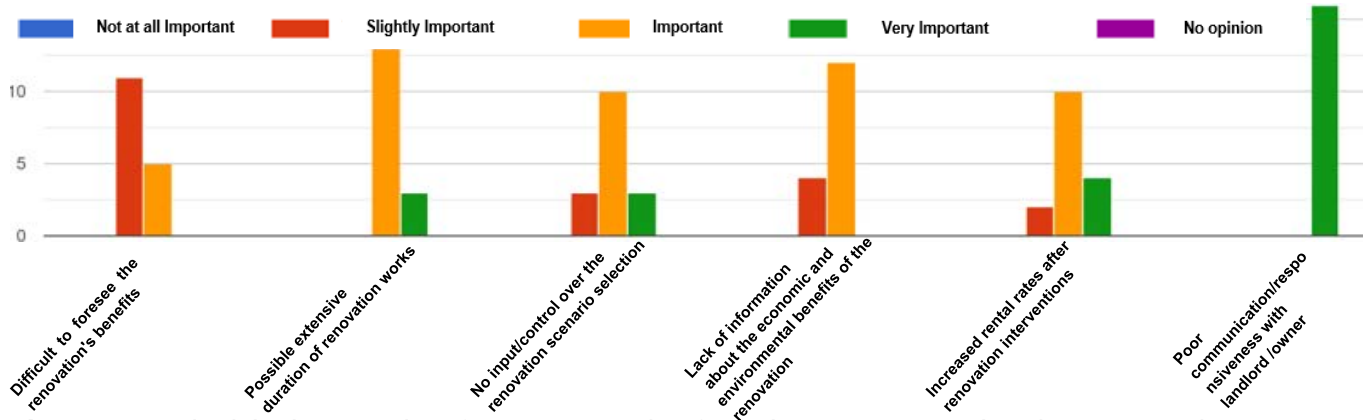


Figure 148: Finnish site - Barriers for not requesting from the Owner to undertake a renovation

11 Annex III – Questionnaire Results

The results used in the questionnaire analysis (Chapter 6) are presented in the following links (aggregated fully anonymized data, per pilot site and per end-user type)

Italian Pilot Site

Owners Questionnaire:
https://drive.google.com/file/d/1QhxDaiqcf0pS2tO6QtRmp7mA1yE67D3p/view?usp=sharing

Inhabitants Questionnaire:
https://drive.google.com/file/d/1tWJ1NmLwIqQQtvqz8W_LB1S6xZG08Rri/view?usp=sharing

Polish Pilot site

Owners Questionnaire:
https://drive.google.com/file/d/1kMC3iNAJSFRFSZNqtJxvQZMXJM9WsJ9a/view?usp=sharing

Inhabitants Questionnaire:
https://drive.google.com/file/d/1jKa1ZxkCE27Rgezb1u_FWd-gwJnPOUvf/view?usp=sharing

Finnish Pilot site

Owners Questionnaire:
https://drive.google.com/open?id=1lTf9WlJxMSwhFFt0K4bFr12Lzo7p5Tqw

Inhabitants Questionnaire:
https://drive.google.com/file/d/1QxY289xAgT-Z0jDR80Uou9Blq8lyWyMt/view?usp=sharing