BIM4EEB

BIM based fast toolkit for
Efficient rEnovation in Buildings

D2.4 List of service companies' needs and requirements for BIM-based renovation processes

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EXECUTIVE SUMMARY

The report describes renovation processes, listing needs and requirements for service companies to be considered for the definition of ontologies and the development of the BIM management system.
The activities focus on the definition of information to be stored within a digital logbook. Considered information has been grouped as:

- General and administrative information, mainly referring to building ID, Registry, Urban and services data, Geotechnical and Geological data, Tender agreement, Dimensional data, Accessibility, Maintenance plan and Economic data
- Building construction information, describing performance of Technical Building Systems, Envelope and Structure
- Building Energy Performance, focusing on EPC general information, Energy use, Primary energy, Delivered energy, Emissions, Thermal Comfort, Visual Comfort, Acoustic Comfort and Energy needs
- Building Operation and Use, referring to Energy consumption and production, Energy generation, Maintenance, Indoor conditions and Climate data
- IoT information, considering smart indicator, e-mobility and Smart district

For each group of information, the activities point out the source of information, who are the stakeholders providing the information, who are the stakeholders requiring the information and which is the use of information in O&M. Hence, this structure of information will be the basis for the development of ontologies (WP3) and for the definition of specification and overall design with the definition of users' profile for accessing the BIM Management System (WP4).
The BIM Management System developed in WP4 will be the main repository for the Digital Logbook data for renovation processes during the pilot phase of demonstration in relevant environment (WP8).

PUBLISHING SUMMARY

The report describes main information to be considered by service companies in case of a residential renovation. Within BIM4EEB project, information collected around buildings should be used for providing services as: energy analysis and audits, energy management, project design and implementation, maintenance and operation, monitoring and evaluation of savings, property/facility management, energy and/or equipment supply, provision of service (space heating, lighting, etc.).
By outlining main barriers to be overcome and main benefits for stakeholders, the report presents needs and requirements to be considered in a digital environment, represented by the digital logbook that will be stored and accessed through the BIM Management system.
As outlined in D2.1, the analysis of the requirements allows to ensure the best adaptation of the methodological and technological features of BIM4EEB toolkit to the specific needs.

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1 Introduction

The document presents the results of activities carried out for defining service companies' needs and requirements for BIM-based renovation processes. The main results are a list of needs and requirements to be collected for the development of a digital logbook and to be implemented in the BIM Management System.
Particularly, in the presented activities, service companies are mainly represented by facility managers and energy service companies. Moreover, attention has been paid for considering benefits to be derived by Public authorities using information from the BIM Management System in renovation processes.
As a lack of information or an incomplete knowledge about building information generally represents barriers during renovation processes, the goal of T2.4 is to define the structure of a digital logbook to be used by:

- Facility managers in defining activities to be proposed for renovation;
- Energy service companies in defining impacts of different solutions on energy demand
- Users and owners for having a complete idea about the condition of the buildings they are occupying/own.

1.1. Research questions

In order to define the list of needs and requirements, the activities of T2.4 have been developed considering the following research questions:

- Which are the services to be considered?
- Who will be the main users of digital logbooks?
- Which are the main interests of service companies in renovation processes?
- Which are the main sources of information?
- Which kind of information need to be stored in a digital logbook?

For providing an answer to the abovementioned questions, the research focuses on the collection of information to be used by service companies in an ordered structure.
Main services considered during T2.4 are connected to the energy use of a building (e.g. energy analysis and audits, energy management, energy and/or equipment supply, monitoring and evaluation of savings), to the maintenance of properties and condition of buildings (maintenance and operation, property/facility management, provision of service) and to the possibility of establishing a feedback loop from operation and maintenance to project design and implementation.
In order to overcome barriers mainly related to the lack of information or incomplete knowledge about building information, the research proposes to collect information in a digital environment. Particularly, this information is stored or collected in Documents related to building permits, properties, localization and legislation; Agreements between stakeholders; Agreements related to building use and operation; Reports and certificates or Data directly collected around the building.

1.2. Methodology

For defining and collecting a complete list of requirements, a structure has been created for storing information. Considering that the outcome of T2.4 activities is the creation of a list identifying information and stakeholders using this information, the structure is composed of:

- Group and subgroup of information
- Information
- Source of information
- Stakeholders providing the information
- Stakeholders requiring the information
- Use of information in O&M

A draft of information has been created staring from the literature review.

Indeed, different concepts have been developed concerning digital logbooks and building passports. However, main differences with respect to the concept that will be adopted within BIM4EEB are related to the users of the digital logbook and to the way for accessing it. Within BIM4EEB, several stakeholders will be able to access information collected during the building lifecycle through the BIM Managements system. Hence, the logbook could be accessed not only by owners and clients, but also by facility managers, public authorities, occupants, designers and installers. Indeed, building passports are useful to support building owners with personalised advice to renovation options, e.g. resulting from on-site energy audits and in order to fulfill specific quality criteria and indicators established in dialogue with the owner. However, the same information fruited by owners could be also fruited by other stakeholders, e.g. for improving building performances or for suggesting maintenance needs during building lifecycle. Moreover, the logbook will not be an electronic file to be shared, but it will be stored within a platform.
Furthermore, information has been ordinarily collected on a spreadhseet, shared among the Consortium for collecting feedbacks. Hence, the definition of information relies on the direct experience of different professionals (as researchers, constructors, software developers).

1.3. The concept of a digital logbook

The definition of needs and requirements is the starting point for the development of a digital logbook, being considered as a repository of building information to be stored and continuosly updated for characterising a building and its previous interventions.

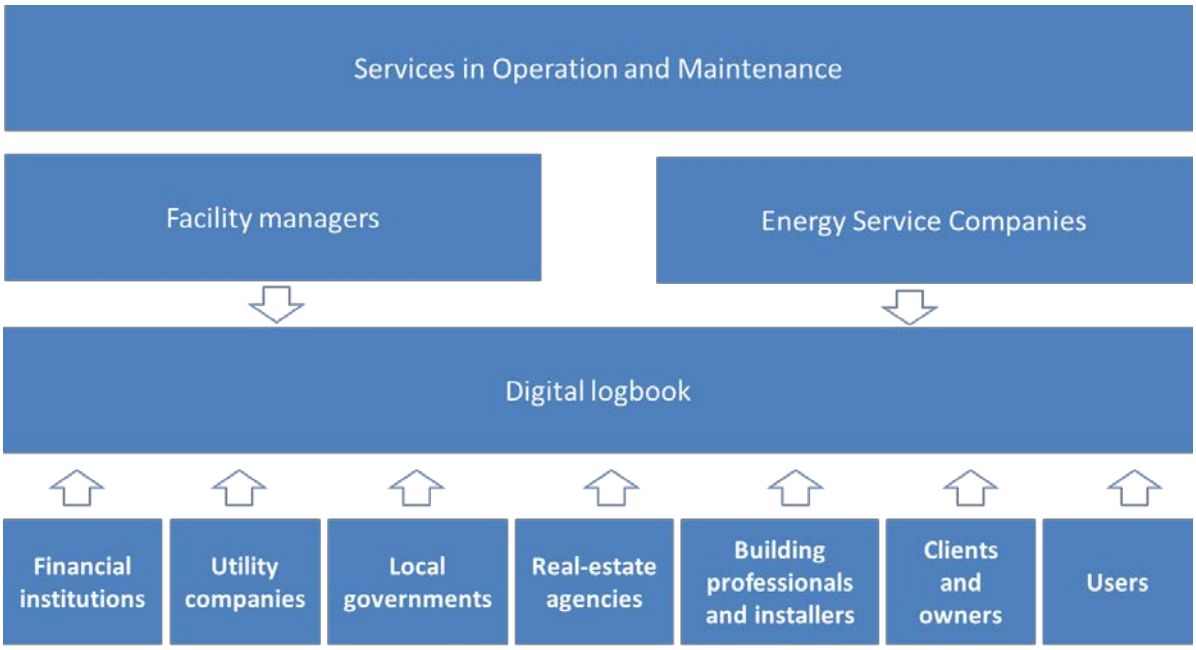

Figure 1. Main stakeholders considered in the definition of information to be stored within a digital logbook

Several kinds of information are stored in the the digital logbook. This information needs to be collected and updated during building lifecycle considering different sources, as drawings, on-site visits, automated data from smart meters or monitoring devices and warrantee manuals.
Stored information should satisfy requirements as the possibility to evolve overtime, to be constantly updated and to be fed with new inputs. It could concern:

- available financing options for renovation projects (e.g. green loans, incentives, tax credits)
- energy bills
- energy production

- energy consumption (primary, final, net energy consumption, energy needs for heating and cooling, energy consumption of lighting systems, building heat transfer coefficient)
- energy cost
- smart meter data
- monitoring system data
- equipment maintenance requirements
- insurance
- property plans and obligations
- indoor climate (air temperature, air relative humidity)
- airtightness and ventilation (type of ventilation system, air exchange rates, efficiency of heat recovery)
- indoor air quality (CO2 concentration, VOC content)
- thermal comfort (PPD and PMV)
- executed maintenance
- building plans
- building type
- age
- climate

Therefore, as different kinds of information and several sources of it need to be considered for the definition of a digital logbook, D2.4 presents the adopted concept of digital logbook, considered as a repository of dynamic and non-dynamic information to be accessed through an interactive and dynamic tool by different users (as facility managers, ESCo, building occupants, public authorities and market actors).

2 State of the Art

Existing approaches for collecting and storing information during building renovation processes are represented by logbooks and building passports. Within that context, different solutions have been developed for overcoming barriers as financial constraints, the need to reduce the time of renovation, discomfort during the works and the lack of knowledge regarding the best solutions available.

According to BPIE [1], *a Building Renovation Passport is defined as a document - in electronic or paper format - outlining a long-term (up to 15 or 20 years) step-by-step renovation roadmap for a specific building, resulting from an on-site energy audit fulfilling specific quality criteria and indicators established during the design phase and in dialogue with building owners. The expected benefits in terms of reduced heating bills, comfort improvement and CO2 reduction are a constitutive part of the BRP and are explained in a user-friendly communication. The renovation roadmap can be combined with a repository of building-related information (logbook) on aspects such the energy consumption and production, executed maintenance and building plans.*

The concept of a digital logbook has been coupled with a renovation roadmap within iBRoad project [2; 3], aiming to guide building owners through their building renovation process by providing a customised step-by-step renovation plan. The building logbook has been conceived as a repository for all building related information, while the individual building renovation roadmap provides a customised long term horizon renovation plan for the specific building and use. In particular, benefits could be derived by building owners and are mainly represented by the possibility to access the building logbook data, an in-depth building diagnosis, alerts and reminders, benchmark with other buildings, access to the detailed version of their renovation roadmap and relevant financing options available for the specific renovation.

2.1. Main barriers to be overcome

While defining renovation processes to be adopted for improving building performances, owners and potential investors need to overcome barriers, mainly related to difficulties in accessing information concerning existing buildings or represented by difficulties in accessing finance. Furthermore, stakeholders encounter difficulties because of the lack of knowledge about what to do and in which order for improving building conditions and about the advantages of alternatives for renovation. Difficulties are also related to legal aspects, especially considering local laws and regulations to be specifically applied in renovation processes.
Moreover, while referring to operation and maintenance, an additional barrier is represented by the fact that information collected during design stages is generally not used nor updated after the construction stage.
Also when information is available, it is often difficult to be accessed because it is available in a paper-based way.
Those difficulties represent barriers for planning, financing and implementing renovation activities.
Indeed, structural barriers affect the renovation market because of the fragmentation of the construction industry and its general modus operandi. Generally, the construction industry is characterized by a lack of communication and mutual understanding among the involved professional disciplines in a project. Energy efficient refurbishments and renovations involve a plethora of different stakeholders intervening with diverse organizational boundaries making information sharing extremely complex. This combined with the current standards in the industry being subcontracting with new teams of designers, builders, and suppliers for every new project means coordination and learning are inhibited and it is harder to develop integrated teams of professionals working in symbiosis. As energy efficient renovations often require the use of new technologies and advanced materials, every building must be studied in detail in order to assess the right set of solutions to be applied given its unique characteristics. It is harder to achieve this when stakeholders

intervene individually with little information sharing and following their own interests and priorities often leading to the duplication of efforts, all of which can be limited through open logbooks.

2.2. Main benefits for stakeholders

Main stakeholders who can contribute or benefit when accessing a digital logbook are represented by users, clients and owners, authorized third persons. Among the authorized third persons, BIM4EEB considers energy experts, utility companies, facility managers, financial institutions and public authorities. Particularly, according to privacy purposes, private data can be used by public bodies, e.g. for statistical purposes or for comparison. In that case, before the use, data have to be anonymised to be made available in a public DB.

The main stakeholders representing the target audience for the use of a digital logbook are:

- Clients, who brief the design team to ensure that a good quality logbook is produced and derive benefits because of a detailed knowledge about the building they are acquiring, using or selling;
- the Lead Consultant/Designer, who is to be responsible for developing the building logbook, ensuring that the client's requirements are laid down throughout the process and that the actual design intent is passed to the facilities manager;
- facility managers, who are likely to be carrying out final production of the logbook, having a better understanding of the building and contributing in developing a historical record of the building. Moreover, they have ready access to information on the design, commissioning and energy consumption of their building and enable fine tuning of the building with consequent improvements in energy efficiency;
- Occupants and Users, who understand better how to use their space and improve levels of comfort and energy efficiency;
- Financial entities and real estate professionals, who necessitate detailed information on the current building structure, status quo of asset, materials and systems, consumption, as well as syndicated data such as district information as well as climate in order to perform their own due diligence and produce an audit on the investment risks of renovating a particular asset, expected savings, payback periods and return on investments, feasibility of envisioned interventions, etc. This can be resource and time consuming for many third parties or banks especially for smaller scale projects. When information in logbook is updated after the construction or renovation stage, the actors will also have the possibility to compare actual operational energy savings resulting from a refurbishment with the predicted savings on which financing contracts where drafted. This can give an indication on the loan repayment risks.

2.3. Operation & Maintenance in digital environments

In order to define which information should be collected within a digital logbook, T2.4 analyses existing logbooks, mainly referring to CIBSE, BPIE, and Cornwall Council.

CIBSE building logbook [4] collects information grouped into:

- Building history
- Purpose and responsibilities
- Links to other key documents
- Main contacts
- Commissioning, handover and compliance
- Overall building design
- Summary of areas and occupancy
- Summary of main building services plant
- Overview of controls/BMS
- Occupant information

- Metering, monitoring and targeting strategy
- Building performance records
- Maintenance review
- Results of in-use investigations
- Relevant compliance and tests certificates

Within the context of Construction Services, according to the Cornwall Council [5], *the Building Log Book is to provide a simple summary document, describing how the new or refurbished building is intended to work and be serviced. It also provides a means to log the energy performance and maintenance of the services within the building and an historical record of building alterations, maintenance and energy performance.*
By making this information available to facility managers, energy consumption can be monitored and controlled in accordance with the design intent, improving the understanding, management and operation of buildings and resulting in more sustainable buildings with lower running costs.

For developing a digital logbook, iBRoad project considers:

- what data should be sought and why should it be collected;
- which stakeholders could provide or benefit from accessing that information;
- where is the information stored, who owns the data and how could it be accessed;
- data availability and protection.

Furthermore, users to be addressed have to be considered. In particular, digital logbooks need to be developed addressing not only building occupants, but also stakeholders who can derive benefits during operation and maintenance. Hence, as those stakeholders are actively involved, they can provide input and constantly update data about buildings. The research mainly addresses facility managers and energy service companies so that building features (e.g. about maintenance) and performances (e.g. energy performance) are updated.

3 Needs and requirements for BIM-based renovation processes

Within BIM4EEB project, main interests of service companies in renovation processes to be considered are represented by:

- Renovation policy impact
- Impact on energy demand
- Investment requirement
- Impact on comfort
- Impact on real-estate value
- Environmental protection policy
- CO_2 savings
- Recommended timeline
- Health and safety
- Fire safety issues
- Connection with building automation system
- Visualisation such as work orders, how and where maintenance actions will be done, installation instruction etc.

3.1. Energy Service Companies (ESCo)

ESCOs are companies providing energy services to final energy users, including the supply and installations of energy efficient equipment, and/or the refurbishment of the building [6]. ESCOs are mainly responsible in implementing innovative and successful business models to improve energy efficiency in the public building sector.

ESCOs finance or arrange financing while proposing activities for achieving energy saving and their remuneration is directly tied to the energy savings achieved. Hence, having the possibility to access information collected around buildings in the form of digital logbooks should support ESCOs in defining solutions in a reliable way as performance achievements are strictly related to updated information about the building itself. In particular, within BIM4EEB, it should be considered the possibility that ESCOs access energy consumption data, while respecting privacy, i.e. by aggregating data for local areas.

When referring to public renovation processes, attention should be paid considering Energy Performance Contracting (EPC), that is a form of financing for capital improvement which allows funding energy upgrades from cost reductions. Indeed, it should be outlined that energy service contracts for public buildings are mainly based only on a discount on the energy service fee, and not on an energy performance contract designed to gain a deep renovation.

Within this context, an updated digital logbook (with feedback loop) give ESCos the possibility to obtain additional indications and KPIs (lowest performance gaps, highest savings, highest kwh savings per euro invested) on their most effective refurbishment packages and solutions with respect to different building typologies, climate areas, etc. giving them the possibility to identify and segment their most interesting market offerings.

3.2. Facility managers

Main benefits of digital logbooks for facility managers are represented by the possibility to ensure that building services are properly commissioned and handed over to the FM.

Collecting information along building lifecycle will support facility managers in different activities, mainly related to the strategies to be applied for maintenance. Particularly, storing information about equipment and appliances should outline when maintenance activities need to be taken (e.g. when unexpected values

are registered when a system is not working, when the warranty period is expiring and it is required a new intervention).
Particularly, the support of digital logbooks for facility managers has been identified as [7]:

- Managing the building will be easier with information always available and updated
- Informing staff and contractors and saving time in searching for key information
- Improving the understanding of buildings
- Providing an historical record
- Identifying energy problems by logging performance
- Enhancing occupant satisfaction

3.3. "National" differences to be considered (Poland, Finland, Italy)

Within BIM4EEB, for the development of a digital logbook, national differences should be outlined.
Particularly, among the main differences, it should be considered:

- Different national renovation standards
- Differences in funding programmes and national incentives
- Different conditions of the building stock
- Different calculation for evaluating energy performances (calculation methods, standards and norms)
- Different market situation for energy audit products

In detail, it should be worth to mention that service companies' needs and requirements for BIM-based renovation processes may differ in each country mainly because of specific national law, regional regulations, guidelines and rules.

3.3.1 Poland

In Poland buildings permissions for renovation processes have legal restrictions for precise energy certificates. There is legal need to track usage of non-renewable energy sources and future energy consumption of each renovated building. This is all related to CO_2 savings policy. BIM4EEB toolkit should perform information for Owners and Local Authorities to investigate legal regulations of Environmental Protection Policy.
National strategy is to improve outdoor air quality. Coal is still major heating fuel and big amount of existing residential buildings have old heating infrastructure. Local Authorities and Energy Service Companies guidelines are to improve heating infrastructure in renovated residential buildings. There will be strong need for BIM4EEB toolkit to perform full information about existing and planned heating infrastructure. There is also very strong need from Energy Service Companies to track air pollution generates by existing and renovated buildings to prepare air quality improvement strategies.
Furthermore, it occurs a national policy to co-finance energy friendly solutions in renovation processes and strong need for financial institutions and buildings owners to track those issues. Major number of renovation processes are trying to be co-founded from special grants for building thermal resistant improvement policy.
Many residential buildings in Poland have historical background.

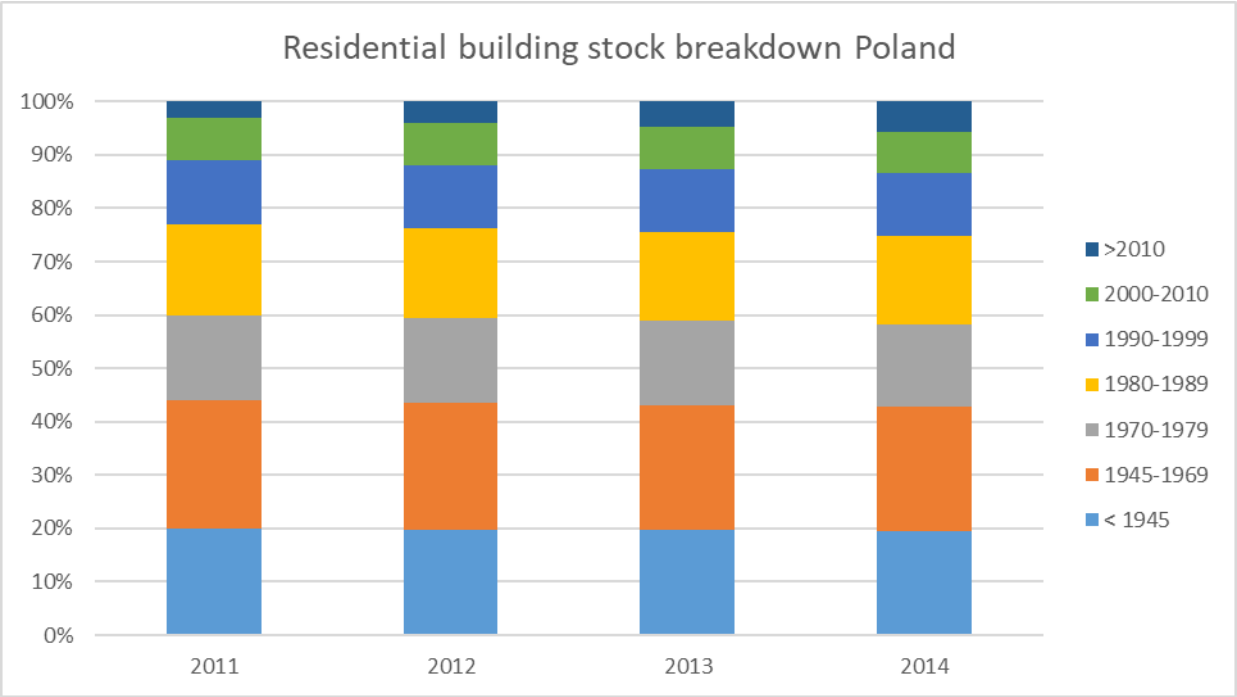

Figure 2. Residential building stock breakdown in Poland [8]

Renovation processes of old buildings indicated in register of monuments can generate additional regulatory and legal needs for Owners and Facility Mangers. BIM4EEB should contain historical information for service companies to prepare proper renovation strategies and regulations.
Major number of residential buildings in Poland required full renovation process because of safety issues. Facility managers and Owners should gain from BIM4EEB toolkit full data about necessary investments requirements for future renovation processes. Many of these cases impact on inhabitants living comfort and safety. There are legal responsibilities in Poland for Owners to solve this issue.
Many specific needs and requirements for service companies for BIM-based renovation processes in Polish market are related to CO_2 saving policy and are caused by poor technical condition of a great number of existing residential buildings.

3.3.2 Finland

While considering the Finnish implementation of BIM for renovation processes, it should be highlighted that there are generic regulations applied to renovation processes. These regulations are mainly represented by the national building code, which main parts concerns aspects related to Indoor Climate and Ventilation [9] and Energy Performance [10].
Instead, there are not yet national standards specifically focused on the implementation of BIM for renovation. International (for new construction and renovation) standards used concerns IFC (Industry Foundation Classes), DD (Data Dictionary), IDM (Information Delivery Manual), MVD (Model View Definition) and BCF (Building Collaboration Format).
Common practises for BIM (new construction and renovation) are represented by Common BIM Requirements 2012 (COBIM), based on the BIM Requirements published by Senate Properties in 2007. The update project was funded by Senate Properties in addition to several other real estate owners and developers, construction companies and software vendors. BuildingSMART Finland participated also in the financing of the project. As a result, the updated Series 1-9 and new Series 10-13 were released in Finnish on March 27th 2012.

While considering differences in funding programmes and national incentives, Business Finland should be mentioned as it is a national organisation that provides national funding for R&D&I. Business Finland's portfolio includes multiple programs that are connected with digitalisation and energy efficient buildings. The most relevant with BIM4EEB project are:

- The Digital Trust Finland program helps Finnish companies build business on digital trust and safety, attracts investments and facilitates ecosystems in Finland [11].
- Mixed Reality program offers Finnish companies funding and global networks for the development and utilization of virtual reality (VR) and augmented reality (AR) solutions in business operations [12].
- The Smart Energy Finland Program brings together the services for technical development and exports. A hundred million euros will be granted to smart energy solution innovations by the Program in 2017–2021. The program will also grant support for the international expansion of growth-oriented companies that possess growth potential and feature renewable energy and smart energy solutions in their product portfolio [13].

For what concerns the different conditions of the building stock, the main building stock in Finland is built since 1945, especially 1960's and 70' was booming period in Finnish residential construction. Figure 3 visualises residential building stock in Finland according to age.

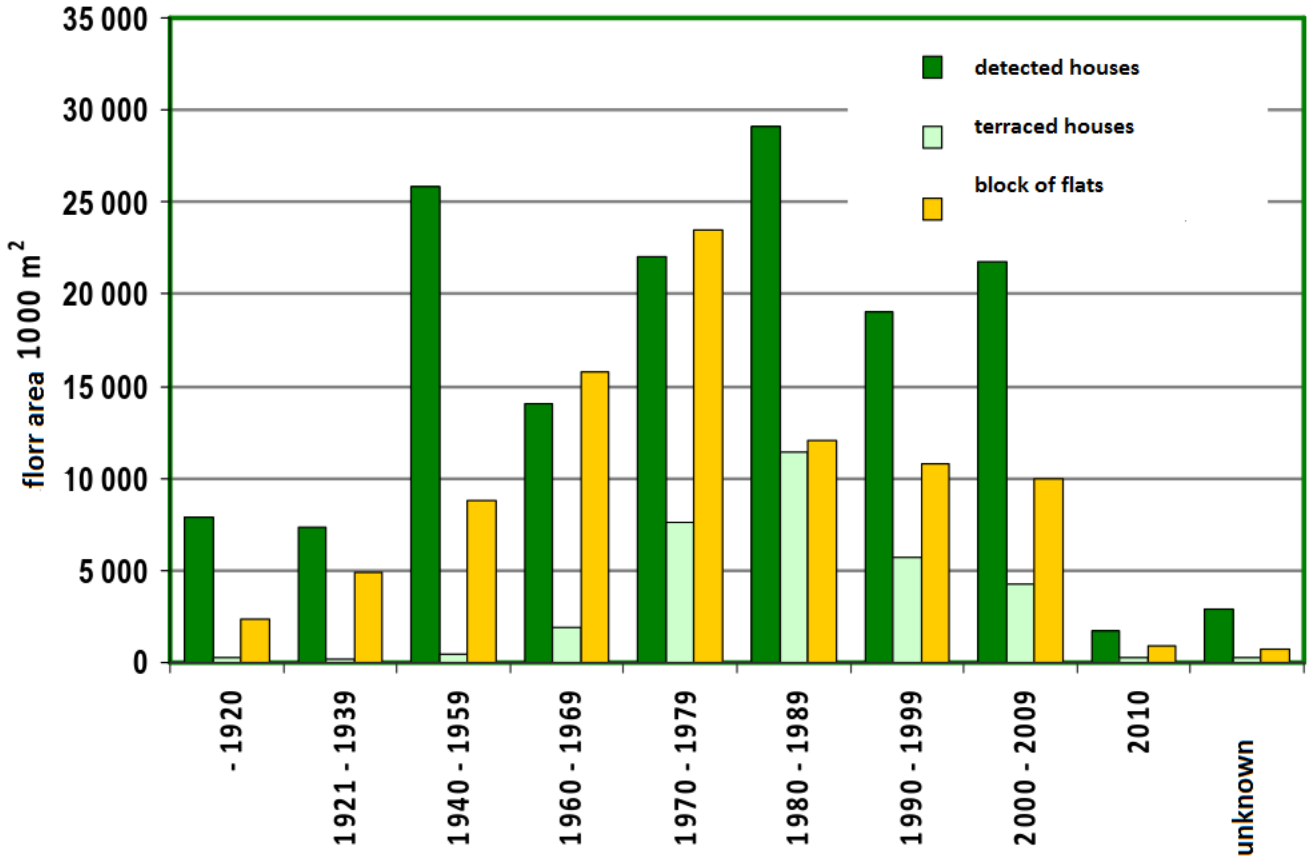

Figure 3. Residential building stock by age and building type in 2010 in Finland [14]

In order to consider different calculation for evaluating energy performances (calculation methods, standards and norms), Finnish guidelines to calculate energy are presented in report "Annex to the explanatory memorandum for the Ministry of the Environment Decree on improving the energy

performance of buildings undergoing renovation or alteration: Calculation Different market situation for energy audit products" [15]. In addition, simulation tools such as IDAice are used.
Furthermore, there are numerous tools that use simplified methods. Typically, those tools are based on Excel and they are not available for public. There are also a couple of commercial tools available such as tools form Granlund and Equa.

3.3.3 Italy

Referring to the Italian situation, there are national standards that declare the performance (e.g. thermal transmittance of each component of the building envelope) to be achieved, especially in case of public works [16].
Furthermore, considering differences in funding programmes and national incentives, in Italy, support schemes promoting energy efficiency and renewable sources are or have been as follows:
• White certificates;
• "Heat account" subsidy;
• Tax deductions;
• Tariffs for renewable electricity sources.
• Different conditions of the building stock
Moreover, there is a national standard defining the calculation method to be adopted for evaluating energy performances [17].
Referring to the condition of the Italian building stock, it is worth mentioning that a great part of buildings has been built before the adoption of regulations related to energy performance, therefore renovation strategies need to be taken into account.

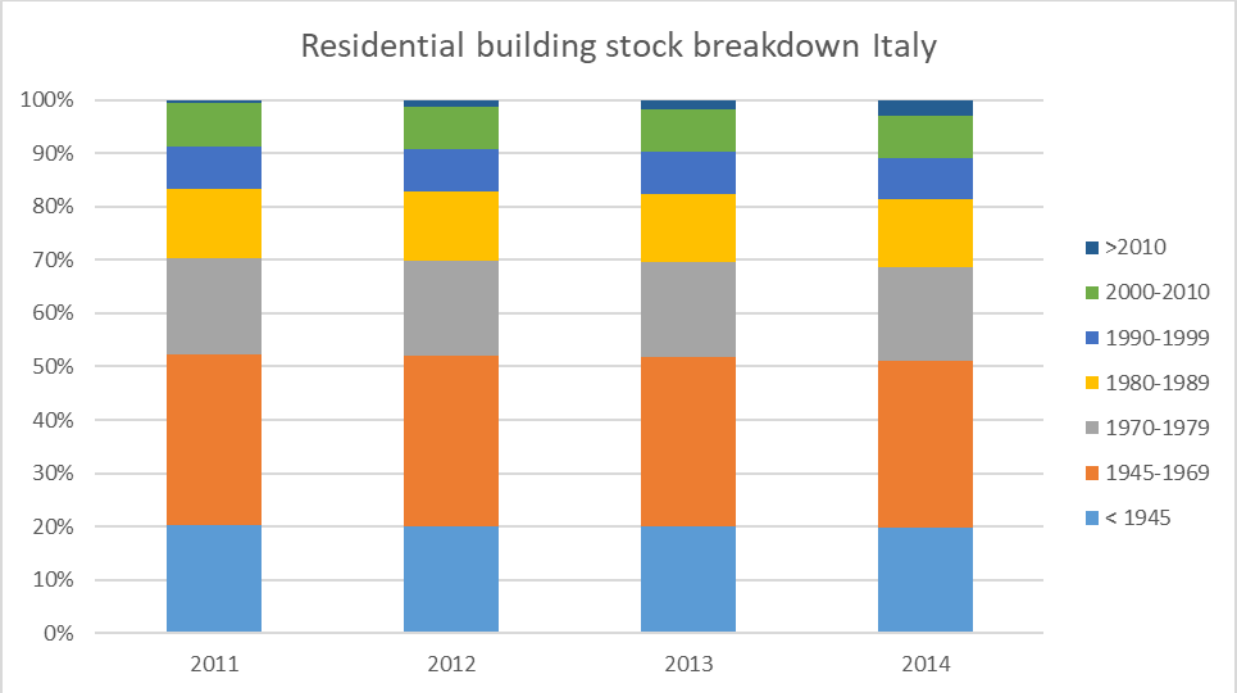

Figure 4. Residential building stock in Italy [8]

4 A digital logbook for fulfilling service companies' needs and requirements

4.1. Sources of information

Different sources of information have to be considered for fulfilling service companies' needs and requirements. Particularly, main sources of information are listed in Table 1.
Source of information can be grouped in: Documents related to building permits, properties, localization and legislation; Agreements between stakeholders; Agreements related to building use and operation; Reports and certificates; Data directly collected around the building.

Documents related to building permits, properties, localization and legislation	Building permit
	Cadastre
	Notarial deed
	Map Coordinate Systems
	National legislation
	Drawings
	Logbook
	Regional/Local Public Authorities
Agreements between stakeholders	Owner-inhabitant agreement (e.g. rent contract)
	Owner-project leader agreement
	Owner-professionals (if any) agreements
	Owner-contractor agreement
	Contractor-subcontractors (if any) agreements
	Tender agreement
Agreements related to building use and operation	Electrical energy agreement
	Gas supply agreement
	Thermal energy agreement
Reports and certificates	Energy Performance Certificate
	Thermal comfort certificate (report)
	Visual comfort certificate (report)
	Acoustic comfort certificate (report)
	Energy bills

	On-site inspections
	On-site energy audit
	Warrantee documents
	Weather reports
Data directly collected around the building	Building user
	Smart metering
	BACS

Table 1. Sources of information for BIM4EEB digital logbook

Information will be stored within BIM4EEB platform represented by the BIM Management System. Some information will be directly collected through digital tools (e.g. connection with sensors installed in the pilot cases), some information will be inputted during previous stages (e.g. design), some information (when missing) will be inputted during operation (e.g. warrantee documents).
Moreover, a section of the digital logbook will store information related to purpose and responsibilities of involved stakeholders during renovation processes (e.g. relevant building service contacts). Among the main stakeholders to be considered, contacts will be collected for:

- A/C maintenance contractor
- Boiler maintenance
- Building services designer
- Diesel Oil Supplier
- Electricity emergency
- Electricity supplier
- Fire alarm installer
- Gas emergency
- Gas supplier
- Lead contractor
- Lead designer
- Lift maintenance contractor
- Main sub-contractor
- O&M author
- Planning supervisor
- Sub-contractor for other services
- Services installer sub-contractor
- Waste contractor
- Water emergency
- Water supplier

4.2. Use of information – features of the digital logbook

The digital logbook will be conceived as a repository of dynamic and non-dynamic information, as:

- Property identification (legal and fiscal aspects);
- Building plans and urban licences;
- Relevant statistical information about the building;
- Registration of previous renovation works;
- Record of the building construction features;

It will be an interactive and dynamic tool for accessing information on behalf of:

- Facility managers
- ESCo
- Users
- Public Authorities (to provide the available information about the building or existing incentives, tax reductions, etc);
- Market actors (that may participate in a marketplace of qualified building professionals like installers);
- Financial services to find specific information like: loans, subsidies for energy efficiency, etc…).

4.3. Logbook information

T2.4 develops activities in order to provide an answer to the question "who needs what" in terms of data and information, with a special focus on operation and maintenance. Hence, starting from the results of previous research projects focusing on digital logbooks, information has been grouped considering General and administrative information (represented by areas and occupancy, summary of main building services plant, overview of controls/building energy management system, occupant information); Building construction information; Building energy performance; Building operation and use; IoT information.

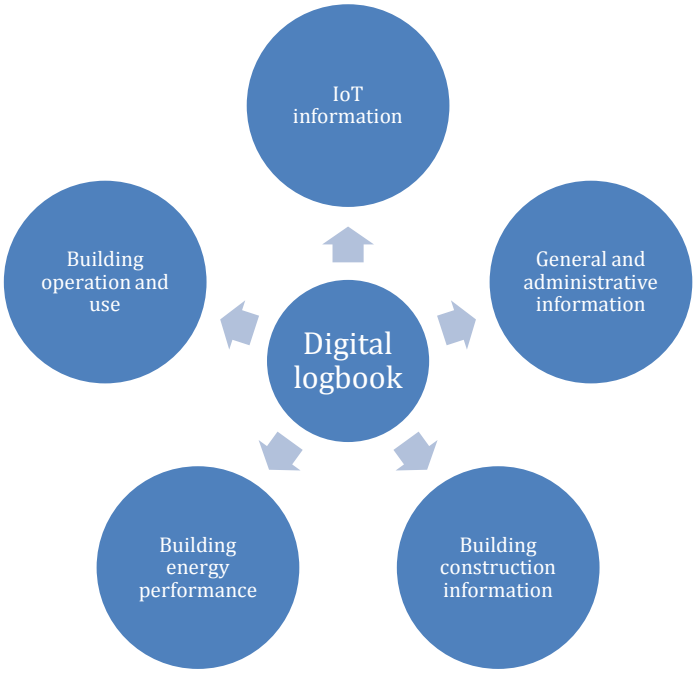

Figure 5. Group of information considered for the development of BIM4EEB digital logbook

4.3.1 General and administrative information

Subgroup of information	Information	Source of information	Stakeholders providing the information	Stakeholders requiring the information	Use of information in O&M
Building ID	Name of the building			National/Regional/ Local Public	Energy audit; Useful data for
	Main destination				

	Other destinations (if any)	Building permit; Contract/Agreement	Owner; Local Public authorities; Building user	authorities; inhabitants/end-users; project leader; design team and other involved professionals	renovation process; Economic/financial evaluation
	Building category				
	Building permit ID (condoni)				
	Construction year				
	Last renovation (partial or general) year				
	Energy class	EPC	Owner; Inhabitant; Building manager; Building service company	Owner; Inhabitant; Building manager; Building service company; Public authorities	
	Cadastre ID	Cadastre; Notarial deed	Owner; Inhabitant; Building professionals	Project leader; Buyer; Public authorities	
	Building address (nation, province, town, post code, street/road/square, nr)	Cadastre; Contract/Agreement	National/Regional/ Local Public authorities; Owner; Building user	All actors	
	GIS coordinates (Longitude, latitude)	Map Coordinate Systems	National/Regional/ Local Public authorities	Owner; Project leader; Buyer	
	Height above the sea level		National/Regional/ Local Public authorities	Owner; Project leader; Buyer	
	Distance from sea		National/Regional/ Local Public authorities	Owner; Project leader; Buyer	
	Max number of occupants	National legislation; Contract/Agreement	National/Regional/ Local Public authorities	Owner; Project leader; Buyer	
Registry	Owner ID (name, fiscal code/VAT number, address of legal registration, ownership type, contacts, e.g. telephone number, e-mail, etc.)	Cadastre; Contract/Agreement	Owner; National Public authorities	Design team; Constructor; Inhabitant; Building manager; Building service company	Energy audit; EPC update; cadastral update
	Inhabitant ID (Name, fiscal code/VAT number, address of legal registration, Title of possession, contacts, e.g. telephone number, e-mail, etc.	Owner-inhabitant agreement (e.g. rent contract)	Building user, owner, inhabitant	Owner; National/Regional/ Local Public authorities	Energy audit; EPC update; cadastral update
	Contractor ID (name, VAT number, agreement ID, data of submission, contacts, e.g. telephone number,	Owner-contractor agreement	Contractor	Owner; National/Regional/ Local Public authorities	Control/ Assessment; Economic/financial evaluation

	e-mail, certified e-mail, etc.)				
	Subcontractors (if any) ID (name, VAT number, agreement ID, data of submission, contacts, e.g. telephone number, e-mail, certified e-mail, etc.)	Contractor-subcontractors (if any) agreements	Subcontractor	Contractor; owner; National/Regional/ Local Public authorities	Control/ Assessment; Economic/financial evaluation
	Building and construction professionals ID (name, fiscal code/VAT number, agreement ID, data of submission, contacts, e.g. telephone number, e-mail, certified e-mail, etc.)	Owner-professionals agreement	Building and construction professionals	Owner; National/Regional/ Local Public authorities	Control/ Assessment; Economic/financial evaluation
	Construction operators ID (name, fiscal code/VAT number, agreement ID, data of submission, contacts, e.g. telephone number, e-mail, certified e-mail, etc.)	Contractor company registry	Construction company	Owner, Building user; Inhabitant	Control/ Assessment; Economic/financial evaluation
	Management organizational chart and responsibilities ID (name, fiscal code/VAT number, telephone number, e-mail, certified e-mail, etc.)	Owner-professionals agreement	Owner; Building professionals	Process stakeholders	Control/ Assessment; Economic/financial evaluation
	O&M operators ID (name, fiscal code/VAT number, agreement ID, data of submission, contacts, e.g. telephone number, e-mail, certified e-mail, etc.)	O&M company registry	O&M company	Facility manager	Maintenance interventions data logging
	Energy/Services suppliers ID (name, VAT number, type of agreement, date of submission, contacts, e.g. telephone number, e-mail, certified e-mail, etc.)	Contract/Agreement	Owner; Inhabitant; Building manager; Building service company	Buyer; Building User	Energy audit; Economic/financial evaluation
	Energy delivery points ID	Contract/Agreement	Owner; Inhabitant; Building manager; Building service company	Owner; Inhabitant; Building manager; Building service	Energy audit; Useful data for renovation process;

				company; Public authorities	Economic/financial evaluation
Urban and services data	City planning indexes (surface and urban destination)	Design/As-built documentation; Public authorities; Laws and regulations (national, regional, local)	Public Authorities; Building professionals; Owner	Owner; Buyer; Public authorities	Control/ Assessment (public and or owner and buyer); Economic/financial evaluation
	Urban constraints (Public)				
	Easements (Private)				
	Presence and distance between the building and services in the territory				
	Connection with primary services (distance)				
Geotechnical and Geological data	Reason of the geotechnical or geological investigation (if any)	Geological maps; Intended use	Owner, Public authorities; Diagnostic company	Public authorities; Building professionals; Buyers	Technical evaluation; Economic-financial evaluation
	Responsible for the investigation ID (if any)	Agreement; Technical report	Owner	Public authorities; Building professionals; Buyers	Technical evaluation; Economic-financial evaluation
	Diagnostic company ID (if any)	Owner-Diagnostic company agreement	Owner	Public authorities; Building professionals; Buyers	Technical evaluation; Economic-financial evaluation
	Geological/ Geotechnical report of foundation soil	Laws and regulations; Contract/Agreement	Building professionals; Diagnostic company; Public authorities	Public authorities; Building professionals; Buyers	Technical evaluation; Economic-financial evaluation
Tender agreement	Tender agreement	Tender agreement	Owner; tenderer	Project leader	
	Tender type	Tender agreement	Owner; tenderer	Project leader	
	Timeline chart (Start-Expiry Dates Main events)	Building permit; Tender agreement	Project leader; Owner	Owner	
	Drawings and reports		National/regional/local public authority; Financial institutions	National/regional/local public authority	
Dimensional data	Net floor area	Drawings; On-site inspections; Permit documentation; As built	Building professionals; National Public Authority	Building professionals; Facility manager; Owner; Buyer	Technical evaluation; Economic-financial evaluation
	Gross floor area				
	Outdoor surface				
	Building height				

	Gross minimum height	documentation; Design/As-Built report			
	Maximum gross height				
	Average gross height				
	Minimum net height				
	Average net height				
	Maximum net height				
	Number of floors				
	Number of floors above earth				
	Number of floors underground				
	Total volume above the ground				
	Total volume underground				
	Net volume				
	Superstructure total volume/Total volume above the ground				
	Substructure total volume/ Total volume underground				
	Ancillary rooms area				
	Covered area				
	Exposed surface				
	Hedge ratio				
	Ratio of south surface				
	Ratio of east surface				
	Ratio of north surface				
	Ratio of west surface				
Accessibility	Public accessibility	Drawings, on-site inspections, laws and regulations	Local / Regional / National authority	Building professionals; Building user; Owner	Technical evaluation; Economic-financial evaluation
	Accessibility for impaired people				
Maintenance plan	Agreement type	Laws and regulations, warrantee documents, on-site inspections	Facilities management (FM) adviser; building professionals	Owner; Inhabitant; Building user; Public authorities	Periodical/continuous control/ Assessment
	Agreements duration				
	Contractors ID				
	Mandatory certifications to be updated (start and expiry date)				
	Main interventions (relevant)				
	Average annual cost of interventions realized				
	Problems and delays				
	Periodical issues				

	Technical Assessment				
Attachment: Licenses	Certified evaluation	Regional/Local Public Authorities	Regional / Local Public Authorities	Building professionals	Data required in order to do a renovation process
	Matching certification				
	Fractionation				
	Cadastral records				
	Building license or permit				
	Regularization title concession				
	Certification of urban destination				
	Certificate of habitability				
	Technical reports				
	EPC				
Attachment: Drawings	Cadastral map extract	Regional/Local Public Authorities	Regional/Local Public Authorities	Building professionals	Useful data for renovation process
	Cadastral map				
	Technical drawings				
	Urban drawings				
Other information	Energy and Construction market	National/Regional/ Local Public Authorities	Financial Services; Regional/Local Public Authorities; Building user; Energy Sector - Engineers	Utility companies	Compare market prices of similar buildings and zones
	Benchmark/statistical data for comparison purposes				
	Governmental taxes and incentives		National/Regional/ Local Public authorities	Financial institutions	Investment requirements
	Financial programs		Financial Services; Regional/Local Public Authorities		Financing options available in the area for renovation projects (e.g., green loans, incentives, tax credits)
Economic data	Administrative cost (Design and construction cost: for the Safety Coordinator in the design stage; for the Safety Coordinator in the construction stage; technical expenses for the management of construction works, etc.)	Contract/Agreement	Construction company; Owner; Building professionals	Public authorities; Building user	Technical evaluation; Economic-financial evaluation

	Energy cost	Energy bills; Statistical data	Owner; Building administrator	Building professional; Owner	Economic-financial evaluation
	Insurance cost (Employee insurances; building insurance; PV insurance)	Insurance company agreement	Insurance company	Construction company, Building user, Owner, PV company	
	Operation and use costs (for consulting, monitoring, maintenance interventions, etc.)	Contract/Agreement	O&M company; Owner; Building professionals	Public authorities; Building user	Technical evaluation; Economic-financial evaluation
	Administrative costs	Contract/Agreement; Project leader	Building administrator; Owner	Buyer	Economic-financial evaluation
	Total amount of works (percentage breakdown)	Tender agreement; Pricelist	Owner; Tenderer; Facility manager	Public authority	
	Infrastructures costs	Building permit; Laws and regulations	Public authority; Tenderer	Owner	
	Taxes	Tender agreement; Building permit	Owner; Tenderer; Facility manager	Public authority; Facility manager	
	Kind and amount of funding	Financial institutions	Owner; Public authority; Facility manager	Public authority; Facility manager; Building user	

Table 2. Structure for creating BIM4EEB digital logbook concerning general and administrative information

4.3.2 Building construction information

Subgroup of information	Information		Source of information	Stakeholders providing the information	Stakeholders requiring the information	Use of information in O&M
Technical Building Systems	Heating system	Plant type	Drawings (design, construction, O&M); On-site inspections;Technical reports; Testing documentation; Warrantee documents; As built documentation	Building professionals and installers; Energy Auditors; National Public Authority	National/Regional/Local Public Authorities; Building professionals; Facility manager; Building user; Owner	Statistical data for comparison purposes; Useful data for renovation process; Definition of maintenance intervention; Automated renovation recommendations
		Heater terminal unit type				
		Distribution type				
		Distribution type				
		Heat generator type				
		Volume flow for air circuits				
		External leak				
		Type of fuel				
		Heat generator nominal power				
		Plant type				

	Cooling system	Cooler terminal unit type Distribution type Control system type Cooler type Volume flow for air circuits External leak Type of energy Cooler nominal power	Drawings (design, construction, O&M); On-site inspections;Technical reports; Testing documentation; Warrantee documents; As built documentation	Building professionals and installers; Energy Auditors; National Public Authority	National/Regional/Local Public Authorities; Building professionals; Facility manager; Building user; Owner	Statistical data for comparison purposes; Useful data for renovation process; Definition of maintenance intervention; Automated renovation recommendations
	Lighting system	Plant type Distribution type Tipo di regolazione Used energy type Nominal power Massflow rate for water circuits Area served Controls Equipment	Drawings (design, construction, O&M); On-site inspections;Technical reports; Testing documentation; Warrantee documents; As built documentation	Building professionals and installers; Energy Auditors; National Public Authority	National/Regional/Local Public Authorities; Building professionals; Facility manager; Building user; Owner	Statistical data for comparison purposes; Useful data for renovation process; Definition of maintenance intervention; Automated renovation recommendations
	Domestic hot water system	Plant type Distribution type Control system type Heat generator type Nominal power Type of fuel Capacity Area served Tank End uses End-use fixture types	Drawings (design, construction, O&M); On-site inspections;Technical reports; Testing documentation; Warrantee documents; As built documentation	Building professionals and installers; Energy Auditors; National Public Authority	National/Regional/Local Public Authorities; Building professionals; Facility manager; Building user; Owner	Statistical data for comparison purposes; Useful data for renovation process; Definition of maintenance intervention; Automated renovation recommendations
	Ventilation system	Plant type Distribution type Control system type Nominal power	Drawings (design, construction, O&M); On-site inspections;Technical reports; Testing documentation; Warrantee documents; As built documentation	Building professionals and installers; Energy Auditors; National Public Authority	National/Regional/Local Public Authorities; Building professionals; Facility manager; Building user; Owner	Statistical data for comparison purposes; Useful data for renovation process; Definition of maintenance intervention; Automated

						renovation recommendations
	Renewable energy system	Plant type (PV, solar heat, hydro, wind) Distribution type Grid connection (True/False) Type of energy produced (electricity, heating, cooling) Plant nominal power	Drawings; On-site inspections; Warrantee documents	Building professionals and installers; Energy Auditors; National Public Authority	National/Regional/Local Public Authorities; Building professionals; Facility manager; Building user; Owner	Statistical data for comparison purposes; Useful data for renovation process; Definition of maintenance intervention; Automated renovation recommendations
	Building automation and control	Plant type Types of inputs Types of outputs Controllers	Drawings (design, construction, O&M); On-site inspections;Technical reports; Testing documentation; Warrantee documents; As built documentation	Building professionals and installers; Energy Auditors; National Public Authority	National/Regional/Local Public Authorities; Building professionals; Facility manager; Building user; Owner	Statistical data for comparison purposes; Useful data for renovation process; Definition of maintenance intervention; Automated renovation recommendations
	Fire-fighting system	Fire Fighting Equipment Fire estinguisher Fire protection facilities Automatic fire-extinguishing plan	Drawings (design, construction, O&M); On-site inspections;Technical reports; Testing documentation; Warrantee documents; As built documentation	Building professionals and installers	National/Regional/Local Public Authorities; Building professionals; Facility manager; Building user; Owner	Statistical data for comparison purposes; Useful data for renovation process; Definition of maintenance intervention; Automated renovation recommendations
Envelope	Walls	Walls type Constructive solution Surface area information Thermal insulation characteristics Thermal transmittance (U-value)	Drawings; On-site inspections	Building professionals and installers; Energy Auditors; National Public Authority	National/Regional/Local Public Authorities ; Building professionals; Facility manager	Statistical data for comparison purposes; Useful data for renovation process; Definition of maintenance intervention
	Roofs	Roofs type				

		Constructive solution Thermal insulation characteristics Thermal transmittance (U-value)	Drawings; On-site inspections	Building professionals and installers; Energy Auditors; National Public Authority	National/Regional/Local Public Authorities ; Building professionals; Facility manager	Statistical data for comparison purposes; Useful data for renovation process; Definition of maintenance intervention
	Floors	Floors type Constructive solution Thermal insulation characteristics Thermal transmittance (U-value)	Drawings; On-site inspections	Building professionals and installers; Energy Auditors; National Public Authority	National/Regional/Local Public Authorities ; Building professionals; Facility manager	Statistical data for comparison purposes; Useful data for renovation process; Definition of maintenance intervention
	Windows	Windows type Constructive solution Thermal insulation characteristics External doors perimeter External windows perimeter External s-w absoprtance of window frames Thermal transmittance (U-value)	Drawings; On-site inspections	Building professionals and installers; Energy Auditors; National Public Authority	National/Regional/Local Public Authorities ; Building professionals; Facility manager	Statistical data for comparison purposes; Useful data for renovation process; Definition of maintenance intervention
	Doors	Doors type Constructive solution Thermal transmittance (U-value)	Drawings; On-site inspections	Building professionals and installers; Energy Auditors; National Public Authority	National/Regional/Local Public Authorities ; Building professionals; Facility manager	Statistical data for comparison purposes; Useful data for renovation process; Definition of maintenance intervention
	Thermal bridges	Thermal bridge type Cause	Thermography investigation	Building professionals and installers; Energy Auditors; National Public Authority	National/Regional/Local Public Authorities ; Building professionals; Facility manager	Statistical data for comparison purposes; Useful data for renovation process; Definition of maintenance intervention
Structure		Structure type	Drawings			

	Rising structures	Design principle		Building professionals and installers	National/Regional/Local Public Authorities ; Building professionals; Facility manager	Statistical data for comparison purposes; Useful data for renovation process; Definition of maintenance intervention
		Structure material				
	Foundation structures	Structure type				
		Design principle				
		Structure material				

Table 3. Structure for creating BIM4EEB digital logbook concerning building construction information

4.3.3 Building energy performance

Subgroup of information	Information	Source of information	Stakeholders providing the information	Stakeholders requiring the information	Use of information in O&M
EPC general information	Energy label	Energy Performance Certificate	Building professionals and installers; Energy Auditors; National Public Authority	Energy auditors	Definitions of alternatives about how to reduce energy use and save money
	EPC number				
	Type of EPC				
	Issue date				
	Term date				
	Energy audit type				
	Audit expert name				
	Audit date				
	Audit report				
Energy use	Energy use for heating	On-site energy audit; EPC	Building professionals and installers; Energy Auditors; National Public Authority	National/Regional/Local Public Authority; Facility managers; Energy auditors; Design team	Statistical data for comparison purposes; Definition of benchmarks; Definition of alternatives for reaching energy saving; Definition of the energy demand of a set of renovation packages to be implemented in a specific sequence
	Energy use for cooling				
	Energy use for ventilation				
	Energy use for domestic water heating				
Primary energy	Primary energy for heating	On-site energy audit; EPC	Building professionals and installers; Energy Auditors; National Public Authority	Energy auditors; design team	Definition of the energy demand of a set of renovation packages to be implemented in a specific sequence
	Primary energy for cooling				
	Primary energy for ventilation				
	Primary energy for domestic water heating				
	Primary energy for lighting and electrical appliances				

	Primary energy for elevators and escalators				
Delivered energy	Delivered energy for heating	On-site energy audit	Building professionals and installers; Energy Auditors; National Public Authority	Energy auditors; design team	Definition of the energy demand of a set of renovation packages to be implemented in a specific sequence
	Delivered energy for cooling				
	Delivered energy for ventilation				
	Delivered energy for domestic water heating				
	Delivered energy for lighting and electrical appliances				
	Delivered energy for elevators and escalators				
Emissions	CO2 emissions	EPC	Building professionals and installers; Energy Auditors; National Public Authority	Building user; Owner; National Public Authority; Design team	Understanding the emissions the house actually produces; Statistical data for comparison purposes; Definition of benchmarks
	CO2 emissions rate for surface unit				
	CO2 emissions rate for volume unit				
Thermal Comfort	Indoor air average temperature	Thermal comfort certificate (report)	Building professionals and installers; Energy Auditors; National Public Authority	Building user; Owner; Building professionals; Public local authorities	Understanding the comfort the house actually delivers; Definition of alternatives to improve the comfort; Statistics to monitor the susceptibility for energy poverty or health issues
	Working average temperature				
	Average relative humidity				
	Air speed				
	Average rate				
	Unsatisfied percentage				
Visual Comfort	Average illuminance	Visual comfort certificate (report)	Building professionals and installers; Energy Auditors; National Public Authority	Building user; Owner; Building professionals; Public local authorities	Understanding the comfort the house actually delivers; Definition of alternatives to improve the comfort; Statistics to monitor the susceptibility for energy poverty or health issues
	Daylight factor				
Acoustic Comfort	Level of apparent soundproofing capacity	Acoustic comfort certificate (report)	Building professionals and installers; Energy Auditors;	Building user; Owner; Building professionals; Public local authorities	Understanding the comfort the house actually delivers; Definition of alternatives to
	Equivalent continuous level of a weighted sound pressure				

	Maximum level of weighted sound pressure		National Public Authority		improve the comfort; Statistics to monitor the susceptibility for energy poverty or health issues
Energy needs	Thermal energy needs for heating	Building user	Building professionals and installers; Energy Auditors; National Public Authority	Building professionals	Understanding how to improve the needs of occupants
	Thermal energy needs for cooling				
	Thermal energy needs for ventilation				
	Thermal energy needs for domestic water heating				
	Primary energy needs for heating				
	Primary energy needs for cooling				
	Primary energy needs for ventilation				
	Primary energy needs for domestic water heating				
	Total primary energy needs				

Table 4. Structure for creating BIM4EEB digital logbook concerning building energy performance

4.3.4 Building operation and use

Subgroup of information	Information		Source of information	Stakeholders providing the information	Stakeholders requiring the information	Use of information in O&M
Energy consumption and production	Energy source	List of energy sources	Energy bills; Smart metering; Energy certification; Design/as-built documentation (drawings and report)	Building professionals and installers; Energy Auditors; Building User; Energy sector-Business	Building user / Building owner; Facility managers; Financial institutions; Energy auditors; Design team (Energy expert, Building Service designer), when making the "As is" simulation model before the renovation measurements; Public authorities	Building check/assesment; Econimic/finacial evaluation; Renovation; retrofitting
	Metering system information	Type of meter				
		Period of meter				
		Energy metered				

Energy generation	Renewable energy sources	List of renewable energy sources	Smart metering; mechanical metering; Design/as-built documentation (drawings and report); EPC	Building professionals and installers; Energy Auditors; Building User; Energy sector-Business	Energy auditors; Building user / Building owner ; Design team (Arch, Struc, Building Service designer, Elec) before renovation; Public authorities	Building check/assesment ; Econimic/finacial evaluation; Renovation; retrofitting
	Metering system information	Type of meter				
		Period of meter				
		Energy metered				
Maintenance	Electrical system	Company name/Contractor	Maintenance plan; Assessmentreport; Laws and regulaitons; Warrantee documents; Design/as-built documentation (drawings and report); EPC	Building professionals and installers; Building user; Owner	Facility management team; Public authorities	Building check/assesment ; Econimic/finacial evaluation; Renovation; retrofitting; Statistical data for comparison purposes
		Agreement				
		Agreement duration				
		Responsible ID				
		Maintenance ID				
		Emergency contact name				
		Total annual cost Delivery station (Cost of preventive maintenance intervention; Cost of mandatory periodic maintenance intervention; Cost of corrective maintenance; Cost renovation/upgrade intervention)				
		Total annual cost Distribution (Cost of preventive maintenance intervention; Cost of mandatory periodic maintenance intervention; Cost of corrective maintenance; Cost renovation/upgrade intervention)				
		Total annual cost Terminal (Cost of preventive maintenance intervention; Cost of mandatory periodic maintenance intervention; Cost of corrective				

		maintenance; Cost renovation/upgrade intervention)				
		Date				
		Validity or next update				
		Maintenance certificate				
		Expiry date of certificate				
		Inspections				
		Maintenance report				
	HVAC system	Company name/Contractor	Maintenance plan; Assessmentreport; Laws and regulaitons; Warrantee documents; Design/as-built documentation (drawings and report); EPC	Building professionals and installers; Building user; Owner	Facility management team; Public authorities	Building check/assesment; Econimic/finacial evaluation; Renovation; retrofitting; Statistical data for comparison purposes
		Agreement				
		Agreement duration				
		Responsible ID				
		Maintenance ID				
		Emergency contact name				
		Total annual cost Delivery station (Cost of preventive maintenance intervention; Cost of mandatory periodic maintenance intervention; Cost of corrective maintenance; Cost renovation/upgrade intervention)				
		Total annual cost Distribution (Cost of preventive maintenance intervention; Cost of mandatory periodic maintenance intervention; Cost of corrective maintenance; Cost renovation/upgrade intervention)				
		Total annual cost Terminal (Cost of preventive maintenance intervention; Cost of mandatory periodic maintenance intervention; Cost of corrective				

		maintenance; Cost renovation/upgrade intervention)				
		Date				
		Validity or next update				
		Maintenance certificate				
		Expiry date of certificate				
		Maintenance report				
	Firefightin g system	Company name/Contractor	Maintenance plan; Assessmentrepo rt; Laws and regulaitons; Warrantee documents; Design/as-built documentation (drawings and report); EPC	Building professionals and installers; Building user; Owner	Facility management team; Public authorities	Building check/assesment ; Econimic/finacial evaluation; Renovation; retrofitting; Statistical data for comparison purposes
		Agreement				
		Agreement duration				
		Responsible ID				
		Maintenance ID				
		Emergency contact name				
		Total annual cost Delivery station (Cost of preventive maintenance intervention; Cost of mandatory periodic maintenance intervention; Cost of corrective maintenance; Cost renovation/upgrade intervention)				
		Total annual cost Distribution (Cost of preventive maintenance intervention; Cost of mandatory periodic maintenance intervention; Cost of corrective maintenance; Cost renovation/upgrade intervention)				
		Total annual cost Terminal (Cost of preventive maintenance intervention; Cost of mandatory periodic maintenance intervention; Cost of corrective maintenance; Cost				

		renovation/upgrade intervention)				
		Date				
		Validity or next update				
		Maintenance certificate				
		Expiry date of certificate				
		Maintenance report				
	Other "Special" systems	Company name/Contractor	Maintenance plan; Assessmentreport; Laws and regulaitons; Warrantee documents; Design/as-built documentation (drawings and report); EPC	Building professionals and installers; Building user; Owner	Facility management team; Public authorities	Building check/assesment; Econimic/finacial evaluation; Renovation; retrofitting; Statistical data for comparison purposes
		Agreement				
		Agreement duration				
		Responsible ID				
		Maintenance ID				
		Emergency contact name				
		Total annual cost Delivery station (Cost of preventive maintenance intervention; Cost of mandatory periodic maintenance intervention; Cost of corrective maintenance; Cost renovation/upgrade intervention)				
		Total annual cost Distribution (Cost of preventive maintenance intervention; Cost of mandatory periodic maintenance intervention; Cost of corrective maintenance; Cost renovation/upgrade intervention)				
		Total annual cost Terminal (Cost of preventive maintenance intervention; Cost of mandatory periodic maintenance intervention; Cost of corrective maintenance; Cost				

		renovation/upgrade intervention)				
		Date				
		Validity or next update				
		Maintenance certificate				
		Expiry date of certificate				
		Maintenance report				
	Walls	Company name/Contractor	Maintenance plan; Assessmentreport; Laws and regulaitons; Warrantee documents; Design/as-built documentation (drawings and report); EPC	Building professionals and installers; Building user; Owner	Facility management team	Building check/assesment; Econimic/finacial evaluation; Renovation; retrofitting; Statistical data for comparison purposes
		Agreement				
		Agreement duration				
		Responsible ID				
		Maintenance ID				
		Emergency contact name				
		Total annual cost (Cost of preventive maintenance intervention; Cost of mandatory periodic maintenance intervention; Cost of corrective maintenance; Cost renovation/upgrade intervention)				
		Date				
		Validity or next update				
		Maintenance certificate				
		Expiry date of certificate				
		Maintenance report				
	Roofs	Company name/Contractor	Maintenance plan; Assessmentreport; Laws and regulaitons; Warrantee documents; Design/as-built documentation (drawings and report); EPC	Building professionals and installers; Building user; Owner	Facility management team	Building check/assesment; Econimic/finacial evaluation; Renovation; retrofitting; Statistical data for comparison purposes
		Agreement				
		Agreement duration				
		Responsible ID				
		Maintenance ID				
		Emergency contact name				
		Total annual cost (Cost of preventive maintenance intervention; Cost of mandatory periodic maintenance				

		intervention; Cost of corrective maintenance; Cost renovation/upgrade intervention)				
		Date				
		Validity or next update				
		Maintenance certificate				
		Expiry date of certificate				
		Maintenance report				
	Floors	Company name/Contractor	Maintenance plan; Assessmentreport; Laws and regulaitons; Warrantee documents; Design/as-built documentation (drawings and report); EPC	Building professionals and installers; Building user; Owner	Facility management team	Building check/assesment; Econimic/finacial evaluation; Renovation; retrofitting; Statistical data for comparison purposes
		Agreement				
		Agreement duration				
		Responsible ID				
		Maintenance ID				
		Emergency contact name				
		Total annual cost (Cost of preventive maintenance intervention; Cost of mandatory periodic maintenance intervention; Cost of corrective maintenance; Cost renovation/upgrade intervention)				
		Date				
		Validity or next update				
		Maintenance certificate				
		Expiry date of certificate				
		Maintenance report				
	Windows	Company name/Contractor	Maintenance plan; Assessmentreport; Laws and regulaitons; Warrantee documents; Design/as-built documentation (drawings and report); EPC	Building professionals and installers; Building user; Owner	Facility management team	Building check/assesment; Econimic/finacial evaluation; Renovation; retrofitting; Statistical data for comparison purposes
		Agreement				
		Agreement duration				
		Responsible ID				
		Maintenance ID				
		Emergency contact name				
		Total annual cost (Cost of preventive maintenance				

		intervention; Cost of mandatory periodic maintenance intervention; Cost of corrective maintenance; Cost renovation/upgrade intervention)				
		Date				
		Validity or next update				
		Maintenance certificate				
		Expiry date of certificate				
		Maintenance report				
	Doors	Company name/Contractor	Maintenance plan; Assessmentreport; Laws and regulaitons; Warrantee documents; Design/as-built documentation (drawings and report); EPC	Building professionals and installers; Building user; Owner	Facility management team	Building check/assesment ; Econimic/finacial evaluation; Renovation; retrofitting; Statistical data for comparison purposes
		Agreement				
		Agreement duration				
		Responsible ID				
		Maintenance ID				
		Emergency contact name				
		Total annual cost (Cost of preventive maintenance intervention; Cost of mandatory periodic maintenance intervention; Cost of corrective maintenance; Cost renovation/upgrade intervention)				
		Date				
		Validity or next update				
		Maintenance certificate				
		Expiry date of certificate				
		Maintenance report				
Indoor conditions	Intended use	Rooms type	Smart metering; Laws and regulations; Control/ Assesment	National public authorities; Building user; Inhabitant	Building professionals	Definitions of alternatives about how to improve indoor conditions of occupants
		Room temperature				
		Room humidity				
		Room hourly air change				
		Electrical power				

Climate data	Weather data	Degree days	Weather reports; Laws and regulations	Energy Auditors; National public authorities; Building user; Inhabitant	Building professionals	Definitions of alternatives about how to improve indoor conditions of occupants giving the climate data
		Rate of raininess				
		Outside air temperature				
		Wind speed				
		Solar radiation				

Table 5. Structure for creating BIM4EEB digital logbook concerning building operation and use

4.3.5 IoT information

Subgroup of information	Information	Source of information	Stakeholders providing the information	Stakeholders requiring the information	Use of information in O&M
Smart indicator	Smart Readiness Indicator	BACS	Building professionals and installers	-Building user -Facility manager	Control of its energy consumption and/or generation
	Other smart indicators				Integration of renewable energy systems
E-mobility	Electric vehicle (EV)	BACS	Building professionals and installers	Building user / Facility manager	Alerts and reminders on refurbishment need
	EV charging points				
Smart district	Smart district indicators		Building professionals and installers / National/Regional/Local Public authorities	Building user	Improvement suggestions

Table 6. Structure for creating BIM4EEB digital logbook concerning IoT information

5 Conclusions

Collecting data related to building use and operation in the BIM Management System proposed within BIM4EEB project will support stakeholders in linking the gap between building operation and building design. Indeed, a barrier is a limited degree of learning from experiences of use and operation of existing buildings, when new building projects are planned [18]. While monitoring constantly data collected around building, it is possible to close the feedback loop between operation and design.

Furthermore, users and occupants understanding of the design intent and of the way buildings work can be improved. Moreover, the digital logbook enhances the commissioning and handover process and provides a vehicle for recording building alterations and performance.

The service companies' needs and requirements for BIM renovation processes will be used as a source of information for developing ontologies during the WP3 and for defining the specification and overall design with the definition of users' profile for accessing the BIM Management System developed in WP4.

The ontologies will bring the results of WP2 to define classes, rules, datatypes, and properties that could arise from needs and requirement defined in D2.4. Group, Information, and Sources will be a source to define ontology entities, and then nurturing data to the Digital Logbook stored in the BIM Management System. Stakeholder and Uses will be a primary source of information to define Users, Roles and Workflow management in the Common Data Environment developed in WP4.

The BIM Management System developed in WP4 will be the main repository for the Digital Logbook data for renovation processes during the pilot phase of demonstration in relevant environment (WP8). Stakeholders may access the BIM Management System to create, edit and query the data related to the building renovation activities. Stakeholders will query data and get all information about building renovation process and will be able to filter data useful to know who, what, when and where about a thing in a workflow.

In order to get consistent data and reusable information, it will be crucial to define ontology entities terms that bring sufficient complexity exploited the D2.4 results, and will be taken into account for the refinement and harmonisation of them to couple with the heterogeneous kind of data that will be gathered during the project.

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