ITEA4 22003 FireBIM

Deliverable D4.1: Use case scenarios and initial solutions for custom and industrial applications

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Version history

Version	Date	Coordinator	Change
1.0	2025-03-14	Megan De Prins (Buildwise)	First version
2.0	2025-05-06	Megan De Prins (Buildwise)	Added solution 3.12, updated overview table

Contents

1 Introduction

The **ITEA4 22003 FireBIM project** aims to enhance fire safety compliance in building design by integrating **Building Information Modeling (BIM)**. This deliverable, **D4.1: Use Cases**, outlines the **FireBIM use cases and scenarios**, developed in alignment with EU initiatives. These use cases serve as a foundation for the **FireBIM platform (WP3), custom applications (WP4), and demonstrators (WP5)**, ensuring that BIM models incorporate the necessary information for automated compliance checks.

The document is structured into two main sections:

- **Section 2** describes the **five identified use cases** and their associated **ten use case scenarios**.
- **Section 3** presents an initial set of **eleven candidate solutions** proposed to address the identified use case scenarios.
- **Section 4** presents a **mapping** of the proposed solutions to the use case scenarios.

By addressing key challenges in fire safety compliance, this document establishes a structured approach to defining and verifying fire safety-related information within BIM models. This reduces manual effort and enables **reliable, automated compliance verification**, streamlining the process and improving overall safety standards.

This deliverable serves as a **basis for deliverable D4.2** “User Requirement Document (URD) for custom and industrial applications” which will also describe relations with business cases and the FireBIM Platform (WP3).

2 Use cases

2.1 Use Case 1 – Ensuring that the required information for checking the compliance on Fire Safety Regulations is in the BIM model

2.1.1 Description

A. Overall idea

This use case focuses on ensuring that BIM information models are enriched with the necessary and appropriately structured information to enable automatic validation of fire safety legislation compliance, as outlined by the FireBIM framework. Architects and other designers need clear guidance on what information to include in their models and how to structure it, ensuring it meets the requirements for automated compliance checks. Similarly, the project coordinator or building owner (appointing party) must know how to specify the Exchange Information Requirements (EIR) to support compliance checks and how to verify that the delivered information models meet these requirements.

To support more effective compliance, this use case also seeks to verify and specify the specific set of information requirements needed for each fire safety compliance domain, such as compartmentation, escape routes, and others. This allows for more focused and directed analysis during the conceptual design phase and aids decision-making as the building design evolves. Currently, appointing parties are often unaware of the necessary information requirements for fire safety compliance, architects and designers lack a structured and consistent way to enrich models with the required information, and fire safety experts frequently need to manually analyse projects and provide feedback based on incomplete or unclear data relevant to fire safety.

By addressing these challenges, this use case establishes a clear, consistent framework for specifying and verifying fire safety-related information in BIM models, reducing manual effort and enabling reliable, automated compliance checks from the use cases defined in FireBIM.

B. Target audience/persona

Design team, BIM modellers, contractors, manufacturers

C. Building phase

0	**1**	**2**	**3**	**4**	**5**	6	7
Strategic Definition	Preparation & Planning	Concept Design	Spatial Coordination	Technical Design	Manufacturing & Construction	Handover	Use

D. Objectives

D.1 Provide Clear Guidance on Information Requirements for Compliance

The design team and other stakeholders who enrich the BIM model with data need a clear understanding of the specific information required to meet fire safety compliance checks. This includes knowing exactly what data is needed, where it should be placed in the model, and how it should be structured to ensure reliable and automated compliance checks. The goal is to eliminate ambiguity about the required information, enabling stakeholders to efficiently enrich the BIM model in a consistent and compliant manner.

D.2 Enable Automated Quality Checks

Architects, engineers, and BIM modellers want the ability to verify whether their models meet fire safety compliance requirements through automated quality checks. By leveraging the IDS (Information Delivery Specification) format, automated checks can be integrated into modelling tools, viewers, and other BIM environments. The IDS ensures that compliance-related data in the model is machine-readable, structured, and aligned with international standards, such as ISO 19650. Open formats promote interoperability and long-term usability across different software platforms, reducing the risk of vendor lock-in and enabling reliable automated validation processes.

D.3 Enable Directed Compliance Checks for Specific Fire Safety Domains

The goal is to allow architects and other designers to perform compliance checks targeted at specific fire safety domains—such as compartmentation, escape routes, and material fire resistance, rather than validating the entire regulation at once. This focused approach ensures that the right information is included in the model at the right time and for the right purpose. By tailoring the compliance checks to specific domains, users can prioritize the most relevant aspects of fire safety during the design process, improving efficiency and supporting more informed decision-making.

D.4 Simplify Workflow Integration for Fire Safety Compliance

Provide practical tools and guidance to ensure the integration of compliance-related information into existing BIM workflows. This includes offering clear instructions for how stakeholders should develop, check, and maintain BIM models to meet fire safety requirements. The focus is on enabling a seamless adoption of FireBIM processes within the standard project lifecycle, ensuring that all stakeholders understand how to use the platform effectively and benefit from its capabilities.

E. Rationale

For fire safety compliance checks to be performed effectively in the BIM environment, the necessary information must be embedded in the model in a structured and consistent way. Without this foundational data, compliance checks cannot reliably be automated or facilitated by rule sets and data retrieval. Missing or unstructured information results in inefficiencies, time-consuming manual processes, and a greater risk of non-compliance.

This use case ensures that BIM models are enriched with the required fire safety data, structured in machine-readable formats and aligned with open standards like ISO 16739 (IFC). By defining Information Delivery Specifications (IDS) for common fire safety domains, such as compartmentation, escape routes, and material compliance, this approach provides a clear framework for validating that models contain the necessary information for specific compliance checks.

The ability to perform directed compliance checks on specific domains ensures that the right information is available at the right time and for the right purpose. This focus on domain-specific validation during early design phases improves efficiency, reduces rework, and supports informed decision-making. Aligning with international standards ensures interoperability across tools and long-term accessibility of compliance-related data, promoting consistency and scalability in fire safety management.

By enabling automated or semi-automated compliance checks, this use case minimizes human error, reduces reliance on manual processes, and enhances collaboration between disciplines. Ultimately, it lays a robust foundation for reliable, efficient, and proactive fire safety compliance, ensuring safer building designs.

While checking information facilitates compliance assessment of BIM models for fire safety regulations by validating information pertaining to compartmentation, escape routes, and material fire resistance, the scope is primarily confined to data attributes and relations embedded within model elements. It does not extend to an evaluation of modelling conventions or geometric properties. Consequently, UC1 alone cannot guarantee complete compliance with fire safety requirements. A comprehensive assessment necessitates supplementary quality assurance procedures that address geometric conformity and adherence to modelling standards, ensuring both information accuracy and spatial integrity within the BIM model.

2.1.2 UC1 – Scenario 1: Fire-code requirement generation (EIR)

A. Partners involved

Provided by	All partners
Contributors	Rf-Technologies, BIM-Connected, VN2R, ISEP, Exactusensu
Partners interested in this scenario	DBI: We are interested in helping architects, BIM designers etc. so that their project basis can be used for digital checks against building regulations. ASSAR: This scenario can help standardize the way fire safety data is included in BIM models. It is a prerequisite for all further uses/applications Rf-Technologies: this case is a prerequisite for use case 4 (compliance at material, component and system level). Including checking available data for fire compartmentation BIM-Connected: We believe that adoption of these technologies starts with enabling modelers to easily verify compliancy while not overloading them with unnecessary information requirements. VN2R: VN2R is interested in this scenario as it is essential to clearly define the information that must be integrated into BIM models to facilitate effective fire safety compliance checks. This approach will not only streamline workflows across projects but also enhance the quality of the models and minimize any potential gaps in the process. DST: is interested in expanding their BIM-services and related toolsets to support (more) automatic data verification to support fire safety assessment, from models in open and native formats. This first scenario will help the user with the discovery of relevant and applicable rules (from the Fire Code Repository), which in turn will be used to extract related exchange information requirements. ISEP: is interested in understanding the BIM models enrichment strategies regarding fire safety information. A clear understanding between relevant and non-relevant fire safety information is also crucial for the user to optimize the data enrichment strategy. Exactusensu: is interested in this scenario in order to help the users (architects and engineers) to better design their buildings with the least amount of iterations.

B. User Stories

(1) As an architect during the design phase I want to have a clear view or list of what information is required for my design to be checked against fire requirements required on specific projects. The list of requirements must be divided according to the fire regulations, so it is possible to incorporate the requirements into the design according to the project timeline.

(2) As a fire-safety expert I want to be able to communicate clearly which information is needed in each design stage to ensure that designs are fire-code compliant from an early stage and prevent costly and major design changes are needed at a later moment.

(3) As a BIM Manager, I want to ensure that the Exchange Information Requirements (EIR) are clearly defined so that all project stakeholders can include the necessary fire safety information at each stage, ensuring compliance with fire safety regulations throughout the project lifecycle.

(4) As an Architect/Engineer, involved in the design phase, I want to receive precise guidelines on the level of detail and completion required for each building element in the BIM model, so that I can accurately model components such as walls, doors, and fire protection systems, ensuring that they meet fire safety requirements, without wasting efforts on adding information that is not (yet) required.

C. Identification

Actor(s)	Architect: user Fire-safety expert: user							
Building phase(s)	All phases, but primarily:							
	0	1	2	3	4	5	6	7

	Strategic Definition	Preparation & Planning	Concept Design	Spatial Coordination	Technical Design	Manufacturing & Construction	Handover	Use
Goal	1. Specifying		2. Modelling		3. Verifying		4. Using the data	
	To specify the EIR, i.e. information required to carry out one or more analyses or checks		To enrich the BIM model with the information specified in the EIR		To verify that the BIM model contains all the information specified in the EIR		To realize analyses, checks, visualisations based on information in the BIM model	
Scope	This scenario applies to the identification and specification of information requirements for fire safety compliance checks within BIM models. It focuses on enabling compliance checks for specific fire safety domains, such as compartmentation, escape routes, and material compliance, across all relevant project phases, from concept design to construction. The scenario supports Use Cases 2, 3, and 4 by ensuring that BIM models are prepared with the necessary data for validation against fire safety regulations.							

D. Evaluation

Added value	Scenario 1 is pivotal in providing users with a clear view of the information that needs to be included in BIM models to enable effective fire safety compliance checks. By generating Exchange Information Requirements (EIR) in a format that suits the user's needs, this scenario supports the enrichment of BIM models with the necessary information for validation against regulations. This clarity enhances the efficiency and accuracy of compliance checks by ensuring that models are equipped with the right information at the right time, supporting consistent workflows across projects.
Boundary conditions	Connection with Other Scenarios: • Scenario 2: Scenario 1 provides users with a clear list of the required information for fire safety compliance checks, ensuring that models include the necessary data for the quality checks defined in Scenario 2. Connection with Other Use Cases: • Use Case 2 and Use Case 3: These use cases independently determine the fire safety checks they aim to perform. Scenario 1 supports this by helping users understand which information is needed in the BIM models to enable these checks. Connection with Work Packages: • Work Packages 2 and 3: These work packages define the fire safety rules, compliance checks, and requirements for BIM models. Scenario 1 translates these requirements into actionable guidance for end users, providing clarity on what information must be included in the BIM models and how it should be structured. Other boundaries: • Defining fire requirements during the initial stages of a project can be challenging due to the wide range of countries involved, each representing various variables such as differing codes and, consequently, diverse interpretations by fire experts. Additionally, architects and engineers should be willing to understand the IFC schema and integrate it into the model.

2.1.3 UC1 – Scenario 2: Quality checking for fire-code exchange information requirements

A. Partners involved

Provided by	All partners
Contributors	VN2R; Exactusensu; ISEP
Partners interested in this scenario	VN2R: VN2R's interest in this scenario lies in providing robust methods to ensure that BIM models contain the necessary information for each fire safety rule check. By focusing on quality assurance and control checks, VN2R seeks to enhance the reliability of compliance

	checks and ensure that the models meet the required standards for fire safety, contributing to a more efficient and consistent regulatory process. DST: To enable the automatic 'health check' of required information for fire safety, a machine-interpretable set of requirements can be integrated in our workflows and reported in the project dashboard. ASSAR: Automated compliance check for EIR, would be the only way to introduce EIR without generating lots of extra work. ISEP: is interested in understanding the best practices for the quality check of the BIM models regarding the fire safety information. This is an essential step for a successful code-check based on the FireBIM platform. Exactusensu: is interested in this scenario, as a reliable BIM model is mandatory for a robust compliance check.

B. User Stories

(1) As a BIM Coordinator, I want to verify that the coordinated design contains the necessary and correctly structured information, consistently applied across all models, without duplication, to enable fire safety compliance checks for specific rule sets.

(2) As an Architect or Engineer, I want to check if my model includes the necessary and correctly structured information to validate my design decisions against fire safety regulations for specific rule sets.

(3) As a Manufacturer creating BIM objects, I want to verify that my objects contain the correct information required for fire safety compliance, ensuring they meet the needs of designers and project requirements.

(4) As a Regulatory Compliance Officer, I want to check if the BIM model is suitable for verifying compliance with fire safety legislation, ensuring it contains the necessary data and is structured correctly.

C. Identification

Actor(s)	BIM Coordinator / BIM Manager: user Architect: user Modeler: user Engineer: user Fire-Safety Expert: user							
Building phase(s)	0 Strategic Definition	1 Preparation & Planning	2 Concept Design	3 Spatial Coordination	4 Technical Design	5 Manufacturing & Construction	6 Handover	7 Use
Goal	1. Specifying To specify the EIR, i.e. information required to carry out one or more analyses or checks		2. Modelling To enrich the BIM model with the information specified in the EIR		3. Verifying To verify that the BIM model contains all the information specified in the EIR		4. Using the data To realize analyses, checks, visualisations based on information in the BIM model	
Scope	The scope of Scenario 2 involves performing quality checks on Building Information Modelling (BIM) models to ensure they include the necessary information, structured correctly and consistently, to enable fire safety compliance checks. This scenario focuses on verifying whether the models are ready for specific fire safety rule sets, rather than the entire regulation, and ensuring they can be used effectively within the FireBIM platform and other external applications. The quality checks ensure that information is not duplicated, aligns across all models, and meets the requirements defined by Work Packages 2 and 3.							

D. Evaluation

Added value	The added value of Scenario 2 is in its ability to ensure that BIM models are complete, accurate, and ready for fire safety compliance verification, thereby reducing the risk of delays and costly revisions during the project lifecycle. By implementing robust quality checks, this scenario helps to identify and resolve issues early, ensuring that models meet the required standards for fire safety information. This proactive approach not only enhances the reliability of the FireBIM platform but also supports the efficient integration of fire safety compliance processes into existing BIM workflows. Furthermore, it enables seamless interoperability with external applications, ensuring that models are consistently prepared for fire safety checks across different platforms and projects.
Boundary conditions	**Connection with Other Scenarios:** • Scenario 1: Scenario 2 relies on the information requirements identified, organized, and provided by Scenario 1. These requirements serve as a basis for verifying whether BIM models include the necessary and correctly structured data for fire safety compliance checks. **Connection with Work Package 2 (WP2):** • Scenario 2 is closely aligned with WP2, which defines the fire safety rules and establishes the data dictionaries and ontologies. The quality checks in Scenario 2 must ensure that the BIM models contain the information required by the rules defined in WP2. This alignment guarantees semantic consistency and interoperability, ensuring that the models are suitable for compliance checks and knowledge management. **Connection with Work Package 3 (WP3):** • Scenario 2 is also connected to WP3, which specifies the information needs and tasks required for the FireBIM platform. The quality checks and associated processes in Scenario 2 must align with the requirements outlined in WP3, ensuring that BIM models are not only ready for fire safety compliance checks but also compatible with the data processing and analysis functionalities of the FireBIM platform. **Other boundaries:** • A key challenge in performing fire requirements checks is minimizing complexity and incorporating the appropriate tools to provide practical workflow solutions. Additionally, large models must be checked without compromising performance. Moreover, architects and engineers must possess a thorough understanding of the workflow, and the tools required to execute these checks efficiently throughout the process.

2.2 Use Case 2 – Compliance checking and additional guidance for prescriptive fire safety regulations in building design

2.2.1 Description

A. Overall idea:

Facilitate the use of prescriptive fire safety regulations in building design by combining BIM (for visualizations and analyses) with digitized compliance checks.

Relation to other use cases:

- The BIM model should contain the necessary information in order to realize these checks (cf. UC1).
- For compliance checking of specific building materials, components and systems, see UC4.

B. Target audience/persona

Design team: architects, fire safety engineers, BIM-modelers, MEP/structural engineers

C. Building phases

0	1	2	3	4	5	6	7
Strategic Definition	Preparation & Planning	Concept Design	Spatial Coordination	Technical Design	Manufacturing & Construction	Handover	Use

D. Objectives

Use BIM to obtain a **better and faster insight in a building's configuration and its fire safety design** through a combination of 2D/3D visualization and overviews of relevant data extracted from the model.

(1) **Assist building designers during the design process** by measuring, analysing and summarising geometrical and non-geometrical fire safety information in a BIM model.

(2) Based on (2), perform **automated compliance checking** with the most common fire safety legislation.

(3) Use outputs of (2) and (3) to **facilitate design discussions** with the fire safety engineer, fire departments, permit applications and fire safety checks during commissioning.

E. Rationale

(1) The design process of a (complex) building often takes more than a year for designers and engineers. This gives the design team a thorough understanding of the building and its structure, functions, movements flows, risks, etc. For third parties (e.g. fire department, city authorities) it can however be challenging to gain the same insights in short notice when evaluating a project for building permit. Reluctant to take any risks, this can lead to long evaluation periods and overly conservative recommendations. Additionally, faults that are overlooked can result in costly design changes after the building has already been constructed.

(2) Rule-based fire safety design is a valuable but often cumbersome part of building design. It currently still involves a lot of manual counting, measuring and calculating to see if a design complies with all applicable fire safety regulations. The process becomes ever so confusing if multiple sets of regulations apply (e.g. hospitals, schools, elderly care facilities, existing buildings with a new extension, etc.) Moreover, all these checks have to be repeated with every major design change. A tool that (partially or completely) automates this process by compiling all relevant fire safety data from the BIM model and performing automated compliance checks, could offer building designers valuable assistance during the design process. It could also help designers who are not as familiar with (certain parts of) the regulations (e.g. junior members of a team, international design teams, etc.)

(3) Output from (2) could serve as a starting point for the fire engineer and/or regulatory compliance officer to evaluate a building project. This could speed up the evaluation process.

2.2.2 UC2 – Scenario 1: Understanding a building in terms of fire safety

A. Partners involved

Provided by	ASSAR
Contributors	DBI / TUe / BIM-Connected / Buildwise / VN2R, Exactusensu / Peutz
Partners interested in this scenario	DBI: DBI are interested as it will be a feature that will help us and other fire consultants quickly screen a project at start-up. Today this is done manually, which is time-consuming and with a risk of errors. ASSAR: This scenario will help architects gain better insight into the fire safety design of their projects. VN2R: VN2R is highly interested as a design and BIM consultancy firm. This scenario is crucial for helping our clients understand the fire safety design aspects of their projects, enabling them to make informed decisions early in the design phase. Exactusensu: as fire safety experts, the main interest in this scenario is to help architects to draw the initial iterations of the project.

B. User Stories

(1) As an architect during pre-design and technical design I want to have a clear overview of the buildings fire safety solutions in order to communicate effectively and avoid mistakes.

(2) As a fire safety engineer during beginning of a project (in all phases), I want to have a clear overview of the buildings fire safety solutions in order to guide the buildings designers

(3) As an MEP/structural engineer during pre-design I want to have a clear overview of the fire safety compartmentations in order to create a technical/structural pre-design that fits these boundaries.

(4) As an MEP/structural engineer during technical design, I want to have a detailed and complete understanding of the compartmentations in order to create a technical/structural solutions that fits these boundaries

(5) As a regulatory compliance officer during building permit request, I want to have a quick and clear presentation of the building layout (with regards to fire safety) in order to assess whether the building conforms to regulations and the permission can be granted.

C. Identification

<table>
<tr><td>Actor(s)</td><td colspan="8">Architect
Fire safety engineer
MEP/structural engineer
Regulatory compliance officer (city/fire brigade)</td></tr>
<tr><td rowspan="3">Building phase(s)</td><td colspan="8">All phases, but primarily:</td></tr>
<tr><td>0</td><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td></tr>
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<tr><td rowspan="2">Goal</td><td colspan="2">1. Specifying</td><td colspan="2">2. Modelling</td><td colspan="2">3. Verifying</td><td colspan="2">4. Using the data</td></tr>
<tr><td colspan="2">To specify the EIR, i.e. information required to carry out one or more analyses or checks</td><td colspan="2">To enrich the BIM model with the information specified in the EIR</td><td colspan="2">To verify that the BIM model contains all the information specified in the EIR</td><td colspan="2">To realize analyses, checks, visualisations based on information in the BIM model</td></tr>
<tr><td>Scope</td><td colspan="8">This scenario does not include compliance checks. The viewer only gives an overview of the data available in the model.
Most common information necessary to understand a building with regards to fire safety
• General info
  ○ Height classification
    ▪ BE: low/medium/high-rise
    ▪ DK: max height of upper floor (5m/9,6m/22m/45m)
    ▪ PT: max height of upper floor (9m/28m/50m/>50m)
  ○ Occupancy
    ▪ BE: Max. number of people + occupant type 1-3 (non-self-reliant/sleeping/awake)
    ▪ DK: Use category 1-6 (overnight/daytime, knowledge of escape routes, the ability to get to safety on their own, Maximum number of people)
    ▪ PT: Max number of people + sleeping occupancy / non-self-reliant occupancy
  ○ Function (building/section/room)
    ▪ Construction year (building permit)
• Layout
  ○ Distance to site boundaries and other buildings
  ○ Fire compartments and subdivisions
    ▪ BE: subcompartments and rooms with specific requirements</td></tr>
</table>

	▪ DK: fire cells ▪ PT: subcompartments and rooms with specific requirements o Evacuation routes o Evacuation stairs o Evacuation exits ▪ doors ▪ windows including fire rescue area in terrain ▪ Gates o Fire truck routing • Passive fire safety measures o EI rating of walls/floors (design requirement) o R rating of structural elements (design requirement) o Doors and windows ▪ BE: EI1 rating, closing mechanism ▪ DK: EI2 rating, closing mechanism, smoke ▪ PT: EI2 rating, closing mechanism o Fire protection (K1 10) and/or reaction to fire (Euroclass) for claddings and finishing • Active fire safety measures: o Detection & warning ▪ Automatic fire alarm system ▪ Automatic warning systems o Suppressing & extinguishing ▪ Automatic fire ventilation system ▪ Automatic pressurization system ▪ Automatic sprinkler system ▪ Hydrants ▪ Fire hoses ▪ Dry risers ▪ Fire extinguishers o Evacuation ▪ Escape route and panic lighting system ▪ Smoke ventilation o Fire safety Control Unit • Location of risks o Electrical units (low / high voltage) o Dangerous storage: gases, inflammable goods, etc o Productions

D. Evaluation

Added value	• Speed up and facilitate building design by developing a tool that gives the designer a live overview of relevant fire safety data in the model • Facilitate communication in the design team and with third parties through better visualizations of fire safety information. • Avoid digital labour and duplication of info in BIM models.
Boundary conditions	• Data requirements evolve throughout project. Close link to UC1: definition of IDS • Data requirements differ by country. Focus on commonalities to start • Visual filtering depending on targeted use • Different data types: o Elements

	▪ e.g. table of compartments, list of evacuation stairs, list of evacuation exits, etc. o Relations between elements ▪ e.g. compartment has x exits/stairs o Parameters ▪ e.g. area of compartments; width/height of stair risers; etc o Geometrical ▪ e.g. width of corridors, o Computed ▪ e.g. combined width of exit doors per compartment

2.2.3 UC2 – Scenario 2: Automated compliance checks for prescriptive fire requirements

A. Partners involved

Provided by	ASSAR / DBI / BIM-Connected
Contributors	TUe / Buildwise / VN2R / ISEP / Exactusensu / Peutz
Partners interested in this scenario	DBI: It will help the designers and fire engineer create a design within the prescribed limits, as well as clarify areas of the project that cannot be handled within the prescribed limits. Rf-Technologies: fire compartmentation (definition of fire resistance of the boundaries) is a prerequisite for use case 4. Peutz: For us, this will be the main goal of FireBIM (differentiated per building phase). ASSAR: Automated compliance checking is a preferred goal of the project. It would assist architects during the design process and reduce menial, repetitive tasks. VN2R: It will help our clients to understand how to structure information in BIM models and incorporate fire safety elements, enabling automated compliance checks. This approach will significantly benefit our clients by reducing rework and ensuring compliant designs before the building permit analysis phase. ISEP: is interested in understanding how to perform an early stage and automated compliance checks regarding the prescriptive fire requirements. Exactusensu: As the primary objective of the project, this will enable cost savings during the design phase, benefiting the entire team, especially during the initial architectural iterations.

B. User Stories

(1) As an architect during the early design phase, I want to perform quick compliance checks to verify whether a concept design conforms to relevant parts of prescriptive fire safety regulations with regards to

(2) As an architect during the technical design phase, I want to efficiently translate the spatial layout into a technical design that complies with prescriptive fire safety regulations.

(3) As an architect during the technical design process, I want to perform complete compliance checks to verify whether a building design conforms to prescriptive fire safety regulations.

(4) As a fire safety engineer during the beginning of a project (in all phases), I want to have a clear overview of the building compared to the prescriptive fire safety solutions to guide the buildings designers.

(5) As a regulatory compliance officer during permit evaluation, I want to have an overview of compliance checks performed by the design team to facilitate the assessment.

(6) As a contractor during the technical design (or before the manufacturing phase), I want to validate the works/outcome of our external advisors/engineers:

   a. to check if the desired escape path is correct, in relation to the floor plan design, based on the building code.
   b. to check whether fire prevention measure (+ fire sealing) should be used for HVAC+E systems.

C. Identification

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<tr><td>Scope</td><td colspan="8">

Automated compliance check based on building geometry, pathfinding algorithms, BIM metadata and fire safety regulations
The scope for this scenario will be limited to compliance checking of fire compartmentation and escape routing. The relevant checks will differ depending on the project phase:

Early design / concept design

Max. floor area of fire compartments
Min. number of escape exits
Max. number of people allowed in a compartment
Max. travel distances

Distance between staircases/exits (door-to-door)
Distance from any point in compartment to evacuation route (point-to-door)
Distance from any point in compartment to 1st exit (point-to-door)
Distance from any point in compartment to 2nd exit (point-to-door)
Distance from any dead end on evacuation route to 1st exit (point-to-door)

Min. usable height/width and max. usable slope of escape routes
Spatial separation of compartments (e.g. by a lobby)

Technical design

Fire resistance rating for walls/floors
Fire protection (K1 10) and/or reaction to fire (euroclass) rating for claddings and finishes.
Requirements for doors (fire resistance, reaction to fire, smoke resistance, closing mechanism, direction of opening, etc.)

Countries will be selected based on participating parties in application development.

</td></tr>
</table>

D. Evaluation

Added value	• Give designers immediate first-line feedback on regulation compliance, without interruption the design process for calculations • Speed up fire safety compliance checking (for fire safety engineers / fire brigade) of BIM models created by third parties.
Boundary conditions	• Regulations for fire compartments and escape paths differ between countries ○ DK: Evacuation path runs on orthogonal grid with 90° angles. Furnishings not taken into account

	○ BE: Shortest 'realistic' path. Obstacles and furnishings taken into account. ○ NL: Two different checks: Calculating the shortest path including internal walls and additionally calculating the shortest path without internal walls. The calculation is done by taking the shortest 'realistic' path without obstacles and furnishings. ○ PT: In rooms, shortest path should be calculated with obstacles and furnishings taken into account. In corridors, evacuation path runs on orthogonal grid with 90° angles. • Definitions of certain concepts (e.g. areas/ distances /compartmentations etc.) differ between countries

2.2.4 UC2 – Scenario 3: capturing existing buildings for retrofit design projects

In recent years, the building rehabilitation market in Europe has become a key driver of the construction industry, accounting that approximately 35% of European buildings are over 50 years old. By 2030, the European Commission aims to retrofit 35 million buildings, reflecting both private and public sector efforts in revitalizing aging buildings. Therefore, a relevant number of new design projects for fire safety compliance checks are retrofit projects of existing buildings. However, most of these buildings lack the geometric information required for the fire safety code checks, since no design drawings are typically available. This includes information about compartment areas, number and location of openings, existence (or not) of fire detection systems, safe evacuation routes, etc. Also, information related to the surrounding areas of the building is very relevant, such as neighbourhood buildings, roads, walkways, etc., which in most situations are poorly detailed.

A. Partners involved

Provided by	ISEP
Contributors	VN2R / Exactusensu / ASSAR
Partners interested in this scenario	ISEP: it will open the possibility to promote specialized training courses and consultancy services to the AEC market, particularly in the topic of reality capture and digitalization of building assets regarding the specificity of the fire safety design on retrofit projects. VN2R: VN2R is interested in this scenario because it offers the potential to improve model quality for both new construction and retrofit projects. By enabling a systematic evaluation of fire safety requirements from the earliest stages of design, this approach ensures greater efficiency and compliance. A key benefit is the use of point cloud data, which enables the creation of highly accurate models by incorporating all existing constraints. This provides a reliable and solid foundation for subsequent development phases, starting from the very beginning and supporting a streamlined and effective design process. Exactusensu: With the current construction situation, most large cities will need to adapt existing buildings to the current regulatory needs. Building refurbishment will therefore become a pillar in the near future. This project will therefore be important in driving forward the verification of the legal requirements to be implemented. ASSAR: A significant part of Assar's portfolio consists of renovation projects, and this is only expected to increase as regulations on embedded carbon get stricter. Capturing the existing building and its surroundings in BIM is an important, but time-consuming part of these projects. We greatly welcome any innovation that helps streamline this process.

B. User Stories

(1) As an architect, in the preliminary design stage, I want to have reliable and precise geometric information, not only from the existing building but also from the surrounding zones, in order to define optimal constructive solutions regarding the fire safety.

(2) As a fire safety engineer, during the design stage, I would like to have a 3D BIM model including all the relevant geometric information regarding the floor plans, vertical circulation, escape routes, openings, fire compartments and barriers, ceiling heights and volumes, structural elements, facades, etc., in order to effectively assess and plan the fire safety measures.

(3) Also, as a fire engineer and during the design stage, I need a clear understanding about the topography (and defining the reference plane), the access conditions for fire vehicles, the existing fire equipment, and the conditions for neighbouring buildings, such as identifying their height, openings, distance from them, and their usage types.

(4) As a fire safety engineer, during the permit evaluation, I want to have a BIM model based on reliable geometric information that can be used for further retrofit/upgrades of the building, to ensure that the retrofit strategies meet fire safety standards.

C. Identification

Actor(s)	*Architects, fire safety engineers and building contractors*							
Building phase(s)	0 Strategic Definition	1 Preparation & Planning	2 Concept Design	3 Spatial Coordination	4 Technical Design	5 Manufacturing & Construction	6 Handover	7 Use
Goal	1. Specifying To specify the EIR, i.e. information required to carry out one or more analyses or checks		2. Modelling To enrich the BIM model with the information specified in the EIR		3. Verifying To verify that the BIM model contains all the information specified in the EIR		4. Using the data To realize analyses, checks, visualisations based on information in the BIM model	
Scope	A retrofit project of an existing building requires the collection of specific geometric information using a reality capture strategy, to ensure that the fire safety standards are accomplished. In addition, the information about the surroundings of the building is relevant for some specific checks. Also, new buildings still require information about the surroundings. The key information includes: 1. General building layout: accurate dimensions and spatial layouts of all floor's plans; identification of room size and use (e.g., residential, commercial, storage) to check against zoning and occupancy limits. 2. Circulation and accessibility: clear mapping of all evacuation routes and exits; measurements of corridor widths, door dimensions, and exit distances; dimensions of staircases (width, tread depth, riser height) for compliance with escape and accessibility regulations; elevator dimensions and placement for emergency use; ramps, lifts, and accessible doorways for compliance with disability access standards. 3. Fire safety features: placement and geometry of fire-rated walls, doors, and floors; locations of service penetrations or other potential openings; location and dimensions of emergency exits and signaling areas; position and clearance of entry points for firefighters and emergency vehicles. 4. External features: locations and sizes of external windows, doors, and openings to verify compliance with external fire spread regulations; dimensions of roadways and pathways for emergency vehicle clearance and turning radii. 5. Compliance with zoning and building codes: total building height, floor-to-floor dimensions, and distances from property lines; gross floor area and usage allocations for compliance with density and occupancy rules. All the geometric information of the existing building and surroundings is used to develop (or enrich) a BIM model that will be used for record keeping and for the further automated code checks.							

D. Evaluation

Added value	Allow to have an automated and validated workflow to collect geometric information about existing buildings under new retrofit projects. This workflow retrieves information about the interior and exterior of the buildings and their surrounding area. The proposed reality capture workflow is robotic-based, on-time and easy to implement, while the existing procedures are typically manual-based, time-consuming and cause delays in the fire safety design process. Allow the efficient development of BIM models of existing buildings under retrofit projects, and their compatibilization with the FireBIM platform. The development of an efficient scan-to-BIM

	procedure will allow us to include in the FireBIM workflow the retrofit project of existing buildings, which represents a significant part of the new designs in some European countries. Allow to collect non-geometric information of the existing buildings, mainly related to the materials and fire extinction elements, which is relevant for specific fire safety checks.
Boundary conditions	Access to high-end equipment (e.g., LiDAR scanners or drones), high-end hardware (e.g., to process point cloud data) and high-end software (e.g., to efficiently manage big point-cloud data). Expertise can differ significantly between European countries. Smaller firms or municipalities in less economically developed regions may lack the resources to invest in or utilize these technologies effectively. In dense urban environments or underground areas (e.g., older cities), physical obstacles such as narrow streets, dense foliage, or underground structures can hinder data capture and reduce the accuracy of scans. National regulations may impose additional restrictions, such as specific permits required for drone use in public areas or near sensitive infrastructures. Countries with frequent adverse weather (e.g., heavy rain or snow), as well as seasonal changes in vegetation (e.g., leaves obstructing views of buildings during summer) or low-light conditions (common in northern countries in winter), can disrupt outdoor data collection, particularly for photogrammetry and drone-based surveys.

2.3 Use Case 3 - Facilitate the management of fire code exceptions for a building permit

2.3.1 Description

A. Overall idea

Help architects and engineers obtain timely approval for safe, evidence-based solutions that deviate from prescriptive fire safety legislation.

This use case mainly focuses on the approval process in Belgium but can be expanded for use in other countries.

B. Target audience/persona

Architects and engineers, public authorities, insurance companies

C. Building phase

0	1	2	3	4	5	6	7
Strategic Definition	Preparation & Planning	Concept Design	Spatial Coordination	Technical Design	Manufacturing & Construction	Handover	Use

D. Objectives

(1) Use the FireBIM platform to objectify and categorize different types of exceptions from the prescriptive fire code, by comparing them with fire safety legislation in other countries. This might give insight into whether a specific situation or exception is reasonable or not. It can also help the designer to proof whether a design choice can be seen as an 'equivalent solution'. (Dutch: *'gelijkwaardigheid' van oplossingen*). The approach can be used both by building designers (to make sensible design choices and build a case) and by public authorities (to evaluate the proposed exception).

(2) Create a web-based platform that enables users to create custom rulesets based on project-based requirements.

a. Create, edit and delete rules and safe these changes for evaluation (Level1-3) of models.

b. Export custom IDS based on parameters needed validate custom set as mentioned in 2a.

E. Rationale

Fire safety regulations can impose significant constraints on building design. For large or complex buildings, designers often apply for exceptions, using performance-based calculations to demonstrate that an alternative approach provides a similar level of safety. These exceptions are frequently granted but only after a lengthy approval process—nine months is common in Belgium. Designers must decide whether to risk a long approval process and potential rejection for a better design or settle for a less satisfactory design from the start.

2.3.2 UC3 – Scenario 1: Designing with an equivalent level of fire safety

A. Partners involved

Provided by	ASSAR
Contributors	ASSAR, ETEX
Partners interested in this scenario	ASSAR: By demonstrating that a design choice deviates from Belgian fire code but would still comply with the equivalent fire code of other countries, we hope to build a strong case to get approval from public authorities. Etex: Understand the preliminary needs in the early design phase and adapt the service and digital product and system information to ensure the right information is integrated. Move the expertise that would normally be integrated much later in the process, towards the technical design phase to ensure the feasibility during execution and increase fire safety.

B. User Stories

(1) As an architect / fire safety engineer during building design I want to verify whether a design choice that doesn't comply with prescriptive fire legislation, can reasonably be considered safe.

(2) As a public authority during permit evaluation, I want to check whether a building design that deviates from the fire code is can be allowed as an 'equivalent solution'.

(3) As a manufacturer, I want to adapt my digital product and system information in order to suit the requirements for a smoother permit approval and increase practical insights during the design phase.

C. Identification

Actor(s)	Architect / fire safety engineer / public authorities							
Building phase(s)	0 Strategic Definition	1 Preparation & Planning	2 Concept Design	3 Spatial Coordination	4 Technical Design	5 Manufacturing & Construction	6 Handover	7 Use
Goal	1. Specifying To specify the EIR, i.e. information required to carry out one or more analyses or checks		2. Modelling To enrich the BIM model with the information specified in the EIR		3. Verifying To verify that the BIM model contains all the information specified in the EIR		4. Using the data To realize analyses, checks, visualisations based on information in the BIM model	
Scope	Geographical: The fire code that is taken into account is limited to the countries participating in the project and/or this use case scenario. Technical: See scope UC2. The same sections of the fire code will be taken into consideration for this use case scenario.							

D. Evaluation

Added value	• Faster approval times • Better insight in fire safety legislation in other countries • More freedom for design teams to create complex or non-standard designs

Boundary conditions	Alignment with public authorities
	• Practical usability depends strongly on the approval of this scenario by the public authorities in charge of fire code exceptions.
	  ○ The proposed approach should align with their expert opinion.
	  ○ Reduction of approval times is only possible if the scenario provides a clear solution to why the approval process takes a lot of time. It might be a problem of liability, staffing, administrative burden, unclear or overly complex procedures, unclear communication by the design team, etc.
	  ○ The information package that is transfered to the authorities (possibly including a BIM model) should comply with their expectations and requirements.
	Alignment of fire safety legislation
	• Not every fire safety concept has a one-to-one translation in each national fire code.
	• The fire safety of a building is usually designed holistically. It might be difficult to evaluate only the part of a building that requires an exception, without considering the wider context.
	Alignment with other use cases
	• Optimise the use of the outcome of use case 2 to improve the understanding of increased insights and their needs to make better judgements.
	• Verify the process from use case 4 in regard of compliance checks to ensure the checks are aligned with the requirements to check for fire safety and its exceptions in order to approve deviations whilst still covering the needs for fire safety.

2.3.3 UC3 – Scenario 2: Identify required values & insights for fire brigade

Provided by	Etex
Contributors	Etex
Partners interested in this scenario	Etex: The firebrigade has always been a valuable and important partner in order to achieve and approve the fire safety of buildings. Their experience and responsibility must be supported with improved insights. Providing a single source of truth in a digital format will help their judgement. As a manufacturer it's valuable to understand how our products, data and knowledge will be able to support their decision making for better fire safety and a smoother approval process.

A. User Stories

As a fire brigade, there is an import role in the final discission making whether public buildings get their approval for commissioning. However, their involvement during the construction process itself is quite limited. Therefor their overall impact and responsibilities can be listed as below:

Use Case 1. Late activity and involvement in the construction process

Use Case 2. low impact into the design and engineering

Use Case 3. High potential but low responsibility into acceptance of deviations

Use Case 4. Very limited capabilities to be able to work with a digital BIM model

As the fire brigade as a limited involvement during the construction process and has limited potential towards digital developments, their main benefits and can be found in:

- Increased level of insights (data for UC2)

The result must be incorporated back into the other UC's to be challenged for their impact and possibilities/opportunities.

The final outcome of this exercise will be verified again to see if they meet the expectations of the fire brigade.

B. Identification

Actor(s)	Fire brigade, Fire safety engineers							
Building phase(s)	0 Strategic Definition	1 Preparation & Planning	2 Concept Design	3 Spatial Coordination	4 Technical Design	5 Manufacturing & Construction	6 Handover	7 Use
Goal	1. Specifying To specify the EIR, i.e. information required to carry out one or more analyses or checks		2. Modelling To enrich the BIM model with the information specified in the EIR		3. Verifying To verify that the BIM model contains all the information specified in the EIR		4. Using the data To realize analyses, checks, visualisations based on information in the BIM model	
Scope	Question fire brigade about their current strategy and options. Challenge current and future BIM developments to increase the insights and potential to approve deviations based on data, geometrical visualizations and model checks. Incorporate the feedback to challenge the other UC's. Outcome must be verified again with original contributors.							

C. Evaluation

Added value	Increase the outcome and effect of other UC's with improved insights due to integrating a practical approach.
Boundary conditions	Gathering info and challenging outcome of other UC's. No developments required.

2.4 Use Case 4 - Fire safety compliance checks at the material, component and system level

2.4.1 Description

A. Overall Idea

The idea is to help designers and (sub)contractors to guide and validate the choices of materials, components and systems, in order to be compliant with the defined fire compartment rules and required fire resistance of the compartment boundaries. Materials, components and systems include everything needed to restore the fire resistance of fire compartment boundaries when MEP installations are going through them, and the types of walls used as boundary.

B. Target audience/persona

Designers and (MEP-) contractors (for the use), manufacturing companies (for the realization), fire engineers (validation)

C. Building phase

Technical design (RIBA4), manufacturing and construction (RIBA5), exploitation (use) (RIBA 7)

D. Objectives

(1) Automated or guided compliance check on the level of materials (e.g., fire-safe sealings, …), components (e.g. fire dampers, fire doors...) or systems (e.g. wall configurations with different layers...), by using the combination of BIM information and indications / regulations from the FireBIM platform.
(2) Facilitate the conversion of generic models to models with very specific materials, where material selection should be validated.
(3) Facilitate the conversion of generic models to brand specific components or systems, taking into account (brand) specific additional requirements to achieve the required fire safety.
(4) Facilitate the validation of different variants as proposed by the execution team (often based on other material choices or alternative components or systems)

The development of validation tools (and configurators) depends on the output of Use case 1, in particular the creation of a set of Information Delivery Specifications (IDS) related to the fire safety domains of compartmentation (partitioning) and material compliance.

E. Rationale

The conversion, in a building project, of generic fire safety solutions (materials, components and systems) into concrete, brand or material specific solutions is often accompanied by the need for additional validations, as well as additional measures to achieve the required fire safety. By providing the designer or contractor with validation tools and configurators, the additional required measures are made visible, cost estimation are made easier, time is saved and, most importantly, errors are avoided in the execution phase. Correcting these errors in execution phase are often associated with high additional costs and project delays.

The conversion of many fire safety requirements is heavily reliant on material selection. It is critical for manufacturers of (bulk) materials and material systems (e.g., specific configuration of drywall with combination of frame, insulation, panel types, glue, and other fastening materials) to assist designers with the materialization of their conceptual models. They can, of course, integrate their products into the project with this assistance, which is related to validation of compliance based on their products. Smart product configurators, perhaps even directly linked to modelling tools, are a natural next step in this process.

2.4.2 UC4 – Scenario 1: Compliance checking tool for ventilation penetrations (into compartment boundaries)

A. Partners involved

Provided by	Rf-Technologies
Contributors	Rf-Technologies / VN2R / Exactusensu
Partners interested in this scenario	DBI: In Denmark, there are huge challenges in getting the knowledge about material performance requirements, in relation to fire requirements throughout the construction chain. Often the errors are not discovered until the building is built and about to be handed over. As a testing institute, DBI want to help the process so that knowledge about the materials and their control becomes easier and can be done as early as possible in the design, so that errors can be found before they are built. VN2R: VN2R is interested because it allows us, as consultants, to guide our clients in making compliant decisions regarding fire dampers and ventilation penetrations through compartment boundaries. This ensures that fire safety requirements are met early in the design process, avoiding costly errors later on. Exactusensu: is interested in defining the fire limits of the various compartments, in order to assist the HVAC engineers in the development of the respective projects.

B. User Stories

(1) As an HVAC installer / designer I would like to be able to localize where fire dampers are needed and be guided in choosing brand-specific solutions that are compliant with the required fire resistance of the compartment boundaries, as defined in the overall design of the project. The tool should help me find a compliant fire damper, based on the type of wall (type/material/thickness/fire resistance) and available sealing methods. It would allow me to report back if additional measures would be required.

C. Identification

Actor(s)	MEP designer, (sub)contractor, Fire engineer, Manufacturer							
Building phase(s)	0 Strategic Definition	1 Preparation & Planning	2 Concept Design	3 Spatial Coordination	4 Technical Design	5 Manufacturing & Construction	6 Handover	7 Use
Goal	1. Specifying To specify the EIR, i.e. information required to carry out one or more analyses or checks		2. Modelling To enrich the BIM model with the information specified in the EIR		3. Verifying To verify that the BIM model contains all the information specified in the EIR		4. Using the data To realize analyses, checks, visualisations based on information in the BIM model	
Scope	(large) The validation rules, incorporated in the compliance checking tool for ventilation penetrations through compartment boundaries, are entirely based on European standards (starting from EN 15650 and EN 1363-1). The tool and application are common to all countries where EU regulation is used (which is actually broader than just EU-members).							

D. Evaluation

Added value	(high) Service penetrations through fire compartment boundaries (whether ventilation ducts or other) are a big source of non-compliancy in buildings and rejections by fire brigades or controlling authorities. The compliance checking tool can provide more insights in earlier stages, reducing costs and delays in building acceptance. Since the rules for checking are based on European standards, the tool is applicable and can be widely adopted in EU-countries. The stakeholders are the design teams and the (mechanical) contractors.
Boundary conditions	(low complexity) Ideally the tool builds on the output of use case 2 output c: “Automated compliance checks – simple validation (fire compartments). The EI-classification will serve as input to match with the fire damper classification. The input will be a combination of data and geometric aspects for 3 objects: the compartment boundary, the fire damper and the fire-resistant seal.

2.4.3 UC4 – Scenario 2: Compliance checking for other penetrations (into compartment boundaries)

A. Partners involved

Provided by	Rf-Technologies
Contributors	Rf-Technologies / VN2R / Exactusensu
Partners interested in this scenario	DBI: In Denmark, there are huge challenges in getting the knowledge about material performance requirements, in relation to fire requirements throughout the construction chain. Often the errors are not discovered until the building is built and about to be handed over. As a

	testing institute, DBI want to help the process so that knowledge about the materials and their control becomes easier, and can be done as early as possible, so that errors can be found before they are built. VN2R: VN2R is focused on helping clients manage compliance checks for various service penetrations, such as pipes and cables. This will help our clients detect non-compliance issues before installation, reducing the risk of rework and project delays. Exactusensu: is interested in defining the fire limits of the various compartments, in order to assist the electrical and plumbing engineers in the development of the respective projects

B. User Stories

(1) As a MEP designer/contractor it is important to identify every opening and crossing of services (e.g., pipes, cables, trays...) through a compartment boundary. Today this is often a manual job. The second part is to find a suitable penetration seal that is certified to restore the required fire resistance. If needed the installer will need to report back the additional measures required to get to a compliant solution. Those measures might need to be validated by the fire engineer / manufacturer.

C. Identification

Actor(s)	MEP designer, (sub)contractor, Fire engineer, Manufacturer							
Building phase(s)	0 Strategic Definition	1 Preparation & Planning	2 Concept Design	3 Spatial Coordination	4 Technical Design	5 Manufacturing & Construction	6 Handover	7 Use
Goal	1. Specifying To specify the EIR, i.e. information required to carry out one or more analyses or checks		2. Modelling To enrich the BIM model with the information specified in the EIR		3. Verifying To verify that the BIM model contains all the information specified in the EIR		4. Using the data To realize analyses, checks, visualisations based on information in the BIM model	
Scope	(Large) The validation rules, incorporated in the compliance checking tool of EN-1366-3 penetrations through compartment boundaries, are largely based on European standards. Local (national) exception rules are limited and could be left out. The tool and application are common to all countries where EU regulation is used (which is actually broader than just EU-members).							

D. Evaluation

Added value	(High) Service penetrations through fire compartment boundaries are a big source of non-compliancy in buildings and rejections by fire brigades or controlling authorities. The compliance checking tool can provide more insights in earlier stages, reducing costs and delays in building acceptance. Rules for most penetrations (pipes, cables, trays, blank seals...), are based on a European set (summarized in EN 1366-3). The stakeholders are the design teams and contractors.
Boundary conditions	(low complexity) As with the compliance tool for ventilation penetrations, this tool builds on the output of use case 2 output c: “Automated compliance checks – simple validation (fire compartments). The EI-classification will serve as input to match with classification of the service. The input will be a combination of data and geometric aspects, quite similar to PoC a.

2.4.4 UC4 – Scenario 3: Identify required values for manufacturers & subcontractors (installers)

Provided by	Etex
Contributors	Etex, NOA, Buildwise,...
Partners interested in this scenario	

A. User Stories

As a subcontractor or manufacturer, there is a lot of specific knowledge and experience that could heavily impact the underpinning of the acceptance of a deviation.

- Late activity and involvement in the construction process
- medium impact into the design and engineering
- High potential but low responsibility into acceptance of deviations
- Low capabilities to be able to work with a digital BIM model

The main challenge will be incorporating digital developments into a subcontractor's skills. Adding to this their insights must be consulted much sooner in the process to make sure the final engineered BIM model meets the available products/systems and installers manual.

For installers we would mainly see benefits in

- Increased level of insights (data for UC2)

For manufacturers there is a potential to have bigger involvement and opportunities depending on their BIM maturity level. Therefor the importance and impact below will have a proper variation:

- High availability of data (data for UC1)
- Increased level of insights (data for UC2)
- Extra verification opportunities with automated model-checking (Data for UC4)

The result must be incorporated back into the other UC’s to be challenged for their impact and possibilities/opportunities.

The final outcome of this exercise will be verified again to see if they meet the expectations of the subcontractors and manufacturers.

B. Identification

Actor(s)	Manufacturers, (sub)contractors							
Building phase(s)	0 Strategic Definition	1 Preparation & Planning	2 Concept Design	3 Spatial Coordination	4 Technical Design	5 Manufacturing & Construction	6 Handover	7 Use
Goal	1. Specifying To specify the EIR, i.e. information required to carry out one or more analyses or checks		2. Modelling To enrich the BIM model with the information specified in the EIR		3. Verifying To verify that the BIM model contains all the information specified in the EIR		4. Using the data To realize analyses, checks, visualisations based on information in the BIM model	
Scope	Question multiple manufacturers and (sub)contractor firms about their current strategy and options. Challenge current and future BIM developments to increase the insights and potential to approve deviations based on data, geometrical visualizations and model checks. Incorporate the feedback to challenge the other UC’s. Outcome must be verified again with original contributors.							

C. Evaluation

Added value	Increase the outcome and effect of other UC's with improved insights due to integrating a practical approach.
Boundary conditions	Gathering info and challenging outcome of other UC's. No developments required.

2.5 Use Case 5 - Virtual trainings

The use case 5 (Fire trainings) included in this document has not been developed further than in the project proposal. This use case varies from the others requiring other knowledge and skills as fire simulation. Since its scope is slightly different and does not feed into the other use cases, virtual trainings will not be developed in the first instance. The priority is given to the first four use cases.

2.5.1 Description

A. Target audience/persona

Building owners & facility managers, fire departments, …

B. Objective

Create virtual trainings based on the actual BIM model of the construction, in line with specific fire safety regulations.

C. Rationale

Fire safety trainings are more generic in nature (which is an excellent starting point). On top of this generic approach, virtual trainings that employ the real building configuration - and situations/accidents based on the structure's typical behaviour - might be an important benefit to a variety of complex buildings (hospitals, industrial sites, offices, schools, etc.).

This use case has been pitched by some of the contacted, interested market partners, but has not yet been fully developed by the project partners, which are mainly interested in tests as end-client on own construction projects.

3 Solutions

This section aims to list intentions for solutions to support the scenarios defined in section 2 (Use cases).

3.1 Template : 2D/3D visualisation of fire safety data in BIM

3.1.1 Description

A. Goal & Related scenario(s)

Goal : Visualization of fire safety data in BIM for design collaboration.
Related scenarios:

(1) 2.2.2 UC2 – Scenario 1: Understanding a building in terms of fire safety

See UC2-S1 'Scope' for full overview of relevant data to be considered. Country-specific templates should be created due to differences in regulations and iconography.

B. Type

Visualisation template for software

- Proprietary design software: Revit / Archicad / etc.
- Open BIM: IFC
    - Ensure correct exports from design software
    - Visualization and filtering -> online viewers TU/e (?)

Each template or set of templates includes modelling guidelines to inform the user how the BIM model should be structured for correct visualization.

C. Partners interested in the realization

- ASSAR: develop templates in Revit, provide data sets, validate results of prototypes developed for other softwares.
- Buildwise: develop templates for IFC (which software?)
- TU/e: develop templates for web-based visualization.

D. Actors

Primary: architects and fire safety engineers
Secondary: MEP engineers, structural engineers, contractors

3.1.2 Implementation

A. Sequence of actions (by users and parts of the solution) - describe the user experience in a broad outline.

When modelling in BIM, the user (architect, modeller, fire safety engineer) will be able to rely on premade visualization templates to generate clear, appealing and complete 2D and 3D views of a model without the need for manual lay outing or annotating. The views can be exported for communication with other parties.

B. Input data - what the user must give the application to achieve the use case.

An incomplete or complete BIM model *created using the accompanying modelling guidelines.*

C. Output data - the results obtained, what the application sends back to the user.

The fire safety visualizations could include the following examples:

(1) 2D overview plans with all relevant fire safety data in the BIM model:

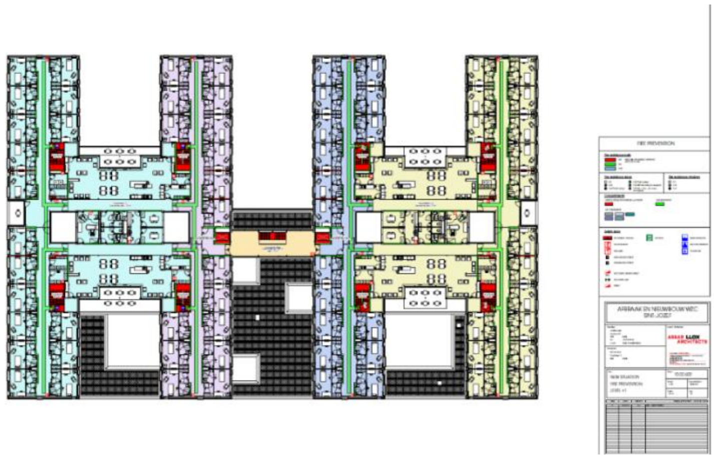

Figure 1. Example output: Fire safety plan of a construction project in Belgium (ASSAR)

(2) simplified/filtered 3D views of a building to give quick insight into the layout:

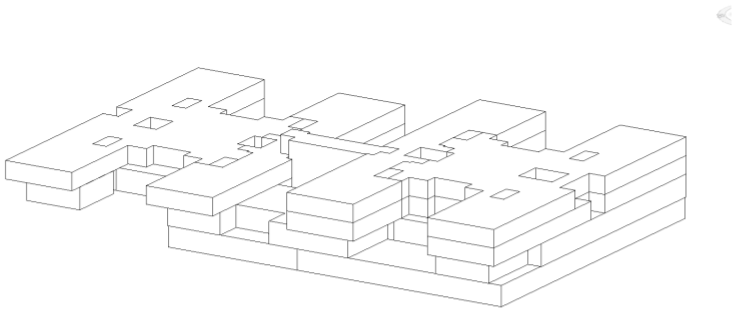

Figure 2. Example output: 3D view of fire compartments (mock-up, ASSAR)

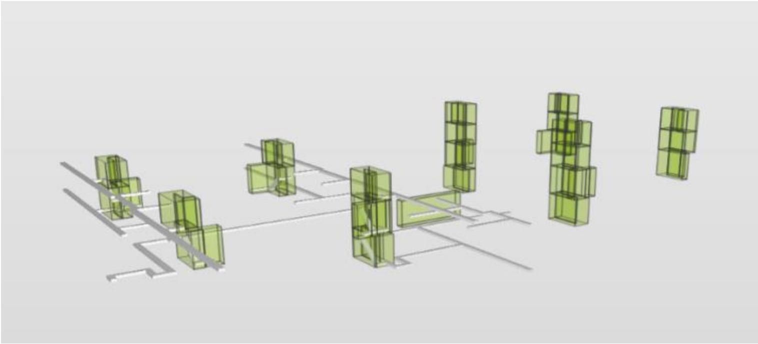

Figure 3. Example output: 3D view of evacuation route and staircases (mock-up, ASSAR)

D. References - standards needed for the UC

- BEL : AR/KB 7/7/1994 Basisnorm Brand Annex 2/1 Lowrise buildings
- NLD : Besluit Bouwwerken Leefomgeving, Hoofdstuk 4, Afdeling 4.2
- DNK : Bygningsreglementet (BR18), Chapter 5 (§82-§158)

- PRT : Regime Jurídico da Segurança Contra Incêndio em Edifícios (RJ-SCIE) + Regulamento Técnico de Segurança Contra Incêndio em Edifícios (RT-SCIE)
- LTU : ...

E. Application limitations

Templates typically rely on a one-to-one interpretation of the modelled data. The user will need to follow the modelling guidelines in detail to ensure that everything is visualized correctly. Alternatively, the user could be given the option to change the templates to fit their own established modelling practices.

F. Highlight differences by country

The data that is included in the templates, as well as the visualization conventions (what is di*splayed and how) might differ from country to country depending on local legislation and best practices.*

G. Process for interacting with the PoC

3.2 Application: Visualizing fire safety design for emergencies

3.2.1 Description

A. Goal & Related scenario(s)

Goal: Quickly visualize a buildings fire safety design for fire brigades in emergency situations. The application should focus on simplified visuals that contain the most essential information, give an overview of the building, and make it easy to orient oneself.

Related scenarios:

(1) 2.2.2 UC2 – Scenario 1: Understanding a building in terms of fire safety

B. Type

Application for mobile devices (tablet/phone) used by emergency services. This can build upon the work in application 3.1, with specific templates for emergency services that query and visualize all relevant information that is available. This could potentially also be extended with a visualization of 'live' data, such as sensor data.

C. Partners interested in the realization

ASSAR: provide data sets, validate results, workshop with end-users

TU/e: extend application 3.1 with specific templates, query building, sensor data integration

D. Status

The consortium agreed to focus development efforts on applications related to evacuation and compartmentalization. Applications for emergency intervention are out of scope for development. However, a viewer developed for any of the other applications should require little change to be usable for interventions as well.

3.3 Plug-in : Smartview fire safety design assistance

3.3.1 Description

A. Goal & Related scenario(s)

Goal: Assist architects during the design process with live data summaries and visual feedback of relevant fire safety data in a BIM model. This gives them an immediate overview of the state of the design/model, without having to interrupt the workflow for manual counting and measuring. The assistance could include data summaries (e.g. list of available compartments with included rooms and calculated areas, list of available exit doors with individual and combined with) as well as view filters/queries on 2D or 3D views of the model.

(1) 2.1.3 UC1 – Scenario 2: Quality checking for fire-code exchange information requirements

(2) 2.2.2 UC2 – Scenario 1: Understanding a building in terms of fire safety

B. Type

Plug-in in the modelling software used by building designers. Proposed: Revit.

C. Partners interested in the realization

Assar: provide data set, provide user requirements, validate results (Belgian fire safety perspective), validate results (user perspective)

D-studio: develop proof-of-concept for automation of Smartview generation from software-independent definition

DBI: Validate results (Danish fire safety perspective), validate results (user perspective)

D. Actors

Architects, fire safety engineers, contractors

3.4 Plug-in/application: Early design guidance and compliance checker

3.4.1 Description

A. Goal & Related scenario(s)

Create an application that guides its users in the early stages of a building project (concept design + spatial layout) by performing step-by-step compliance checks of the data in a BIM model with applicable fire regulations.

The application uses a space/room-based approach and works with BIM models that contain only a limited amount of data, to avoid burdening the designers. (see Figure 4, approach A)

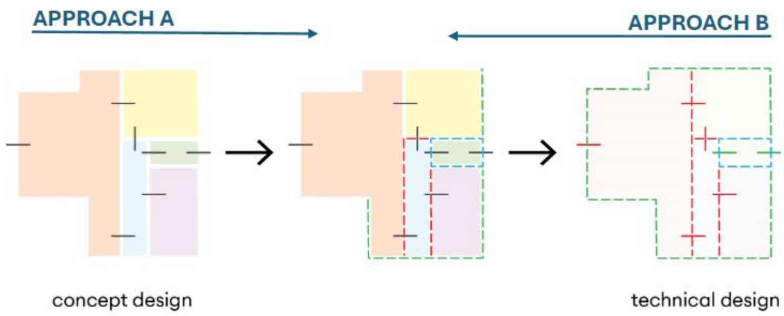

Figure 4

For now, the scope of the application is limited to compliance checking of fire compartments & escape paths. The following elements are checked:

- Level 1 (= critical design decisions)
  - Max floor area of fire compartments
  - Min. number of escape exits (doors and stairs)
    Max. number of people allowed in compartment
  - Max. distance to escape exits (1st, 2nd exit + dead ends) [pathfinding]
  - Max. distance between staircases
- Level 2 (= could still be changed in later project phase)
  - Geometry of escape routes
    - Min. usable height/width
    - Max. floor slope
  - Spatial separation of compartments

The main benefits are:

- Intuitive approach for designers
- Little additional input required
- Concepts behind fire safety design are stored in the model
- End result = complete model

Related scenarios

(1) 2.1.3 UC1 – Scenario 2: Quality checking for fire-code exchange information requirements
(2) 2.2.2 UC2 – Scenario 1: Understanding a building in terms of fire safety
(3) 2.2.3 UC2 – Scenario 2: Automated compliance checks for prescriptive fire requirements

B. Type

Plugin for primary design software (Revit/Archicad/etc.), or application/online platform that communicates with the primary design software through a plugin.

C. Partners interested in the realization

Assar: provide data set, provide user requirements, validate results (Belgian fire safety perspective), validate results (user perspective)

D-studio: can develop a Revit plug-in (+ Archicad), when we come to a clearly defined specification and related modeling guidelines.

DBI: provide user requirements, validate results (Danish fire safety perspective)

VN2R: provide user requirements, validate results (Portuguese fire safety perspective)

Peutz: provide user requirements, validate results (Dutch fire safety perspective)

D. Actors

Architects, Fire safety engineers

E. Sequence of actions (by users and parts of the solution) - describe the user experience in a broad outline.

General sequence *for the first check (max. compartment size), when working with a Plugin*

(1) Open the BIM model in the modelling software
(2) Open the plugin in the modelling software
(3) In plugin: Enter Building characteristics
(4) Assign standard compartments to rooms (if not already done)
(5) In plugin: Check information quality -> model compliance report
(6) In plugin: Check fire compartment size -> Fire safety compliance report

General sequence for the first check (max. compartment size)*, when working with a SaaS solution.*

(1) Upload the federated model
(2) Enter Building characteristics
(3) Assign standard compartments to rooms (if not already done)
(4) Check information quality -> model compliance report
(5) Check fire compartment size -> Fire safety compliance report

The sequence of actions will be developed in more detail in a user journey flowchart.

F. Input data - what the user must give the application to achieve the use case.

The user selects the following input at the start of the project ('Building characteristics'):

(1) Category of the building depending on height, function and/or occupancy
(2) Any other characteristics necessary to determine which regulations should be referenced.

The user creates a BIM model of the project that contains the following elements.

Some checks require more data than others. The first check (maximum compartment area) can be performed with only the the <u>underlined</u> data.

- General shape and layout of the building:
    - <u>Rooms/spaces</u>
        - GUID
        - name
        - geometry: area (calculated)
        - fire compartment [Compartment 1, Compartment 2, ... , Evacuation staircase, Lobby, etc.]
        - subcompartment [kitchen, boiler room, protected escape route, etc.]
        - occupancy [awake/sleeping]
        - number of people [#]
    - <u>Level (ifc BuildingStorey)</u>
        - name
        - elevation
    - Walls
        - GUID
        - Geometry
        - isRoomBounding
    - Floors
        - GUID

        - Geometry
    - Doors
        - GUID
        - Geometry
        - Use: isInternal / isExternal / isEmergencyExit

          Ideally, this information should be deduced automatically from the combination of rooms on each side. E.g. a door that only borders one room is an external door; a door that borders two rooms belonging to different compartments is on a compartment boundary; a door that borders an evacuation staircase will be used for evacuation; etc

G. Output data - the results obtained, what the application sends back to the user.

Throughout the process, the user receives visual and textual feedback that includes:

- Boundary conditions and assumptions:
    - Building characteristics
    - Which legislation was used for the check
- Which compliance check was performed and methodology
    - [Compartment area check]
    - [Compartment area was approximated as the sum of the net/gross areas of the rooms] or [Compartment area was calculated according to Belgian fire safety legislation]
- The result of the validity check: is the input data correctly defined and can it be used for the check
    - [Compartment 3 is not continuous.]
    - [The following rooms are not part of a compartment.]
- The result of the compliance check
    - [Per floor, a list of compartments with
        - Limit value for check
        - Actual value for check
        - Percentage: how close to limit value
        - PASS/FAIL
        - List of rooms (Name/GUID) that are part of the compartment]
- Visual overview of the input data and highlight of any elements that failed the check. (colour? BCF?)
- If relevant, a suggestion for improvement.
    - [Building storey 1 should be divided in at least 5 compartments]
    - [Some rooms on Ground Floor are not part of a compartment]

The result of the check can be exported as a report (csv/ pdf) for future reference.

H. References - standards needed for the UC

- BEL : AR/KB 7/7/1994 Basisnorm Brand Annex 2/1 Lowrise buildings
- NLD : Besluit Bouwwerken Leefomgeving, Hoofdstuk 4, Afdeling 4.2
- DNK : Bygningsreglementet (BR18), Chapter 5 (§82-§158)
- PRT : Regime Jurídico da Segurança Contra Incêndio em Edifícios (RJ-SCIE) + Regulamento Técnico de Segurança Contra Incêndio em Edifícios (RT-SCIE)

I. Application limitations

The user is advised to consult the modelling guidelines*, to ensure that the necessary input data is modelled correctly. While the application does check the input data for completeness and validity, it might not be possible to filter out all oversights or modelling errors. A detailed output report that shows how the data was interpreted, is therefore indispensable.*

J. Highlight differences by country

While the basics of the application will be the same for each country, t*he following aspects might differ depending on the applied fire safety legislation:*

- Building characteristics provided by user (to determine the category of the building and the applicable legislation)
- Data included in the BIM model
- Compliance check

Furthermore, it is important to note that differences in how certain fire safety concepts are legally defined (e.g. fire compartments) might require different *modelling conventions per country.*

K. Process for interacting with the PoC

Will be specified later.

3.5 Plug-in: Early design: from compliant spaces to building elements

3.5.1 Description

A. Goal & Related scenario(s)

Create an application that helps designers go from a fire safety compliant concept design to a compliant technical design.

The application uses the space/room-based output from application 3.4 (Plug-in/application: Early design guidance and compliance checker) and translates it to requirements for the building elements linked to each room. These element requirements can then be overlayed and written into the element parameters of the BIM model. This translation can be made directly into the architecture model, or into a (newly generated or pre-existing) fire safety model. (see Figure 5)

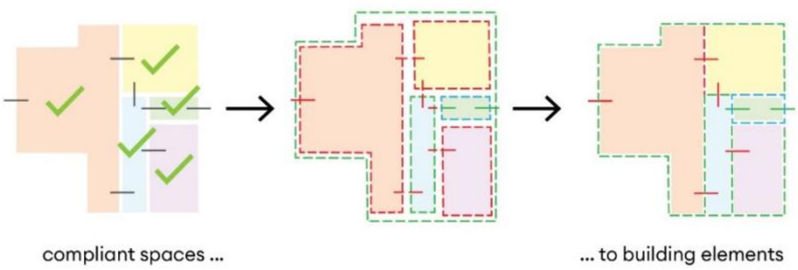

Figure 5

For now, the scope of the application is limited to compliance of fire compartmentation & escape paths. The following elements are controlled for:

- Requirements for walls/floors
  - Fire resistance
- Requirements for doors
  - Fire resistance
  - Reaction to fire
  - Smoke resistance
  - Min. width/height
  - Closing mechanism

    - Direction of opening
- Requirements for wall, floor and ceiling finishes
    - Reaction to fire

The main benefits are:

- Intuitive approach for designers
- Little additional input required. The translation from compliant spatial layout to compliant building elements is done (semi-)automatically.
- Concepts of fire safety design are stored in the model, not only the end result
- End result = complete model

Related scenarios

(1) 2.1.3 UC1 – Scenario 2: Quality checking for fire-code exchange information requirements
(2) 2.2.2 UC2 – Scenario 1: Understanding a building in terms of fire safety
(3) 2.2.3 UC2 – Scenario 2: Automated compliance checks for prescriptive fire requirements

B. Type

Plugin for primary design software (Revit/Archicad/etc.), or application/online platform that communicates with the primary design software through a plugin.

C. Partners interested in the realization

Assar: provide data set, provide user requirements, validate results (Belgian fire safety perspective), validate results (user perspective)

D-studio: can develop a Revit plug-in (+ Archicad), when we come to a clearly defined specification and related modeling guidelines.

DBI: provide user requirements, validate results (Danish fire safety perspective)

VN2R: provide user requirements, validate results (Portuguese fire safety perspective)

Peutz: provide user requirements, validate results (Dutch fire safety perspective)

D. Actors

Architects (+ Fire safety engineers)

E. Sequence of actions (by users and parts of the solution) - describe the user experience in a broad outline.

The sequence of actions will be developed in more detail in a user journey flowchart.

F. Input data - what the user must give the application to achieve the use case.

See application 3.4.

This plugin uses the same input, after it has been verified by the application.

G. Output data - the results obtained, what the application sends back to the user.

The fire safety requirements for each building element are either written into the architecture model as element parameters, or as a separately generated fire safety model with dummy elements.

H. References - standards needed for the UC

- BEL : AR/KB 7/7/1994 Basisnorm Brand, Annex 2/1 Lowrise buildings

- NLD : Besluit Bouwwerken Leefomgeving, Hoofdstuk 4, Afdeling 4.2
- DNK : Bygningsreglementet (BR18), Chapter 5 (§82-§158)
- PRT : Regime Jurídico da Segurança Contra Incêndio em Edifícios (RJ-SCIE) + Regulamento Técnico de Segurança Contra Incêndio em Edifícios (RT-SCIE)

I. Application limitations

The application does not repeat the compliance checking done by application 3.4 and relies on the correctness of the input to generate a correct output. This limitation could be solved by integrating applications 3.4 and 3.5 in a single tool.

J. Highlight differences by country

While the basics of the application will be the same for each country, the following aspects might differ depending on the applied fire safety legislation:

- Building characteristics provided by user (to determine the category of the building and the applicable legislation)
- Data included in the BIM model
- Compliance check

Furthermore, it is important to note that differences in how certain fire safety *concepts are legally defined (e.g. fire compartments) might require different modelling conventions per country.*

K. Process for interacting with the PoC

Will be specified later.

3.6 Application/Plug-in: technical design compliance checker

3.6.1 Description

A. Goal & Related scenario(s)

Create an application that performs automated compliance checks of a BIM model with applicable fire regulations in the technical design phase of a building project.

The application uses an element-based approach and works with BIM-models that contain detailed and (nearly) complete information with regards to fire safety at the element level. The user will be guided by the application to add missing space-based information that is needed to complete the checks. (see Figure 6, approach B)

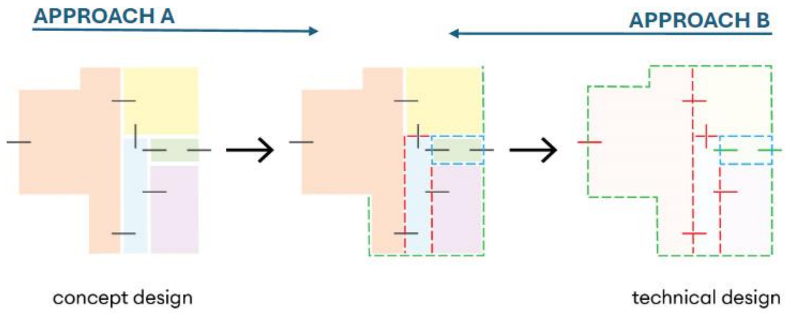

Figure 6

For now, the scope of the application is limited to compliance checking of fire compartmentation & escape paths. This includes the following compliance checks:

- Space-based requirements: if not check before (see application *3.4)*

- Element requirements: fire resistance, fire protection, reaction to fire, door properties, clash detection (technical penetrations), etc.

Related scenarios

(1) 2.1.3 UC1 – Scenario 2: Quality checking for fire-code exchange information requirements
(2) 2.2.2 UC2 – Scenario 1: Understanding a building in terms of fire safety
(3) 2.2.3 UC2 – Scenario 2: Automated compliance checks for prescriptive fire requirements

B. Type

Standalone application (for validation of IFC files) with possibility to communicate with the primary design software (Revit/Archicad/etc.) through a plugin.

C. Partners interested in the realization

Assar: provide data set, provide user requirements, validate results (Belgian fire safety perspective), validate results (user perspective)

BIM-Connected:

Buildwise:

D-Studio: develop a Revit-addin to generate the escape route, based on clearly defined specification, business logic (documented path algorithms, e.g., A* or visibility graph). In parallel, co-develop an IFC-based application.

DBI: provide user requirements, validate results (Danish fire safety perspective)

Stam + De Koning: ...

D. Actors

Architects, contractors, fire safety engineers

E. Sequence of actions (by users and parts of the solution) - describe the user experience in a broad outline.

For each type of check, the application first checks the completeness of the data, and then the compliance with relevant fire safety regulations.

QUESTIONS:

> *Is a completeness check within the scope of this application or should it be part of EIR compliance checking (see application 3.7)?*
>
> *Are compliance checks performed in applications 3.4 and 3.5 repeated here? Or are they excluded from the scope?*
>
> *Compliance check: Does the application check whether the 'required rating' of each element in the model compliant with the legal minimum requirements? Or does it check whether the 'actual rating' of elements in the model is compliant with the legal minimum?*

The sequence of actions will be developed in more detail in a user journey flowchart.

F. Input data - what the user must give the application to achieve the use case.

The user selects the following input at the start of the project (Building characteristics):

- Category of the building depending on height, function and/or occupancy
- Any other characteristics necessary to determine which regulations should be referenced.

The user provides a BIM model of the project containing the following information.
Note that not everything is required for each individual compliance check. The user could also use the application to verify whether the necessary information for a specific check is available in the model.

Underlined information is specific to the technical design phase. Other information could already be checked in earlier project phases, but are prerequisites for checks in the technical design phase.

- Rooms/spaces
  - GUID
  - name
  - geometry: area (calculated)
  - fire compartment [Compartment 1, Compartment 2, Evacuation staircase, Lobby, etc.]
  - subcompartment [kitchen, boiler room, protected escape route, etc.]
  - occupancy [awake/sleeping]
  - number of people [#]
- Walls/floors (separation)
  - GUID
  - Geometry
  - isRoomBounding
  - Fire resistance
- Claddings and finishes (walls/floors/ceilings)
  - GUID
  - Fire protection (K1 10)
  - Reaction to fire (Euroclass)
- Doors
  - GUID
  - Geometry
  - isInternal / isExternal / isEmergencyExit
  - Smoke resistance
  - Min. width/height
  - Closing mechanism
  - Direction of opening

G. Output data - the results obtained, what the application sends back to the user.

To be determined.

H. References - standards needed for the UC

- BEL : AR/KB 7/7/1994 Basisnorm Brand, Annex 2/1 Lowrise buildings
- NLD : Besluit Bouwwerken Leefomgeving, Hoofdstuk 4, Afdeling 4.2
- DNK : Bygningsreglementet (BR18), Chapter 5 (§82-§158)
- PRT : Regime Jurídico da Segurança Contra Incêndio em Edifícios (RJ-SCIE) + Regulamento Técnico de Segurança Contra Incêndio em Edifícios (RT-SCIE)

I. Application limitations

The complexity of these evaluations increases due to the overflow of properties through the evacuation route. For example, the width of a staircase intended for an emergency evacuation is determined by the sum of the intended capacity of all fire compartments of which the staircase is the designated escape route.

J. Highlight differences by country

While the basics of the application will be the same for each country, the following aspects might differ depending on the applied fire safety legislation:

- Building characteristics provided by user (to determine the category of *the building and the applicable legislation)*

- Data included in the BIM model
- Compliance check

Furthermore, it is important to note that differences in how certain fire safety concepts are legally defined (e.g. fire compartments) might require different modelling conventions per country.

K. Process for interacting with the PoC

Will be specified later.

3.7 Web - Application : IDS generator / IFC-checker

3.7.1 Description

Not all projects are equal, therefore this product aims to create an application that enables fire-safety experts to create a custom IDS to ensure clear communication of information needs tailored to a specific project without putting unnecessary strain on designers and architects. Designers can subsequentially upload their IFC-files for a compliancy check and receive a rapport based on the predefined IDS.

A. Goal & Related scenario(s)

Goal 1 : The goal of this application is to generate an IDS file that specifies the information needs according to the regulations which the model will be checked against.

Goal 2: The goal of this application is to enable designers to check if models are compliant with the IDS generated under goal 1.

Related scenarios:

(1) 2.1.2 UC1 – Scenario 1: Fire-code requirement generation (EIR): Define the Scope of Fire Safety Compliance Checks

(2) 2.1.3 UC1 – Scenario 2: Quality checking for fire-code exchange information requirements: Fire-code exchange information requirements compliance checking

(3) 2.4.2 UC4 – Scenario 1: Compliance checking tool for ventilation penetrations (into compartment boundaries)

(4) 2.4.3 UC4 – Scenario 2: Compliance checking for other penetrations (into compartment boundaries)

B. Type

Web-application

C. Partners interested in the realization

BIM-Connected: Development

D. Actors

- BIM Coordinators
- Fire Safety Experts
- Modelers

E. Sequence of actions (by users and parts of the solution) - describe the user experience in a broad outline.

- Goal 1:
  - Go to the web-application;
  - Create a new project;
  - Select applicable regulations though manual selection or predefined filters.
  - Save the preset
  - Export IDS.
- Goal 2:
  - Go to web-application
  - Select project
  - Upload IFC-file
  - View Report

F. Input data - what the user must give the application to achieve the use case.

User-input:

- Goal 1:
  - Selection of fire-safety regulations
- Goal 2:
  - IFC-File

FireBIM:

- Machine readable input parameters for each rule that relates to fire-safety regulations

G. Output data - the results obtained, what the application sends back to the user.

- Goal1:
  - IDS-File.
- Goal 2:
  - Validation rapport

H. References - standards needed for the UC

- BEL : ...
- NLD : ...
- DNK : ...
- PRT : ...
- LTU : ...

I. Application limitations

- Goal 1: The application will generate an IDS based on machine-readable regulation defined according to the FireBim standard.
- Goal 2: The application wil generate a validation report based on the predefined rule-set in Goal 1.

J. Highlight differences by country

None

K. Process for interacting with the PoC

Will be specified later.

3.8 Developing Modelling Guidelines, Process Maps, and Sample BIM Models for Fire Safety Compliance

3.8.1 Description:

This scenario focuses on creating comprehensive modelling guidelines, detailed process maps, and sample BIM models to ensure that industry professionals can develop BIM models optimized for fire safety compliance checks using the FireBIM platform. The goal is to support stakeholders across different countries in creating BIM models that are user-friendly, accessible, and easy to adopt, making the FireBIM platform's capabilities and requirements clear and practical.

A. Goal & Related scenario(s)

- Develop Modelling Guidelines: Provide clear, practical guidelines for creating BIM models that are compatible with the FireBIM platform's requirements, focusing on best practices in both native environments and open formats, as well as creating checklists and validation processes.
- Define Process Maps for Regulation Checks: Establish process maps that guide stakeholders through the necessary steps for each type of fire safety regulation check, ensuring that all relevant workflows are easy to follow and implement.
- Create Sample Compliant BIM Models: Develop a library of sample BIM models that illustrate each fire safety regulation check provided by the FireBIM platform, serving as practical references for the industry.

Related scenarios:

(1) 2.1.2 UC1 – Scenario 1: Fire-code requirement generation (EIR)

(2) 2.1.3 UC1 – Scenario 2: Quality checking for fire-code exchange information requirements

(3) 2.2.4 UC2 – Scenario 3: capturing existing buildings for retrofit design projects

B. Type

Text files provided by FireBIM platform, along with model guidelines, process maps, and sample BIM models in IFC format.

C. Partners interested in the realization

VN2R: Compile model guidelines and define practical steps to develop a compliant BIM model in accordance with the EIR

D. Actors

Architects, engineers, modelers and BIM Coordinators.

3.8.2 Implementation:

A. Sequence of actions (by users and parts of the solution) - describe the user experience in a broad outline.

The user “BIM Coordinator” interacts with the FireBIM platform and follows these steps:

- Select the FireBIM Library.
- Search for “Model Guidelines & Sample BIM models”.
- Search the data required:
  - Model guidelines and process maps.
  - Sample BIM models
- Decides how to view the information: either by download it or viewing it directly within the platform.
- Saves or print the data for improve project EIR’s or BIM Execution Plan.
- Update model or start modelling according to the FireBIM-provided data.

The user “Architects, Engineer or Modelers” interacts with the FireBIM platform and follows these steps:

- Select the FireBIM Library.
- Search for “Model Guidelines & Sample BIM models”.
- Search the data required:
  - Model guidelines and process maps.
  - Sample BIM models
- Decides how to view the information: either by download it or viewing it directly within the platform.
- Update model or start modelling according to the FireBIM-provided data.

B. Input data - what the user must give the application to achieve the use case.

Although it is not a direct input to the application, the user must first identify the fire safety domain to address—such as compartmentation or evacuation—to find the applicable data.

C. Output data - the results obtained, what the application sends back to the user.

The user receives from FireBIM platform:

- A text file (that user can print as a pdf document, word document or cvs file) with applicable model guidelines.
- A sample BIM Model in IFC.
- Process map diagram

The foundation of the application's content will be built upon all the fire safety domains that FireBIM incorporates. These domains and codes will serve as the primary framework, ensuring comprehensive coverage of fire safety standards and regulations within the application.

D. Application limitations

A key limitation of the application is the editable format of the guidelines. Since the format is not standardized, version control issues may arise, making it difficult to ensure that users are consistently informed of updates to the FireBIM guidelines. This could lead to the use of outdated information, potentially affecting compliance and accuracy.

Another limitation is the manual process required to identify applicable guidelines, process maps, or sample models. Users must actively search through available resources, which can be time-consuming and inefficient.

Additionally, the model guidelines will be defined based on the most widely used native modeling software. As a result, users of less common tools may find that the guidelines do not fully accommodate their software, limiting the application's applicability across all platforms.

E. Highlight differences by country

The general model guidelines will serve as the primary reference; however, an appendix will be included to address country-specific exceptions, ensuring that the guidelines remain adaptable to the legal, regulatory, and practical requirements of different countries. This approach enables the guidelines to function as a universal framework while simultaneously recognizing and accommodating the diverse needs of various jurisdictions.

F. Process for interacting with the PoC

F.1 Process:

Step 1: Create Modeling Guidelines for Fire Safety Compliance

Develop comprehensive modeling guidelines that provide practical instructions for creating BIM models optimized for use with the FireBIM platform. These guidelines should focus on best practices and user-friendly documentation.

Actions:

- Best Practices in Native Environments: Document the best practices for developing BIM models within their native environments, ensuring that models are built efficiently and correctly from the outset.
- Best Practices in Open Formats: Provide guidance on how to effectively export and manage BIM models in open formats, ensuring compatibility with the FireBIM platform.
- Creating Checklists: Develop easy-to-use checklists that industry professionals can follow to ensure their BIM models meet all necessary criteria before being submitted for compliance checks.
- Validation Processes: Outline simple validation processes that can be used to check the readiness of a BIM model for fire safety compliance verification.
- User-Friendly Documentation: Ensure that all guidelines are documented in a clear, accessible format, making them easy to understand and implement by industry professionals.

Step 2: Develop Process Maps for Fire Safety Regulation Checks

Create detailed process maps that visually and textually illustrate the steps involved in conducting each type of fire safety regulation check using the FireBIM platform. The focus is on making these workflows easy to follow and implement.

Actions:

1. Outline Workflow Steps: Create visual and textual process maps that guide stakeholders through the sequence of tasks required for compliance verification, from data preparation to final submission.
2. Define Inputs, Outputs, and Decision Points: Document the inputs, outputs, and key decision points within each process to provide a clear understanding of what is needed at each stage.
3. Focus on Usability: Ensure that the process maps are designed to be user-friendly, making them accessible and easy to implement by all relevant stakeholders.
4. Educational Distribution: Distribute the process maps widely to educate and guide industry stakeholders on the FireBIM compliance verification workflow.

Step 3: Provide Sample BIM Models Compliant with FireBIM Requirements

Develop a library of sample BIM models that illustrate each fire safety regulation check provided by the FireBIM platform. These models will serve as practical references, helping the industry understand and apply the modeling guidelines effectively.

Actions:

1. Create Sample Models for Each Regulation Check: Develop sample BIM models that specifically illustrate how to meet the requirements of each fire safety regulation check supported by the FireBIM platform.
2. Thorough Documentation as Modeling Guidelines: Ensure that the modeling guidelines serve as thorough documentation for these sample models, detailing how the requirements are met within each model.
3. Public Access and Use: Make the sample BIM models publicly available, allowing industry professionals to study and reference them as examples for their own projects.
4. Practical Application: Encourage the use of these samples as benchmarks for developing compliant BIM models, building confidence in the FireBIM platform's capabilities and requirements.

Added Value:

- Support for Industry Adoption: By providing practical, user-friendly guidelines, process maps, and sample models, this scenario facilitates the adoption of the FireBIM platform, making it easier for professionals to develop compliant BIM models.

- Consistency and Accessibility: The modeling guidelines and process maps ensure that workflows are consistent and easy to follow, reducing errors and enhancing the reliability of fire safety compliance checks.
- Practical Reference: The sample BIM models serve as tangible examples that industry professionals can use to understand and apply the FireBIM platform's requirements in their own projects.

3.9 Application: automated detection of ventilation duct and other service penetrations intersecting with compartment boundaries

3.9.1 Description

The tool helps the user to identify and locate in a project every intersection of the ventilation system and other service penetrations with compartment boundaries. The tool combines a geometric analysis (clash or crossing between two elements) and the analysis of the properties of the objects (wall, floor, service).

A. Goal & Related scenario(s)

Goal: the application should be able to identify and navigate to physical clashes between objects defined as ventilation ducts and other services and objects defined as compartment boundaries (walls and floors). Not all walls or floors are compartment boundaries (required fire resistance).

The user can then add generic or brand specific objects (i.e. fire damper) and sealing methods for each of the detected clashes as fit, in compliance with the required fire resistance and regulation.

Related scenarios:

(1) 2.4.2 UC4 – Scenario 1: Compliance checking tool for ventilation penetrations (into compartment boundaries)

(2) 2.4.3 UC4 – Scenario 2: Compliance checking for other penetrations (into compartment boundaries)

B. Type

Webbased (open source), and/or plug-in type for Revit

The application would rely on the analysis of the properties of the different objects (ventilation ducts, other services and compartment boundaries). This approach should allow a software agnostic application.

C. Partners interested in the realization

Rf-Technologies: define relationships with regulation, validate results

Stam + De Koning: validate results, provide data set

VN2R

Exactusensu

D. Actors

MEP designer, (sub)contractors, fire engineers, manufacturers

E. Sequence of actions (by users and parts of the solution) - describe the user experience in a broad outline.

The required information used to make the clashes is split over many different models (architectural, structural, MEP models (multiple, often per type of service), fire safety model).

1. Access the tool. Create a new the project or access an existing one.

2. Upload all the required and validated models that will be used for the clashes. At minimum this is the fire safety model and a MEP model of a service.
3. Ruleset definition for the clashes: the order in which clashes are made
4. The tool creates a database of all detected clashes, adds a unique ID to each clash. The information gathered from the different models is grouped together per clash in the database.
5. The user validates the created database, and the information gathered for each clash.
6. Action to group clashes per type: all identical clashes (type of wall, type of service, required fire resistance, distances available...) should be clustered (often similar clashes are found on several floors). This could be a manual action by the user or, preferably, an automated function with a validation of the user.

F. Input data - what the user must give the application to achieve the use case.

The input consists of data found in different models (architectural, structural, MEP models (multiple, often per type of service), fire safety model). The minimal information consists of the required fire resistance (expressed in E and I criteria), the type of wall (material, thickness,...), the type of service penetration (type, size, material...), the distances to structural parts (walls, ceilings, beams...) and other services, existing openings (structural model).

G. Output data - the results obtained, what the application sends back to the user.

A database containing all the detected clashes with their own ID and related information. The user should be able to download and convert this to excel (for cost estimation for example). The user should be able to verify the clashes in the 3D model (link to visual in the consolidated model, BCF export).

H. References - standards needed for the UC

- BEL : TV254
- NLD : ...
- DNK : ...
- PRT : ...
- LTU : ...
- EU: EN 1366-2, EN 1366-3, EN 15882-2, EN 15582-5, EN 1363-1

I. Application limitations

The solution has value and can be used even for a limited number of MEP services. We will have to define which service penetrations we want to include and which not.

We also need to assess the feasibility of checking for minimal distances, remote or on-wall installations, combined and multiple penetrations. This defines the way (physical) clashes between objects can be found.

J. Highlight differences by country

The solution is universal to all countries as we are checking clashes between models with this tool. The content of the database will probably be common too.

K. Process for interacting with the PoC

Different steps are required, some which require manual validation by the user. As a user following interactions with PoC are defined:

- Upload and identification of the different models (which MEP service is uploaded, which models contains fire resistance requirements...)

- Action to start identifying physical clashes by the solution. This is the starting point for the creation of the database. The solution must fill in all available information for each of the clashes.
- The output, the created table with clashes, must be shared with the user. The solution must indicate (for example in red) crucial information it is missing for each clash. At this point the user can either manually fill in the gaps, or improve the quality of the uploaded model and reinitiate the clash detection.
- Ideally the tool will make suggestions for grouping similar clashes. This can be done manually, by the user, as well. Each clash grouped retains its individual ID and properties. Grouping allows to adopt a similar sealing method per group.
- Export the table to a useable format (excel or similar).

3.10 Application/plug-in: Product selection and compliance checking tool for ventilation penetrations and other service penetrations into compartment boundaries

3.10.1 Description

Where ventilation ducts cross compartment boundaries, fire dampers are used to restore fire resistance. To provide a compliant solution, the fire damper must have the correct classifications (based on test reports). These classifications depend on the required fire resistance (type and time), and the type of boundary (wall or floor, material, thickness, sealing method...).

Similarly, where other service penetrations such as pipes, cables, trays... cross a compartment boundary, the openings must be sealed with solutions that restore the fire resistance of the wall. Those solutions include many different products (for example collars) and materials (boards, coatings...). All solutions need to be fire tested and certified.

European standards define also a number of generic (standardized) boundaries, which could be integrated into the tool along with user defined boundaries. The selection tool should integrate this information together with the sealing method classification (to be provided by the manufacturer or user).

For each clash, the solution will suggest sealing methods in accordance with the type of MEP service. The solution will gather this information from a sealing method database (*master database)* containing certified solutions. The master database contains general solutions and information provided by manufacturers. The user could also add other solutions. Ideally, the user could indicate upfront has preferred sealing solutions.

The user can either validate the sealing method or look for alternatives in the database.

Once all choices have been validated, the output can be generated.

A. Goal & Related scenario(s)

Goal: The tool should help the user to select a compliant sealing method. Compliance is defined on the one hand by the required fire resistance of the compartment boundary (wall or floor) and the type of boundary (type of material, thickness...), and on the other hand by classifications of the sealing method.

Related scenarios:

(1) 2.4.2 UC4 – Scenario 1: Compliance checking tool for ventilation penetrations (into compartment boundaries)

(2) 2.4.3 UC4 – Scenario 2: Compliance checking for other penetrations (into compartment boundaries)

B. Type

Probably a web-based tool (open source).

C. Partners interested in the realization

Rf-Technologies: define relationships with regulation, define the properties in the database, fill in the master database

Stam + De Koning: validate results, define the properties in the database, provide data set

VN2R
Exactusensu

D. Actors

MEP designer, *(sub)contractors, fire engineers, manufacturers*

E. Sequence of actions (by users and parts of the solution) - describe the user experience in a broad outline.

This builds on the solution 3.9, detection of clashes of service penetrations and ventilation ducts.

The clashes database of 3.9 will be the input. The tool will select a solution for each clash, based on the master database in the tool, possibly extended by additional user defined solutions. Prior to using the solution, it could be possible that the user might want to add those user defined solutions. A template for adding new solutions is required. This is the same template used to fill in the master database. Besides the required information, each solution in that database should also link to the certificates.

Next step is also not mandatory: the user could indicate in the master database which solutions he prefers. The solution could take this into account when suggesting sealing methods.

The user then uses the tool. It will suggest a sealing method for each clash and add it to the clashes database. For grouped clashes it will provide a single solution. If no suitable solution can be found in the master database, the tool will notify the user. Each proposed solution must be compliant with the required fire resistance requirement of the compartment boundary.

The user must manually validate the choices.

Once every clash has been resolved, the user can generate outputs.

F. Input data - what the user must give the application to achieve the use case.

At minimum the user must validate the solution proposed by the tool.

He can add custom sealing methods to his version of the master database. And he can identify preferred sealing methods.

He must choose the outputs have desires.

G. Output data - the results obtained, what the application sends back to the user.

A validation report showing, per penetration, the chosen solution, the wall requirements and the result. The result would be an OK, not OK or "to be validated further". It would be nice if, from the report, the user could navigate to the penetration in the model. Export output should be:

- A PDF (a document that shows that, at the (technical) design phase, the choices made were compliant with the regulation, with links to certification)
- A CSV or similar that includes additional information about the sealing method (links to certification, installation drawings,...). This format can allow the user to add the cost of the sealing method and make overall calculations and estimates.
- A BCF, or file format that can be used by the installer as a plan for installation
- If possible, floor plans per service showing the location of each clash with their reference ID. This output is for the installation company on the building site.

H. References - standards needed for the UC

- BEL : TV254
- NLD : Isso brandveilige doorvoeringen, handboeken doorvoeringen
- DNK : ...
- PRT : ...
- LTU : ...

- EU: EN 1366-2, EN 1366-3, EN 15882-2, EN 15582-5, EN 1363-1

I. Application limitations

Not all service penetrations (in the EN 1366-3 definitions) can be dealt with in this matter. The same limitations apply as in 5.10.

J. Highlight differences by country

For many countries sealing methods will be quite similar. Methods can vary depending on the required fire resistance. But also in the light of market practices, habits and sometimes availability of products and materials. It is important that users can add sealing methods of their own.

K. Process for interacting with the PoC

Create and fill in the master database:

For ventilation ducts

- Step 1: Translate technical ordonnance “TV 254” to requirements for the creation of the IDS (support UC1)
- Step 2: Map standardized compartment boundaries according to EN 1363-1, in combination with commonly available sealing materials. Expand, where possible, to non-standardized compartment boundaries (e.g. shaft walls) and commonly available specific sealing materials. Specify the minimum required information for those objects.
- Step 3: Based on the output of step2, establish a validation matrix showing the fire resistance level for the combination of a ventilation component, compartment boundary and sealing material/method (hand-over to WP3 for PoC implementation – validation tool to match the obtained fire resistance levels with the project requirements).

For other services

- Step 1: Translate technical ordonnance “TV 254” to requirements for the creation of the IDS (support UC1) - define the different penetration types (e.g. plastic and metal piping, cabling...)
- Step 2: Map standardized solutions according to EN 1366-3, including types and lay-outs of penetrations, boundaries and sealing materials (part will be common to 4.1b).
- Step 3: Based on the output of step 2, establish a validation matrix showing the fire resistance level for the combination of the penetration(s), compartment boundary and sealing material/method (hand-over to WP3 for PoC implementation – validation tool to match the obtained fire resistance levels with the project requirements).

3.11 Techniques for Digital surveys of existing buildings

3.11.1 Description

The tool/framework is conceived to assist the design team, mainly architects and fire safety engineers, in the retrofit project of existing buildings, particularly in collecting geometric information based on reality capture strategies. The proposed framework uses photogrammetry and LiDAR to conduct a digital survey, performs a point cloud segmentation assisted by AI, and also enables a Scan-to-BIM approach for generating BIM models. These models will then be used to automatically extract features and perform the compliance check with fire safety codes based on the FireBIM platform.

A. Goal & Related scenario(s)

Goal: The application aims to acquire point cloud data using digital technologies such as drones and laser scanners to perform a Scan-to-BIM analysis. This analysis enables the creation of a BIM model, incorporating all essential attributes required for evaluating compliance with fire safety codes. The required attributes are related to the building under study as well as the surrounding areas of the building (e.g., neighbourhood buildings, roads, walkways, etc).

Related scenarios:

- 2.2.4 UC2 – Scenario 3: capturing existing buildings for retrofit design projects

B. Type

The application begins with a digital survey of existing buildings and surrounding areas using advanced digital technologies, such as, LiDAR and photogrammetry, which generate two independent point clouds. Reality capture will be performed using LiDAR technology from Leica Geosystems, employing Terrestrial Laser Scanning (TLS), Mobile Laser Scanning (MLS), and Airborne Laser Scanning (ALS). Additionally, photogrammetry will be supported by RGB cameras mounted on DJI drones.

The two independent point clouds will be integrated into a unified dataset, that will be processed and segmented using Artificial Intelligence (AI) techniques. The segmentation will classify the building components, such as floor, vertical circulations, escape routes, openings, fire compartments and barriers, structural elements, facades, etc., facilitating the assessment of fire code check.

Furthermore, a Scan-to-BIM analysis will be performed, enabling the identification of individual building components. From these BIM models features, mostly based on geometric information that can be used for further retrofit/upgrades design of the building. Figure 7 represents an overview of the described process.

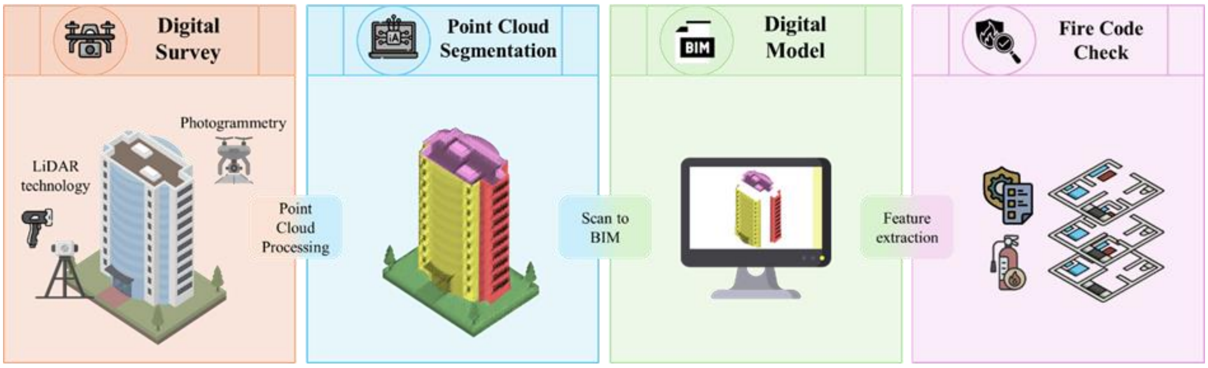

Figure 7. Overview of the digitalization process of existing buildings under retrofit design

C. Partners interested in the realization

ISEP will be responsible for: i) the digital surveys of existing buildings, using LiDAR and photogrammetry technology; ii) point cloud processing and segmentation supported by supervised AI; iii) Scan to BIM process.

VN2R will be responsible for: i) Systematization of the features extraction from the BIM model; ii) Features export to the FireBIM platform using structured data formats.

Exactusensu will be responsible for: i) identify a case study; ii) agile the contacts with the own of the building and other relevant authorities; iii) provide existing technical documentation about the case study; iv) validate the features that will be inserted on the FireBIM platform.

D. Actors

Architects and fire safety engineers.

3.11.2 Implementation

A. Sequence of actions (by users and parts of the solution) - describe the user experience in a broad outline.

The process begins with a digital survey on interior and exterior areas of the existing building. The interior survey is performed TLS and MLS, while the exterior survey is performed through photogrammetry and ALS.

For processing LiDAR point cloud data, Cyclone Register will be used to extract and align the data. Additionally, free and open-source software, such as, CloudCompare and Open3D can be used for further processing and analysis.

For photogrammetry data processing, a property from DJI will be used. Other commercial software solutions, such as, Agisoft Metashape, Pix4D, and RealityCapture, are also possible alternatives. Also, Bentley iTwin is a solution for processing photogrammetry data since supports open-source formats.

Point cloud data acquired from these technologies is then merged into a unified point cloud. This process can be accomplished using open-source software like MeshLab or commercial software, such as Autodesk ReCap. Once the unified point cloud is created, it will be processed and segmented using AI techniques in Python. Among the most recommended methods in the literature are PointNet, Dynamic Graph CNN, and the Density-Based Spatial Clustering of Applications with Noise (DBSCAN) algorithm.

Regarding the Scan-to-BIM process, a mesh generation will be applied to the segmented point cloud data. After, BIM objects are created based on the model mesh using semi-automated procedures. Once the BIM model is created, relevant features are extracted that will be fed the FireBIM platform for the fire code-checks.

B. Input data - what the user must give the application to achieve the use case.

The user must provide point cloud data of the existing building to the application, specifying the typology of the building (e.g., residential, office, hospital, hotel).

C. Output data - the results obtained, what the application sends back to the user.

The application provides: i) *segmented point cloud data; ii) BIM model of the existing building; iii) set of structured features that are relevant for the fire safety code-checks.*

D. Application limitations

The application has limitation: i) in handling incomplete or failed point clouds; ii) in segmenting point clouds with high level of discretization; i*ii) in defining objects with complex geometry; iv) in processing very large size files.*

E. Highlight differences by country

The *regulations governing the UAV operations may differ across countries.*

F. Process for interacting with the PoC

Dedicated proof of concept will be performed regarding the following steps.

- Data acquisition and processing regarding LiDAR and photogrammetry;
- Data merging and unified point cloud creation;
- AI-based point cloud segmentation;
- Scan to BIM process;
- Integration with FireBIM platform.

This proof of concept based on the previous steps ensures that each step is carefully executed and validated, leading to a successful outcome of this application.

3.12 Application: Comparing fire safety compliance between countries

3.12.1 Description

The application lets users perform an automated compliance check on a building using fire safety legislations from different countries to compare how the project would be evaluated in each country.

A. Goal & Related scenario(s)

In many European countries, fire safety legislation is prescriptive. When building designers want to venture outside the limits of the prescriptive code, the burden of proof lies with them.

In Belgium for example, any deviations from the federal fire code must be submitted for approval to the Ministry of the Interior. An approval can be obtained by demonstrating an "equivalence of solutions", i.e. the proposed solution offers the same level of fire safety as provided by the fire safety legislation.

With this application, designers can look for equivalent solutions by checking a BIM model against the fire safety legislation of other European countries, with different fire safety traditions and construction practices. If a check turns out positive, it can serve as a basis to develop an "equivalent solution".

This comparison between countries is currently an uncommon approach, as it requires the involvement of fire safety experts from several countries. By automating the compliance checking process, building designers could easily check their building design with different sets of legislations and use the results to support their case.

This application is an extension of the solutions described in 3.4 and 3.6, and will follow the same development scope.

The main benefits are:

- Intuitive approach for designers
- Fast automated analysis
- No knowledge of foreign fire safety legislation required to use the application

Related scenarios

(1) 2.1.3 UC1 – Scenario 2: Quality checking for fire-code exchange information requirements
(2) 2.2.2 UC2 – Scenario 1: Understanding a building in terms of fire safety
(3) 2.2.3 UC2 – Scenario 2: Automated compliance checks for prescriptive fire requirements
(4) 2.3.2 UC3 – Scenario 1: Designing with an equivalent level of fire safety

B. Type

Plugin for primary design software (Revit/Archicad/etc.), or web-based application.

C. Partners interested in the realization

Assar: provide data set, provide user requirements, validate results (Belgian fire safety perspective), validate results (user perspective)

D. Actors

Architects (+ Fire safety engineers)

E. Sequence of actions (by users and parts of the solution) - describe the user experience in a broad outline.

The user performs an automated compliance check using the applications 3.4 and 3.6,which shows that a certain aspect of the design is not compliant with the relevant fire safety legislation.

The user can then select one or more other countries (e.g. a neighbouring country) and rerun the automated compliance checks to verify whether the same design would comply with the fire safety legislation in these countries.

The application gives the user an output report which compares the compliance for each selected country.

If the results are positive (i.e. the design would be compliant in other countries), the user can use the output report to work towards a solution that provides an equivalent level of safety to that required in their own national fire safety legislation.

F. Input data - what the user must give the application to achieve the use case.

See applications 3.4 and 3.6.

This application would have the same input requirements

G. Output data - the results obtained, what the application sends back to the user.

The user receives a compliance report that compares the level of compliance according to selected sets of national or regional fire safety legislation.

Ideally, the output report would include links to an online library that includes contextual information about each potential solution.

H. References - standards needed for the UC

- BEL : AR/KB 7/7/1994 Basisnorm Brand, Annex 2/1 Lowrise buildings
- NLD : Besluit Bouwwerken Leefomgeving, Hoofdstuk 4, Afdeling 4.2
- DNK : Bygningsreglementet (BR18), Chapter 5 (§82-§158)
- PRT : Regime Jurídico da Segurança Contra Incêndio em Edifícios (RJ-SCIE) + Regulamento Técnico de Segurança Contra Incêndio em Edifícios (RT-SCIE)

I. Application limitations

The application is intended to compare differences between countries. It can be used as a basis for discovery, to point designers (architects/fire safety engineers) in the right direction and let them browse potential solution to which they normally wouldn't have access.

However, fire safety solutions cannot be copy-pasted between different countries without considering the context in which they were developed. Further research would thus be necessary to translate the output of the application into a practical solution that can be implemented in a design project.

J. Highlight differences by country

The input requirements (building characteristics, IDS, modelling conventions, etc.) should be harmonised as much as possible so the user doesn't have to give a full set of input data for each country included in the comparison. This would make the application too cumbersome to use.

K. Process for interacting with the PoC

Will be specified later.

4 Mapping of solutions to use case scenarios

	2.1.2 UC1 – Scenario 1: Fire-code requirement generation (EIR)	2.1.3 UC1 – Scenario 2: Quality checking for fire-code exchange information requirements	2.2.2 UC2 – Scenario 1: Understanding a building in terms of fire safety	2.2.3 UC2 – Scenario 2: Automated compliance checks for prescriptive fire requirements	2.2.4 UC2 – Scenario 3: capturing existing buildings for retrofit design projects	2.3.2 UC3 – Scenario 1: Designing with an equivalent level of fire safety	2.3.3 UC3 – Scenario 2: Identify required values & insights for fire brigade	2.4.2 UC4 – Scenario 1: Compliance checking tool for ventilation penetrations (into compartment boundaries)	2.4.3 UC4 – Scenario 2: Compliance checking for other penetrations (into compartment boundaries)	2.4.4 UC4 – Scenario 3: Identify required values for manufacturers & subcontractors (installers)
3.1 Template : 2D/3D visualisation of fire safety data in BIM			X							
3.2 Application: Visualizing fire safety design for emergencies			X							
3.3 Plug-in : Smartview fire safety design assistance		X	X							
3.4 Plug-in/application: Early design guidance and compliance checker		X	X	X						
3.5 Plug-in: Early design: from compliant spaces to building elements		X	X	X						
3.6 Application/Plug-in: technical design compliance checker		X	X	X						
3.7 Web - Application : IDS generator / IFC-checker	X	X						X	X	
3.8 Developing Modelling Guidelines, Process Maps, and Sample BIM Models for Fire Safety Compliance	X	X			X					
3.9 Application: automated detection of ventilation duct and other service penetrations intersecting with compartment boundaries								X	X	

	2.1.2 UC1 – Scenario 1: Fire-code requirement generation (EIR)	2.1.3 UC1 – Scenario 2: Quality checking for fire-code exchange information requirements	2.2.2 UC2 – Scenario 1: Understanding a building in terms of fire safety	2.2.3 UC2 – Scenario 2: Automated compliance checks for prescriptive fire requirements	2.2.4 UC2 – Scenario 3: capturing existing buildings for retrofit design projects	2.3.2 UC3 – Scenario 1: Designing with an equivalent level of fire safety	2.3.3 UC3 – Scenario 2: Identify required values & insights for fire brigade	2.4.2 UC4 – Scenario 1: Compliance checking tool for ventilation penetrations (into compartment boundaries)	2.4.3 UC4 – Scenario 2: Compliance checking for other penetrations (into compartment boundaries)	2.4.4 UC4 – Scenario 3: Identify required values for manufacturers & subcontractors (installers)
3.10 Application/plug-in: Product selection and compliance checking tool for ventilation penetrations and other service penetrations into compartment boundaries								X	X	
3.11 Techniques for Digital surveys of existing buildings					X					
3.12 Application: Comparing fire safety compliance between countries		X	X	X		X				