BIMy Project:
D3.3 Report of BIMy Usage and the Specific Applications that (will) work over BIMy

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Version	Date	Author	Change
0.01	2020-11-23	GN	Introduction and scope
1.00	2021-03-23	OK	Finalization

1 Table of Contents

1 Introduction

In this document, the applications for end users developed during the project, the usage areas of these applications, the usage areas of BIMy and the different applications that can work on the BIMy project will be mentioned.

Use case scenarios created in line with the needs determined in the early stages of the project create a daily use area for the project. In this context, the applications that will be explained sequentially have been created over these scenarios and bring the BIMy project to a very different point with its innovative approaches and solutions to the problems encountered.

Along with the developments on the platform, BIMy platform has made many simulations and applications such as building permit application and VR disaster simulation work by using BIM-GIS data and transformed versions of these data.

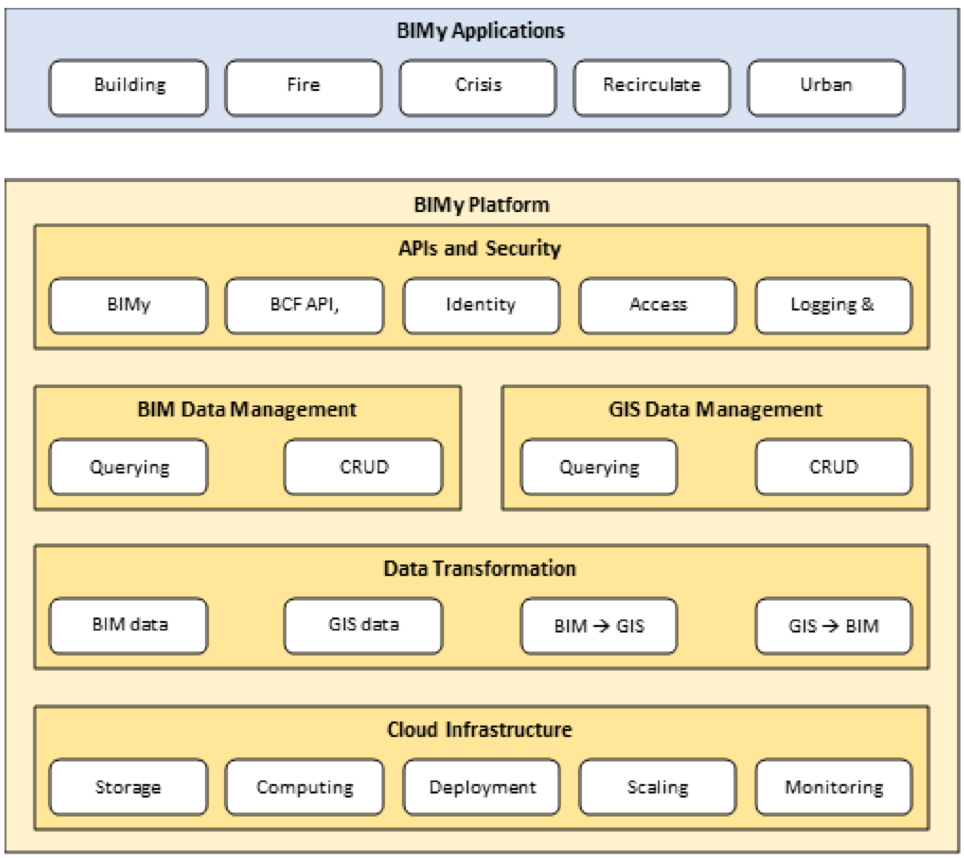


Figure 1BIMy platform infrastructure

As shown in figure 1, the BIMy platform works in integration with 5 main applications. These applications are specially created for the needs of the project, and are user-oriented applications.

The applications developed on the platform and the detailed information and BIMy usage information of these applications are explained within the scope of this deliverable.

2 Salubrity Checker

We expect that in the coming years the first steps will be taken towards a more digital approach to various controls and regulations. New possibilities for (semi-)automatically funneling data to various performance evaluations that are carried out in the context of a design: both mandatory aspects such as EPBD calculation, but also other calculations such as LCA analysis, acoustic analysis, etc. All these calculations are now seen as an administrative burden - for which many man-hours are spent because they always involve separate input forms and calculation programmes, with their own agreements on geometry and data - while the main purpose of such calculations is to arrive at a better design. The BIMy-platform is a perfect starting point for such kind of digital administration on a larger scale, where large sets of BIM and GIS-data is needed in order to perform all the necessary checks.

One of the test cases is based on the “salubrity checker” and it is representative for the automatic checking of requirements of a building code, by converting these requirements into a (coded) rule and applying it to the BIM model (on the BIMy-platform). A more extended version of this concept could be applied off course in the framework of a digital building permit process (see § 11.1.5). This type of rule-checking requires usually both geometrical and technical information from the model. If the model isn’t based on very strict modelling conventions (e.g. LOIN, IDS, cfr. 7.5) and data structure conventions, the automatization of such checkers fails easily. Hence the need for standardization on the one hand and easy tools to perform quality checks before applying automatic rule-checking on the other hand.

The application is based on the local building codes. It allows to verify one of the salubrity criteria presented by the document: the criterion of minimum natural lighting. To do this, the program extracts from an IFC file the necessary data available and allows the user to check the conformity of the model with the rules in effect.

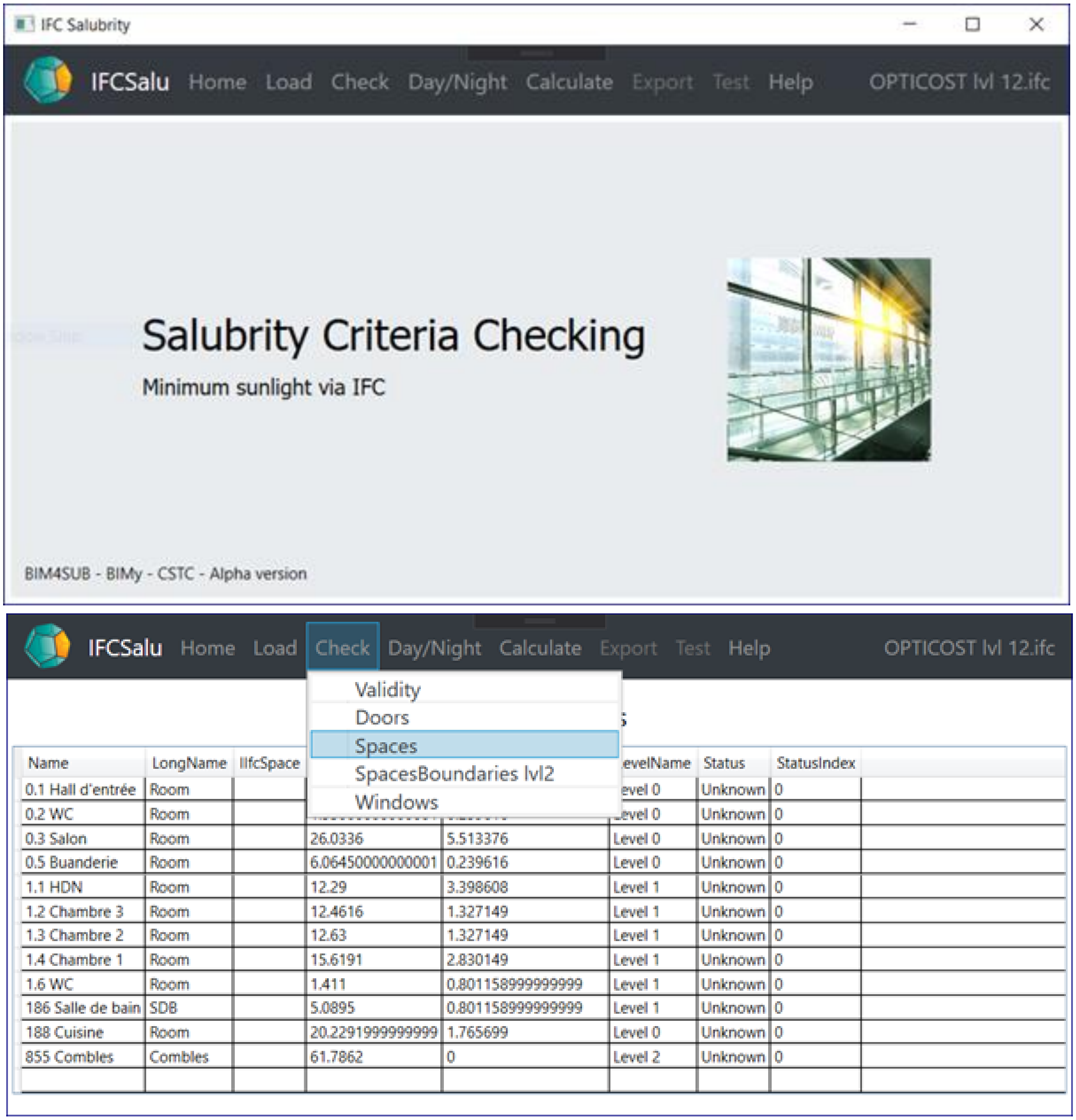


Figure 2: Screenshots from the IFC-based application

3 Revit Model Checker

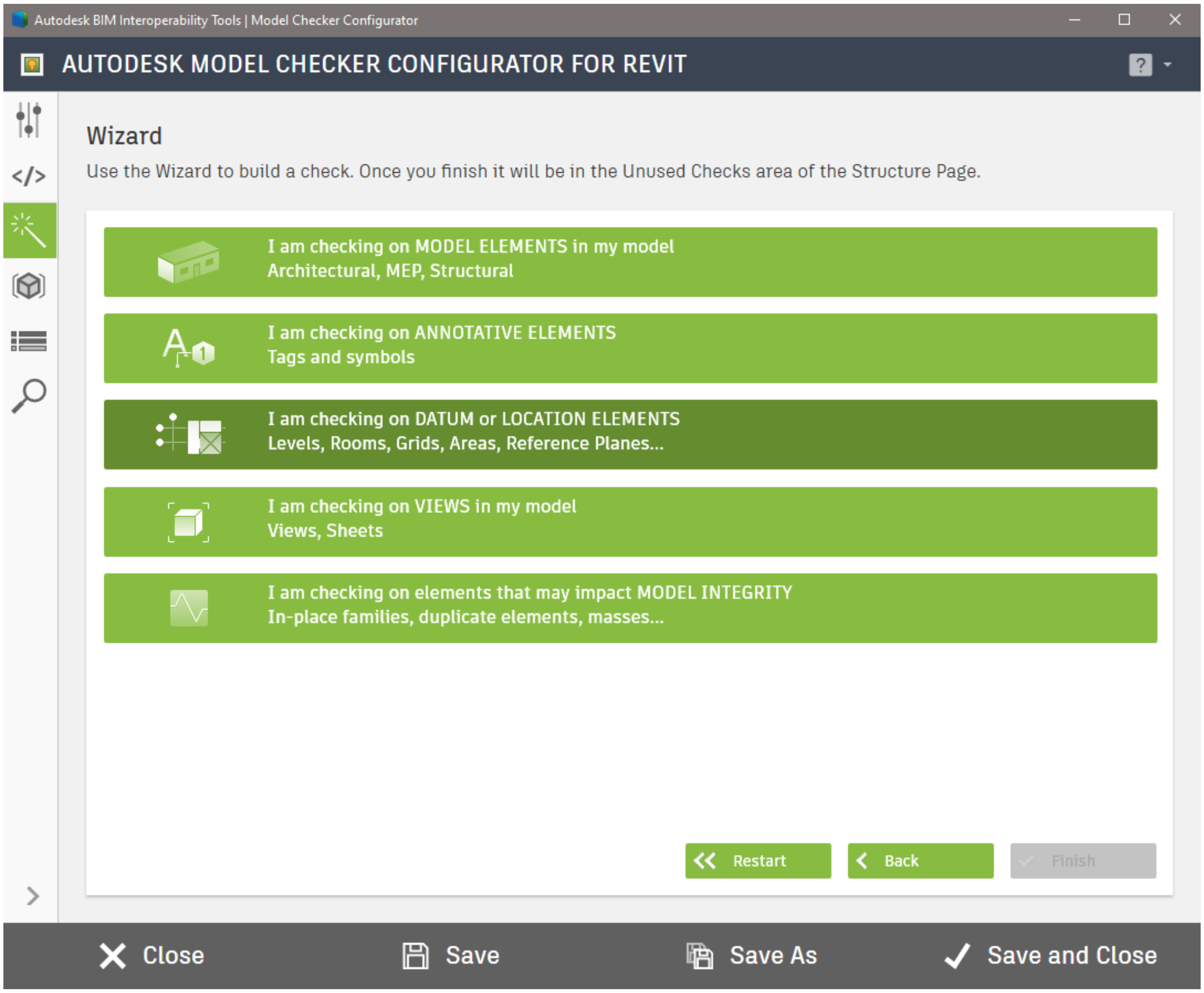
The modelling guidelines are used as a base to create the checkset. The checks are built around these parameters. Some of these parameters/elements are specifically written for IFC models (on the BIMy platform the standard file format) but are 'translated' to Revit parameters to be able to check native in Revit before exporting to IFC. This will improve both the Revit model quality and the IFC export quality.

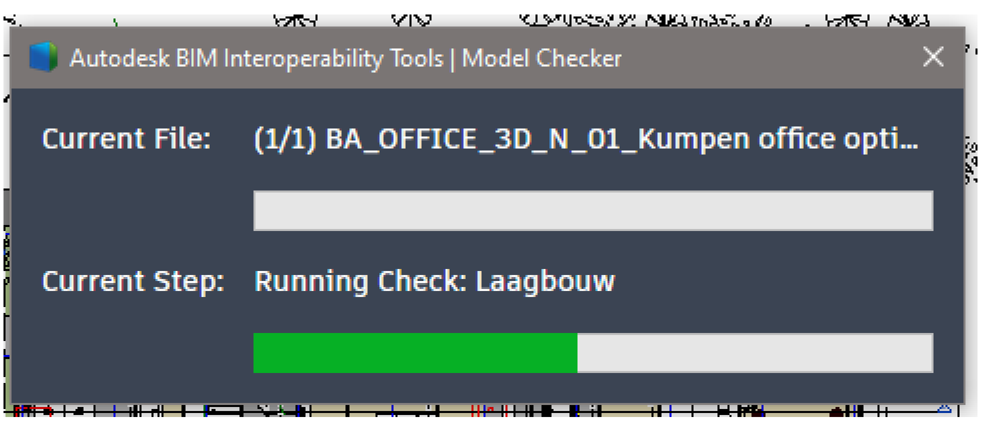
- **Draft modelling guidelines for digital building permit (Assar, Willemen)**: start from the Flemish legislation, define a set of 10 modelling parameters/elements that must be included.
  Selection based on legislation (see D2.1)

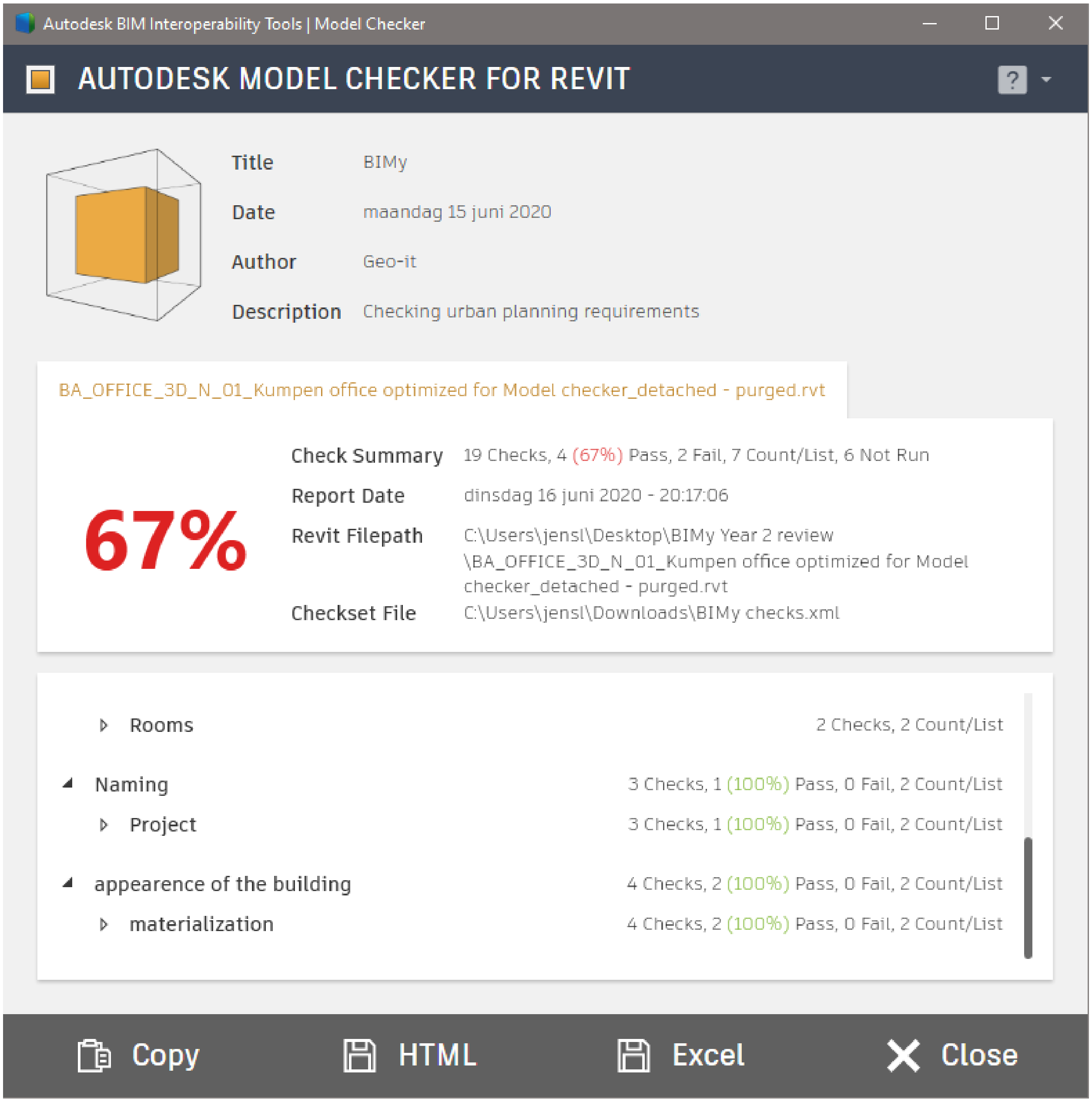
○ **BIM**

- **Name**: File is named following certain conventionBA_[Project-ID]_[Object]_[Situation]_[Number]_[Free text].EXT
- [Situation] options: B: Existing situation
  N: Completed situation
  V: Situation according to the last permit (if different from existing situation)
- **Location** (georeferenced)
- **Levels:**
- For each building level: '-2', '-1', '+0', '+1', '+2', etc.
  '+0' is the lowest level from which you can exit the building (without stairs)
- For cornice height: 'Cornice'
- For ridge height: 'Ridge'
- For ground level: 'Ground'
- The level '+0' serves as local reference for the building at elevation 0,00m
- **Elevation:** Define the TAW elevation of the '+0' level.
- **Rooms** (with name/function, and surface area)
- **Walls and floors**
- Materials (**= Revit naming**)
  (IfcMaterialLayer, IfcMaterialLayerSet, IfcMaterial)

- Fire Resistance (= **native Revit parameter**)
  (Pset_WallCommon > FireRating,
  Pset SlabCommon > FireRating)
- Part of façade or not? (Pset_WallCommon > IsExternal) (**in Revit: External: Yes/No**)






Autodesk BIM Interoperability Tools | Model Checker
AUTODESK MODEL CHECKER FOR REVIT
Title BIMy
Date maandag 15 juni 2020
Author Geo-it
Description Checking urban planning requirements
BA_OFFICE_3D_N_01_Kumpen office optimized for Model checker_detached - purged.rvt
67%
Check Summary 19 Checks, 4 (67%) Pass, 2 Fail, 7 Count/List, 6 Not Run
Report Date dinsdag 16 juni 2020 - 20:17:06
Revit Filepath C:\Users\jensl\Desktop\BIMy Year 2 review \BA_OFFICE_3D_N_01_Kumpen office optimized for Model checker_detached - purged.rvt
Checkset File C:\Users\jensl\Downloads\BIMy checks.xml
Rooms 2 Checks, 2 Count/List
Naming 3 Checks, 1 (100%) Pass, 0 Fail, 2 Count/List
Project 3 Checks, 1 (100%) Pass, 0 Fail, 2 Count/List
appearence of the building 4 Checks, 2 (100%) Pass, 0 Fail, 2 Count/List
materialization 4 Checks, 2 (100%) Pass, 0 Fail, 2 Count/List
Copy
HTML
Excel
Close

4 Long-term Vision - Circular Economy - Urban Mining

The linear construction market starts from mining the materials to fabrication, assembling, use, demolition and dumping. To go to a circular economy the built environment will be the source of building materials.

This is called ‘urban mining’. Parts of buildings that are planned to be demolished of refurbished can be sold by their owners.

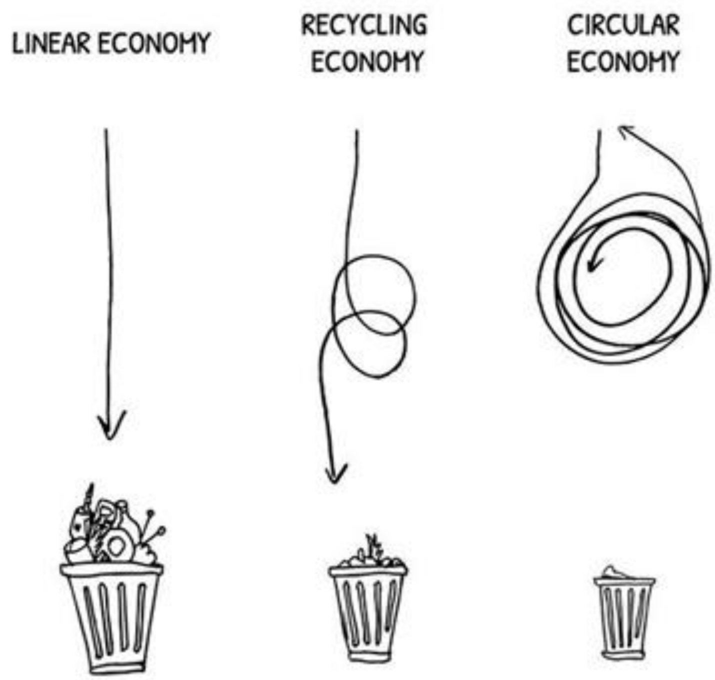


Figure 3: Linear Economy figure

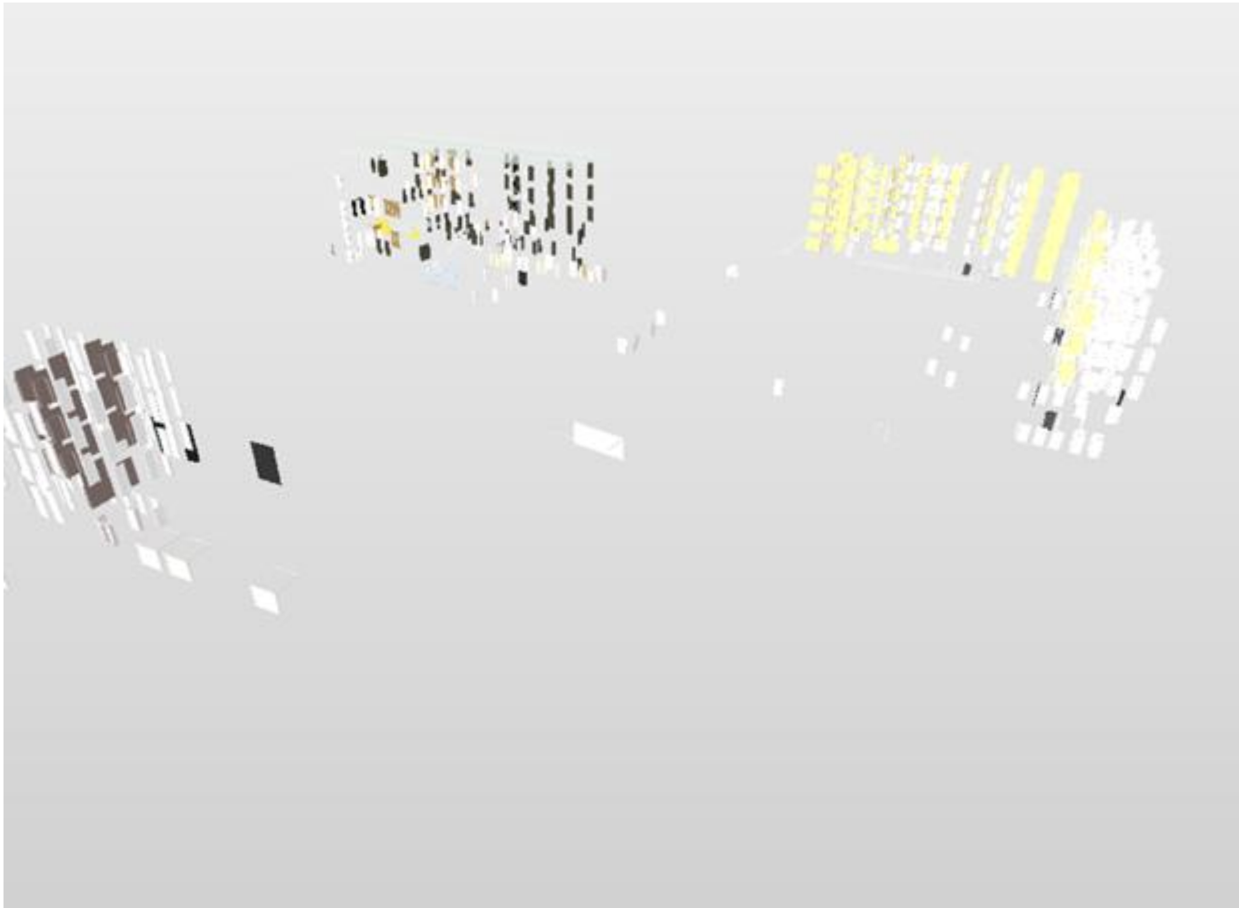
You can see these different objects from different sources as “Lego blocks” who will be combined to a new (part of a) building. Companies that will be specialized in collecting, upgrading and reselling these objects have the need to look for those materials in an easy way. Not only a view on the geometry is important, but also the characteristics of the material itself, the geolocation (nearby, far away), the location in the building (easily accessible?), characteristics of reuse (not attached, screwed, glued, …), availability in time (now, in the future,…) et cetera. These companies can then select, bid, buy, upgrade and resell the parts they are interested in. This industry is already growing:

- the business of collecting and reselling building parts already exists.
- platforms that serve as a cadastre for materials already exist
- a lot of research is done related to reuse of materials: see www.bamb2020.eu

Scenario is:

1. Selecting the area to search in. This can be a circle around a certain geographical point or drawing a selection frame on a map of the area.

2. Setting selection criteria for IFC categories (IFCdoor, IFCwall, ...) in combination with filtering for certain parameters (LoadBearing, FireRating, Material, ...).



3. Selecting the time period in which materials could be available. (For example, half a year from today's date.)
4. Viewing the results: where can they be found? number of elements? What data is linked to it (material passport)? How can it be disassembled?....

State of the art of these functionalities and Gap: Most BIM software allows information to be filtered from a group of BIM models. These BIM models must therefore first be collected and opened in one software environment. It is possible to read out additional information from the selected items. However, the parameter 'time' is too widely interpretable to be used as a unique parameter in a BIM model. Buildingsmart, for example, defines 18 variants of planning data, none of which can even be used to indicate when material is available for reuse. The geometry of objects is important to estimate their reusability. If certain cut-outs are made in building components, their reusability can be greatly reduced (e.g. cut-outs in façade panels or ceiling elements). The current definition of LOD is insufficient to provide an unmistakable answer to this question.

Alternative use of this functionality can be:

1. Examination on the presence of hazardous materials (for example a thermal insulator like polyurethane that may be considered toxic in the future).
2. Instead of a permit to demolish everything, a government can examine and indicate in the BIMy platform the materials that need to be dismantled for reuse.
3. A fire intervention team can use this functionality to look for gas valves, water hydrants
4. Real estate developers can calculate the value of the reusable materials to get a more accurate value of buildings
5. Universities can use this database to do building related research on. For example thermal performance of building, seismic resistance, ...

5 Building Permit App

Whether you want to build a new property or you want to remodel, upgrade, extend, repurpose or replace an existing property, in most countries you will need to apply for a building permit.
The building permit consists of a description of the construction works, the environment, utilities, water infiltration systems etc. It must comply with the urban regulations applicable to the construction site.
Traditionally, the building permit procedure involves drafting the plans, describing the project according to a more-or-less predefined template, providing plans, photos, renderings and technical documentation where applicable, submitting the permit to the local authorities (municipality, city, province or state…), awaiting the permit evaluation, possibly re-submitting a requested amendment etc. until eventually a positive decision has been taken. The entire process involves many stakeholders and can be very complex due to the many aspects that have to be verified. Nonetheless it is a very common procedure.
Applying for a building permit traditionally involves significant paperwork and repetitive data entry by many stakeholders. This approach can take long to complete due to accumulation of lead time, e.g. to correct errors or to amend a permit proposal.
Several countries are currently embracing digital transformation by developing and deploying e-government platforms to improve the efficiency of managing and performing building permit application processes. Some examples:

- In the Netherlands[17], citizens and companies can submit building permit applications online at the “Omgevingsloket” (environmental counter).
- In Belgium, the Flemish region simplified the building permit application process[18] and started developing an online platform[19] to help citizens submit and track their building permit applications. It is also called “Omgevingsloket” and the new building permit is called “omgevingsvergunning” (environmental permit).
- In Finland a similar platform has been in use for some years now. In over 60% of the municipalities building permit requests can be issued through this platform. The platform is called “Lupapiste” (permit point). The vision for the future is to incorporate automated checks using Solibri and artificial intelligence.
- In Estonia a digital permiting platform is already in use. Although the process is still based on ‘digital paper’ (PDF, DWG) a proof of concept was presented using open-source components (BIM server, BIM surfer, Voxel Server). The proof of concept manages to check IFC models and is planned to be implemented in 2021.

Many of these digital platforms currently provide mainly digital counterparts of paper forms and questionnaires. Their primary goal is to reduce the administrative burden for the civil servants. Once available, these platforms are regularly updated to improve usability and further reduce administrative overhead. Attention to the needs of the end users often comes at a lower priority at first.
in their work and still have to improve ways to incorporate the end users and to satisfy their needs. Often the end user must select the topics from a list to which the building permit will provide input to, which requires knowledge on local, regional and national legislation and regulation.

To our knowledge, BIM models are rarely used in these digital platforms. Sometimes a BIM model can be uploaded, but it is not being processed or validated. Integration of GIS data is often supported, mainly driven by mandatory European directives on GIS data.
Vision:
Imagine a digital building permit platform where information from the urban context (GIS) and from the construction project (BIM) are cleverly processed and combined to further reduce the hassle of submitting a building permit proposal.
An architect could provide an address and select the cadastral parcel(s) to which the application applies. When submitting a BIM model to the platform, automated checks will provide instant feedback on validity of the application, without requiring the assistance of a civil servant. Example BIM checks could be:

- Determine the footprint of the building
- Determine the totally constructed footprint on the parcel(s)
- Determine the total inhabitable area and volume
- Determine the floor-to-ceiling height of each inhabitable volume
- Determine the height of the roof and of the gutter
- Identify the model georeferencing (including vertical datum)
- Determine the type / purpose of a construction
- Determine the number of residences in a building project
- Determine whether a building has escalators and elevators
- Determine compliance to thermal insulation requirements
- Determine soundness of foundation type for the soil
- Determine whether a well or drainage installation is allowed

Even though building regulations aren't necessarily all described yet in digital models, some preliminary checks could be implemented by cleverly filtering BIM data and verifying GIS constraints. Often regulations are defined in a hierarchy where fine-grained regulations may overrule larger-scale regulations.
If these checks could run automatically, it would save a lot of time for many stakeholders.
Further, in the case where it is necessary to carry out and document on-site inspections, the possibility to relate inspection documentation with BIM objects would increase the added value of the BIM asset. In the end, governmental entities and end-users can have centralised access to native model information as well as required inspection documentation.

6 Fire and Earthquake Intervention and Training

The VR-based applications help users experience a real disaster in a virtual environment where the urban context (GIS) and detailed building models (BIM) are extracted from real data and are integrated in a semantical context. The 3D models are generated by using the BIMy Platform effectively for extracting virtual 3D layers with pre-queries. ifcOpenShell tool is used to convert IFC models into 3D data compatible with Unity. This enables the extraction of the connected information for earthquake and fire intervention and training scenarios. VR applications are developed for Oculus Rift VR Gear which is a prerequisite to use the simulation.

The VR-based Earthquake Training application, as shown in Figure 4, simulates an earthquake and educates the trainee to understand the essential lessons of disaster preparedness. The safe, neutral and dangerous objects are extracted from the BIM model. Here, a fire is simulated in the kitchen which requires user interaction for fire intervention, e.g. using the extinguishers and follow the evacuation line after switching off the contact breaker or the natural gas valves. While the BIM model serves residents to highlight the point-of-interest objects inside the building, the GIS model of the city enables them to be oriented and learn the points-of-interest in urban context, such as nearest gathering point, pharmacy, hospital. etc.

This work [Kanak2020] was also published at the IEEE SMC 2020 conference.

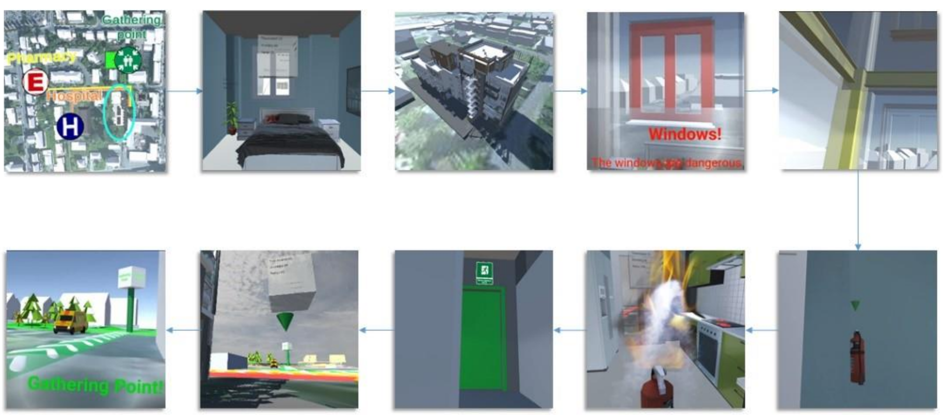


Figure 4: VR-based Earthquake Training including Fire Intervention

The snapshots in Figure 4 are taken from the VR-based Fire Training and Intervention simulator, where the focus is on the fire and earthquake case. This application is applied on the Nursing home OCMW Kortrijk model (2.4.3.1), which afterwards is integrated in the VR training application.

The VR-based training scenario is based on the building plan, locating emergency escape route, locating the fire and intervening by locating the fire extinguishers, following the emergency escape route until run out from the building from the emergency exits. The scenarios are applied for various locations in the building in order to present alternative possibilities that can be encountered during such a disaster. The application is planned to be used by municipalities, city planners, disaster trainees, fire brigade and of course also regular residents.

Figure 5: VR-based Fire Training and Intervention

For the AR-enabled BIM visualisation and evacuation scenario application, real settings are needed for users who are actually present in the ambiance where buildings with BIM models and assets are within sight. Two houses in Skopje, North Macedonia, are modelled as House A (Figure 5) and House B (Figure 6) to execute the AR demonstrators in the real world.

The IFC models of the houses are converted into COLLADA format, by using the IfcOpenShell ~~tool~~, to import the 3D models to Unity. The furniture and LOD500 objects (table, TV, laptop, stove etc.) are used to present a more realistic environment which are used as 3D markers AR. Those objects are the references in the related house to detect the location and orientation. For 3D object detection the well-known AR tool Vuforia is used. After detecting the 3D objects, various scenarios are implemented over the 3D layout. The scenario presents the crucial points, I.e. the point-of-interest objects to the user, and then simulates a fire case in the kitchen. This simulation helps the user to have experience how a fire would look like and let them know what to do in such a situation.

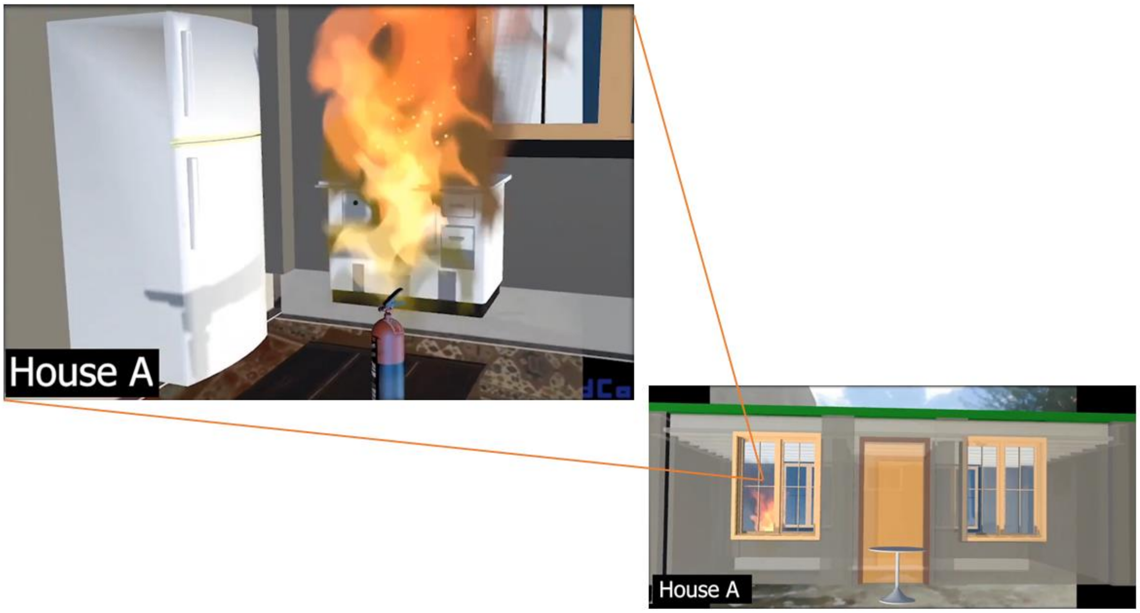


Figure 6: House A from AR-enabled BIM Visualisation and Evacuation Scenario

Figure 7: House B from AR-enabled BIM Visualisation and Evacuation Scenario

7 GIS/BIM Web Viewer over Cloud

The web viewer is based on Cesium which is an open-source JavaScript library for world-class 3D globes and maps. The main motivation behind Cesium is to create the leading web-based globe and map for visualizing dynamic data.

For this Application, we use Cesium-based 3DCityDB's web client demo application that enables the visualization of GIS data on a globe. The CityGML model of New York City dataset is loaded and the visualized buildings are mapped to models in our BIMServer. With this, the 1-to-1 mapping between the building's GIS model and BIM model is implemented.

The Cesium-based visualization enables effective filtering of BIM models and the visualization of query results on a Web platform. Such query results can also be transformed in Collada or FBX format which is used for Virtual or Augmented Reality applications.

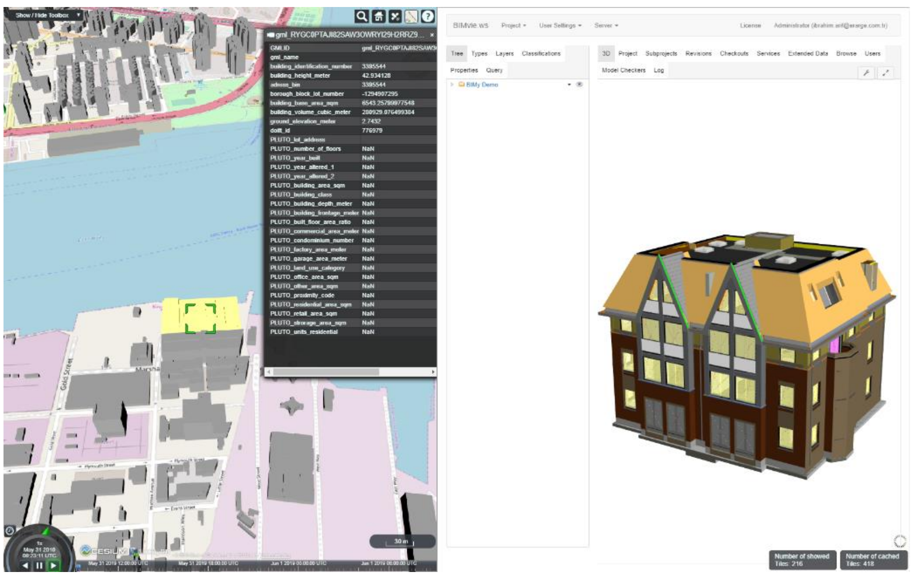


Figure 8: Screenshot on New York City's (City of New York, 2017) GIS model from 3DCityDB-Web-Client connected to the Schependomlaan BIM model (openBIMstandards, 2015) on BIMServer

Figure 9: Screenshot on viewing the Schependomlaan BIM model (openBIMstandards, 2015) on a Cesium based web viewer

8 Fire Prevention

8.1 Required information

When working on a project, architects need to keep in mind regulations and guidelines concerning fire prevention. To be able to communicate certain measures taken to comply with those regulations, certain information should be added to the model so it can be represented on floorplans, sections, 3D views, … etc. This overview of required information is based on Belgian regulations and contains the information that's legally required to be provided. (e.g. when applying for a building permit.)

2. Fire prevention site inspections during construction and maintenance phases

After the specifications and requirements for Fire Prevention have been established during the design phase, project stakeholder must ensure their compliance during the execution phase and further during the maintenance phase. To do so, inspectors carry out site inspections to verify information related to fire resistance of materials, evacuation routes, presence of equipment for fire-related emergencies, protection measures, etc. As such information should normally be included in BIM models, it would be ideal that inspectors have a reliable mechanism to access the relevant information supplied in the models. Further, to ensure that relevant project stakeholders are aware and can act about site inspection results, inspectors should have an effective mechanism to provide inspection data back into BIM models, as they serve as a common shared source of truth. However, reality nowadays is that inspectors normally do not have the means to access the multiple relevant data sets neither have a reliable method to provide site inspection feedback into BIM models.

In this regard, BIMy leverages its interoperability capabilities by connecting with an on-site inspections platform (LetsBuild) and empowers project stakeholders by creating an effective bridge that facilitates data exchange for the fire inspection process. The bridge makes BIM metadata available in the on-site mobile application and allows inspection results to be sent accessible through a BIM model. This information exchange is done based on the IDs of BIM objects, native IDs in the case of models in native formats and GUIDs in the case of IFC models. For this reason, it is crucial to consider that the changes in object IDs would have an impact in such workflow.

The relevant BIM models are sent to the LetsBuild platform using a native plugin for Revit models or by means of direct upload for IFC models. In this platform, the user has access to the following functionalities to facilitate the fire inspection workflow:

- Different BIM Models of a project
- BIM objects metadata
- Library of customisable site form templates according to fire inspection standards
- Sets of project participants that can carry out inspection tasks
- Customisable work breakdown structure
- Library of project documents like 2D plans from the BIM model, reports, specifications, etc.

The user can then leverage these data sources to create site inspections that include BIM objects information, standards specifications in the form of checklist, technical documentation, assignees and more.

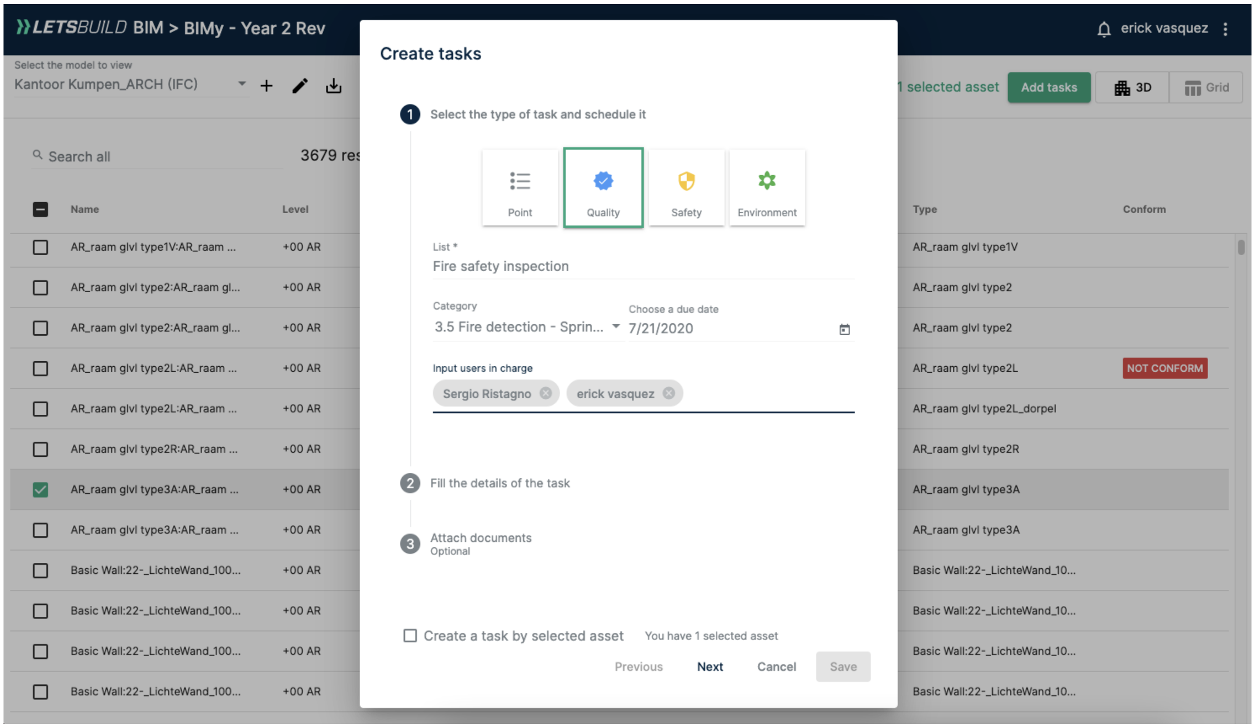


Figure 10: Using LetsBuild BIM module to create inspection tasks linking BIM models, checklists, assignees and more

The inspection task is then transferred to the assigned stakeholder, who can use the mobile application to carry out the site inspection. The site inspector then has access to the relevant BIM metadata, the specified checklist and the technical documentation, significantly facilitating the inspection activity. In addition, such information is made available offline, in case the site inspector needs to work in a location where internet coverage is not guaranteed. For this task, the inspector uses the checklist to verify compliance with the specified standards, but also has the possibility to complement the activity with photos, comments or extra documents.

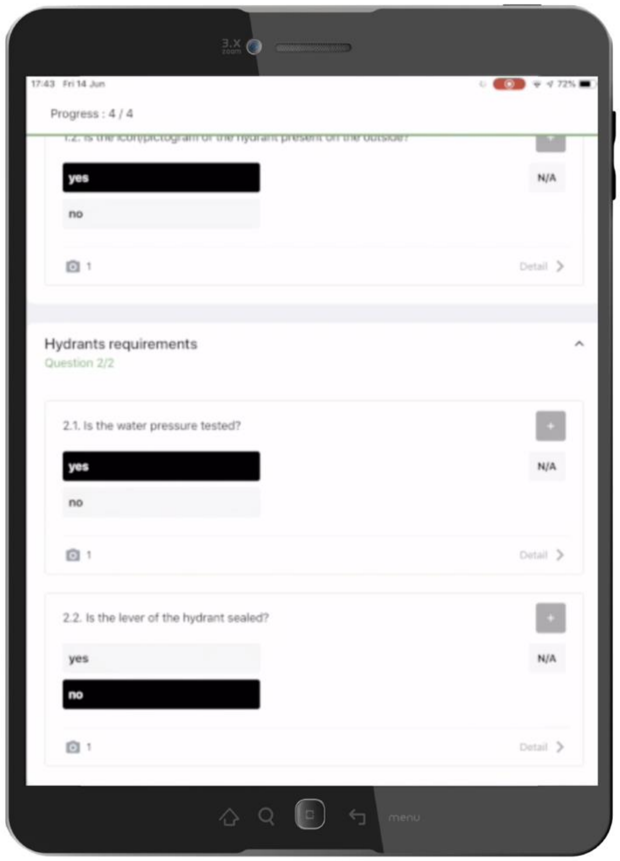


Figure 11: Inspection task linked to BIM object carried out in LetsBuild mobile

After the inspection activity has been finalised, an inspection report is generated and the inspection details are prepared to be made accessible through the BIM model. In the case of Revit, the native plugin is used as the mechanism for information exchange, while in the case of IFC the data is directly added to the BIM objects and available in the IFC file when downloaded from the platform. To illustrate the output using an example, the Revit user sees a summary of the site inspection results by having a 'Conform' or 'Not conform' status on the object level, while also having a URL that includes all the details of the inspection if necessary (site photos, comments, relevant documents, non-conformities, etc)

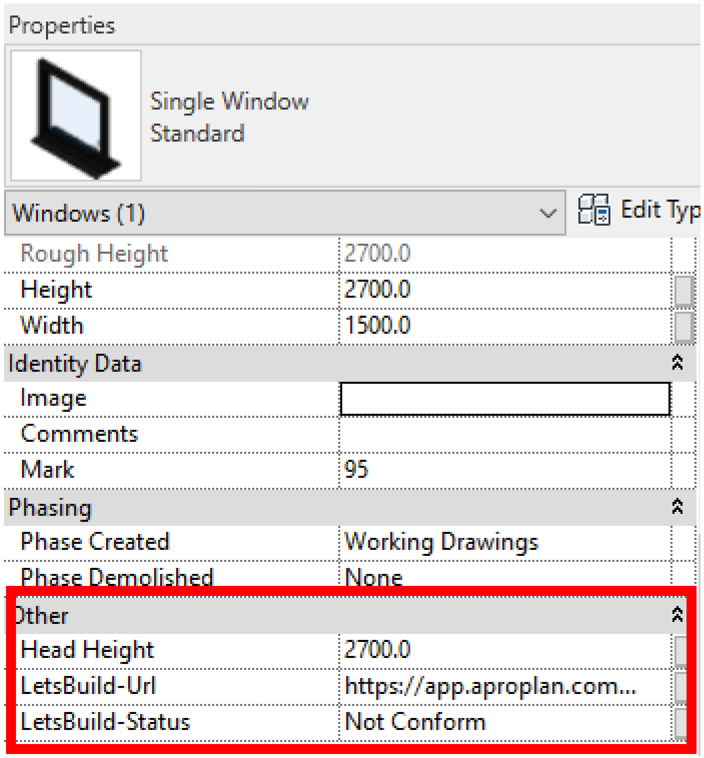


Figure 12: Site inspection details in Revit object