BIMy Project:
D5.1 Demonstrations

(VERSION II)

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Version history

Version	Date	Author	Change
0.01	2019-03-22	Alper Kanak	Introduction and scope
0.02	2019-05-06	Stijn Goedertier	BIMy Platform Data Manager
0.03	2019-05-06	Olivier Gillin	Fire Prevention App
0.04	2019-05-15	Alper Kanak	BIMy Virtual Reality and Augmented Reality App
0.05	2019-06-17	Olivier Gillin	Fire Prevention App
0.06	2019-06-18	Stijn Goedertier	Formatting, add screenshot to Fire Prevention App
0.07	2019-06-20	Dieter Froyen	Reuse of materials
1.00	2019-09-28	Hashmat Wahid	Sections sorted out
1.10	2019-10-22	Alper Kanak	Final – iteration 1
2.00	2020-01-27	Thomas Goossens, Stijn Goedertier	Kickoff demonstator(s) year 2
2.01	2020-06-08	Lise Bibert	Demonstrators Y2 Circular Economy
2.02	2020-10-30	Alper Kanak	First Updates for Iteration#2
2.03	2020-11-25	Francois Robberts	Salubrity Check Demonstrator
		Steven Smolders	Urban Context generation
3.01	2021-02-28	Alper Kanak	Consolidated updates for Y3
		Steven Smolders	Update GIM demo’s
3.02	2021-03-21	Alper Kanak	Final- ready to submit

1 Table of Contents

2 Executive Summary

D5.1 aims to present the demonstrations that have been developed for the dissemination of BIMy outputs and their exploitation to foster the business opportunities. The demonstrator tools have evolved throughout the project duration, despite the indispensable recession of Covid-19 outbreak. This version of D5.1 presents both the previous studies demonstrated in Year#1 and Year#2 review but also the new or updated demonstrators of the Year#3. The Year#3 demonstrators are, for sure, more consolidated than to the previous use cases, as the partners' standalone tools and company-specific expertise have merged into more sophisticated outputs.

The demonstrators are clusters in two iterations:

- Iteration#1 covers the Year1 and partly Year2 activities.
- Iteration#2 covers the activities held throughout the rest of the project.

This deliverable is built on the first version of D5.1, mostly dealing with the second iteration of the project (Year 3 and partly Year 2). Thus, the document which is now being read is the joint version of both iterations. The organisation of the deliverable is as follows:

Section 3 refreshes the BIMy rationale and motivation and the summary of the consolidated use case demonstrators.

Section 4 presents the consolidated demonstrators of Year#3.

Section 5 presents the Year#2 demonstrators.

Section 6 presents the standalone demonstrators of Year#1.

Section 7 revisits the use cases determined during the requirement specification phases in Year#1.

Finally, Section 8 concludes the deliverable.

3 Rationale and Motivation behind the Demonstrations

3.1 BIMy Rationale and Motivation

The BIMy project aims at providing an open collaborative platform for sharing, storing and filtering Building Information Models among different BIM owners/users and integrating and visualizing them in their built and natural environment. BIMy can be seen as an open and generic intermediary that enables interactions between existing and new applications through a unique standardised open API platform. Such a platform will provide a secure collaborative working environment where different stakeholders can benefit and/or utilize BIM models not only at a single building level but also at larger levels that can be scaled up to wider-area smart city applications.

BIMy will overcome the limitations of current BIM exchange platforms, providing the following features: BIM with scale and time (supporting different levels of details and different stages of the building lifecycle), BIM/GIS semantic and dynamic integration (integrating BIM in their built and natural environment), BIM filtering (providing relevant information according to stakeholders and applications), cooperation (supporting stakeholder interactions), simulation and 3D visualisation (mixed and augmented reality through different devices). BIMy is bringing into the consortium all the actors necessary to the successful completion of the platform. There are large companies that can provide a Cloud infrastructure for hosting the BIMy platform and contribute with bigger resources when needed. The smaller companies offer more focused know-how to specified tasks as collaboration or BIM sharing and visualisation. The research partners will support companies with more complicated problems such as creating simple API and modelling and integrating BIM and GIS at different scales and times. BIM owners/users have an important role in the definition of the requirements, modelling, in offering their expertise for different applications and business models as well as the evaluation of demonstrators. The demonstrators in both countries improve the chances to make BIMy more replicable to new countries and environments. This enhances remarkably the market potential of BIMy.

3.2 Updates in D5.1 Version II

The BIMy project aims at providing an open collaborative platform for sharing, storing and filtering BIM among different BIM owners/users and integrating and visualizing them in their built and natural environment. BIMy realisations in the last mile of the project (second half of the project) have been demonstrated within their specific context but also realised within an open and generic intermediary that enables interactions between existing and new applications through a unique standardised open API platform. Such a platform, namely BIMy Platform, provides a secure collaborative working environment where different stakeholders can benefit and/or utilise BIM models not only at a single building level but also at larger levels that can be scaled up to wider-area smart city applications.

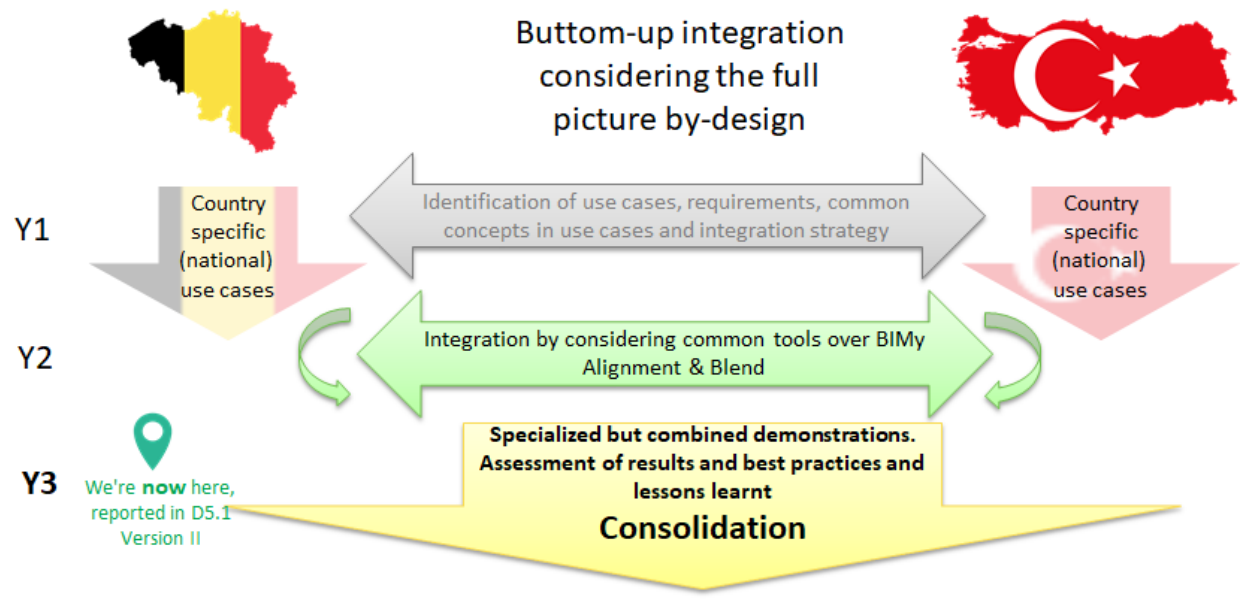


Figure 1. D5.1 Version II Realisation Flow

As illustrated in Figure 1, the achievements reported in D5.1 Version II are built on previous developments realised in Year 1 and Year 2 (Iteration#2). Year 2 studies focused on the integration of BIM and GIS within the context of BIMy first to view and monitor buildings and their surrounding areas for general purposes. Then, more dedicated BIM-GIS data monitoring, filtering and visualisation studies are held for more specific needs, e.g. salubrity checking, urban context, building permit processes, model comparisons, and crisis and disaster preparedness or intervention planning.

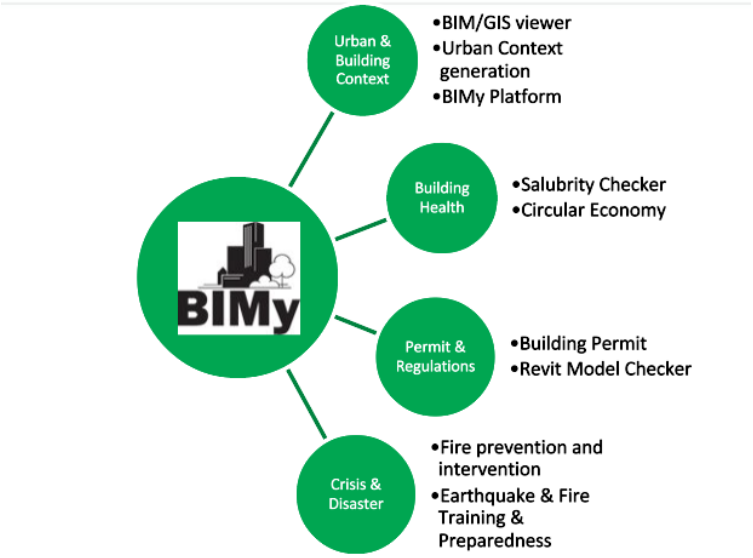


Figure 2. BIMy demonstrators consolidated

As depicted in Figure 2 above, in the second version of D5.1, the BIMy partners focus on consolidating the standalone use cases mainly in four application areas:

I. Urban and Building Contextual Data Management and Visualisation:

Partners have joined forces to develop the BIMy Platform which is the main output of BIMy. The platform operates over Azure cloud and enables the management of heterogeneous BIMy data and tools by interlinked containers (Dockerisation). BIM/GIS viewers are also improved both as iframe within a web browser and also by popping up Unity frames for gaming-like interaction and BIM/GIS visualisation.

II. Building Health & Environment:

In many areas, building codes impose so-called salubrity constraints on constructions. These encompass minimum ceiling heights, minimum door widths and heights, minimum floor area and minimal window size for specific purpose rooms. These checks are mainly performed on paper today. In a BIM model, many of these data elements are readily available (or they can in principle be computed or derived from the BIM model). Salubrity check is an important requirement to build healthy, strong and robust buildings. Thus, the BIMy use case for salubrity checking is crucial for the compliance of buildings with safety requirements and mandatory for building permit.

Moreover, BIMy use cases related to the circular economy facilitate the building lifecycle management not only on a town planning level through alighting urban impact analysis workload for local authorities (such as volume measures, floor surfaces measures, impact on adjacent buildings, landscape impact, etc.) but also on a facility management level, allowing for an efficiency increase and reduced maintenance costs, including deconstruction, renovation, transformation and demolishment of buildings. Better lifecycle management for buildings, will positively influence circular economy market and green projects at city scale by offering the possibility to identify reusable materials, asses the available quantities, determine its quality, etc. This could be a perfect match in the context of the larger Green Deal plan launched by the EU and aiming to boost a clean, circular economy as well as environmentally-friendly technologies.

III. Building Permit and Regulations:

There is a strong need on private sector support and public-private partnership for collecting damage assessment data and its classification; determining the permit requirements that need to comply with not only urban plans but also preparedness plans; applying expedited review processes for the reconstruction or retrofitting of a building; benefiting from the effective planning of recyclability and recovery after a disaster occurs; business responding to lobbying about human and relief impact; increasing operational capacity of authorities and first responders by providing technical support, procurement, maintenance and operational management.

IV. Crisis and Disaster Resiliency:

BIMy has already identified this potential as such technologies can be used for many purposes like in crisis management or increasing the public awareness of people in case of disaster. There are expectations of using BIMs by multiple stakeholders for facilities management, safety and security analysis, crisis management and citizen participation in the pursuit of smart city initiatives. BIMy addresses the effective training, planning and utilising crisis management activities with a special focus on first responders. The BIMy case studies present a more comprehensive approach not only at BUILDING even HOUSE level but also at URBAN level.

The related demonstrators are mainly based on the concept of edutainment (education + entertainment) aiming to simulate an evacuation scenario from a specific apartment in a building when an earthquake or fire occurs. The scenario covers what to be done throughout the evacuation route starting from the specific room of the apartment and ends at the nearest gathering point that is close to the building. The scenario trains people who leave in that specific apartment by presenting the "to-do"s in a virtual but realistic 3D gaming environment (extracted from BIM and GIS model).

4 Demonstrators YEAR 3

Aligned with the use cases mentioned in Section 7, demonstrators have been developed aiming to present the consolidated use of previous BIMy development which were developed as a baseline in Year 1 and further improvements and integrations in Year 2. This section gives an overview of the consolidated demonstrators all of which have been integrated over the BIMy platform over cloud.

4.1 Summary of the Demonstrators/tools/applications

The demonstrators in Year 3 are listed in Table 1:

Table 1. Summary of the Demonstrators Year 3

Nr	One-liner or name of the Tool/Application/Demonstrator	Related Use Case(s)	Lead Participant	Other Contributors
ITERATION #3				
1	BIMy Data Manager & Web-based Platform	ALL	NETAS	ALL
2	AR-enabled BIM Visualisation and Evacuation scenario	TR: Training residents by evacuation simulation in case of earthquakes BE: Fire intervention (Fire Brigade access information in case of intervention) TR: Fire Brigade Crisis Management	ERARGE	NETAŞ
3	Automated Salubrity Check	BE: Fire prevention BE: Digital building permit platform	BBRI	GIM
4	Autodesk Revit model checker to check a native models' compliance with a BIM protocol	All	GeoIT	
5	Automatic generation of Urban context	BE:Integrate Urban context information into BIM Models	GIM	Assar, Willemen

4.2 Demonstrator #1 – BIMy Data Manager & Web-based Platform

The BIMy data manager provides a generic BIM model storage service which is used in the platform applications. It consists of a storage API and an object storage service which has been implemented in the MinIO client verticle and the BIMserver client verticle.

Our reference implementation uses the Eclipse Vert.x toolkit for building reactive applications on the JVM. Vert.x is resource-efficient, that is to say, it can handle more request with less resource compared to traditional frameworks based on blocking I/O. It is also flexible and easily scalable. On the other hand, it makes asynchronous programming easier, without sacrificing correctness and performance. A high performance asynchronous programing is important in BIMy platform since it is needed to handle long-running tasks such as the upload of a BIMy model which can be a large file.

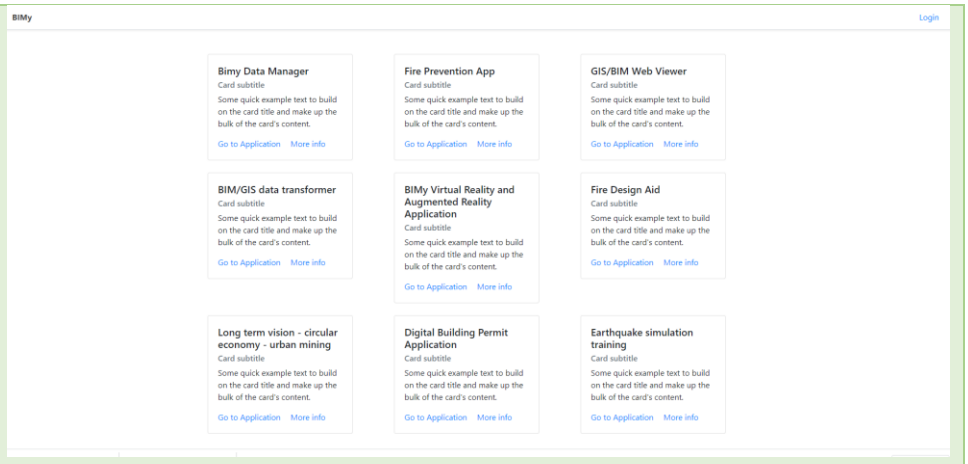
The application contains the following so-called verticles (code that can be deployed on Vertx):

- The HTTP verticle listens to incoming HTTP requests. Those requests will be validated against the OpenAPI specification and a mapping will be done between the request and a Java method. This method will then propagate the request on the event bus, waiting for a reply.
- The BIMserver client verticle listens to the event bus, waiting for incoming request from the HTTP verticle. On event, it will fetch the requested data on the BIMy API and return them via the event bus.
- The MinIO client verticle listens to the event bus, waiting for incoming request from the HTTP verticle. On event, it will fetch the requested data on the BIMy API and return them via the event bus. MinIO has been chosen as object storage technology as it is a highly performant object storage server with an API that is fully compatible with the Amazon S3 cloud storage service.

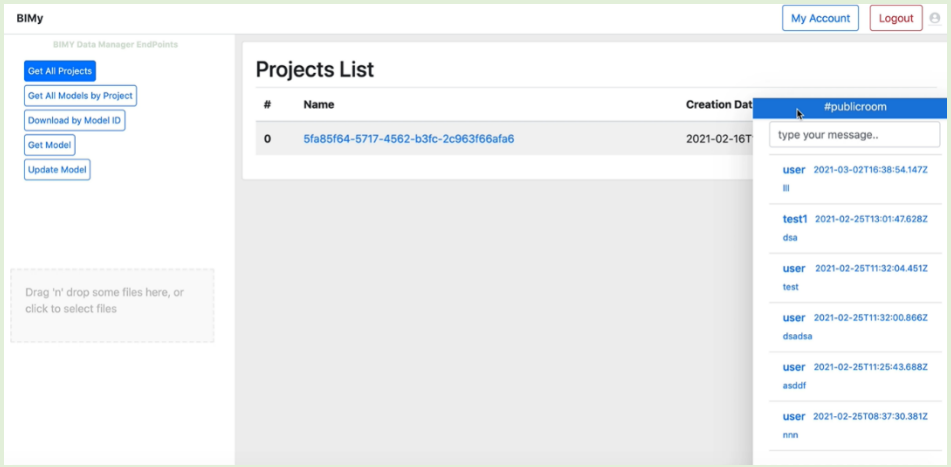
Name of the tool/Application/ similar	BIMy Data Manager & Web-based Platform
Partners Contributing	ALL
Responsible researcher(s) for technical discussions	Gözdenur Yeşilyurt İbrahim Arif Alper Kanak Osman Kumaş
Domain Ontologies/ data models utilised	IFC 2x3, CityGML 3.0, BCF
Data Sources and amount	The application is implemented by using the Azure Cloud facilities and context-specific developments that can be elastically scaled up according to the needs and the BIMy exploitation trend and usage statistics
Motivation (why do we need such an application)	This is the final consolidated application which is based on the main objectives of the project and BIMy vision. The intended users are clients, architects, designers, external advisors, contractors, facility manager, governments (urban planning, fire department, crisis management authorities, tax authorities), municipalities, insurance companies, utility companies, marketers, environmental protection administrators.

Description (How it is implemented and how it works)	The main inputs of the platform are: • BIM & GIS model files • Metadata related to BIM models • BIM-GIS-based BIMy toolsets The main features are: • Upload of BIM data in asynchronous way (also has update, get, and delete features) • Role based access to BIM data • Management and utilisation of various BIM-GIS tools and services • Visualisation of SPARQL queries • Visualisation of cyber resilience check analyses outputs The main outputs are: • BIMy data manager over cloud • Web-based platform with effective and user-friendly interface to BIMy toolsets • Fail or success message indication the result of the operation The developed platform has the following selling points and outputs that enable better positioning in future market provisioning: ▪ Management of heterogeneous BIM and GIS tools within BIMy context that is elastic to be extended and improved with new innovative tools ▪ With the power of event-driven and non-blocking VERT.X, and the ability to handle concurrencies well, your app can scale with minimal hardware. ▪ MinIO server makes it possible to store your data in a high performance, Amazon S3 API compatible object storage. ▪ With the help of Keycloak, identity management and role-based access to your data is achieved. ▪ Hardware-based cyber protection by HSM (Prigm, Hardware Security Module by ERARGE) ▪ AI-based Cyber resilience against intrusion and cyber-attacks (NOVA Cyber Security Solution FAmily by NETAŞ) ▪ Chatbots for stakeholders' communication and collaboration The integration constraints are; MinIO server should be up and running. Keycloak server should be up and running, and roles, users, clients should be registered.

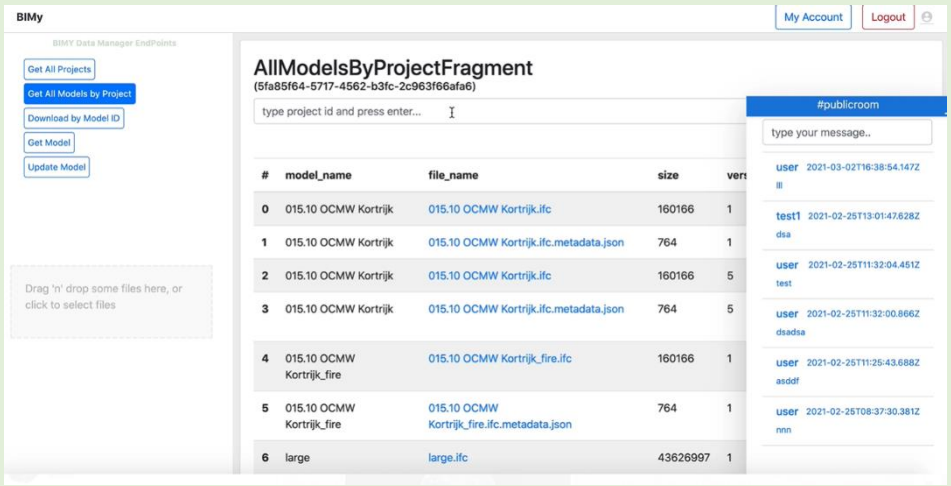
Snapshots and Figures



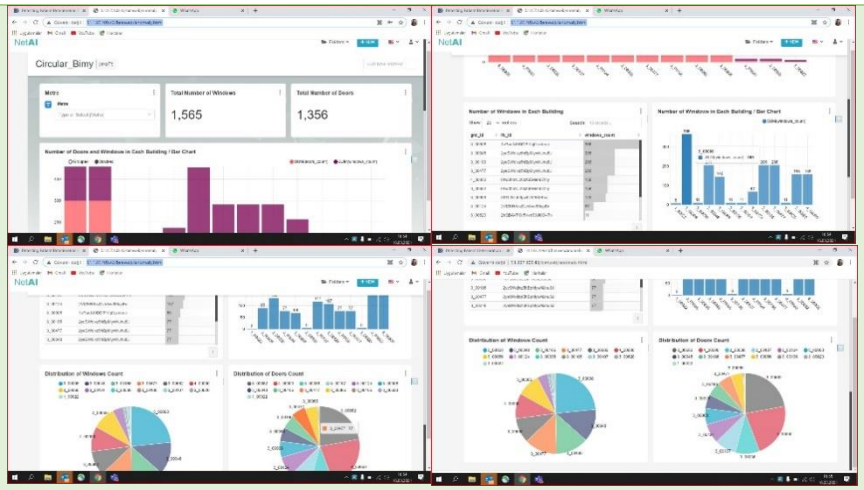
The BIMy solutions portfolio



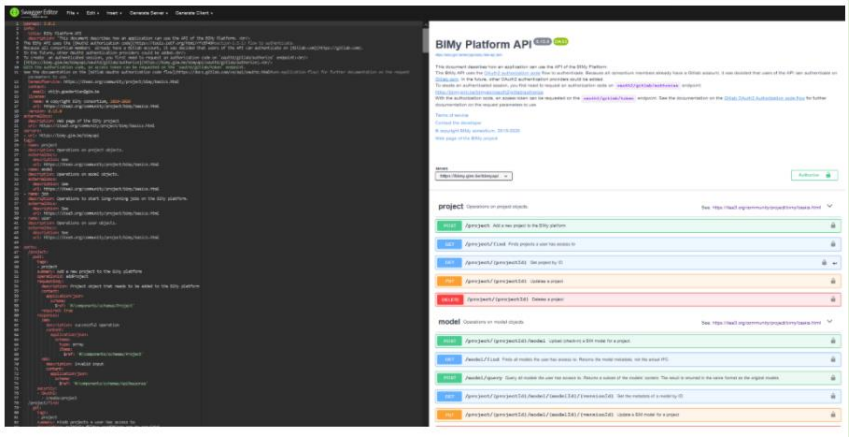
BIM/GIS projects (any AEC project) list and chatroom for multistakeholder collaboration



IFC subprojects in a typical AEC project



Elastic smart query environment that can visualise the SPARQL results by graphics and charts



BIMy Platform API (openAPI specification) at backend

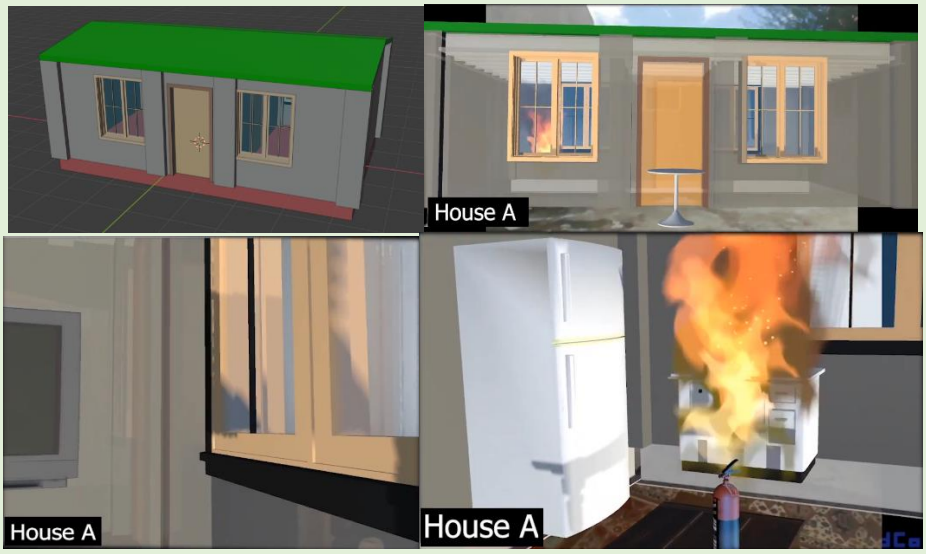
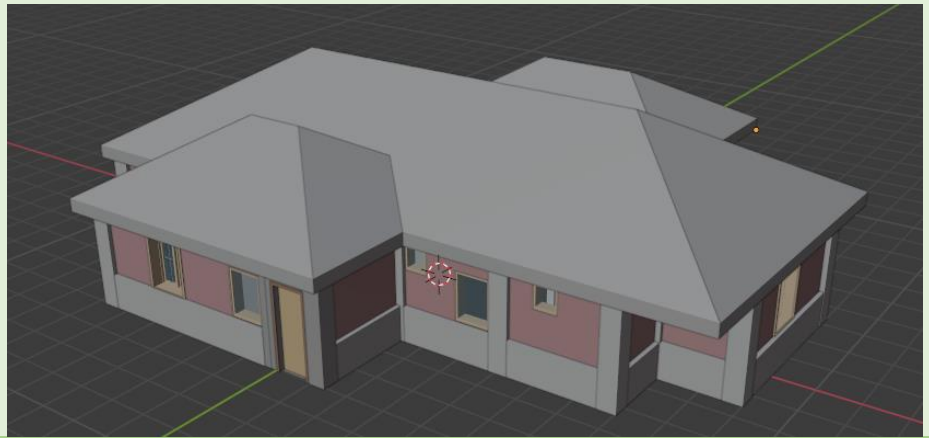
4.3 Demonstrator #2 – AR-enabled BIM Visualisation and Evacuation Scenario

BIMy tackles the use of AR by considering a combined approach where BIM and GIS are interlinked. Unity plays a critical role as a catalyst for the visualisation of 3D BIM models. BIMy leverages the gaming industry visualisation knowledge and experience through Unity for AEC applications. BIMy effectively combines IFCOpenShell and BIMserver for model data management. IFCOpenShell is successfully implemented for BIM data in IFC 2x3 format throughout the project.

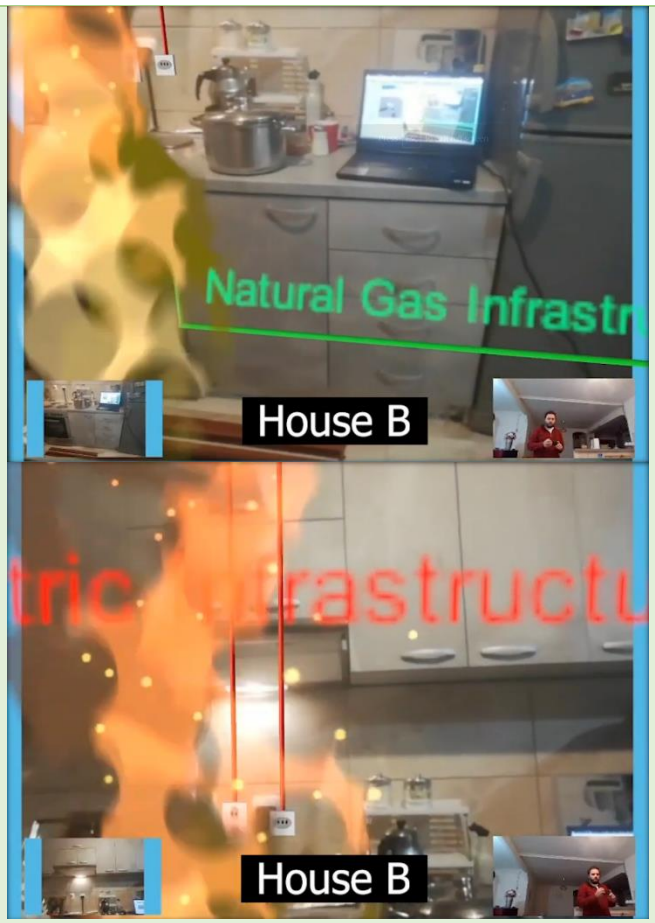
In BIMy project, the AR technology is utilised in two different ways. First, AR is used to simply visualise the BIM and GIS content in its real environment by augmenting the building infrastructure data overlaid on the original scene. Second, AR is used to train residents in case of a disaster by presenting the dangerous zones and hazardous infrastructure, building components and assets in case of a fire or earthquake.

In BIMy, markerless AR is applied to track 3D objects in BIM or GIS setting. Objects like tables, refrigerators or ovens are captured and tracked by well-known SIFT features. Once the object is detected BIM or GIS model is overlaid on the actual camera capture. Note that the BIM and GIS data are extracted by using a SPARQL query and visualised according to the outputs of the query in JSON format. In developed application, the main infrastructural information related to beams and columns, exit doors on the evacuation route, or the natural gas or electricity lines are visualised with different colours as seen in the following snapshots. Microsoft Hololens and smart phones are used as the AR media in demonstrations.

Name of the tool/Application/ similar	**AR-enabled BIM Visualisation and Evacuation Scenario**
Partners Contributing	ERARGE
Responsible researcher(s) for technical discussions	İbrahim ARIF (ERARGE) Alper KANAK (ERARGE) Salih Ergün (ERARGE)
Domain Ontologies/ data models utilised	IFC 2x3, CityGML 3.0 Collada
Data Sources and amount	The data sources are modelled within ERARGE by using Autodesk Revit tool. • **House A**: Small and simple house located in Skopje • **House B**: Bigger and more complex house located in Skopje Both BIM (.ifc) and Collada (.dae) models of 2 pilot houses are available for further demonstrations.
Motivation (why do we need such an application)	The AR technology provides near-realistic experience, since the user is in interaction with the real environment while simulating disaster scenarios like fire case, earthquake etc. This way of simulation presents no life-threatening risks, and it is less costly in compare with real disaster practices.
Description (How it is implemented and how it works)	*House A and House B are modelled within ERARGE to execute the AR-enabled experiments in the real world. The models are with approximate physical measurements (±500mm).* *The IFC models of the houses are converted into COLLADA format, by using IfcOpenShell tool, to import to Unity. The furniture is added, afterwards,*

	essential objects (table, TV, laptop, stove etc.) are selected for 3D model detection for 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 into the house. The main scenario was to show the point-of-interest objects to the user, and then simulate a fire in the kitchen. Which enables the user to have experience how would a fire look like and to know what to do in such a situation.*
Snapshots and Figures	House A:  House B: 


House B
House B
House B


Natural Gas Infrastr
House B
House B

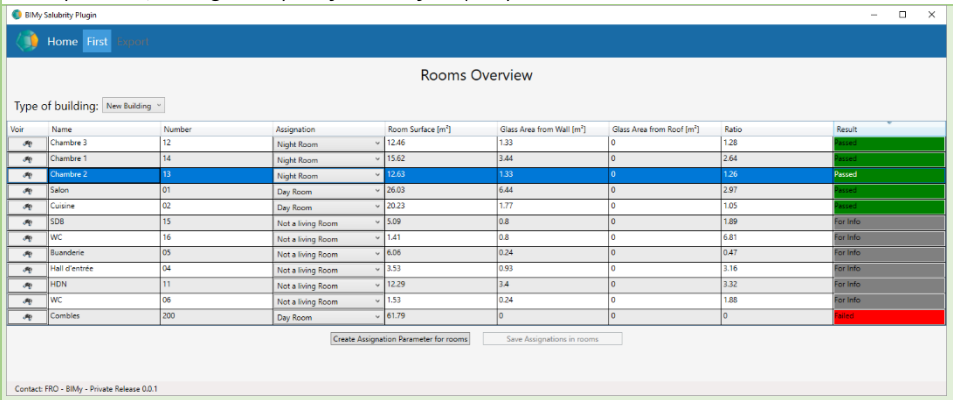
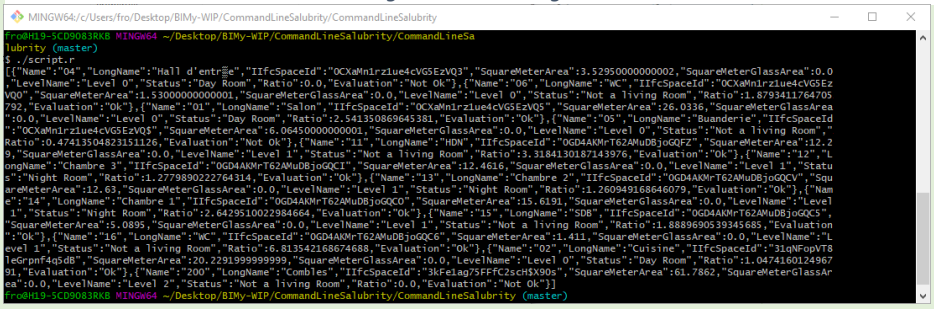
4.4 Demonstrator #3 – Automated Salubrity Check

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 funnelling 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. 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 automatisation of such checkers fails easily. Hence the need for standardisation 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.

Name of the tool/Application/ similar	Automated Salubrity Check
Partners Contributing	BBRI, GIM
Responsible researcher(s) for technical discussions	François Robberts (BBRI)
Domain Ontologies/ data models utilised	IFC 2x3 IFC 4 Autodesk Revit
Data Sources and amount	The application can work on any IFC data
Motivation (why do we need such an application)	Automated regulation check is a great way to improve the value of a BIM model and attract user to the BIMy platform
Description (How it is implemented and how it works)	*The salubrity check will be implemented for two different file formats.* *One version will be an Autodesk Revit plugin that will allow the user to perform the minimal sunlight criterion of the Walloon salubrity requirements.*

	Data needed for the check will be extracted from the model and the result will be provided to the user. Some data has to be inputted manually by the user because it is not usually provided in BIM models. However, the plugin will allow the user to create a custom parameter to save that information for future use of the BIM Model or to allow it to be present into the IFC file extracted. *C# and WPF will be the technology selected for those checks.* *The second version will use IFC as file format, and will be performed by the BIMy platform on the model stored, via API calls. The salubrity checker has been translated to a command line interface application, capable of running on linux server. It takes an IFC file as an input, and return of json with the result of the check.* *This application can therefore be used both by the creator of the BIM model, and to check compliance with the criteria in its BIM environment (here Autodesk Revit), but also by the state official in charge of checking the building's compliance, using an open format file (IFC).*
Snapshots and Figures	 *Figure 4 : Revit Plugin*  *Figure 3 : IFC salubrity check using Command Line Interface*

4.5 Demonstrator #4 – Autodesk Revit model checker to check a native models' compliance with a BIM protocol

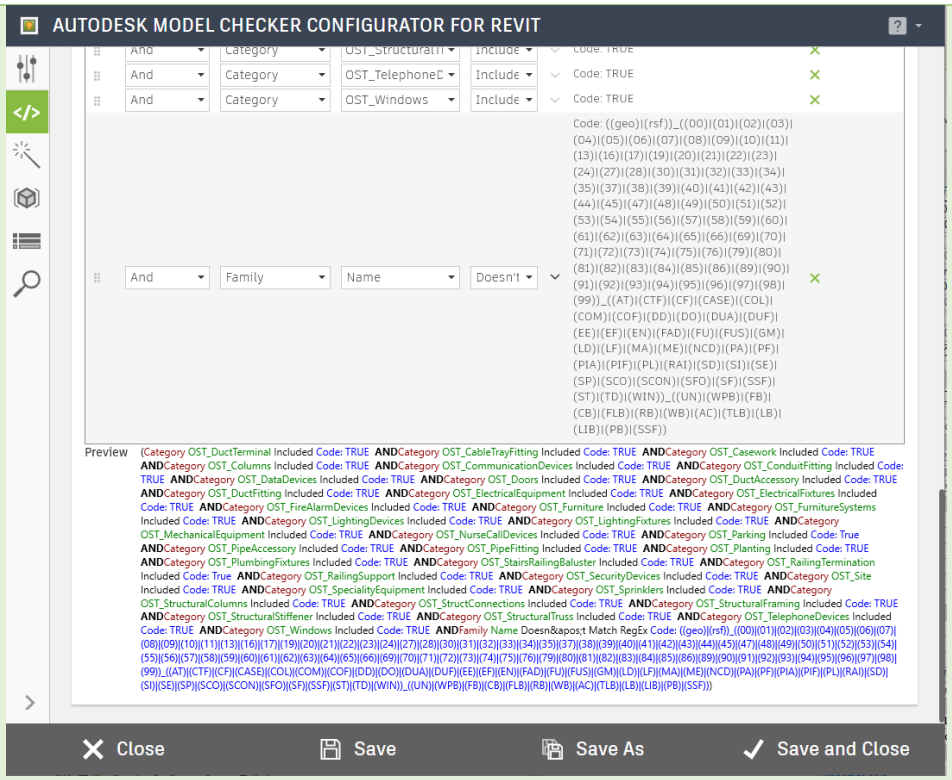
More and more collaborative projects are using BIM modelling as a means of convening parts of building concerning their specific discipline. Autodesk Revit is often the choice as software platform to work on these BIM models and to collaborate on a project. On the one hand working with BIM provides a lot of advantages for the users themselves, and on the other hand it occurs more than ever that the commissioning party requires a BIM to be delivered at the completion phase of the project.

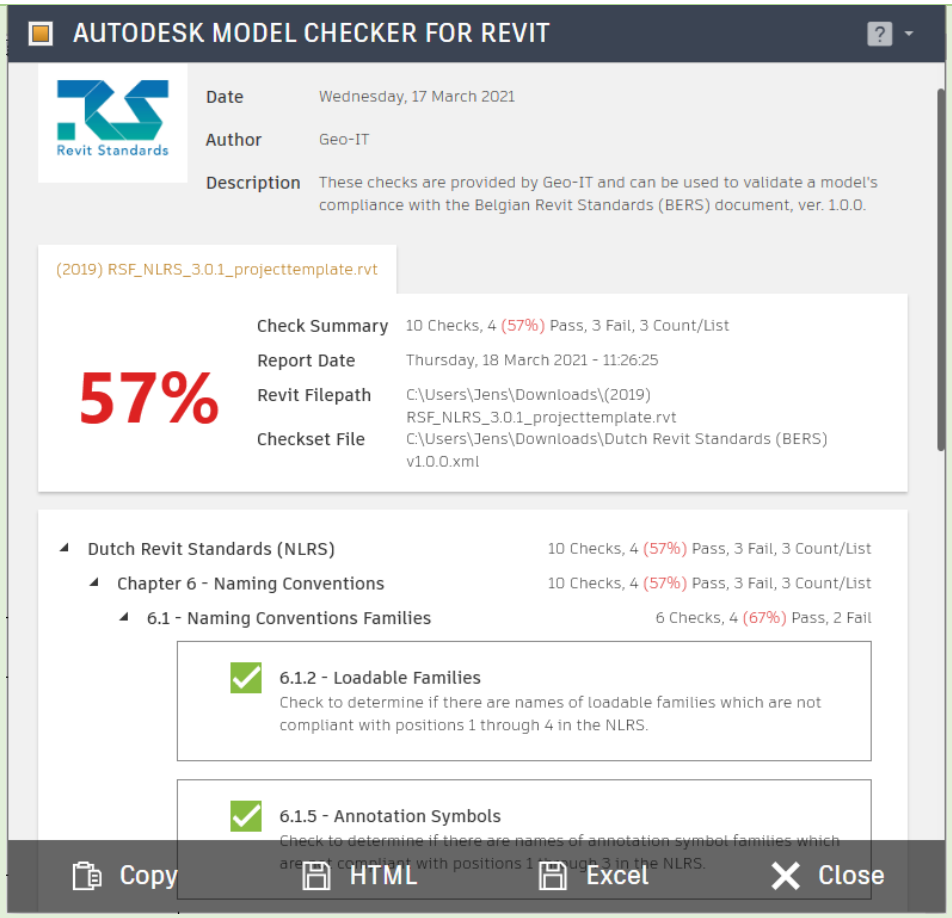
The BIM model that has to be provided will often be subject to a BIM protocol of some sort. We created and example check set to check if a model has used the correct naming conventions predefined in the BIM protocol. By creating such a check set the modeller has the possibility to check his or her model according to the preset rulesets.

Although the example check set we provide here is specifically focused on naming conventions of the Belgian Revit standard, it is possible to use these types of checks for any ruleset imaginable. Every parameter from every category available in Revit can be accessed and used in the checks.

As mentioned above we created a check set to run on a model that needs to be checked on its naming conventions. These should be correct according to the rules from the Belgian Revit Standard. So in this example we focus on a wide range of categories, and checked the naming of the elements. The naming scheme uses 5 to 7 separate slots to input information. We check the first 4 as the other ones are field that can have free texts.

Name of the tool/Application/ similar	**Check sets with the Autodesk Revit model checker**
Partners Contributing	Geo-IT
Responsible researcher(s) for technical discussions	Jens Lathouwers (Geo-IT)
Domain Ontologies/ data models utilised	.RVT files, XML, xlsx
Data Sources and amount	The application can work on any version of Revit since Revit 2018
Motivation (why do we need such an application)	BIM protocols (and other rulesets) are only valuable when they can be enforced and checked. This is why automating the checks, and being able to provide the checks to the modeller, saves all parties a lot of time. The modeller can check before he sends a model if it complies.
Description (How it is implemented and how it works)	*The Autodesk Revit model checker can be installed as a plugin for Revit 2018 onwards.* *It allows for users to build check sets, or to open a checkset he received and check his model based on the selected check set.*

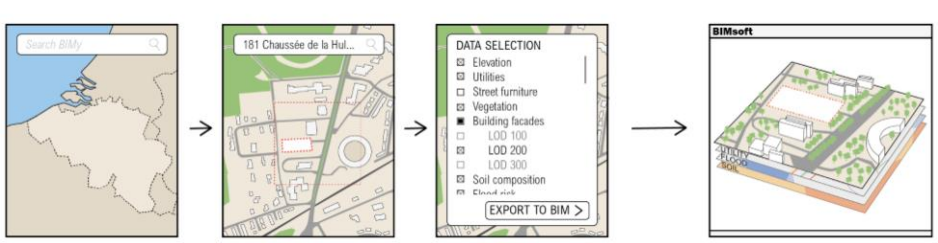
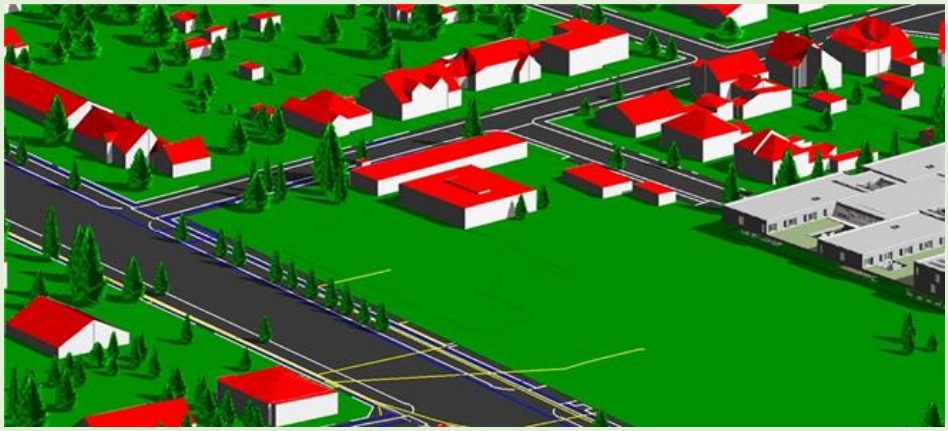
	The checkset provided checks naming schemes of the Belgian Revit standards. Last year's demo checked a model on a few parameters required for a building permit. (Ridge height, Width, Height,…) It can be used to check any aspect of a model as long as it can be checked based on certain parameters. *When the check is run a report will be shown of how much percent of the model is compliant. This can allow the modeller to optimize his model as model elements that have non-compliant values can be selected by clicking on the element in the list, and it will also be selected in the Revit model itself.* *This report can be exported is html or an xlsx file.* *The check sets themselves are saved in xml format and can be exchanged in this way.*
Snapshots and Figures	 *The configuration of a check set*

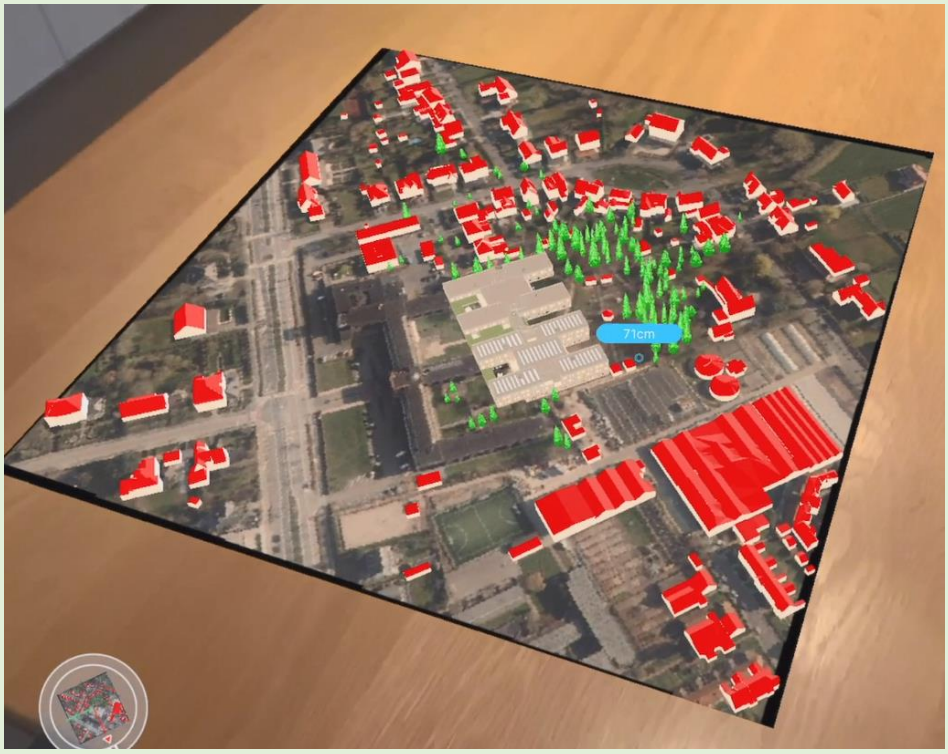


The result of a check executed with the Autodesk Revit model checker.

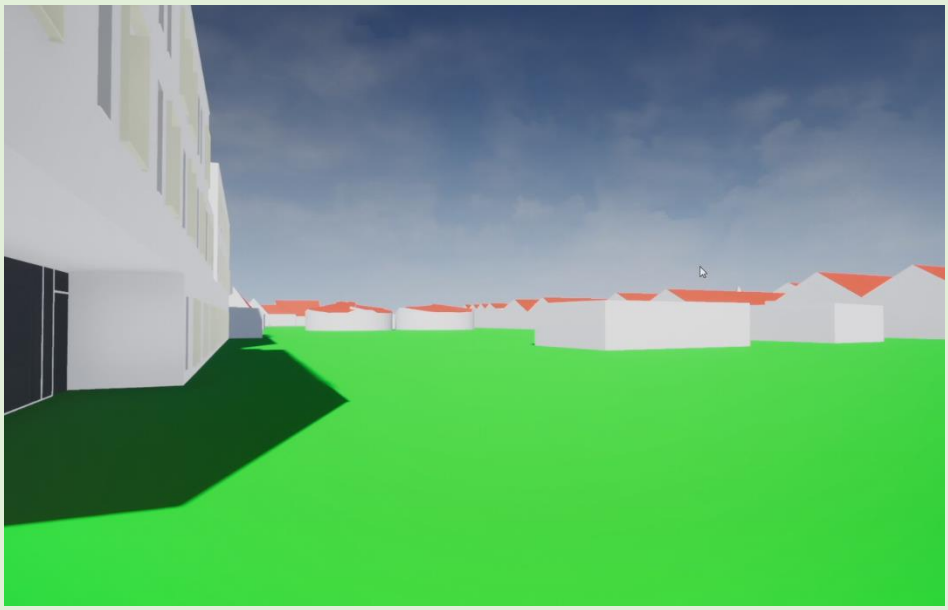
4.6 Demonstrator #5– Automatic generation of urban context for design and construction

Name of the tool/Application/ similar	Automatic generation of urban context for BIM Model design and construction
Partners Contributing	GIM, ASSAR, Willemen
Responsible researcher(s) for technical discussions	Steven Smolders Niels Gabriels
Domain Ontologies/ data models utilised	IFC 2x3, CityGML 3.0 BIMy ADE, 3D Tiles
Data Sources and amount	The following data sources are used: - Digital terrain model - LiDAR data - Buildings in GIS Level of Detail 2 - Trees derived from LiDAR data - Underground infrastructure data - Cadastral parcels - Road surface geometries
Motivation (why do we need such an application)	Over the past two decades, the digitisation of information has profoundly changed site research for architects and designers. Nevertheless, these data sources often produce large amounts of technically incompatible and sometimes contradictory data. The design team still needs to spend countless hours of 'digital labour' to export, reformat, clean out and overlay the data they want to use. As a result, the available information sources are often not used to their full extent. It is a clear example of the division between BIM and GIS: the former is extensively used in building design, the latter in geospatial research. Each technology has its own ecosystem with dedicated applications, file formats, software tools and users. BIMy can be used as a tool for architects and designers to get **easy access to the necessary information** about a project site and its surroundings **in a practical 3D file format**. Imagine this: You, an architect, have decided to take part in a design competition. You visit a single online platform: the BIMy platform. You enter the address to locate the project site. After choosing the size of your workspace (e.g., 200m on each side

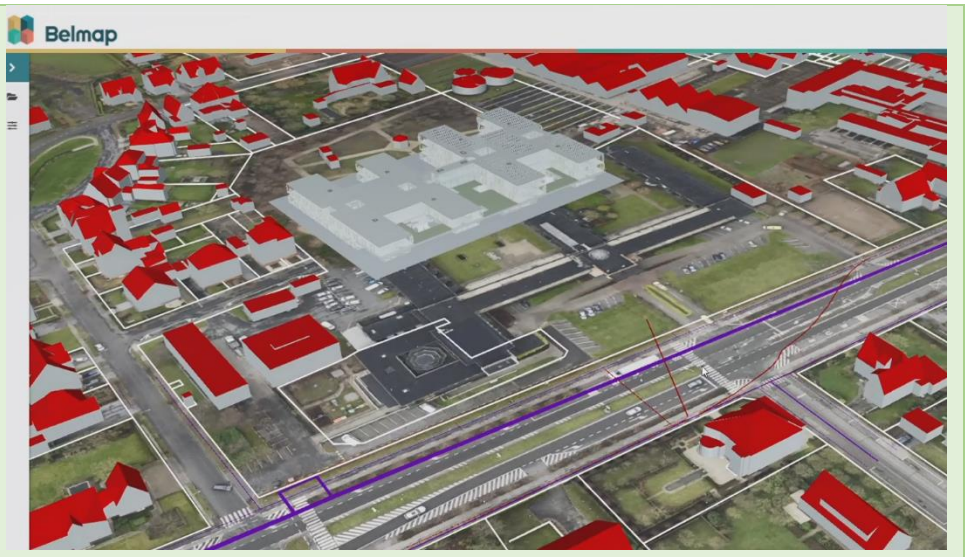
	of the site boundaries), you select the data that should be included and the level of detail. With a click on the download button, you now have **a complete 3D model of the project site and surroundings that is compatible with your favourite BIM modelling software** and holds all the information you need to start designing: 3D elevation, trees, public infrastructure above and below ground level, façades of surrounding buildings, allowed building volumes, information on noise pollution, soil composition etc.
Description (How it is implemented and how it works)	The above vision has now been realised with the development of the BIMy BIM/GIS data transformer. It takes as input LiDAR open data which gets transformed into roof structures constrained by GIMs Belmap-based building footprint layer to derived Buildings in CityGML LoD2 representation. The LiDAR data is also used to derive tree objects. The terrain model is extracted from an open data DTM. Cadastral parcels and road surface geometries are derived from GIMs Belmap product and finally subsoil infrastructure data is added that is made available in an INSPIRE conform GML model. Data is consolidated in the BIMy BIM/GIS integrated data model and from there on translated into IFC which is then imported into Revit and Solibri, into 3D tiles for display in the BIMy web viewer, into obj files for AR visualisation and finally in datasmith files for use in the Unreal gaming engine.
Snapshots and Figures	 *BIMy for urban context integration: concept vision*  *Urban context generated for the Kortrijk care campus – shown in Revit*



Urban context generated for the Kortrijk care campus – shown in Augmented Reality Viewer



Urban context generated for the Kortrijk care campus – shown in Unreal Gaming Engine



Urban context generated for the Kortrijk care campus – shown in Integrated BIM/GIS Web Viewer

5 Demonstrators YEAR 2

Year 2 demonstrators mainly focused on the integration of different solutions, tools and services over the BIMy data platform. The majority of the work was in containerisation of tools over cloud, building up the cloud services including the identity management over KeyCloak, authentication and BIMy data management by considering the user profiling.

5.1 Summary of the Demonstrators/tools/applications

The demonstrated BIMy outputs are summarised in Table 2.

Table 2. Summary of the Demonstrators in Year 2

Nr	One-liner or name of the Tool/Application/Demonstrator	Related Use Case(s)	Lead Participant	Other Contributors
ITERATION #2				
1	Digital Building Permit Application	BE: Digital building permit platform	ASSAR	Willemen, Geo-IT, Letsbuild, GIM, ERARGE, NETAS, BBRI, SIRRIS
2	Earthquake and Fire Disaster Simulation & Training	TR: Training residents by evacuation simulation in case of earthquakes	ERARGE	NETAS
3	BIM/GIS VR/AR Application for Site Inspection	TR: Fire Brigade Crisis Management BE: Fire prevention BE: Integrate urban context information into BIM models BE: long term vision - circular economy - urban mining	GIM	LetsBuild, ERARGE
4	IFC-to-BIM (Urban Context), BIM/GIS data transformer	TR: Fire Brigade Crisis Management BE: Fire prevention BE: Integrate urban context information into BIM models BE: long term vision - circular economy - urban mining	GIM	Willemen
5	Revit Model Checker	BE: Fire prevention BE: Digital building permit platform	Geo-IT	Other Belgian partners
6	Upload IFC and Visualise IFC file in its Urban	TR: Fire Brigade Crisis Management BE: Fire prevention	GIM	Other Belgian partners

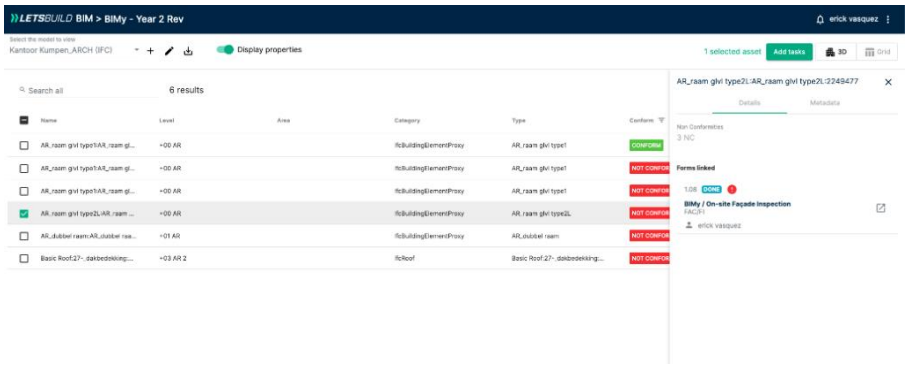
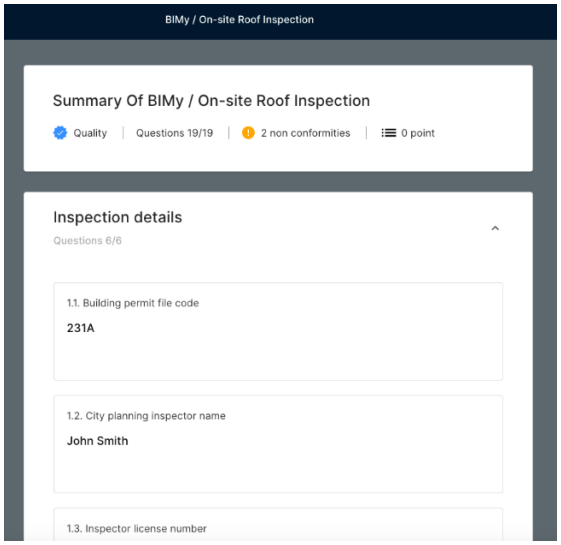
	Context, BIMy-web-viewer / bimy-vue-cesium	BE: Integrate urban context information into BIM models BE: long term vision - circular economy - urban mining	

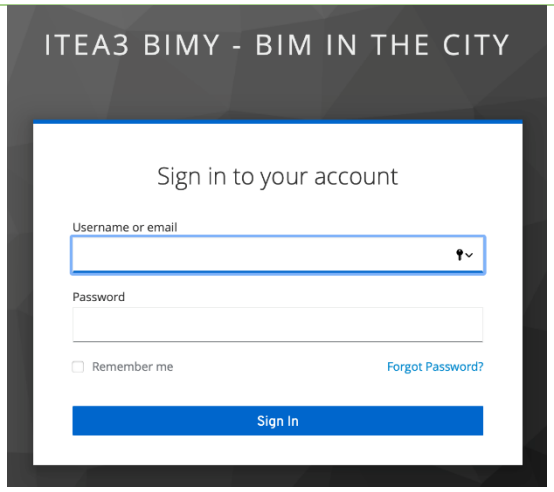
5.2 Demonstrator #1 – Digital Building Permit Application

Name of the tool/Application/ similar	Digital Building Permit Application
Partners Contributing	All: ASSAR, Willemen, Geo-IT, Letsbuild, GIM, ERARGE, NETAS, BBRI, SIRRIS
Responsible researcher(s) for technical discussions	Thomas Goossens
Domain Ontologies/ data models utilised	IFC 2x3 CityGML 3.0
Data Sources and amount	For this demonstrator, the following data will be used • Kumpen Office: this model is available in Revit and IFC. All parties can access and use it. • Additional non-BIM data of the building (e.g. pictures) • Publicly available GIS data
Motivation (why do we need such an application)	We choose this scenario because it will allow us to demonstrate most of the technical capabilities of the platform together in a consistent story.
Story	A new building (the Kumpen Office in Hasselt) will be constructed. The owners of the site will request a building permit through a new digital platform. They will submit a BIM-model, as well as related non-BIM information. Before upload, the model is checked a first time to make sure it complies with the platform standards. If no problems arise, the model can be exported from a native format to IFC, and uploaded to the platform. On the platform, the model will be displayed in its surroundings using (publicly available) GIS data. The platform app will perform some automated checks for compliance with building regulations. In addition, the city planners can inspect, evaluate and give feedback by attaching comments to the model. For the site inspection, the model is transferred to LetsBuild BIM module. In that platform, object models can be associated with inspection tasks to carry out on site with a mobile device. The inspection tasks include one or multiple BIM objects, an inspection checklist, assignees, due date, a work-breakdown structure/categorisation system and a workspace. Further, the inspection task is enriched with a snapshot of the 3D viewer highlighting the relevant objects to inspect.

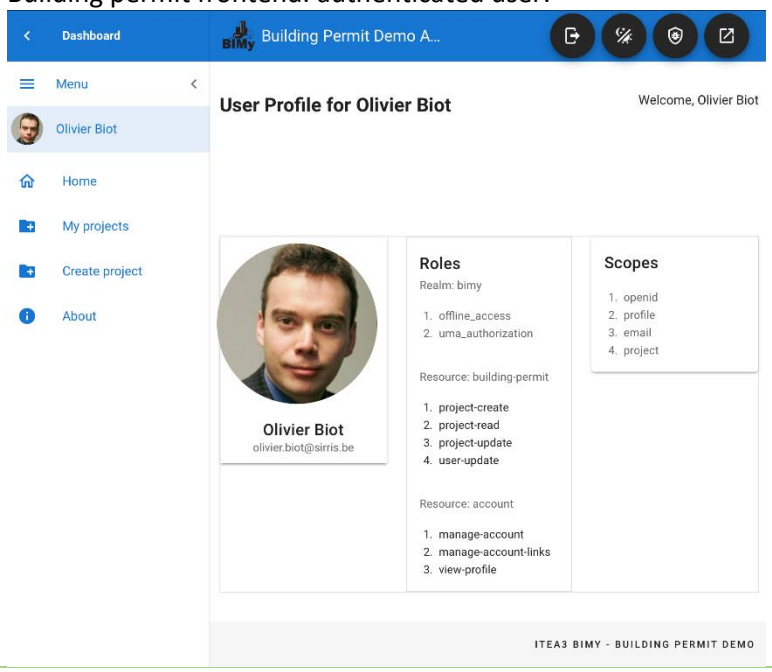
	When site inspections are completed, results are communicated back to the model itself and available for stakeholders in the platform.
Description (How it is implemented and how it works)	• **Draft modelling guidelines for digital building permit (Assar, Willemen)**: start from the Flemish legislation, 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 convention BA_[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) ▪ **Scale** (units) *(https://standards.buildingsmart.org/IFC/DEV/IFC4_2/FINAL/HTML/)* ▪ **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 (IfcMaterialLayer, IfcMaterialLayerSet, IfcMaterial) • Fire Resistance (Pset_WallCommon > FireRating, Pset SlabCommon > FireRating) • Part of façade or not? (Pset_WallCommon > IsExternal) ○ If yes: color? ○ **Other** ▪ 6 pictures of the site in its current condition (before the start of the construction). Camera viewpoints should be marked. (Location, direction and ID) • **Create sample data**: Enrich the Kumpen Office IFC with digital building permit information (Willemen). • **Update of the BIMy data model (GIM, SIRRIS, LetsBuild)**: include the relevant digital building permit properties in it (if not already present).

	• Update of the BIMy API (GIM, SIRRIS, LetsBuild): update according to the new data model. • Implement validation rules and validation framework (GeoIT, GIM): GeoIT will implement the Revit-side validation using the AutoDesk BIM interoperability tools, GIM will implement platform-side validation. • Create file storage infrastructure (NETAS?): create a Dockerised file storage service • Create GIS storage infrastructure (GIS): create a Dockerised Postgres/postGIS and GeoServer (GIM) • Create BIM storage infrastructure (GIM): create a Dockerised BIMserver application (already done). • Create BCF storage (LetsBuild): create a Dockerised MongoDB (already done). • Implement BIMy "Data Manager": o IFC validation: o IFC transformation: IFC-to-BIMyDM (GIM) o querying and filtering: o Implement "Regulatory checks": demonstrate the capability to automate some regulatory checks. Ideally, both platform-side and at the side of the software (e.g. building line, building depth ground floor, building depth first floor, ridge height, surface, volume, indoor door width / room occupation. o IFC-to-3Dtiles transformation for visualisation • Implement BCF annotation (LetsBuild): o Create BCF-XML annotation for adding images to the BIM model o Allow city planners to make annotations to the BIM model • "Digital Building Permit" application (SIRRIS): Web application to upload IFC model and see the result. VueJS/ReactJS, NodeJS >> upload, validation results. • Include GIS data on the platform (GIM): o GRB Reference Map (cadastral map) o elevation map o urban furniture o IMKL underground infrastructure o orthopictures • "BIMy Web viewer" application: CesiumJS, NodeJS (GIM) • Cloud infrastructure (NETAS?): hosting services • Application for site inspections (LETSBUILD) o BIM module with Web 3D viewer to manage inspections linked to BIM objects o Mobile site app to carry out inspections o Inspections templates library o Offline mode • Prototype of building permit client application o VueJS + Vuetify frontend, authentication with keycloak-js middleware

	○ ExpressJS backend (REST API), authentication of bearer token obtained from frontend with keycloak-connect middleware
Snapshots and Figures	 LetsBuild Web 3D viewer indicating BIM objects linked to inspections  LetsBuild BIM module to manage inspections linked to BIM objects  Building permit inspection form to fill on site using LetsBuild Authentication screen from building permit frontend:



Building permit frontend: authenticated user:

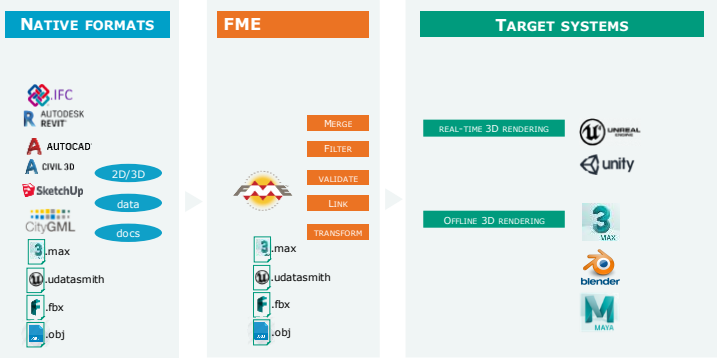
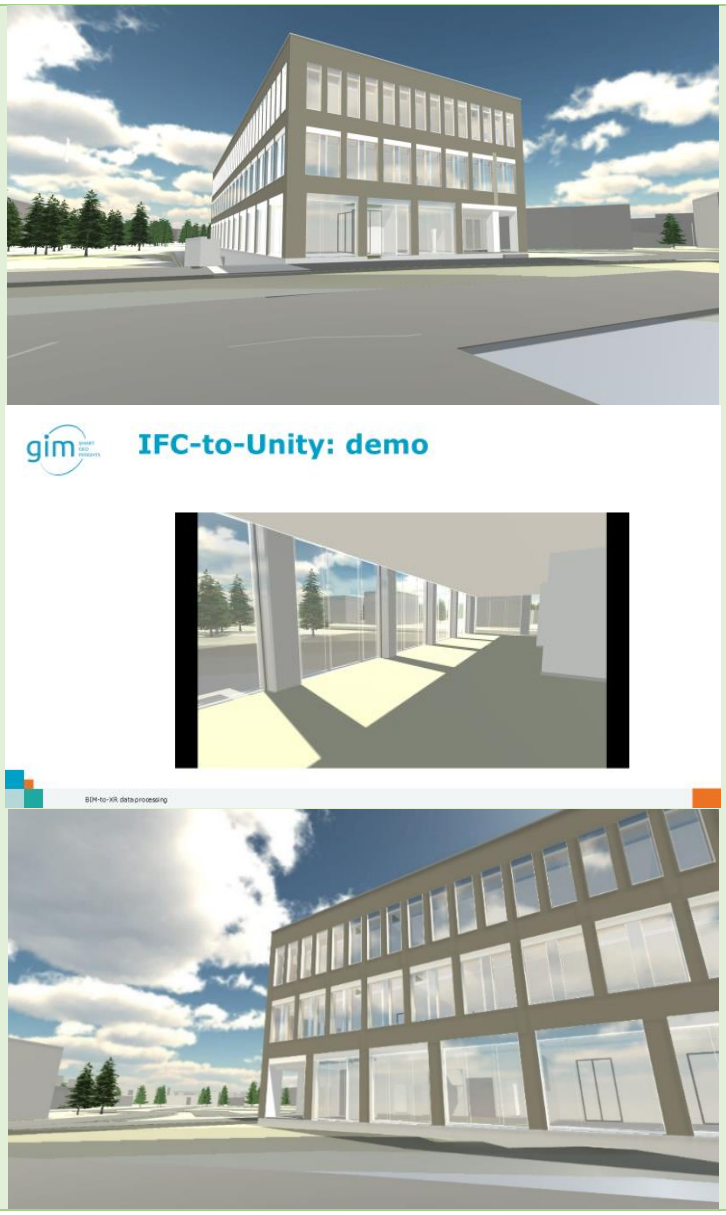


5.3 Demonstrator #2 – Earthquake and Fire Disaster Simulation & Training

Name of the tool/Application/ similar	Earthquake and Fire Disaster Simulation & Training
Partners Contributing	ERARGE, NETAŞ
Responsible researcher(s) for technical discussions	İbrahim Arif Alper Kanak Salih Ergün Osman Kumaş
Domain Ontologies/ data models utilised	IFC 2x3 CityGML 3.0
Data Sources and amount	Kortrijk Care Campus Sint-Jozef (Assar) BIM Model, 280 MB
Motivation (why do we need such an application)	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.
Description (How it is implemented and how it works)	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.
Snapshots and Figures	 VR-based Fire Training and Intervention

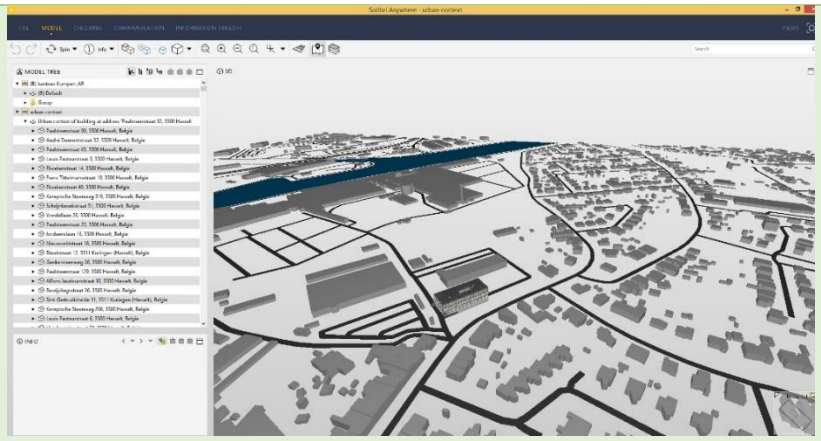
5.4 Demonstrator #3 – BIM/GIS VR/AR Application for Site Inspection

Name of the tool/Application/ similar	BIM/GIS VR/AR application
Partners Contributing	GIM LetsBuild ERARGE
Responsible researcher(s) for technical discussions	Stijn Goedertier – GIM Erick Vasquez – LetsBuild
Domain Ontologies utilised	The following data standards are used: • IFC 2x3 tc2 (buildingSMART, 2007); • Filmbox FBX; • Wavefront OBJ; • GeoTIFF (Open Geospatial Consortium).
Data Sources and amount	The following datasets are used: • the IFC model of the Kumpen Office (Willemen, 2018); • A sample of the Belmap dataset (GIM, 2019); • OpenStreetMap (OpenStreetMap Contributors, 2019).
Motivation (why do we need such an application)	A BIM/GIS data transformations are required in the context of the following user scenarios and requirements: • UCS_Y1_10: TR: Fire Brigade Crisis Management • UCS_Y1_14: BE: Fire prevention • UCS_Y1_08: BE: Integrate urban context information into BIM models • UCS_Y1_02: BE: long term vision - circular economy - urban mining • Req_Y1_057: Visualisation of a simplified 3D IFC Model for the fire brigade • Req_Y1_051: Visualisation of public and private hydrants using a combination of GIS / BIM information • Req_Y1_040: Visualisation of situational plan (BIM+GIS) • Req_Y1_032: Visualize buildings and building parts • Req_Y1_069: Transform BIM IFC model into CityGML

Description (How it is implemented and how it works)	This demonstrator shows how GIS and BIM data can be combined together and visualised in one AR/VR application. 
Snapshots and Figures	

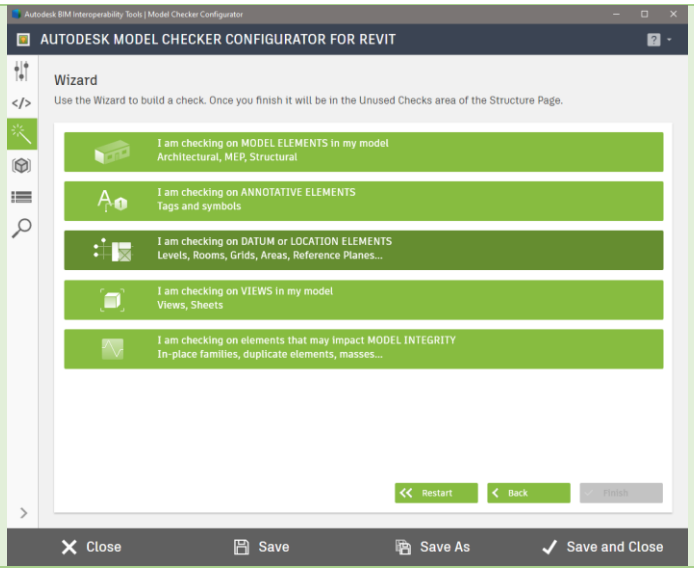
5.5 Demonstrator #4 – IFC-to-BIM (Urban Context)

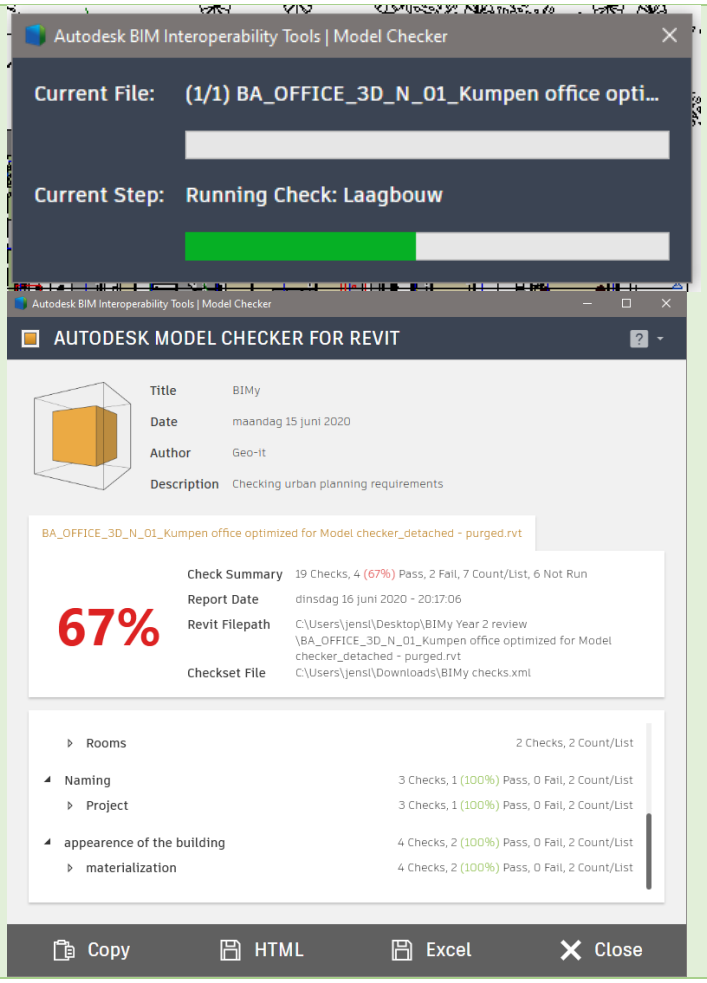
Name of the tool/Application/ similar	IFC-to-BIM (Urban Context), BIM/GIS data transformer
Partners Contributing	GIM, Willemen
Responsible researcher(s) for technical discussions	Stijn Goedertier Lise Bibert
Domain Ontologies utilised	The following data standards are used: • IFC 2x3 tc2 (buildingSMART, 2007); • Filmbox FBX; • Wavefront OBJ; • GeoTIFF (Open Geospatial Consortium).
Data Sources and amount	The following datasets are used: • the IFC model of the Kumpen Office (Willemen, 2018); • A sample of the Belmap dataset (GIM, 2019); • OpenStreetMap (OpenStreetMap Contributors, 2019).
Motivation (why do we need such an application)	A BIM/GIS data transformations are required in the context of the following user scenarios and requirements: • UCS_Y1_10: TR: Fire Brigade Crisis Management • UCS_Y1_14: BE: Fire prevention • UCS_Y1_08: BE: Integrate urban context information into BIM models • UCS_Y1_02: BE: long term vision - circular economy - urban mining • Req_Y1_057: Visualisation of a simplified 3D IFC Model for the fire brigade • Req_Y1_051: Visualisation of public and private hydrants using a combination of GIS / BIM information • Req_Y1_040: Visualisation of situational plan (BIM+GIS) • Req_Y1_032: Visualize buildings and building parts • Req_Y1_069: Transform BIM IFC model into CityGML
Description (How it is implemented and how it works)	This demonstrator shows how GIS data can be included in native BIM tools.

Snapshots and Figures	

5.6 Demonstrator #5 – Revit Model Checker

Name of the tool/Application/ similar	Revit Model Checker
Partners Contributing	Geo-IT
Responsible researcher(s) for technical discussions	Jens Lathouwers Johan van Mol
Domain Ontologies utilised	The following data standards are used: • .RVT version 2020 • Bim interoperability tools V7.1.7159.0
Data Sources and amount	The following datasets are used: • the Revit model of the Kumpen Office (Willemen, 2018);
Motivation (why do we need such an application)	Parties involved in the building process should be able to automate checking if their models are in accordance with the used BIM protocol or the used BIM agreements • UCS_Y1_14: BE: Fire prevention • UCS_Y1_07: BE: Digital building permit platform
Description (How it is implemented and how it works)	This demonstrator shows how architects and urban designers can check their model based on regulations. 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**)
Snapshots and Figures	


Autodesk BIM Interoperability Tools | Model Checker
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Current Step: Running Check: Laagbouw
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
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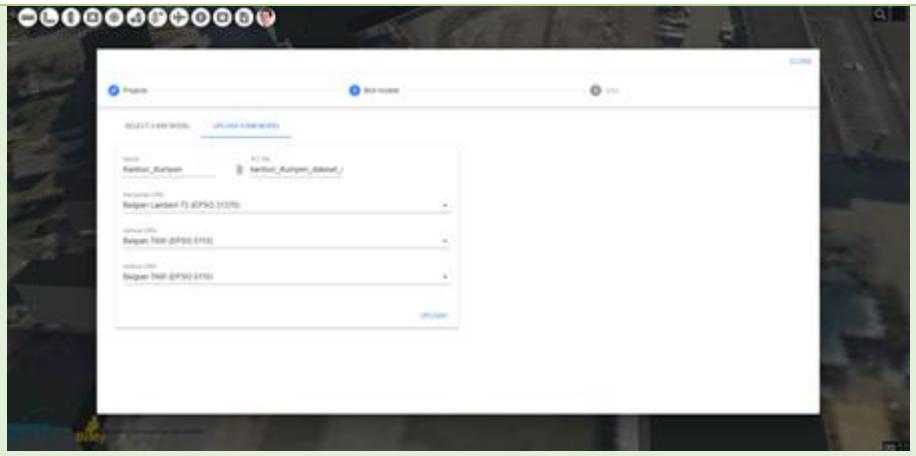
Checkset File C:\Users\jensl\Downloads\BIMy checks.xml
Rooms 2 Checks, 2 Count/List
Naming 3 Checks, 1 (100%) Pass, 0 Fail, 2 Count/List
Project 3 Checks, 1 (100%) Pass, 0 Fail, 2 Count/List
appearence of the building 4 Checks, 2 (100%) Pass, 0 Fail, 2 Count/List
materialization 4 Checks, 2 (100%) Pass, 0 Fail, 2 Count/List
Copy
HTML
Excel
Close

5.7 Demonstrator #6 – Upload IFC and Visualise IFC file in its Urban Context

Name of the tool/Application/ similar	BIMy Integrated BIM/GIS Web Viewer
Partners Contributing	GIM
Responsible researcher(s) for technical discussions	Stijn Goedertier Steven Smolders
Domain Ontologies utilised	The following data standards are used: • IFC 2x3 tc2 (buildingSMART, 2007); • BIMy Data Model.
Data Sources and amount	The following datasets are used: • the IFC model of the Kumpen Office (Willemen, 2018); • A sample of the Belmap dataset (GIM, 2019); • OpenStreetMap (OpenStreetMap Contributors, 2019).
Motivation (why do we need such an application)	A BIM/GIS data transformations are required in the context of the following user scenarios and requirements: • UCS_Y1_10: TR: Fire Brigade Crisis Management • UCS_Y1_14: BE: Fire prevention • UCS_Y1_08: BE: Integrate urban context information into BIM models • UCS_Y1_02: BE: long term vision - circular economy - urban mining • Req_Y1_057: Visualisation of a simplified 3D IFC Model for the fire brigade • Req_Y1_051: Visualisation of public and private hydrants using a combination of GIS / BIM information • Req_Y1_040: Visualisation of situational plan (BIM+GIS) • Req_Y1_032: Visualize buildings and building parts • Req_Y1_069: Transform BIM IFC model into CityGML
Description (How it is implemented and how it works)	This demonstrator shows some of the functionality of the BIMy platform: • -BIM data and GIS data according to BIMy Data Model: IFC, cadastral parcel, elevation model, ortho, building • -Authenticate using OAuth2 • -Measure height, distance, surface • -Upload georeferenced BIM Model via BIMy API • -Create BCF topics Technology used: • -FME • -IfcOpenShell • -BIMy Data Manager, Vertx.io

	• -GeoServer • -ElasticSearch, Postgres • -VueJS, Cesium • -Docker-based deployment
Snapshots and Figures	 https://www.youtube.com/watch?v=JX1dydKvRuM

6 Demonstrators YEAR 1

Aligned with the use cases eight standalone demonstrator were developed in the first year aiming to present a baseline for further improvements and integrations. This section gives an overview of these demonstrators all of which have been planned and demonstrated during the first iteration (year) of the project.

6.1 Summary of the Demonstrators/tools/applications

The demonstrated BIMy outputs are summarised in Table 3.

Table 3. Summary of the Demonstrators in Year 1

Nr	One-liner or name of the Tool/Application/Demonstrator	Related Use Case(s)	Lead Participant	Other Contributors
ITERATION #1				
1	Fire Prevention App	BE: Fire Prevention	LetsBuild	LetsBuild, GIM, ASSAR, BBRI, ERARGE
2	GIS/BIM Web Viewer over Cloud	TR: Fire Brigade Crisis Management	ERARGE	NETAŞ, GIM
3	BIM/GIS Data Transformer	BE: Integrate urban context information into BIM models	GIM	GIM
4	BIMy Virtual Reality and Augmented Reality Application	TR: Training residents by evacuation simulation in case of earthquakes BE: Fire intervention (Fire Brigade access information in case of intervention) TR: Fire Brigade Crisis Management	ERARGE	ERARGE
5	BIMy Data Manager (BIMy API)	All	GIM	All partners
6	Fire Design Aid – Revit Plugin/Toolpallette	BE: Fire intervention (Fire Brigade access information in case of intervention) TR: Fire Brigade Crisis Management	Geo-IT	Geo-IT
7	Long-term Vision - Circular Economy - Urban Mining	BE: long term vision - circular economy - urban mining BE: long term vision - circular economy - suitability for functional change	LetsBuild	LetsBuild, Assar, BBRI, CIRB, Geo-IT, Willemen

6.2 BIMy in Smart City Expo World Congress (SCEWC) 2019, Barcelona

As a part of Fire and Earthquake Intervention and Training demonstrations, a joint simulation was presented to the community of the Smart City Expo World Congress (SCEWC) 2019, held in Barcelona. The demonstrator showed the effective use of the BIMy platform and the visualisation of SPARQL queries. SPARQL queries were realised as pre-queries to extract useful BIM data as virtual 3D layers. The users can switch between these layers and various cases related to earthquake or fire-related disasters were presented to the audience. The BIM-GIS query results were also presented by Grafana over the Web presenting useful graphics and charts. Some snapshots and photos from the meeting are given in Figure 5

Figure 5. Some snapshots from the SCEWC in Barcelona

There was a huge interest to BIMy project and its VR-based interactive demonstration in SCEWC'19. This was evident from the statistics below. During the bilateral discussions at BIMy booth, visitors were informed about the project and asked them to try the VR application. Total time was recorded automatically by a backend timer for each VR session where volunteers started to test the application.

- Number of visitors in SCEWC'19: 497
- Number of VR testers in SCEWC'19: 52
- Average time spent by each VR tester: 242 seconds

6.3 Demonstrator #1 – Fire Prevention App

Name of the tool/Application/ similar	Fire Prevention App
Partners Contributing	ASSAR, LetsBuild, GIM, ERARGE, BBRI
Responsible researcher(s) for technical discussions	Sergio Ristagno
Domain Ontologies/ data models utilised	The BBRI wants to contribute by highlighting fire escape routes in REVIT and visualizing that using the Unity gaming engine.
Data Sources and amount	For this demonstrator, the following models will be used • the REVIT model of the retirement home in Kortrijk (ASSAR, 2019) • Another Revit model illustrating more specific fire prevention related to BIM objects is being identified with Willemen
Motivation (why do we need such an application)	This application will illustrate the benefit of • Having the right information in the BIMy platform to facilitate decision on site during inspections. • Enriching the BIMy models with information from the real life/people visiting the site to maintain a model and document decisions or actions to facilitate maintenance of the building For the first year review, we will use Revit with filtering of objects and data on the application side Later on, we want to perform it on IFC data (not the Revit model) – still filtering on our side Finally, we want to connect with BIM server where the filtering will happen remotely
Description (How it is implemented and how it works)	LetsBuild will provide a platform • to visualize parts of the BIM model during inspection (views (starting in 2D at first) and meta-data of BIM objects), • to perform the inspection in a digital format • to capture and track issues identified during the inspection • to update the BIM model with proof of the audit done and the state of the building (or part of) audited Pre-requisites: • The BIM model is available in the BIMy platform • The BIM model includes views with the relevant information for the field, which can be shared in a PDF format at first • The BIM model has a structure of asset/BIM Object leveraging an agreed classification

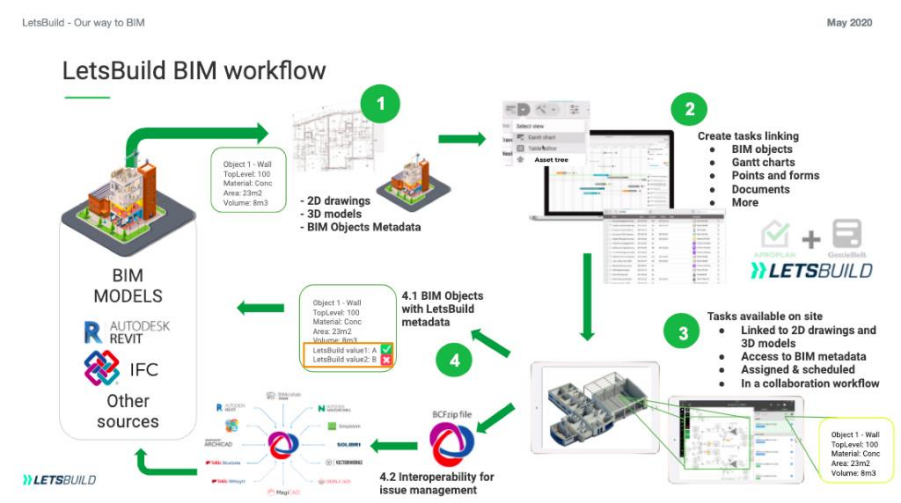
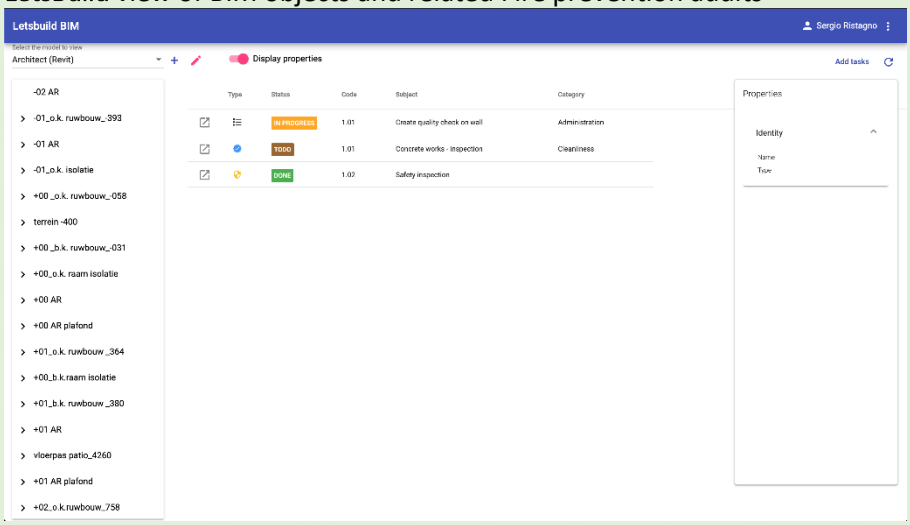
Pre-requisites for the June 2019 demo:

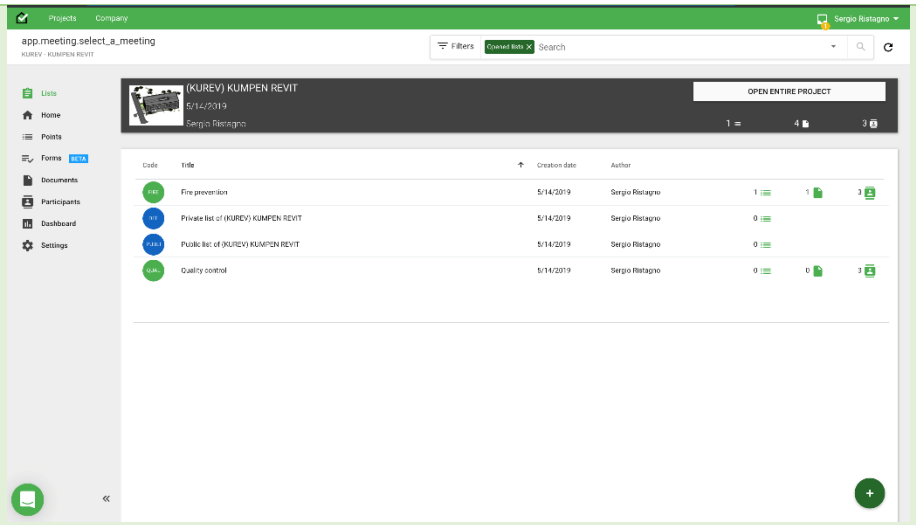
- (by 31/5) Willemen to add specific objects with fire information will be used as objects to be checked during inspection
- (by 31/5) Willemen to add specific views for the fire prevention audit will be included in the Revit model. in Revit the views will have the links to the objects included in the view in order to retrieve automatically the plans showing an object when selecting which plan to use in the inspection.
- (by 31/5) GIM will show the automated generation of a 2D floor plan from IFC file applying known rules (1,6m high cut view of the 3D model, with specific visual information) (Other demo)
- (by 31/5) LetsBuild will illustrate how the information from the inspection is stored/updated in the Revit model
- (by 31/5) GIM will demonstrate using the BIM viewer how object can be visually highlighted using the LetsBuild data (e.g. LetsBuild status of an object: object with non-conformities, object with OK status from LetsBuild)
- (by 31/5) Willemen: ideally the model would have two historical versions 1 (e.g. of building permit) and a version 2 (As-built) and some objects would have a difference in their fire prevention data (e.g. a door with 60 min in version 1 and 30min in Version 2), which would trigger the need for a fire prevention audit.
- (DONE) (by 31/5) Willemen to provide the questions and type of answers to be part of the LetsBuild checklist
- (15/6) LetsBuild to create a video as a back-up
- (stretch goal) LetsBuild to illustrate ad-hoc issue linked to BIM: what could be the creation of an issue linked to an object. Teaser for BCF flow.

Storyboard:

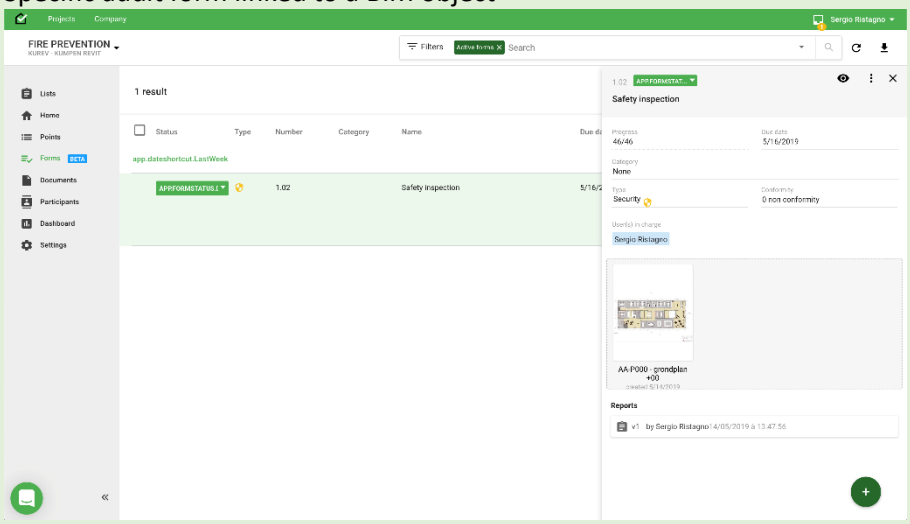
1. Setting the context: Based on Version 1 and version 2 of the model we can illustrate some Objects in the model with Fire prevention data: inner wall, door and a pump during inspection something is preventing the door to be closed Trigger: 2 objects do not have the same fire prevention data. Hence an inspection is needed to be done
2. Using LetsBuild BIM we can create the tasks of inspection and link them specific checklist
    1.1. user selects the object to be audited
        i. it should be easy to find the object to be reviewed from the asset tree: select a specific floor and area
    2.2. user add the details of the task: user assigned, due date, select the floor plan (ideally LetsBuild suggests which one to use as the link between the object and the plan is coming from the Revit view)

	i. opportunity here to show a model created automatically from IFC 3. moving to LetsBuild on the tablet 1.1. the user can open the specific floor plan and can see the audit to be done. i. the user can fill in the form and take pictures to prove his answers. ii. the user finalise/submit his answer and a report is created 2.2. while doing the inspection the inspector identifies an issue with the door and he tracks it using LetsBuild and illustrate that here he would link it to a specific object (Development to be done in the future) 4. back into LetsBuild (web) 1.1. another user can see that the task is completed 5. Yet another user in Revit can check if the object has been inspected 1.1. in Revit, the user can open the model and go to the specific object to inspect 2.2. using the LetsBuild Revit plugin the user can update/refresh the model 3.3. then he should see the additional information coming from LetsBuild: i. Status of the object (OK, has issue, no data) ii. Link to a report with more information about this object iii. Taping on the URL the user can open the page in LetsBuild with all the issues/inspections of this object and go to the report of the inspection to see the actual answers and pictures. 6. Finally yet another user using the BIMy BIM viewer 1.1. he can open the updated Revit model (see step above) and the objects inspected using LetsBuild will have a specific color (e.g. green if status is OK, Orange/Red if an issue is linked to the object) 7. Conclusion: 1.1. demonstrator to explain how the BIMy platform will help this scenario i. the information required in the Model and therefore in BIMy to make such scenario feasible 2.2. in the future the model will be hosted in the BIMy platform Demonstration videos: 2019/05/29: 1) Desktop demo: Bim objects + Quality control checklist creation + Fill form on the web + update Revit module: https://drive.google.com/open?id=1UxC-ot8eP__fQpUzLaLiDj4oPYldKW5F

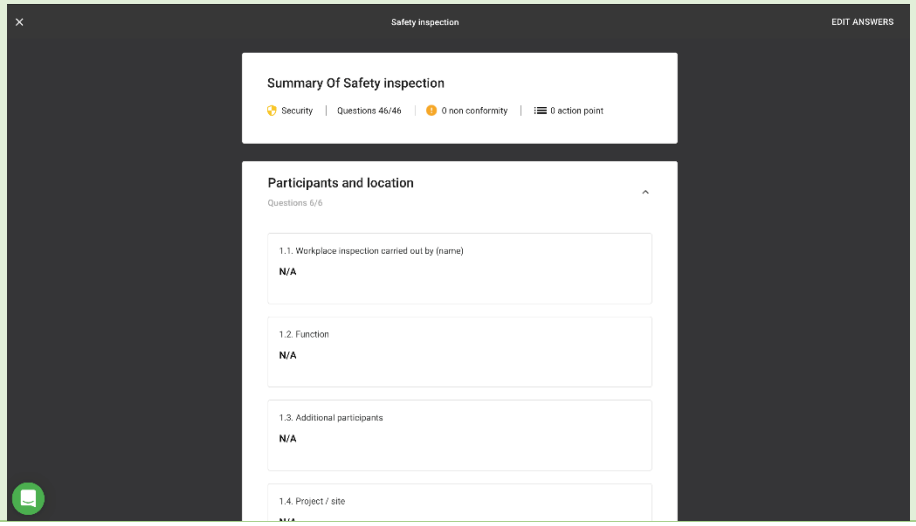
	2) Tablet demo: filling Quality control checklist: https://drive.google.com/open?id=1rFGtj80y5f5OjGQFsSQQypkEU1CJvhhV 2019/06/17 : http://bit.ly/2MT4OZW
Snapshots and Figures	Flow:  LetsBuild view of BIM objects and related Fire prevention audits  Audit in LetsBuild in dedicated Fire prevention



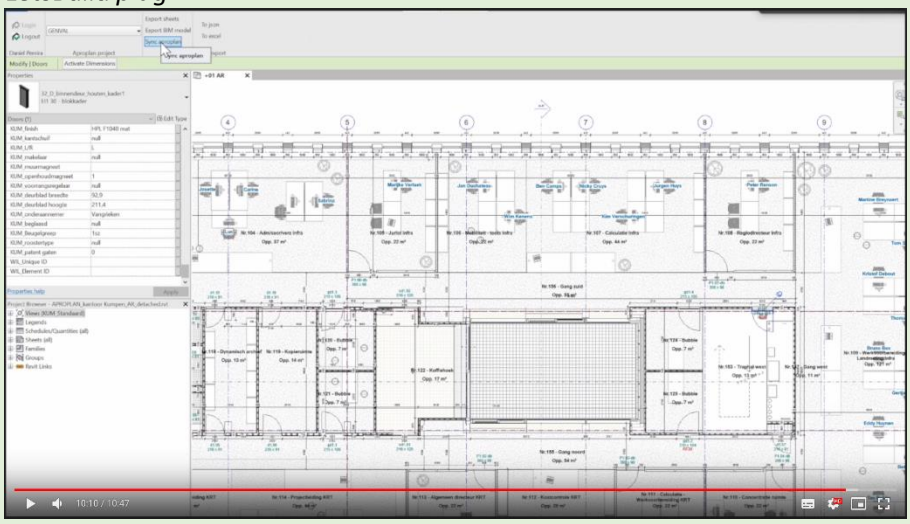
Specific audit form linked to a BIM object



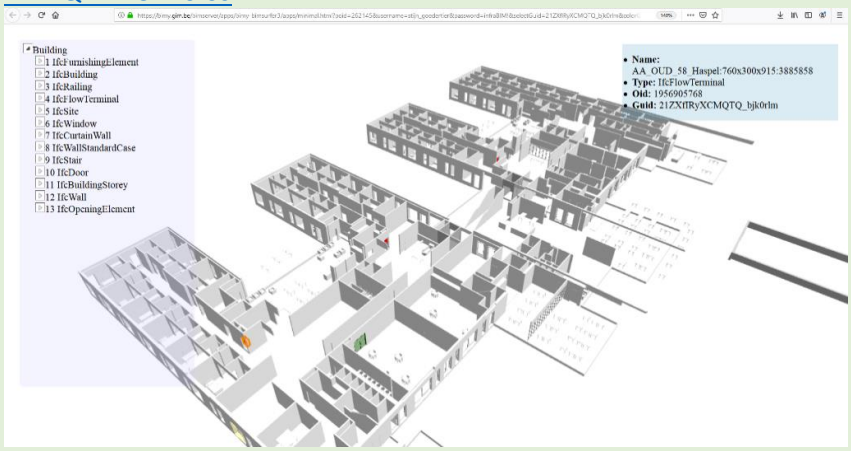
Audit form to be used on tablet or PC:



Update of Revit model in Revit with Audit status and link to details using LetsBuild *plugin:*



Visualize, select and highlight (color) individual BIM objects using the below 3D floorplan viewer that was implemented with BIMSurfer3.
https://bimy.gim.be/bimserver/apps/bimy-bimsurfer3/apps/minimal.html?poid=262145&username=stijn_goedertier&password=infraBIM!&selectGuid=21ZXfIRyXCMQTQ_bjk0rlm&colorGuid=16zV2gpZnEPQxWYU44oios



6.4 Demonstrator #2 – GIS/BIM Web Viewer over Cloud

Name of the tool/Application/ similar	GIS/BIM web viewer over cloud
Partners Contributing	*ERARGE, NETAS*
Responsible researcher(s) for technical discussions	*Ibrahim ARIF* *Alper KANAK*
Domain Ontologies utilised	*The following data standars are used:* • *IFC 2x3 tc2* (buildingSMART, 2007) • *CityGML* (OGC, 2012) • *glTF* (*glTF - GL Transmission Format*, n.d.)
Data Sources and amount	*For this demonstrator, the following datasets are used:* • *the CityGML model of New York City dataset* (City of New York, 2017) • the canonical Schependomlaan dataset (openBIMstandards, 2015)
Motivation (why do we need such an application)	*The GIS and BIM integration is one of the main objectives of BIMy platform. By integrating GIS and BIM, we can make a connection between geospatial data and building information. By doing so one can make smarter queries to filter outbuilding assets even at city-wide level. For instance, one can estimate the amount of recycled materials after the demolition of buildings in a large urban transformation area.*
Description (How it is implemented and how it works)	*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 demonstrator, we use Cesium-based 3DCityDB's web client demo application that enables the visualisation of GIS data on a globe. The CityGML model of New York City dataset* is loaded and the visualised 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 visualisation enables effective filtering of BIM models and the visualisation 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.*

Snapshots and Figures

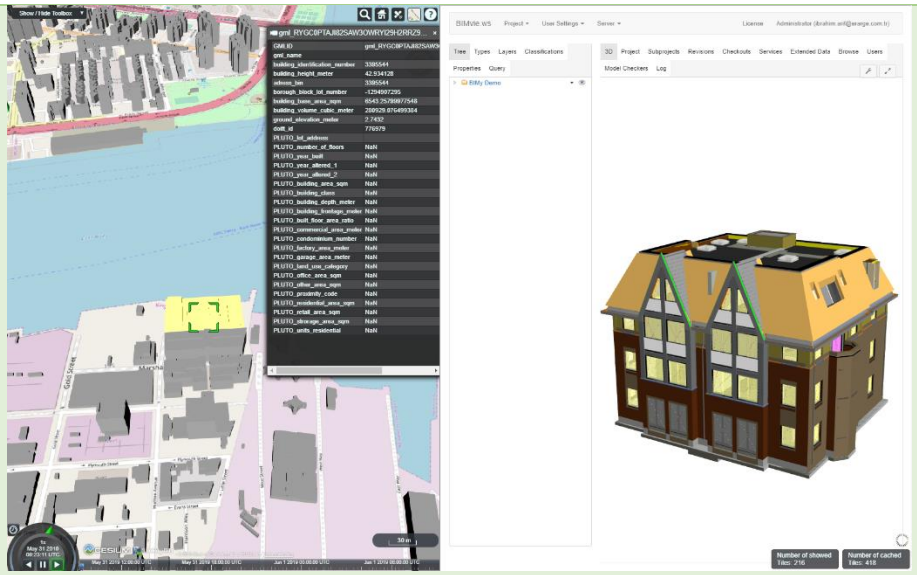
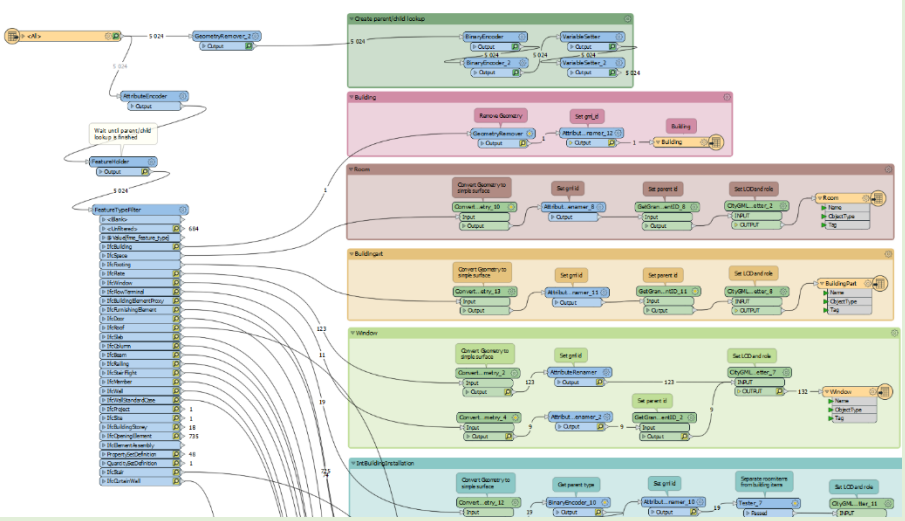
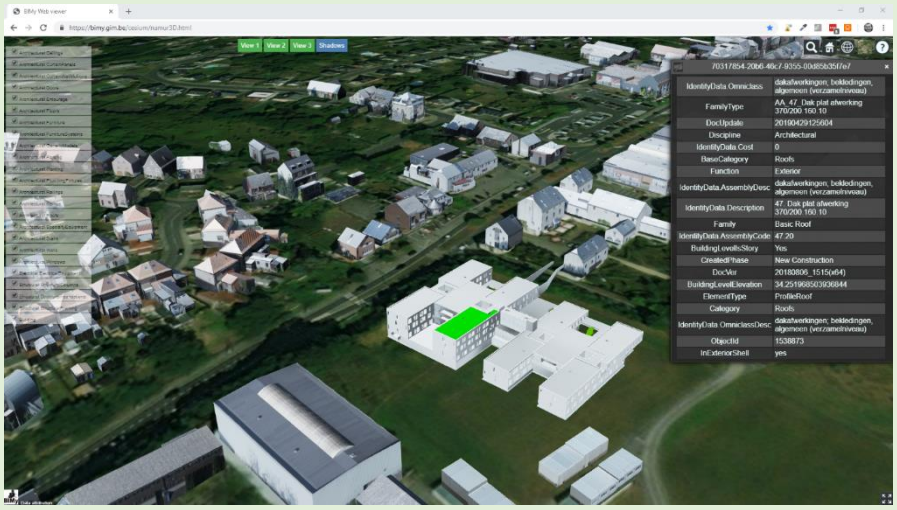


Figure 6 Screenshot on New York City's (City of New York, 2017) GIS model from 3DCityDB-Web-Client connected to the Schependomlaan BIM model (openBIMstandards, 2015) on BIMServer

Figure 7 Screenshot on viewing the Schependomlaan BIM model (openBIMstandards, 2015) on a Cesium based web viewer

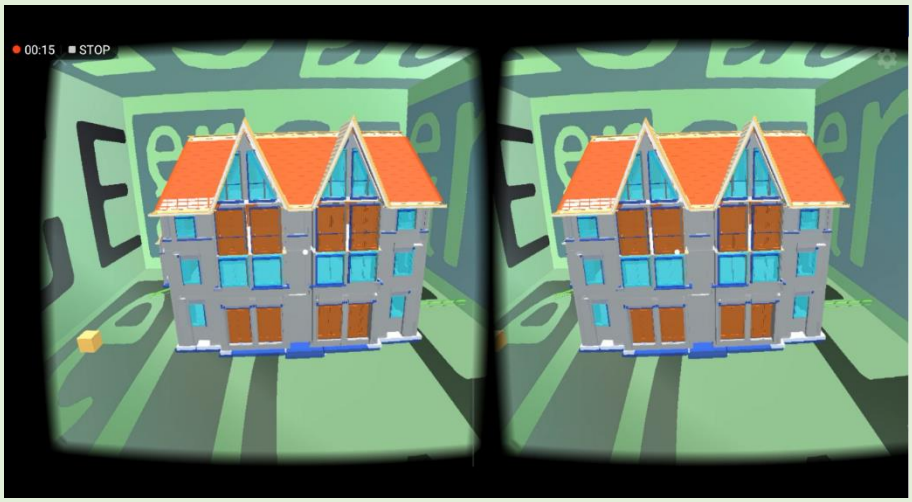
6.5 Demonstrator #3 – BIM/GIS Data Transformer

Name of the tool/Application/ similar	BIM/GIS Data Transformer
Partners Contributing	GIM
Responsible researcher(s) for technical discussions	Stijn Goedertier
Domain Ontologies utilised	The following data standards are used: • IFC 2x3 tc2 (buildingSMART, 2007); • CityGML 2.0 (OGC, 2012); • OGC 3D Tiles (OGC, 2019); • GeoJSON (IETF, 2016).
Data Sources and amount	The following datasets are used: • the REVIT model of the retirement home in Kortrijk (ASSAR, 2019); • the IFC model of the Kumpen Office (Willemen, 2018); • the canonical Schependomlaan dataset (openBIMstandards, 2015); • A sample of the Belmap dataset (GIM, 2019); • Namur 3D textured CityGML dataset (Ville de Namur, 2018).
Motivation (why do we need such an application)	A BIM/GIS data transformations are required in the context of the following user scenarios and requirements: • UCS_Y1_10: TR: Fire Brigade Crisis Management • UCS_Y1_14: BE: Fire prevention • UCS_Y1_08: BE: Integrate urban context information into BIM models • UCS_Y1_02: BE: long term vision - circular economy - urban mining • Req_Y1_057: Visualisation of a simplified 3D IFC Model for the fire brigade • Req_Y1_051: Visualisation of public and private hydrants using a combination of GIS / BIM information • Req_Y1_040: Visualisation of situational plan (BIM+GIS) • Req_Y1_032: Visualize buildings and building parts • Req_Y1_069: Transform BIM IFC model into CityGML
Description (How it is implemented and how it works)	This demonstrator shows how to do a number of data transformations that are needed for the BIMy platform: • IFC to floorplan (SVG) • IFC data to CityGML • CityGML to 3D Tiles • IFC to 3D Tiles

	The transformation logic for these transformations has been documented in deliverable D2.2 (BIMy consortium, 2019c). It then uses the BIM/GIS Web Viewer to visualise BIM models as 3D Tiles in a geospatial context, together with elevation data and map data.
Snapshots and Figures	 *Figure 8 An implementation of the IFC-to-CityGML transformation*  *Figure 9 A visualisation of the Kortrijk nursing home Revit file (ASSAR, 2019) and the Namur3D tiles using CesiumJS*

6.6 Demonstrator #4 – BIMy Virtual Reality and Augmented Reality Application

Name of the tool/Application/ similar	BIMy Virtual Reality and Augmented Reality Application
Partners Contributing	*ERARGE*
Responsible researcher(s) for technical discussions	*Ibrahim ARIF* *Ahmet Mert KARADENIZ* *Alper KANAK*
Domain Ontologies utilised	*The following data standards are used:* • *IFC 2x3 tc2* (buildingSMART, 2007) • *glTF* (*glTF - GL Transmission Format*, n.d.) • *Filmbox (FBX)* (Autodesk, 2006) • *Collada (dae)* (Khronos Group & Sony Computer Entertainment, 2004)
Data Sources and amount	*For this demonstrator, the following datasets will be used:* • the canonical Schependomlaan dataset (openBIMstandards, 2015)
Motivation (why do we need such an application)	Visualizing the BIM data in Virtual Reality and Augmented Reality environment enables an enhanced visual experience for the users to have a better interactional presentation of the targeted building. This application covers two use case scenarios defined by Turkish partners: 1. TR: Fire Brigade Crisis Management – The fire brigade is the potential stakeholder for this application which queries a filtered view of the targeted building in order to study the building in a case of fire. 2. TR: Training residents by evacuation simulation in case of earthquakes – The residents are potential users for this application since they can have a visual overview over the building. Implementing an education over the point of interest objects like emergency exits, evacuation route, etc. enables the users to be aware of situational strategies in the case of an earthquake. And also the following ones indirectly; 1. *BE: Fire intervention (Fire Brigade access information in case of intervention)* 2. BE: Fire prevention
Description (How it is implemented and how it works)	The corresponding building model is downloaded from BIMServer as glTF. The building's main parts are queried separately (IfcWall, IfcSlab, IfcBeam etc.) in order to keep the hierarchical structure alive. This provides us to manipulate the object type group (define a specific color for subgroups like walls, beam, slab etc. elements) in Unity. Since Unity game engine has no glTF import support, the glTF data is converted into FBX or COLLADA format via Blender (v2.8-beta).

	After the conversion is done, the data is imported to the scene in Unity. With the hierarchical structure, we can filter the group types in runtime as a caching mechanism without a need of access to the BIMServer. With this, a Virtual Reality application for Oculus Rift and VR Box (via Android-VR) is developed. Also, for integration of a virtual world with the real environment, an Augmented/Mixed Reality application is developed for Microsoft Hololens.
Snapshots and Figures	 *Figure 10 Snapshot from Microsoft Hololens 3D visualisation of Schependomlaan BIM model (openBIMstandards, 2015)*  *Figure 11 Snapshot from Android-VR visualisation of Schependomlaan BIM model (openBIMstandards, 2015) (outside view)*

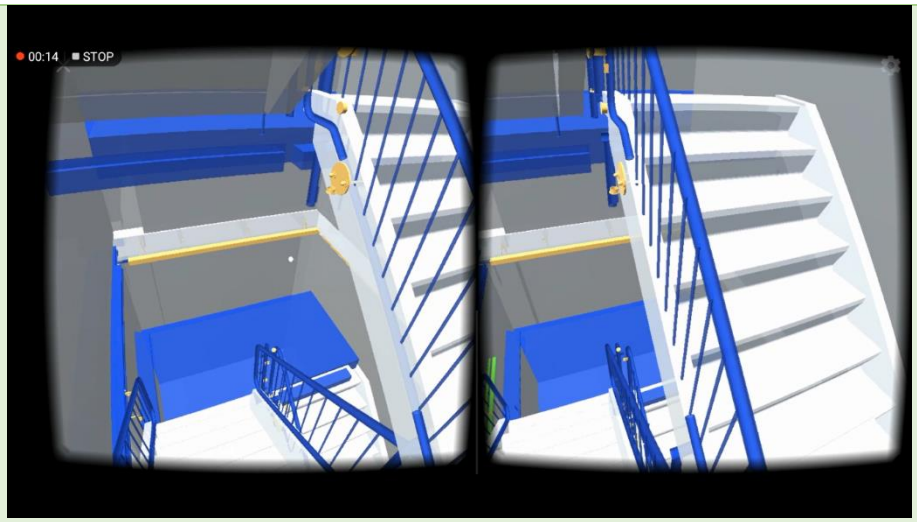


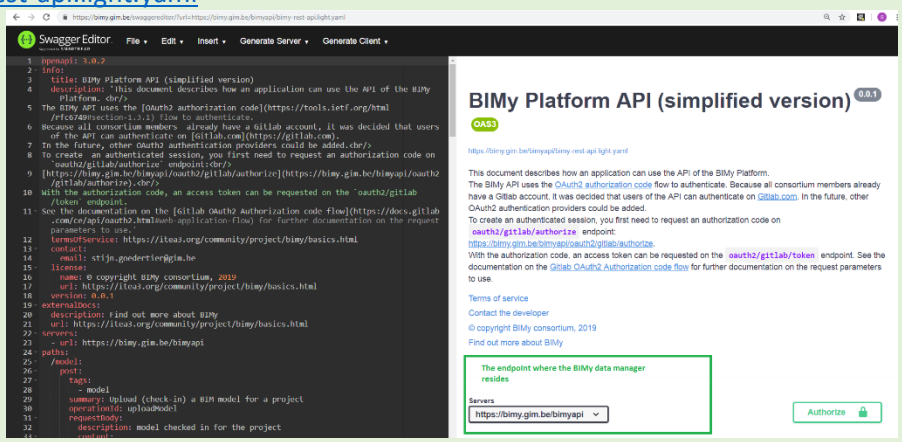
Figure 12 Snapshot from Android-VR visualisation of Schependomlaan BIM model (openBIMstandards, 2015) (inside view)

6.7 Demonstrator #5 – BIMy Data Manager (BIMy API)

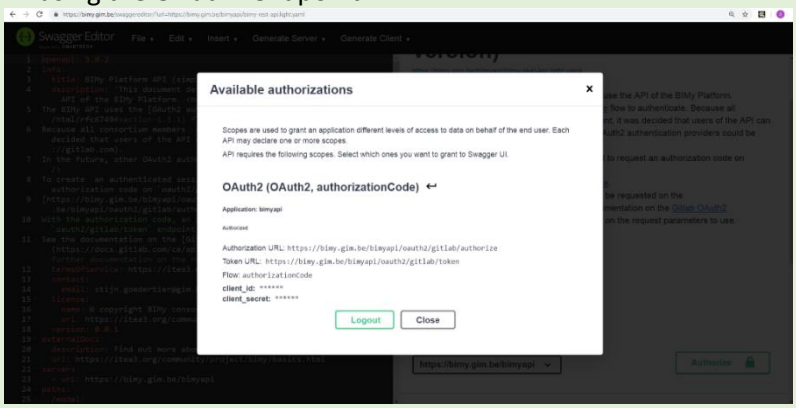
Name of the tool/Application/ similar	BIMy Data Manager (BIMy API)
Partners Contributing	GIM
Responsible researcher(s) for technical discussions	Stijn Goedertier, GIM
Domain Ontologies utilised	This demonstrator uses the BIMy Platform API specs, that are described in deliverable D1.3 (BIMy consortium, 2019b, p. 3). The API specs leverage the following data standards: • IFC • GeoJSON • BCF and BCF-API • glTF • etc.
Data Sources and amount	No datasets in particular were used.
Motivation (why do we need such an application)	The use of a platform with a common API that use used by multiple applications will strengthen the business case of the BIMy platform.
Description (How it is implemented and how it works)	Implementation of the BIMy API specs using the Eclipse Vert.x toolkit for building reactive applications on the Java Virtual Machine. The BIMy data manager listens for incoming ReST requests. Currently, the BIMy data manager is only integrated with BIMserver. This means that each request is translated into a corresponding API call on BIMserver. In the future, the implementation of the API will be enhanced. For example, when a model is uploaded, three operations should be executed in the backend: • The BIM model is validated (e.g. is the BIM model correctly georeferenced) • The BIM model is stored on BIMserver to allow ultra-fast viewing, querying, and filtering; • The BIM model is transformed into a footprint (polygon) geometry and stored in a GIS system. • The BIM model is transformed into a simplified 3D Tiles representation so that it can be viewed in a geospatial CesiumJS viewer. • The BIM model is stored on a filesystem for archival; The BIMy API uses the OAuth2 authorisation code flow to authenticate. Because all consortium members already have a Gitlab account, it was decided that users of the API can authenticate on Gitlab.com. In the future, other OAuth2 authentication providers could be added.

Snapshots and Figures

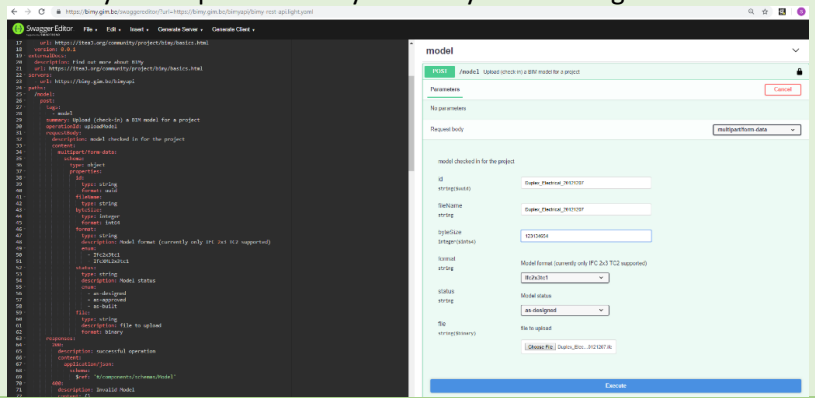
The data manager itself is an API and does not have a graphical user interface. However, we have enhanced to Swagger-Editor tool so that it can be used to authenticate with the BIMy data manager's OAuth implementation. The editor is available here: https://bimy.gim.be/swaggereditor/?url=https://bimy.gim.be/bimyapi/bimy-rest-api.light.yaml



The screenshot below shows how a user can authenticate on the BIMy platform using the OAuth2 endpoint.



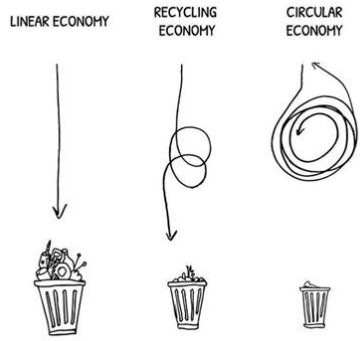
The screenshot below how a user can use the BIMy API to upload a BIM model using the BIMy API implemented by the BIMy data manager.



6.8 Demonstrator #6 – Fire Design Aid – Revit Plugin/Toolpallette

Name Of the tool/Application/ similar	Fire Design Aid – Revit Plugin/Toolpallette
Partners Contributing	*Geo-IT*
Responsible researcher(s) for technical discussions	*Stijn Van Thienen, Geo-IT* *Johan Van Mol, Geo-IT* *Senne Vanden Sompele, Geo-IT*
Domain Ontologies utilised	This demonstrator uses the Autodesk Revit API specs.
Data Sources and amount	*No particular datasets*
Motivation (why do we need such an application)	Fire plans are different for three categories: prevention, intervention and evacuation. Prevention is needed in design phases; intervention is very simplified plans for the firemen who'll enter the building and the evacuation plans are needed to inform people how to handle in case of emergencies. Of course, people can extract those plans out of a BIM model if the right parameters are in the model. Certain parameters are useful for more than one sort of plan. De tool itself will help designers and contractors to check conform Belgian fire regulation within Revit. Afterwards the tool will be optimised to extract the needed plans and reports to support designers and firemen in the optimisation for fire-prevention.
Description (How it is implemented and how it works)	*Based on the Autodesk Revit API, a toolpallette will be created where checks, routines, etc. can be started/run. Faulty values can be highlighted directly in the model, maybe even (automated) corrected.* *Some extra parameters needed must be set up through the same pallette (f.e. level of evacuation, highest level used by people, etc.) so the checks are specified for certain regulation (low, medium or high buildings).*
Snapshots and Figures	*In development*

6.9 Demonstrator #7 – Long-term Vision - Circular Economy - Urban Mining

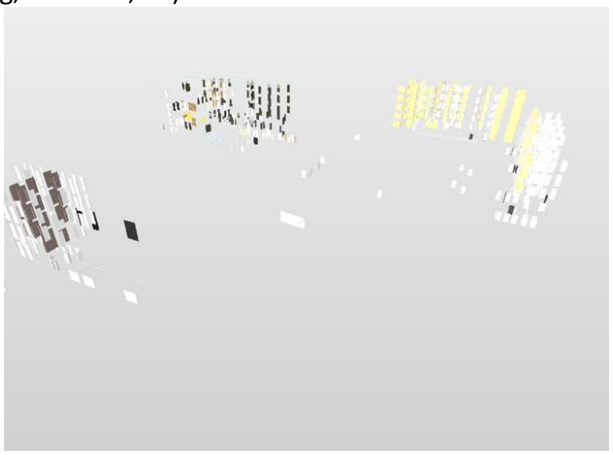
Name of the tool/Application/ similar	Long-term Vision - Circular Economy - Urban Mining
Partners Contributing	LetsBuild, Assar, BBRI, CIRB, Geo-IT, Willemen
Responsible researcher(s) for technical discussions	Dieter Froyen and Hashmat Wahid.
Domain Ontologies utilised	IFC (BIM) data model
Data Sources and amount	Studies still ongoing
Motivation (why do we need such an application)	Urban mining for circular economy: existing buildings that will be transformed or demolished are a source of materials for other building projects. Companies can search for building parts they are interested in if there is a platform that makes it possible to set a query on these assets and present all necessary information.
Description (How it is implemented and how it works)	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.  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 specialised 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, etc.), 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, ...

7 Revisiting the Use Case Scenarios

This document contains an overview of the use cases, for which detailed user stories and requirements are described in deliverable 'D1.2 Platform applications and user requirements' (BIMy consortium, 2019a).

7.1.1 Prioritised Use Case Scenarios

The following use cases are prioritised according to the end-user needs and existing potential of contributing partners to reach the project goals timely. Here the prefix "BE" or "TR" denotes the leading majority partners' countries, Belgium or Turkey. Note that these prefixes do not mean that these use cases are Belgian or Turkish only but just indicates the level of responsibility of which national consortium and the corresponding priority of the country.

UCS_Y1_01: BE: Fire intervention (Fire Brigade access information in case of intervention)

Fire Brigade gets specific information in case of intervention from the intervention dossier. They extract information from BIM: fire rating, location of exit doors, water hydrants, number of inhabitants, etc. Use case aims to facilitate the assessment of the level of risk of a room and faster access to fire location. Here, the fire department uses the information in the BIM model, in combination with geospatial data (e.g. road network, public hydrants), to generate a fire intervention plan. The fire intervention plan is stored on the Fire Incident Management System (e.g. FireMaps) of the fire department. Fire services access Fire Incident Management System to get the fire intervention plan so that they can visualize the location of the building in its urban context and the access to location.

UCS_Y1_02: BE: long term vision - Circular economy - Urban mining

Urban mining for circular economy has become indispensable in recent years. Existing buildings that will be transformed or demolished are a source of materials for other building projects. Companies can search for building parts they are interested in if there is a platform that makes it possible to set a query on these assets and present all necessary information. Here, BIM data provides invaluable information about the content which can then be used to estimate the number of recyclable materials before demolishment starts. This use case aims to use BIM model of a building to query the construction materials and estimate the cost or revenue of the recycled materials.

UCS_Y1_07: BE: Digital building permit platform

BIMY, as a public smart city urban platform, can be used to manage building permits and as-built models digitally. In this use case an architect introduces the "building permit" BIM version to BIMy platform with a security filter. Authorities / Firemen / Consultants have restricted access to the platform and the may have a filtered view of what they need to see from the project. If there is no compliance problem the project is accepted and made public in BIMy platform (only façades for public use; metadata without geometry for subscribed users; complete BIM model for authorities).

UCS_Y1_08: BE: Integrate urban context information into BIM models

Integrating GIS urban context information (e.g. a detailed geometry of the urban context, neighbouring facades, parking space, etc.) in BIM software is needed to create better designs and simulations. Since

this topic is a horizontal need, a separate use case is defined here aiming to set up a base for BIM and GIS interoperability, so the urban context can be integrated in the BIM Models, and the BIM Models can be reused in GIS Building Permit Platforms. This use case aims to reduce the cost of production of 3D BIM Models of the urban context inside and outside the project parcel (nowadays this work is done manually by architects. Moreover, this will facilitate the use of BIM methodology for environmental impact simulations leading to more durable solutions and better designs.

UCS_Y1_10: TR: Fire Brigade Crisis Management

There are expectations of using BIMs by multiple stakeholders for facilities management, safety and security analysis, crisis management and citizen participation in the pursuit of smart city initiatives. This case study addresses the effective training, planning and utilizing crisis management activities with a special focus on fire brigade. The case study presents a more comprehensive approach not only at BUILDING even HOUSE level but also at URBAN level. The case study will help fire departments to learn more about buildings in 3D format (by utilizing BIM models) including their interior and exterior 3D plans. Moreover, by utilizing GIS-based ontologies, fire brigades will have a more comprehensive knowledge about the environment which can present very critical information to identify the best emergency response plan. Such an emergency plan may include the description of intervention processes, evacuation scenarios, firefighting and cooling operations, etc.

UCS_Y1_11: TR: Training residents by evacuation simulation in case of earthquakes

The use case mainly focuses on an edutainment (education + entertainment) solution aiming to simulate an evacuation scenario from a specific apartment in a building when an earthquake occurs. The scenario covers what to be done throughout the evacuation route starting from the specific room of the apartment and ends at the nearest gathering point that is close to the building. The scenario will train people who leave in that specific apartment by presenting the "to-do"s in a virtual but realistic 3D environment (extracted from BIM model).

UCS_Y1_14: BE: Fire prevention

The fire department can access the BIM model (building permit, as-built, refurbishment) for manual and automated fire risk inspections. Depending on the building function, the fire department does regular inspections (e.g. every 5 years). Here, the architect is assisted by a BIM modelling tool that semi-automatically suggests fire escape routes and location of hydrants, sprinklers, smoke evacuation valves, etc. based on the fire regulation. The architect includes the necessary information in the model (as annotations or as object). The architect runs automated quality checks on the BIM model about the fire risk regulation (e.g. distances to staircases, hydrants, and escape routes). In this case study temporal aspect of the BIM model: the status of the plan: 'permit', 'as-built', 'refurbishment', 'periodic check' will be used better prevention.

7.1.2 Non-Prioritised Use Case Scenarios

Non-prioritised use cases are aligned with the secondary goals of the project each of which is either like an extension of the corresponding prioritised use case or a horizontal topic which may support the primary goals of the prioritised use cases.

UCS_Y1_03: BE: 3D urban context visualisation in a Web application

This use case aims to provide an overview of the urban context in a 3D Web application to architects, constructors, real-estate agencies, visitors, insurance companies, etc. Such a use case provides a Web-based visualisation of 3D building, infrastructure and context information.

UCS_Y1_04: BE: Collaboration in construction sector

Architects, clients and contractors can openly collaborate during design and construction. BIMy Platform is not only about extracting data, there are also collaboration features. In this use case is aimed to provide an open platform where all types of documents can be shared: IFC models, datasheets of materials, work plans extracted from the BIM models, render images, etc. However, it cannot replace a collaboration platform for native software that enables the possibility to work with several people on the same model at the same time.

UCS_Y1_05: BE: Data brokerage - Use of BIM+GIS data for business prospection/location intelligence

This use case aims to set up a data brokerage platform that enables various kinds of stakeholders to extract derived information from a large amount of BIMs in order to support various use cases for which detailed information on (planned) buildings is required. Example of such use cases are the correct dimensioning of utility networks extensions, improve the energy efficiency of buildings, assess the renewable energy potential of buildings, determine the optimal location of new businesses or public infrastructure, etc.

UCS_Y1_06: BE: Project benchmarking

The BIMy platform enables to compare projects by providing performance ratios based on the stored as-built BIM models. The BIMy platform can provide relevant default reports. This use case will help architects who are working on a feasibility study for a new housing project as they can access the BIMy platform and select some similar buildings in the same neighbourhood. The platform does not provide the plans (security issues) but it provides a report with a set of variables that enable comparison and performance for a new project (for example: number and type of apartments, average size of each type of apartment; ratio between common surfaces and private surfaces; ratio between construction surface and living area; number of elevators; number of staircases; number of floors; number of apartments by floor...)

UCS_Y1_09: BE: Design and Build Competition / Architectural Contest

he BIMy Platform can be used by the different Design and Build teams in a competition so that the client can evaluate them. This use case will help to promote a new paradigm for the evaluation of projects (more objective and based on performances than the symbolic value of the storytelling behind a design concept). Competitors may send their proposals in BIM format via the Platform and clients can evaluate and compare different projects and compare them extracting information from the models.

UCS_Y1_12: BE: Extracting BIM data for facility management

80% of the total cost of ownership of a building is spent on operation and maintenance. Facility Managers are using Computer Aided Facility Management Software (CAFM) / Integrated Workplace Management System (IWMS) such as Planon, Archibus, IBM Tririga, or Trimble for optimising space usage, asset management, reactive and predictive maintenance, or energy efficiency. Facility managers need to extract

relevant information from BIM data and convert that into information that they can use in their CAFM / IWMS software, for example in the Construction Operations Building Information Exchange (COBie) format. This may require a simplification of the BIM data, using a coherent identification system, clustering objects (e.g. indoor windows / outdoor windows), changing classification values, etc. Vice versa, facility managers may have requirements, which architects can take into account during the design process, lowering the total cost of ownership of a building (e.g. easier access to HVAC units makes renovation cheaper, a smarter floor plan makes it possible to more easily change the function of a space). This use case aims to extract relevant information for facility management from BIM data -that influences the design of buildings lowering the total cost of ownership (TCO).

UCS_Y1_13: BE: Integrate BIM with Testing, Inspection and Certification (TIC)

During construction, operation and maintenance, various testing, inspection, and certification (TIC) activities take place within a building. For example, to see if a construction or renovation was carried out according to plan, or to inspect the structural integrity of concrete pillars, to inspect an elevator. In this use case, the tools (e.g. mobile apps like LetsBuild) that are used for TIC can benefit from access to BIM data. Similarly, it may be relevant to (semi-automatically) update an as-built BIM model with the information that has been gathered in the field.

UCS_Y1_15: BE: Data Brokerage: BIM for fire insurance

Fire risk characteristics are automatically extracted from BIM data and used for data brokering. In this use case, a building owner requests an online fire insurance quote by filling in an online form and grants the insurance company access to a BIM model on the BIMy platform. Then, the insurer securely accesses the relevant BIM model on the BIMy platform, filters it, and extracts the building properties that determine either the fire risk and/or the value of the building. Moreover, the insurer provides a quote for an insurance policy based on among others the key fire risk characteristics and the estimated value of the building.

UCS_Y1_16: BE: long term vision - Circular economy - suitability for functional change

Rather than demolishing a building, a building can be given a completely new function. A project developer therefore needs to query a building for particular properties (e.g. ceiling height). For example, the Tour&Taxis building had high ceilings and therefore could be given a new function (warehouse > conference area). Many office buildings from the 1990s are not suitable, because their design does not allow a new function, e.g. the ceiling heights of 2m20 does not allow fitting new MEP. Architect is hired to make a feasibility study to transform a building for another use (e.g. housing to office). Architect can access BIMy to download the "as-built" BIM model of the existing building in IFC format. They are able to access information such as ceiling heights or bearing capacity of stability elements on the BIM model to decide if he can keep them or not for the new project.

8 Conclusion

This deliverable presents an overview of the demonstrated project outputs which are presented in the iteration of the project. These demonstrators mainly focus on the fundamental features of the BIMy cloud platform like BIM data filtering, visualisation over WEB and basic visualisation and interaction with augmented and virtual reality. The deliverable elaborates the demonstrators presented in Year 1, 2, and 3. The Year 3 demonstrators are the consolidated one where BIM is semantically integrated with GIS data models which enables more effective filtering, higher security of BIMs and more useful visualisation and interaction.

Bibliography

ASSAR. (2019). *BIM model of a nursing home in Kortrijk*.

Autodesk. (2006). *Filmbox (FBX)*. Retrieved from https://en.wikipedia.org/wiki/FBX

BIMy consortium. (2019a). *BIMy - BIM in the City - D1.2 Platform applications and requirements*.

BIMy consortium. (2019b). *BIMy - BIM in the City - D1.3 Platform and API specifications*.

BIMy consortium. (2019c). *BIMy - BIM in the City - D2.2 Integrated BIM/GIS model*.

buildingSMART. (2007). *Industry Foundation Classes, IFC2x Edition 3, Technical Corrigendum 1*. Retrieved from http://www.buildingsmart-tech.org/specifications/ifc-releases/ifc2x3-tc1-release

City of New York. (2017). *NYC Open Data*. Retrieved from https://opendata.cityofnewyork.us/

GIM. (2019). *Belmap*. Retrieved from http://belmap.be/

glTF - GL Transmission Format. (n.d.).

IETF. (2016, August). *The GeoJSON Format*. Retrieved from https://tools.ietf.org/html/rfc7946

Khronos Group, & Sony Computer Entertainment. (2004, October). *Collada (dae)*. Retrieved from https://www.khronos.org/collada/

OGC. (2012, April). *OGC City Geography Markup Language (CityGML) Encoding Standard, version 2.0*. Retrieved from https://www.opengeospatial.org/standards/citygml

OGC. (2019, January 31). *OGC 3D Tiles Specification*. Retrieved from http://www.opengeospatial.org/standards/3DTiles

openBIMstandards. (2015). *Dataset Schependomlaan*. Retrieved from https://github.com/openBIMstandards/DataSetSchependomlaan

Ville de Namur. (2018, June 17). *Namur 3D - Textured Buildings per tile of 200m by 200m*. Retrieved from https://data.namur.be/explore/dataset/namur-3d-batiments-textures-par-dalle-de-200m/

Willemen. (2018). *BIM model of the Kumpen Office in Hasselt*.