# Change toolkit for digital building permit

| | |
|---|---|
| Deliverable number | D6.2 |
| Deliverable name | Results Demonstration Scenario 1- CHEK DBP for new building construction |
| Work package number | WP6 Piloting action coordination and demonstration |
| Deliverable leader | SIA.architects |
| Dissemination Level | Public |

| | |
|---|---|
| Status | Final |
| Version Number | V 1.1 |
| Due date | M34 |
| Submission date | 29/07/2025, resubmitted 26/08/2025 |

Project no. 101058559
Start date of project: 1 October 2022
Duration: 36 months
File name: CHEK_101058559_D6.2_Results Demonstration Scenario 1_V1.1-Final

Funded by the European Union

This project has received funding from the European Union under the Horizon Europe Research & Innovation Programme 2021-2027 (grant agreement no. 101058559).

Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union. Neither the European Union nor the granting authority can be held responsible for them.

## Authors and contributors


| Author | Organisation | E-mail |
|---|---|---|
| Borja Martínez González | SIA | b.martinez@sia-arch.eu |
| Trajche Stojanov | ZWE | ts@zweiconsult.com |


## Quality control

| Author | Organisation | Role | Date |
|---|---|---|---|
| Witold Olczak | MST | WP leader | 15/07/2025 |
| Lucie Kovaříková | IPR | Reviewer | 08/07/2025 |
| Francesca Noardo | OGC | Coordinator | 25/07/2025 |
| Agnieszka Lukaszewska | FAS | Reviewer | 14/07/2025 |
| Orjola Braholli | FHI | Reviewer | 14/07/2025 |

## Document history

| Release | Description | Date | Author |
|---|---|---|---|
| V0.1 | First draft: definition table of content | 08/04/2025 | Borja Martínez González |
| V0.2 | Second draft, after reviewers' feedback | 17/07/2025 | Borja Martínez González |
| V1.0 | Final: all comments attended | 28/07/2025 | Borja Martínez González |
| V1.1 | Uodate Final: Envelope extractor mention | 19/08/2025 | Borja Martínez González |

# Contents

Contents....3
1. Executive Summary ....6
2. Introduction....7
2.1 Workflow Description ....7
2.2 Workflow Approach....8
2.3 Integration of Backend Components for BIM-to-GIS Validation ....11
2.4 Regulations Implemented Across Pilot Sites ....11
3. Pilot Cases Demonstration Scenario 1....12
3.1 Vila Nova de Gaia ....13
3.1.1 Gathering initial data - VCMap ....15
3.1.2 GIS validation....18
3.1.3 GIS to BIM conversion – CityGML2IFC....19
3.1.4 Designing overview ....21
3.1.5 Exporting the model – DiRoots Plugin....24
3.1.6 Georeference assessment – IfcGref/VCMap....27
3.1.7 IFC validation – RDF's IfcViewer....29
3.1.8 Uploading the model to the CHEK platform ....31
3.1.9 CHEK pre-validation and reporting – CYPEURBAN ....34
3.1.10 CHEK pre-validation and reporting – VCMap....42
3.1.11 Model Evolution during Software Development and Pilot Testing ....50
3.1.12 Digital signature of pre-checked IFC project – DiStellar....52
3.1.13 CHEK permitting tools. Municipality side workflow review ....58
3.2 Lisbon ....62
3.2.1 Creating new project using BIMServer.Center ....64
3.2.2 Gathering initial data - VCMap ....67
3.2.3 GIS to BIM conversion - CityGML2IFC ....72
3.2.4 Designing overview ....74
3.2.5 Exporting the model – DiRoots Plugin....78
3.2.6 Georeference assessment - IfcGref ....80
3.2.7 IFC validation – RDF's IfcViewer....83
3.2.8 Uploading the model to the CHEK platform - BIMServer.Center....85

3.2.9 CHEK pre-validation, using tool VC Map ....87
3.2.10 CHEK pre-validation - CYPEURBAN ....90
3.2.11 Model Evolution during Software Development and Pilot Testing ....94
3.2.12 Digital signature of the IFC model - DiStellar ....95
3.2.13 CHEK final-validation and report to municipalities – VCMap/CYPEURBAN ....98
3.2.14 CHEK permitting tools. Municipality side workflow review ....101
3.3 Prague ....103
3.3.1 Gathering initial data – VCMap ....105
3.3.2 GIS to BIM conversion – CityGML2IFC ....107
3.3.3 Designing overview ....110
3.3.4 Exporting the model – DiRoots Plugin ....111
3.3.5 Georeference assessment – IfcGref ....114
3.3.6 IFC validation – RDF's IfcViewer ....116
3.3.7 Uploading the model to BIMServer.Center ....118
3.3.8 CHEK pre-validation – Verifi3D ....119
3.3.9 CHEK pre-validation – VCMap ....127
3.3.10 Model Evolution during Software Development and Pilot Testing ....130
3.3.11 Digital signature of pre-checked IFC project – DiStellar ....132
3.3.12 CHEK permitting tools. Municipality side workflow review ....133
3.4 Ascoli Piceno ....137
3.4.1 Creating new project using BIMServer.Center ....139
3.4.2 Gathering initial data - VCMap ....141
3.4.3 GIS to BIM conversion - CityGML2IFC ....146
3.4.4 Designing overview ....148
3.4.5 Exporting the model – DiRoots Plugin ....151
3.4.6 Georeference assessment - IfcGref ....153
3.4.7 IFC validation – RDF's IfcViewer ....156
3.4.8 Uploading the model to the CHEK platform using tool BIMServer.Center ....158
3.4.9 CHEK pre-validation - VCMap ....159
3.4.10 Model Evolution during Software Development and Pilot Testing ....162
3.4.11 Digital signature - DiStellar ....164
3.4.12 CHEK final-validation and report to municipalities - VCMap ....166
3.4.13 CHEK final-validation and report to municipalities - Verifi3D ....167
3.4.14 CHEK permitting tools. Municipality side workflow review ....170

4. Conclusion......174
5. Annex I. Detailed List of Regulations Implemented in CHEK Demonstration Scenario 1......175
5.1 VILANOVA DE GAI - CYPEURBAN......175
5.2 VILANOVA DE GAIA - VCMAP......176
5.3 LISBON - CYPEURBAN......177
5.4 LISBON - VCMAP......178
5.5 PRAGUE – VERIFI3D......179
5.6 PRAGUE - VCMAP......180
5.7 ASCOLI PICENO – VERIFI3D......181
5.8 ASCOLI PICENO - VCMAP......182
6. References......183
List of Figures......183
List of Tables......187
List of used abbreviations......188

# 1. Executive Summary

This deliverable documents the demonstration process carried out within the framework of the CHEK project, focused on verifying compliance with urban planning regulations in building projects digitized in BIM, applied across various European municipalities.

The main objective has been to assess the interoperability of the BIM-GIS digital tools developed within the project and to define a common structure for the automated validation of building projects against urban planning regulations, using open BIM models within a shared Common Data Environment (CDE).

While the current development is still far from allowing comprehensive all regulatory checks, it lays the foundation for future expansion, making the system scalable and potentially extensible to a broader range of rules and municipalities.

The implementation of specific regulations in each software tool posed significant technical challenges due to the diversity of regulatory criteria and the differing implementation approaches of each tool, each with its own limitations.

The urban regulation verification applications share a key component: the use of the Common Data Environment (CDE), which serves as the central hub for reading and writing project information. In general terms, BIM models—previously validated by designers in IFC format—are processed by the validation tools, which generate a report with the results of the checks, using different formats depending on the software used.

During the pilot tests, a common workflow and software setup was implemented across the four pilot sites. This workflow was only slightly adapted to align the scope of demonstrations with the extent of rule implementation and technical capacity of each validation tool. The choice of tools was driven by their specific functionalities, with each municipality testing different combinations (e.g., VCMap and Verifi3D in Prague) to cover a broader spectrum of regulatory checks. The document is structured by pilot scenario, describing for each one the workflow followed, the tools used, and the input and output data managed.

This deliverable does not include a technical description of the services used, as this information is already documented in the technical deliverables of Work Package 4, particularly in **D4.9 – Software documentation and workshops** (submitted in June 2025). Additional technical details on individual tools and platform components can be found in related deliverables such as **D4.6 – Tools for BIM-based urbanism and accessibility**, **D4.7 – 3D City Model Viewer for pilot use-cases**, and **D4.8 – Checking tools for the CHEK regulations**. Instead, this document offers an operational view of the tools in real-world contexts, with the aim of evaluating their effectiveness and practical applicability.

Each demonstration represents a specific use case and also serves as a stress test for the different applications developed. The diversity of building models and validation mechanisms has made it possible to identify specific strengths and weaknesses of each solution.

The CHEK tools were tested in four European municipalities, each representing a different building typology to reflect a range of regulatory challenges and urban contexts. In Vila Nova de Gaia (Portugal), the pilot focused on a detached single-family house, addressing low-density residential development within an existing allotment. The Lisbon (Portugal) demonstration tested the tools on a mixed-use residential and commercial building planned for an empty urban plot, representing new construction in consolidated urban area. In Prague (Czech Republic), the pilot involved a public school, showcasing the validation of an educational facility within a large redevelopment area (Žižkov Freight Station). Finally, Ascoli Piceno (Italy) explored urban renovation, involving the demolition of obsolete structures and the new construction of a mixed-use building combining residential, commercial, and service functions. These diverse cases allowed the project to evaluate the interoperability and adaptability of the tools across a variety of urban planning scenarios.

# 2. Introduction

This document is part of the deliverables of Work Package 6 (WP6) of the CHEK project, and its main objective is to document the demonstration process carried out in four European municipal contexts to assess the feasibility of a digital workflow for the urban planning validation of BIM projects in open formats. It specifically covers *Demonstration Scenario 1 – New Building Construction*. The complementary *Scenario 2 – Renovation or Extension of Existing Buildings* is addressed separately in Deliverable D6.3.

The data used in the demonstrations comes from digital models developed specifically for each pilot scenario, including BIM models in IFC format, GIS data, local urban regulations, and complementary metadata. These models were prepared by the project's participating designers in collaboration with the partner municipalities.

The document has been produced in the context of real interoperability testing, connecting multiple validation tools (developed within the project) with a shared digital infrastructure based on the use of a Common Data Environment (CDE). This integration enables centralized data management, automation of verification processes, and improved communication among the various stakeholders: designers, software developers, municipal technicians, and project coordinators.

This deliverable is of particular interest to public administrations, software developers, and technical professionals (e.g. architects, civil engineers, Mechanical, Electrical Plumbing Engineers) involved in planning and urban validation processes, as it provides a detailed view of how automated regulation-checking systems could be practically implemented using digital models.

In addition to documenting the workflow and the results obtained, this introduction helps the reader understand the overall project framework, the goals of the pilot, and the relevance of the data used, serving as a starting point for interpreting the content developed in the following chapters.

## 2.1 Workflow Description

The workflow proposed within the CHEK project establishes a common structure for the automated urban planning validation of building projects using BIM models, integrating various digital tools within a common data environment. While the pilot cases use different combinations of software and methodologies, they all share the same conceptual principles and fundamental steps.

The process begins with the collection of geometric information about the environment: topography, adjacent buildings, and property boundaries. After verifying proper georeferencing, this information is used for the preparation of the BIM model by the designer, which must include both geometric and alphanumeric data necessary for subsequent validation. This model, always in open IFC format, is uploaded to the Common Data Environment, which acts as a centralized repository and point of information exchange between applications.

Once the model is available in the CDE, the urban regulation validation software accesses the file and performs a series of automated checks, configured according to the specific planning regulations of each municipality. These checks may include, among others, distances to plot borders, maximum lot coverage, allowed building height, or street alignment.

The validation results are returned to the CDE in the form of a report, accessible to both municipal technicians and designers. This report varies in format and level of detail depending on the tool used but always indicates whether the model complies or not with the regulations assessed.

Although the overall logic of the workflow is common across all scenarios, its specific implementation varies depending on the tools selected, local configurations, and data availability. Therefore, the following subsections provide a detailed description of how the workflow was carried out in each pilot case, highlighting the adaptations made to address issues encountered during the demonstrations, as well as the results obtained.

The tools integrated in the CHEK validation workflow cover both user-facing applications and backend services operating behind the scenes. The Common Data Environment (CDE), available on **BIMserver.center** and developed by **CYPE**, serves as a centralized platform for storing, sharing, and synchronizing IFC models and validation outputs. For model authoring and export, designers used a single authoring tool: **Revit**, in combination with the **DiRoots Exporter**. The **IFCGref/VCMap** tools, developed within CHEK by **TUD/VCS**, was employed to ensure correct georeferencing of BIM models prior to validation.

On the backend, several key components enabled deeper automation and data transformation processes. The **BIM-to-GIS conversion modules** developed by **TUD** were integrated within the backend of **VCMap** to enable the semantic transformation of IFC files into 3D city models, ensuring compatibility with urban-scale GIS validation. Furthermore, **RDF** contributed a suite of tools to support data compliance and structural integrity of IFC files: the **IDS Checker**, which verifies the presence of required parameters according to Information Delivery Specifications (IDS), and the **EXPRESS Validator**, which ensures that IFC files conform to the correct syntactic structure as defined in the EXPRESS schema. These tools are critical for guaranteeing data quality prior to automated rule checking.

For urban regulation validation, three main tools were tested across the pilots: **VCMap** (developed by **Virtual City Systems**), which performs GIS-based spatial rule validation; **Verifi3D** (by **Xinaps**), used for model-checking based on BIM geometry and property sets; and **CYPEURBAN** (developed by **CYPE**), which provides a user-friendly graphical interface to apply and visualize planning regulations. In addition, the **DiStellar** platform by **DiRoots** was used to digitally sign and certify validated IFC models as part of the end-to-end verification process.

## 2.2 Workflow Approach

The approach adopted to implement the workflow in the various pilot cases of the CHEK project is based on a common sequence of steps, in which specific tools and procedures have been applied according to the needs of each project, as described in the project's Description of Action (DoA).

Each step of the workflow can be addressed using one or more tools available within the CHEK ecosystem, resulting in different tool combinations depending on the scenario. The following outlines the main workflow stages, along with the tools or procedures used in the different pilots:

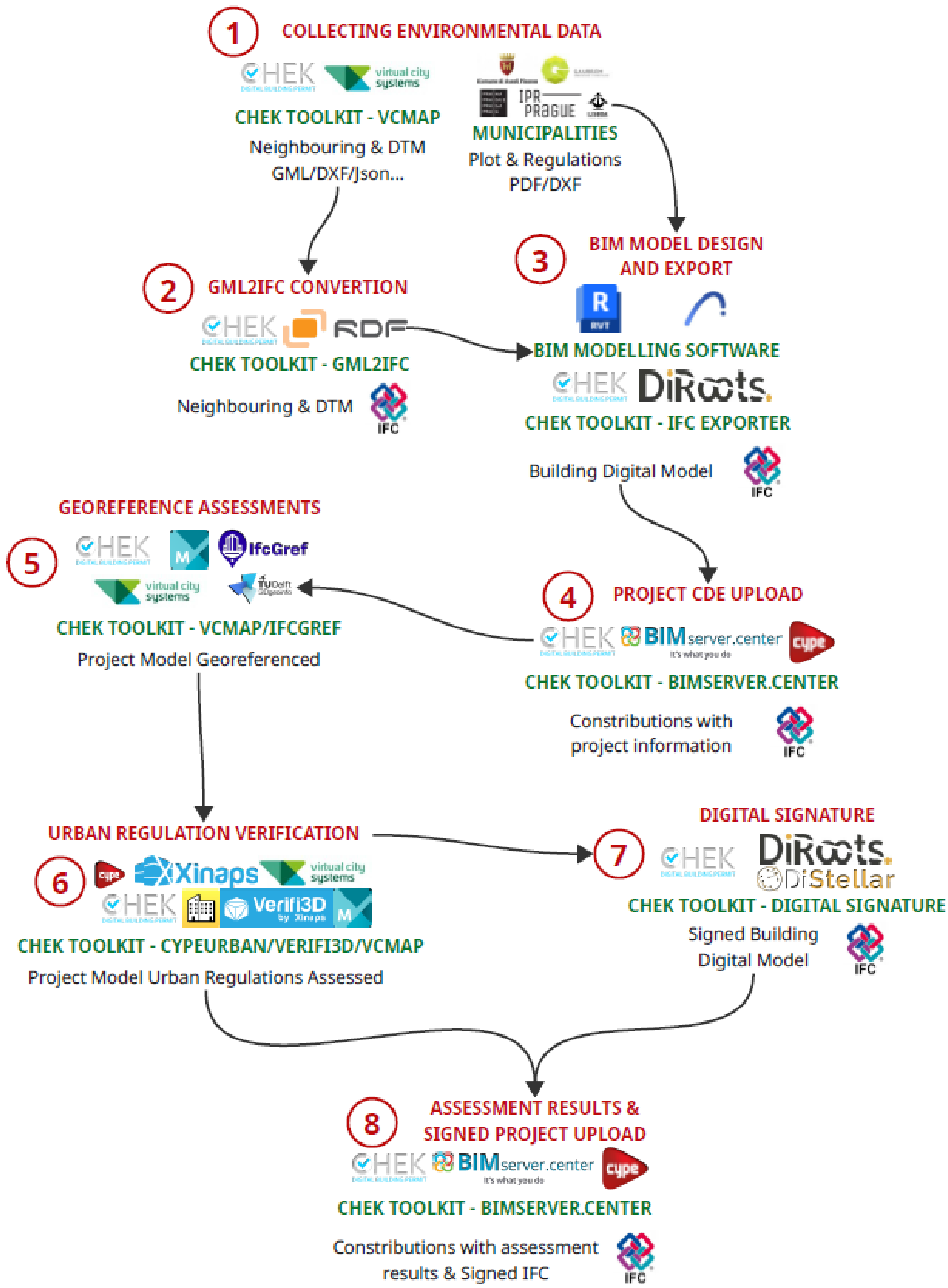



Figure 1 Workflow description and involved partners

1. Collection and preparation of environmental data (topography, plot, surrounding buildings): DXF and PDF files for plot boundaries provided by municipalities, VCMap for extracting 3D GIS data of the topography and surrounding buildings.
2. RDF's CityGML2IFC converter to generate base design content, and georeferenced IFC files as modeling support.
3. Preparation of the BIM model: Revit was the modeling software used in the project, although the exchange format is always IFC, making the workflow extensible to any design software capable of exporting to this format. The DiRoots plugin was used to export the models following the data standards defined by the IDS.
4. Uploading the model to the Common Data Environment (CDE): The BIMserver.center platform was used for uploading, managing, and federating IFC contributions, as well as storing other exchange formats required by the designer (DXF, PDF, JSON, etc.).
5. Georeferencing verification: Correct spatial positioning of the building model is essential for ensuring consistent validation results and compliance with urban regulations. Georeferencing was initially addressed at the early stages of the project, by aligning the BIM model to real-world coordinates prior to design. This step ensures that the design is created within the correct spatial context, matching municipal data such as plot boundaries and terrain. After model authoring and export, a verification step was performed to confirm that the georeferencing information had been preserved correctly in the IFC files. Tools developed within the CHEK project, such as VCMap and IFCGref (by TUD), were used to validate the geospatial integrity of the models.
6. Urban and building regulation verification: Different tools were used depending on the scenario: Verifi3D (Xinaps), VCMap (Virtual City Systems), and CYPEURBAN (CYPE), along with external viewers such as BIMvision, not part of the CHEK ecosystem.
7. Digital signature, once the model has been assessed, and is ready for permitting request.
8. Generation and review of the validation report: Reports were generated in different formats depending on the tool used: interactive HTML and JSON (VCMap), Excel/CSV (Verifi3D), and PDF, IFC, GLTF, and JSON (CYPEURBAN). Communication between stakeholders (designer ↔ municipality) was primarily carried out through direct emails and technical meetings. An effort was made to facilitate interaction through the CDE by integrating embedded commenting and feedback features. While this functionality showed potential to support asynchronous collaboration, it was not fully operational during the initial round of testing.

This modular approach allowed for testing and comparing various software configurations, identifying strengths, limitations, and interoperability requirements that will serve as the foundation for the future development of the CHEK ecosystem.

## 2.3 Integration of Backend Components for BIM-to-GIS Validation

In addition to the tools directly used by designers and municipal staff, the CHEK project relies on several backend components that ensure interoperability between BIM and GIS environments. One of the most critical is the Envelope Extractor, developed by TUD.
This tool automatically processes IFC files uploaded to the Common Data Environment (CDE) and generates simplified GIS-compatible representations of buildings. These representations—essentially geometric envelopes—are used internally by VCMap to enable spatial rule validation at urban scale.
During the conversion, users can define the required Level of Detail (LoD) for the envelope, balancing geometric accuracy and computational efficiency. While this configuration is handled indirectly through VCMap's interface, the actual transformation is executed by the Envelope Extractor in the background.
The result of this process allows for compliance checking of key indicators such as building height, footprint area, setback distances, and alignment with regulatory boundaries, all within the GIS domain. Although not visible to end users, the Envelope Extractor plays a pivotal role in bridging the gap between BIM-based design and GIS-based regulatory validation.

## 2.4 Regulations Implemented Across Pilot Sites

To support the validation of building models in different urban contexts, a set of regulatory rules were implemented and tested during the CHEK demonstrations. These regulations vary by municipality and were integrated into three validation tools: VCMap, CYPEURBAN, and Verifi3D. Each pilot site focused on a different subset of planning regulations, chosen according to local planning frameworks and software capabilities.
The figure below summarizes the number of individual regulatory checks implemented in each municipality, categorized by validation tool. This allows for a comparative understanding of the functional coverage achieved in Scenario 1.

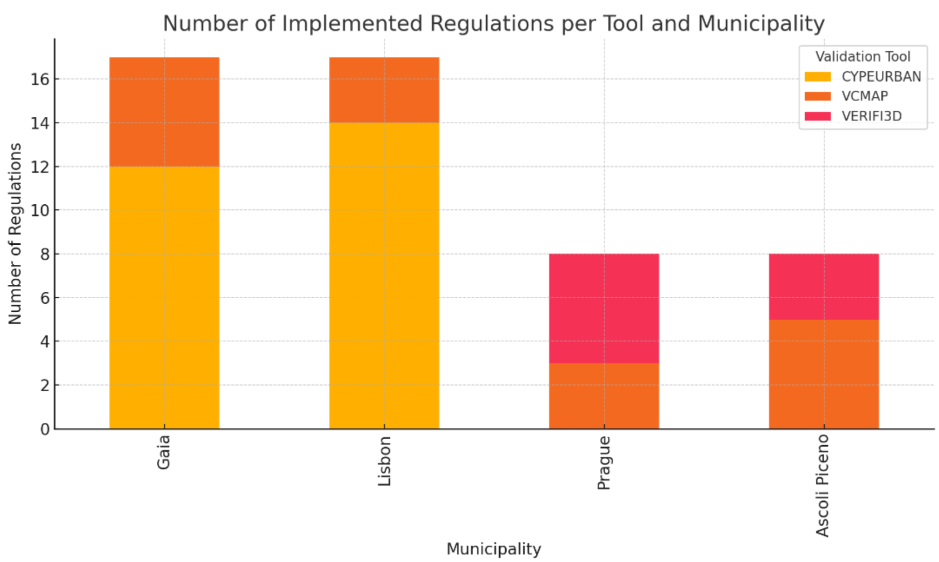



**Figure 2 Simple graph showing regulations implemented per municipality**

A detailed table listing all validated regulations — including the planning article referenced, the tool used, and the corresponding rule identifier — is included in Annex I.

## 3. Pilot Cases Demonstration Scenario 1

This section provides a detailed account of the activities carried out under Scenario 1 of the CHEK project, which focuses on the construction of new buildings. It describes the methods followed and the results obtained in each of the demonstrations conducted.

Each pilot case was developed in a real urban environment, in collaboration with municipal authorities, and involved the application of the proposed workflow to verify compliance with urban planning and building regulations using open-format BIM models. These tests allowed for the assessment of tool interoperability and the practical usefulness of the approach both in design and municipal processes.

The demonstrations under Scenario 1 were carried out in four municipalities: Vila Nova de Gaia (GAI), Lisbon (LIS), Prague (IPR), and Ascoli Piceno (APC), between May and early June 2025. The activities involved two design partners: SIA and ZWEI, each assigned to different pilot cases to reflect diverse urban contexts and regulatory conditions.

- GAI and LIS pilots were executed in parallel from 19 to 23 May, with SIA responsible for the Gaia demonstration and Zwei for the Lisbon case.
- The IPR pilot took place from 26 to 30 May, led by SIA and focused on a public school building in Prague.
- The APC pilot was carried out by SWEI from 28 May to 5 June, focusing on urban renovation and mixed-use development in Ascoli Piceno.

Each scenario addressed different urban and regulatory challenges, allowing for a broad assessment of the CHEK tools' adaptability and performance across multiple contexts.

**Table 1 – Summary Table of Demonstration Activities**

| Municipality | Designer | Date | Validation tools used | Type of Building |
|---|---|---|---|---|
| LIS | ZWE | 19–23.05.2025 | CYPEURBAN, VCMap | Mixed-use building |
| GAI | SIA | 19–23.05.2025 | CYPEURBAN, VCMap | Single-family house |
| IPR | SIA | 26–30.05.2025 | Verifi3D, VCMap | Public school |
| APC | SWE | 09–13.06.2025 | Verifi3D, VCMap | Mixed-use renovation |

The following subsections describe the individual pilot cases executed within this scenario, highlighting the specific elements of each and the technical particularities that influenced their development.

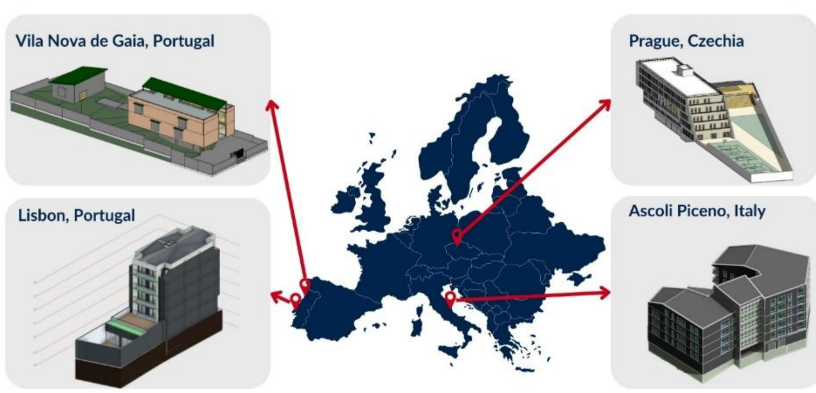



**Figure 3 Municipalities involved, and pilots developed**

## 3.1 Vila Nova de Gaia

The pilot developed in the municipality of Vila Nova de Gaia (Portugal) falls under Scenario 1 of the CHEK project, focused on new building construction. The pilot project is a single-family detached house, described in more detail in section 3.1.3 of deliverable D6.1 “Plan for demonstration of CHEK Digital Building Permit process on demo sites”.

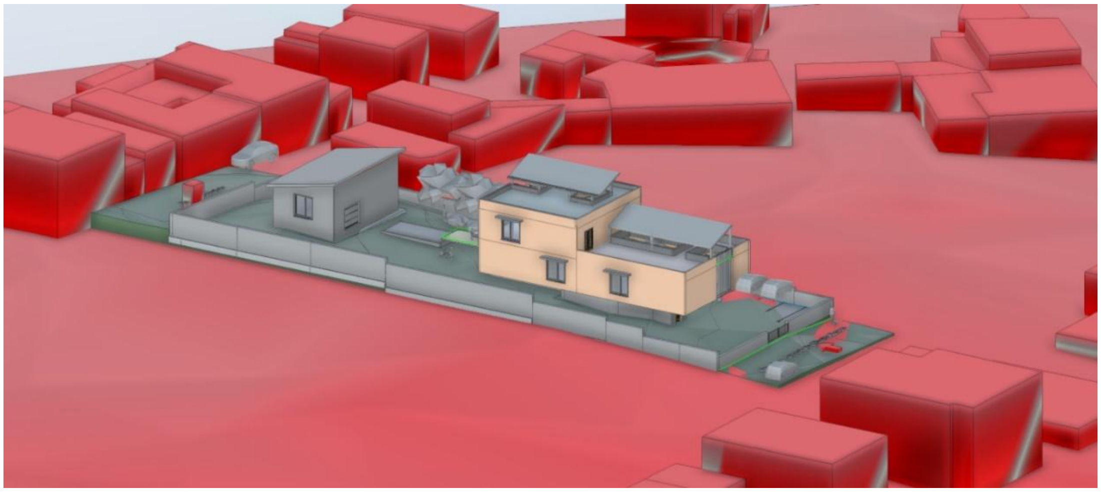


Figure 4 Final version for GAIA Scenario 1

The responsible designer was SIA Architects, who developed the BIM model using Revit. Although the DiRoots plugin was initially considered for IFC export, compatibility issues led to the use of Revit’s native export tools instead.
The model was integrated into the Common Data Environment (CDE) via the BIMserver.center platform, along with additional contributions corresponding to topography, undeveloped land, and urban infrastructure elements.
To obtain the geospatial and urban context, the VCMap tool was used, and the conversion of these data into IFC format was performed using the CityGML to IFC converter developed by RDF.
The validation workflow included georeferencing checks (using VCMap and IFCGref), digital signature of the model via DiStellar, and the application of urban planning rules using both CYPEURBAN and VCMap.
Several technical issues were identified during the demonstration, including the inability of CYPEURBAN to export reports to the municipal profile within the CDE. This led to the implementation of temporary workarounds and local validations by the municipality. These matters are described in detail in the following sections.

Table 2 – Key Findings after performing demo scenario 1 on GAIA's pilot

| Aspect | Finding |
|---|---|
| BIM Model Structure | A modular approach (building, terrain, undeveloped plot) improved federation, export and validation workflows. |
| IFC Export | Due to issues with the DiRoots exporter, native Revit export was used with custom settings, yielding valid IFCs. |
| Georeferencing | Confirmed through VCMap and IfcGref. Manual repositioning was required in Revit due to its limitations with IFC geolocation. |
| Pre-validation | CYPEURBAN and VCMap enabled rule-based checking, but some differences in rule interpretation (e.g. setbacks) suggest a need for harmonization. |
| Municipal Validation | Limited access to signed models and tool constraints required municipalities to replicate the designer's environment. |
| Workflow Gaps | Current CDE and software setup lack direct mechanisms for signed model sharing and cross-role interoperability. |

In summary, the Gaia pilot demonstrated the technical feasibility of the CHEK DBP workflow and highlighted areas for further development—particularly regarding coordination between roles and validation infrastructure within the platform.

### 3.1.1 Gathering initial data - VCMap

**Settings:**

- CHEK Designer account created and validated in BIMserver.center
- Project “DemoFinalScenario1_GAI” created and tagged as “Gaia” for proper indexing in VCMap
- Access to VCMap using CHEK credentials, before performing download

**Inputs:**

- None

**Outputs:**

- Exported contribution from VCMap named “VCMapInitInfo” including:
    - CityGML files for terrain and adjacent buildings
    - DXF and DWG files containing terrain and surrounding buildings

**To Improve:**

- Absence of plot boundary as a layer in VCMap exports. At least a DXF, SHP, or alternative file format is needed for that purpose, and in this case, it was provided by the municipality.
- A “snap” or “coordinate probe” tool inside VCMap will help to extract accurate positioning data needed for the design step modelling, later with vendor software.

**Process Description:**

The process began by accessing BIMserver.center and creating a new project tagged specifically for the municipality of Vila Nova de Gaia, to ensure visibility in VCMap. Once the project was visible in VCMap, the city model was accessed through the "Content" tool, by selecting the pilot project titled DemoFinalScenario1_GAI. Using the interactive map interface, an area surrounding the plot was selected based on urban design needs.
Through VCMap’s export tools, data for terrain and surrounding buildings was downloaded in multiple formats: CityGML, CityJSON, GLTF, DXF, DWG and FBX. The CityGML was chosen as primary output for later BIM process, given its compatibility with the RDF converter for IFC generation. DWG and DXF files were useful as visual references. They presented initial problems with geolocation, but Virtual City Systems, the developer of VCMap corrected it during the demo, attending our request. However, the exported data did not include parcel boundaries. This was later requested to the developers (VCS) to be included in shapefile or DXF format.

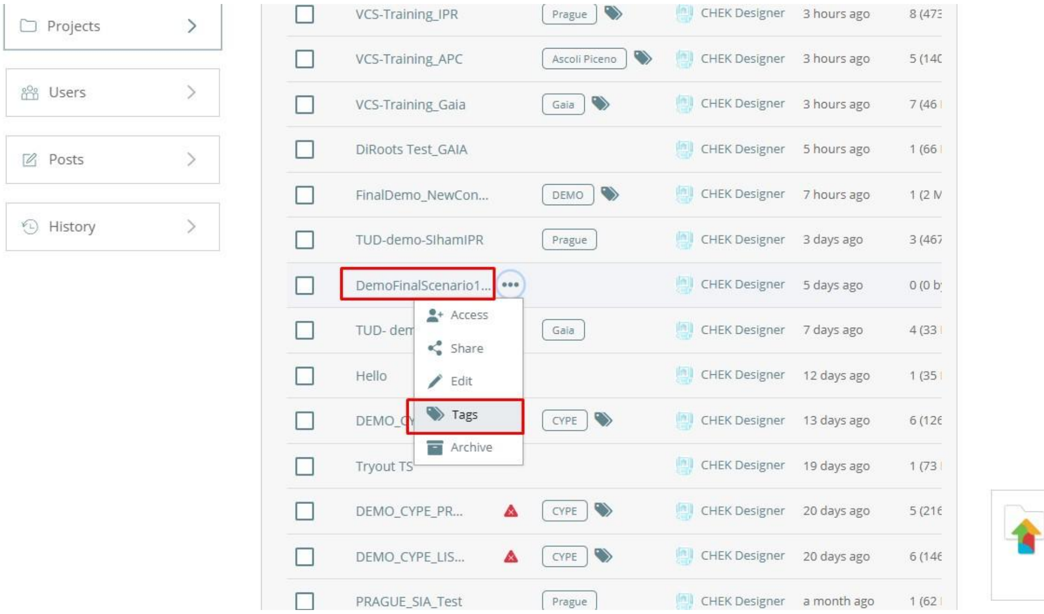



Figure 5 Creation of the project and tagging it to enable visibility in VCMap

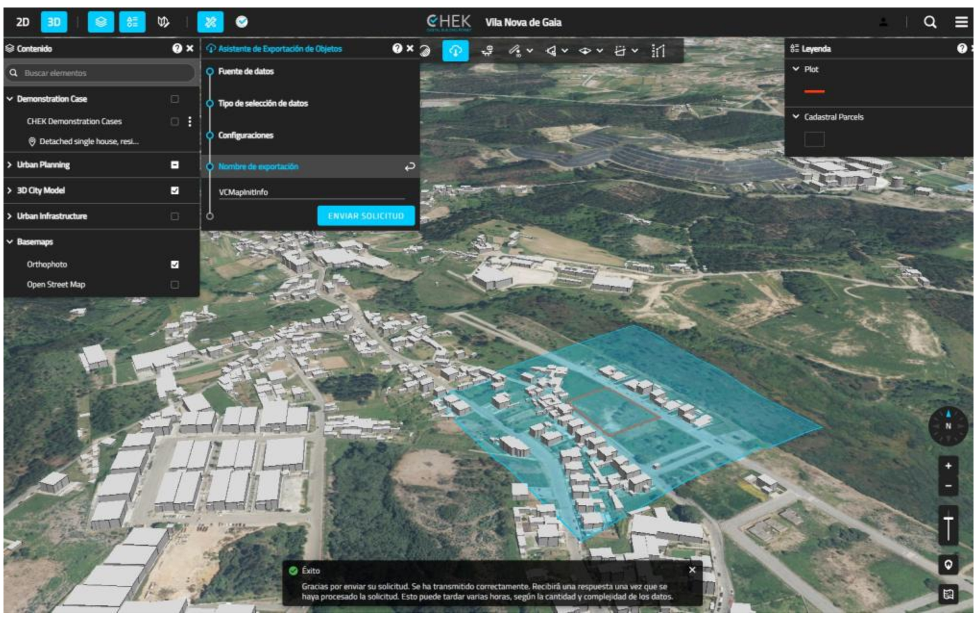



Figure 6 Using “Export Tool” to fetch initial data needed for design

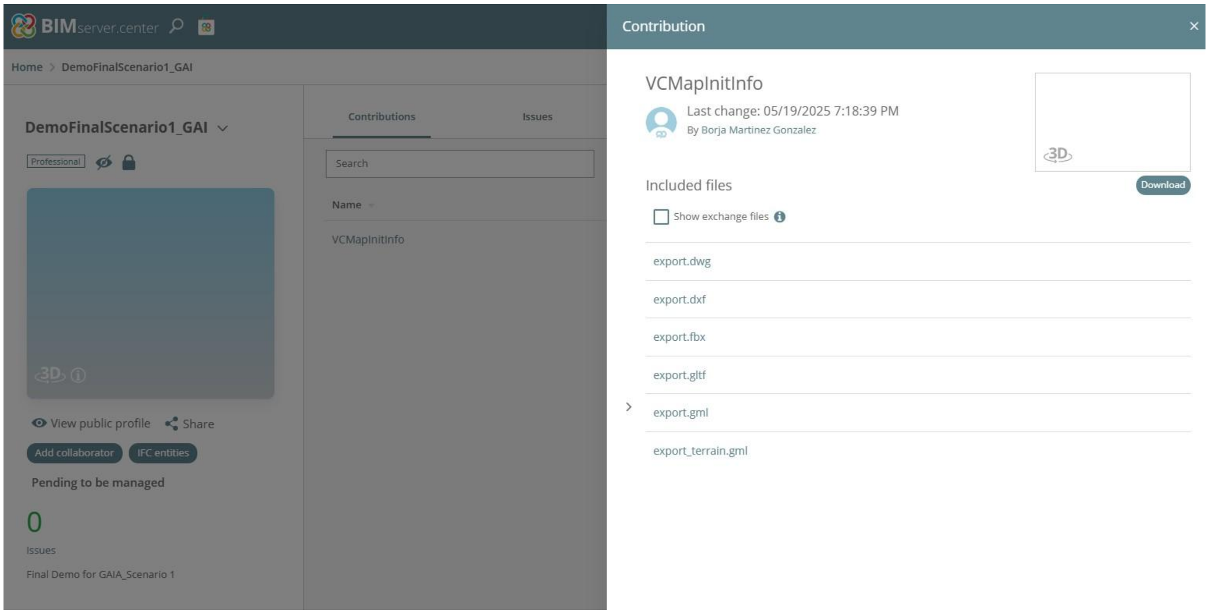



Figure 7 Automatic contribution created by VCMap in BIMServer.Center

### 3.1.2 GIS validation

In this demonstration as well as in the followings, and even in those included in D6.3, no formal GIS validation process was required on the designer's side. All GIS inputs (such as the city model, terrain, and surrounding buildings) were obtained directly from VCMap, a platform already populated with structured, georeferenced data prepared by the municipal authority or their GIS providers. Since the designer did not contribute with new geospatial datasets to be incorporated into the GIS base, no further validation steps were needed.

A true GIS validation workflow may typically apply if IFC files or other spatial inputs are created or modified and intended to be converted and integrated back into a GIS environment (e.g., IFC-to-GML conversion). In this context, GIS validation was not part of the designer's tasks and was not applicable for this step.

### 3.1.3 GIS to BIM conversion – CityGML2IFC

**Settings:**

- Download the standalone version of CityGML2IFC. Administrative rights might be needed.
- Upload outputs as a new contribution to BIMserver.center under the name "InitIFCs", for instance.

**Inputs:**

- Terrain and surrounding buildings in CityGML format (from VCMap).

**Outputs:**

- Two georeferenced IFC files: one for terrain and one for adjacent buildings.

**To Improve:**

- The CityGML2IFC conversion tool could benefit from an embedded viewer or feedback mechanism to verify the output before exporting.

**Process Description:**

Once the urban context was downloaded from VCMap in CityGML format, the next step was to transform this GIS data into BIM-compatible IFC files. This was done using the standalone desktop version of the CityGML2IFC converter developed by RDF. Two separate GML files—one representing the terrain and one containing adjacent buildings—were individually converted.

The conversion preserved both geometry and geographic positioning. The resulting IFC files were tested and confirmed to be correctly georeferenced by checking them against DWG references and through visualization in IFC viewers. These files were not modified or simplified further, as their role in the project was to serve as environmental context.

The terrain model was particularly useful for assessing elevation, while the building file helped visualize setbacks and spatial integration. Both files were uploaded to BIMserver.center as an early contribution, under the label "InitIFCs", and were used during subsequent steps including federated viewing, and project design.

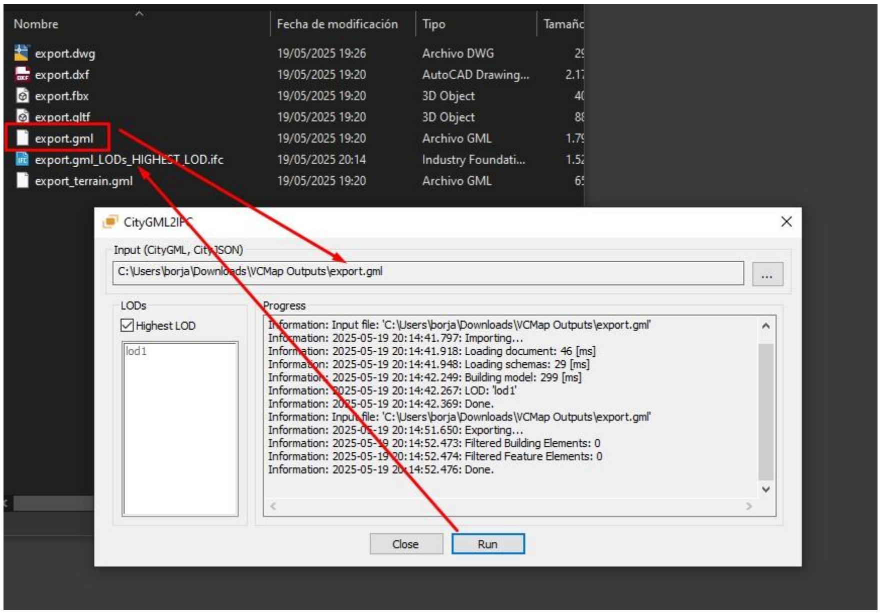



**Figure 8 Converting surroundings from a GML to an IFC file, with RDF's**

**Figure 9 Federating both terrain and surroundings with STEPViewer by RDF's**

### 3.1.4 Designing overview

**Settings:**

A project template was initiated using Autodesk Revit, initially in version 2024 and subsequently migrated to version 2025. The model was authored independently of the CHEK toolset's development timeline, allowing a stable test model to be available as soon as the tools became operable.

After developments, since Revit does not natively interpret IFC geolocation data, imported IFCs were manually positioned using known reference coordinates and snap-aided displacement methods.

Additionally, parameter structures aligned with the expected IDS profiles were progressively created and embedded during the development.

**Inputs:**

This was an exceptional situation: design began long before the live demonstration and tool readiness. No external data inputs were required during this modeling phase.

**Outputs:**

Revit model files containing structured building geometry, landscaping or non-built-up areas inside the plot, fencing and access elements, space definitions, and user-defined parameters suitable for mapping to IFC properties.

**To Improve:**

Revit lacks a native mechanism to link IFC-mapped parameters directly to design intent or to validate conformance against IDS requirements during modeling. The modeling experience would be significantly improved by native support or a plugin to load IDS schemas and track their fulfillment in real time.

**Process Description:**

The model used in this pilot case was not developed as a response to the demonstration week's timeline but was created beforehand as a stable base for testing and iterative tool development. The architectural concept simulated a realistic detached single-family home, representative of the pilot area in Vila Nova de Gaia. Although not reflecting a real architectural commission, the model included a wide variety of building elements to test checking routines and regulatory interpretation.
Since many of the tools in CHEK were still under development during the early stages of modeling, it was necessary to anticipate how features would interact with the model. This involved defining building stories with consistent naming conventions, creating clearly bounded spaces, zoning the plot into built and unbuilt areas, and assigning placeholder parameters in alignment with expected IFC exports. All modeling criteria followed a common reference guide agreed within the project.
Throughout the CHEK project, the model underwent minor revisions to improve compatibility with validation tools. Curtain walls used for roofing were removed after converter feedback indicated parsing issues. Rounded elements were substituted with orthogonal geometries to ensure correct BIM-to-GIS translation. Parameters required by future IDS files were progressively integrated as their definitions became available. The model was also designed to include

intentional non-compliances (such as undersized distances or incomplete classifications) so that the tools could be stress-tested under less-than-ideal conditions.
Despite being prepared before the demonstration itself, the model successfully served as a flexible and sufficiently robust foundation for the full CHEK workflow.

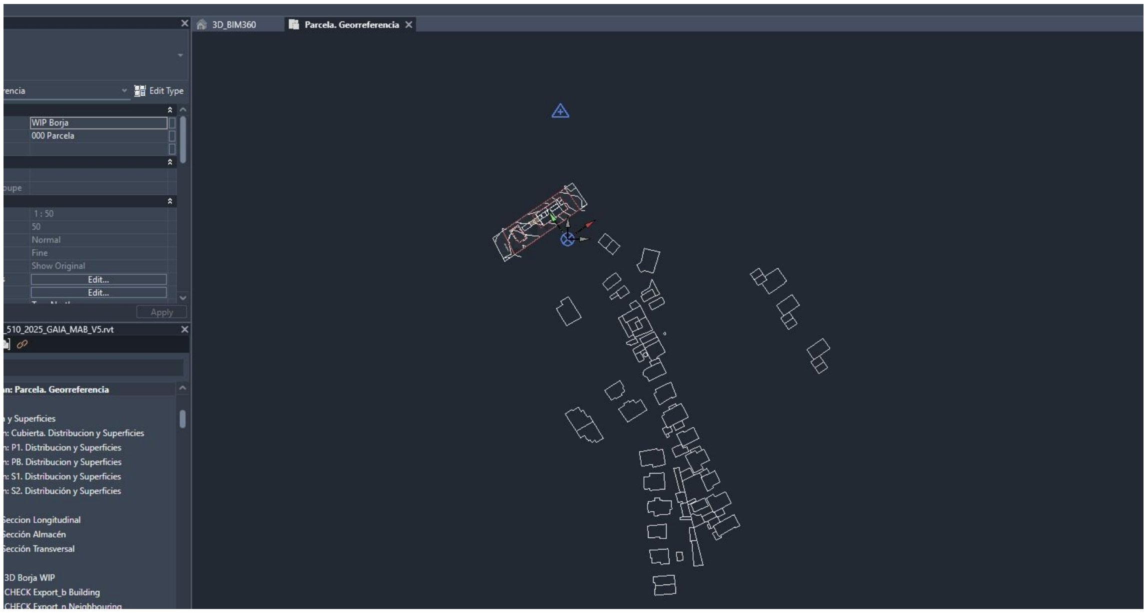


Figure 10 Importing Surroundings IFC. Georreference is lost in Revit import

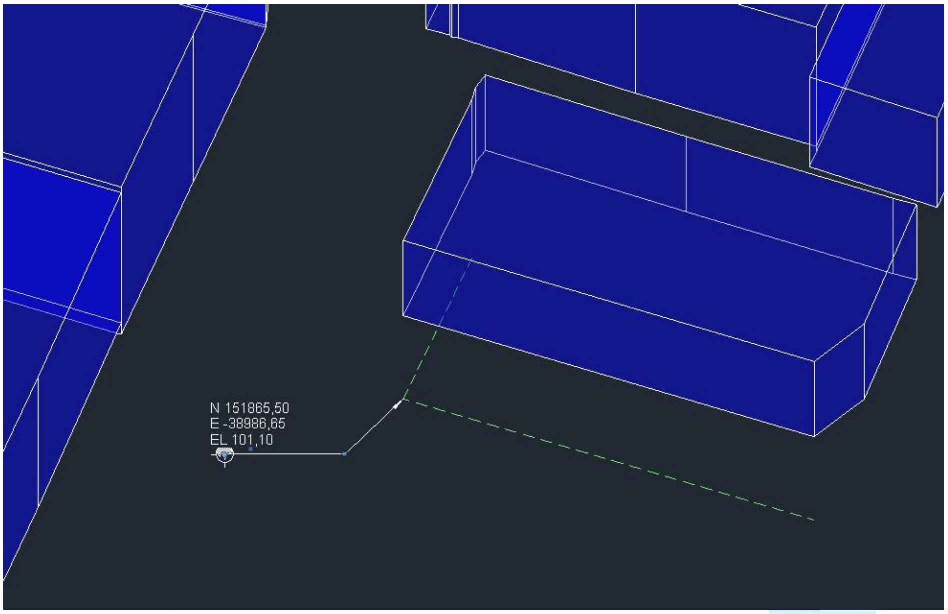


Figure 11 Reading coordinates of the imported IFC file to later move to its position.

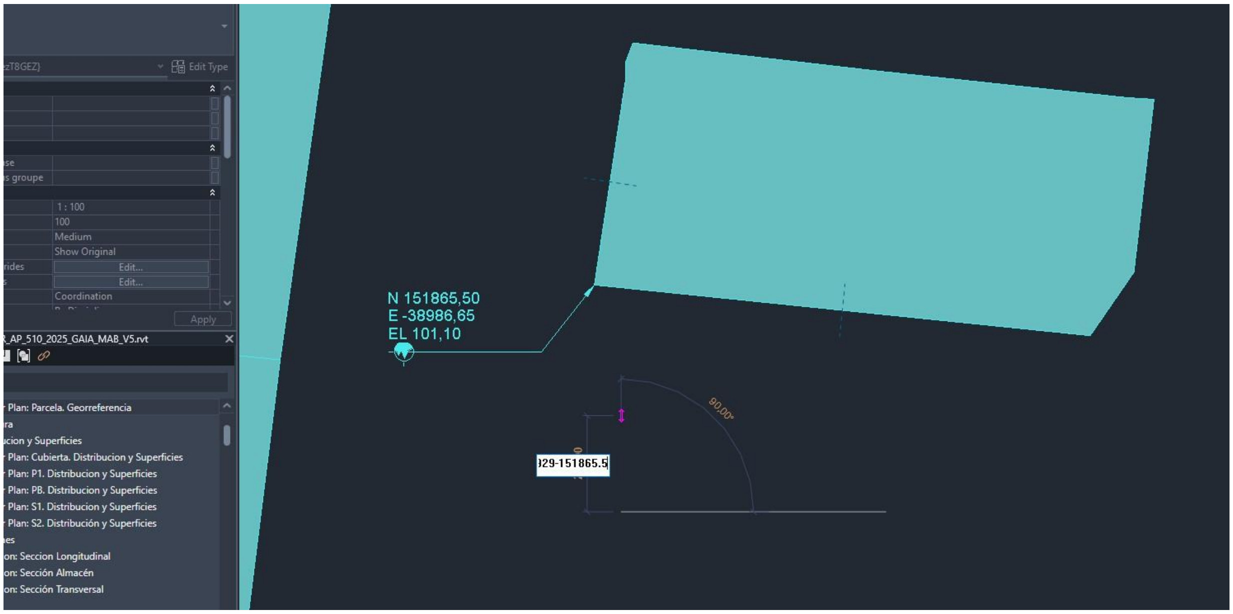



Figure 12 Displacing the IFC file by subtraction of coordinates

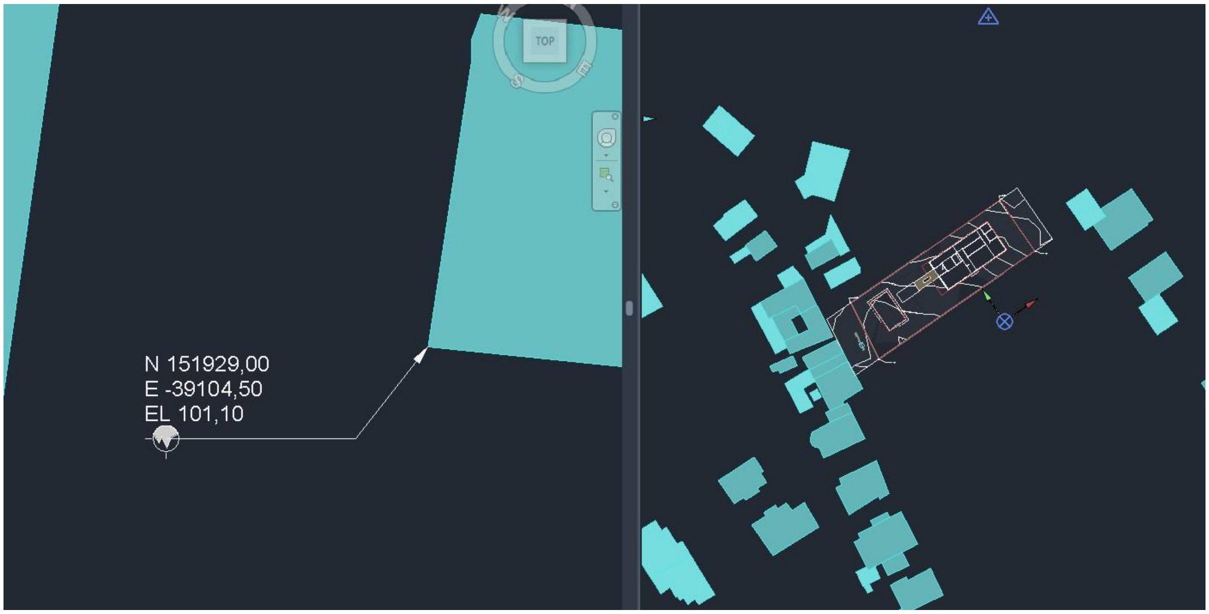



Figure 13 Result after moving Surroundings IFC to its place

### 3.1.5 Exporting the model – DiRoots Plugin

**Settings:**
The original plan for IFC export was to use the CHEK Exporter plugin developed by DiRoots (version 1.0.7), which was specifically designed to streamline the mapping of project parameters to the IFC schema based on the IDS specifications. This exporter provides a user interface to associate Revit parameters with the required properties, allowing the designer to pre-validate the information embedded in the model.
However, during the demonstration, technical issues arose that prevented the plugin from completing the export. Although all configurations (such as loading the correct mapping profile and assigning parameters) were successfully executed, the export function failed to trigger any result and provided feedback was sent to developers while continued the demo with a workaround. Versions 1.0.5 and 1.0.4 of the plugin were also tested, but the issue persisted. Later feedback from the developer pointed out that the problem was related to a conflict with another Revit plugin present in the environment. To avoid delays in the demo timeline, a valid alternative was implemented: using Revit's native IFC export tool, supported by custom configuration files (UserDefinedPropertySets.txt and ExportLayers-IFC.txt) to ensure correct parameter inclusion and classification.

**Inputs:**
The final Revit project file, structured into three distinct but complementary models to be federated (building, terrain, undeveloped plot), with geometry, spatial elements, and custom parameters aligned with CHEK and IDS requirements.

**Outputs:**

- Building IFC: including full geometry and mapped parameters.
- Undeveloped area IFC: representing the non-built portion of the plot.
- Terrain IFC: containing topographic geometry, made visible by associating the object to a defined level and properly categorized.

Each IFC was later uploaded as a separate contribution to BIMserver.center under the label "Project Version 1 – Just [CONTENT]," facilitating later cross-checking and validation steps.

**To Improve:**
While the DiRoots CHEK Exporter is a powerful tool tailored for the CHEK workflow, its behavior proved sensitive to updates and Revit configurations. Prior to the demonstration phase, the exporter had been successfully tested in controlled conditions, confirming its ability to generate compliant IFC files. However, shortly before the Gaia demo, updates to either Revit or the plugin introduced a temporary incompatibility that led to export failures.
Rather than interrupt the demonstration schedule, the team opted for a fallback strategy using Revit's native IFC exporter combined with a customized user-defined parameters file. This approach ensured that essential data—such as parking spaces, site boundaries, and regulatory parameters—were properly exported and retained.

**Process Description:**
The export process required the model to be separated into several functional components: the main building, the undeveloped part of the parcel, and the terrain. These components were modeled and adjusted according to feedback from earlier validation steps and mapped using Revit's internal category system and export configuration files.
When the DiRoots exporter failed to produce the expected IFC output, a fallback was implemented using Revit's standard exporter. For this, it was essential to verify that categories and custom parameters were correctly mapped, ensuring that key elements such as parking spaces and site boundaries were retained. The terrain model, which initially appeared empty in viewers, was successfully fixed by assigning the topography to a project level and categorizing it as IfcGeographicElement.

Despite the fallback approach, the export process yielded valid and compliant IFC files. These were immediately usable within the CHEK ecosystem and were subjected to validation in both VCMap and CYPEURBAN.
In later pilots, a patched version of the DiRoots exporter did work as intended, and its successful implementation is further documented in other demos. In this case, however, the Revit-native export proved to be a reliable and effective alternative.

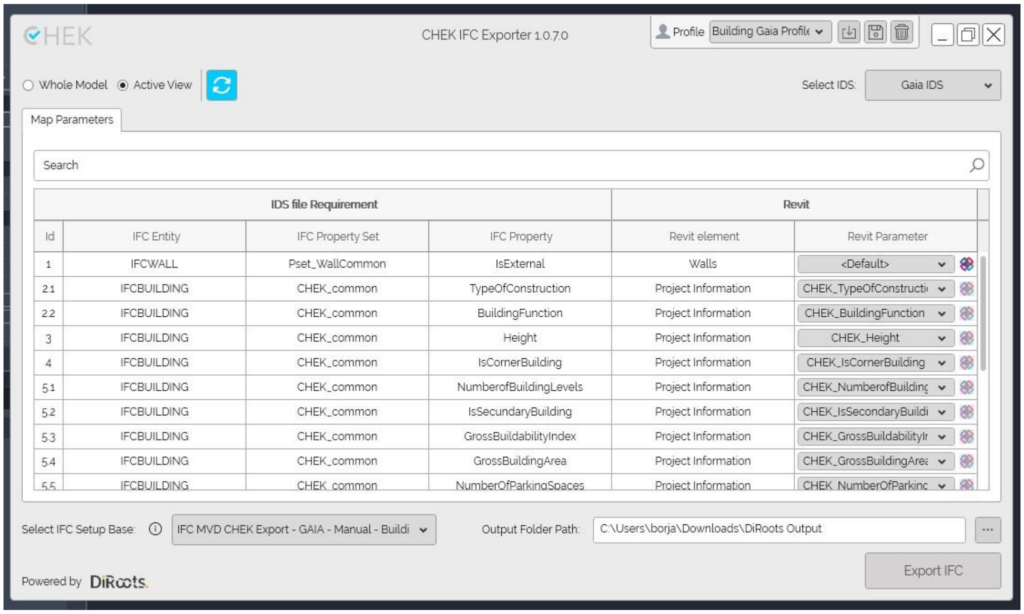



Figure 14 DiRoots Plugin set up ready to export the project

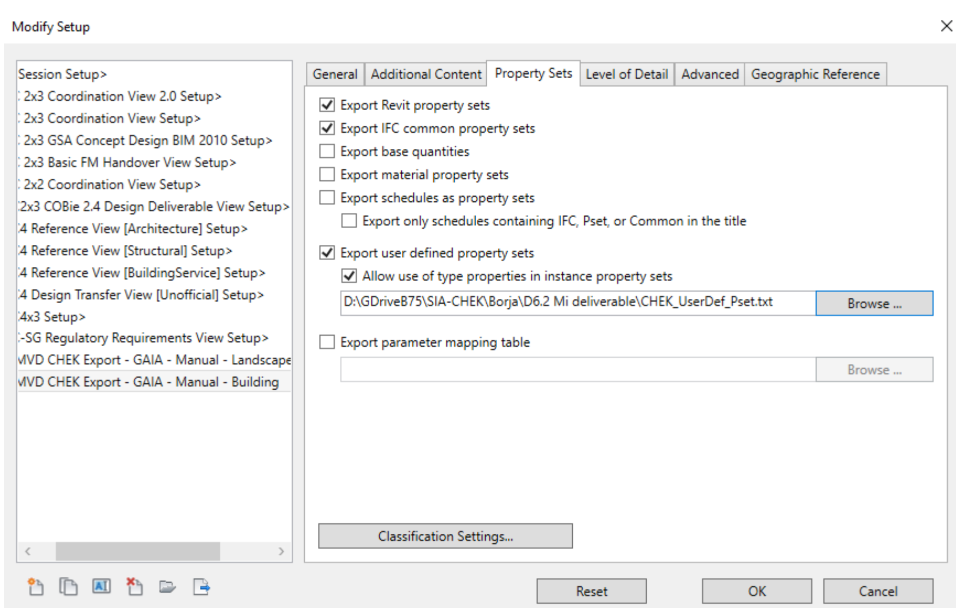



Figure 15 Export settings while using native exporting tools

```
*CHEK_UserDef_Pset.txt: Bloc de notas
Archivo  Edición  Formato  Ver  Ayuda
#
# User Defined PropertySet Definition File
#
# Format:
#     PropertySet:       <Pset Name>     I[nstance]/T[ype]       <element list separated by ','>
#        <Property Name 1>       <Data type>     <[opt] Revit parameter name, if different from IFC>
#        <Property Name 2>       <Data type>     <[opt] Revit parameter name, if different from IFC>
#        ...

PropertySet:     CHEK_common     I       IfcSite, IfcBuildingStorey, IfcSpace, IfcWindow, IfcDoor, IfcBuilding,  fcRoof
        CHEK_IsGroundLevel      Yes/No  CHEK_IsGroundLevel
        CHEK_IsMainEntrance     Yes/No  CHEK_IsMainEntrance
        CHEK_PlotArea   Area    CHEK_PlotArea
        CHEK_Room/sBounding_ID  Text    CHEK_Room/sBounding_ID
        CHEK_RoomUsage  Text    CHEK_RoomUsage
        CHEK_TotalNumberOfPupils        Integer CHEK_TotalNumberOfPupils
        CHEK_TypeOfConstruction Text    CHEK_TypeOfConstruction
        CHEK_RegulatedBuildingHeight    Length  CHEK_RegulatedBuildingHeight
        CHEK_ReducedSpaceArea   Area    CHEK_ReducedSpaceArea
        CHEK_SpaceType  Text    CHEK_SpaceType
        CHEK_RoofType   Text    CHEK_RoofType
        TypeOfConstruction      Text    TypeOfConstruction
        RegulatedBuildingHeight Length  RegulatedBuildingHeight
        ReducedSpaceArea        Area    ReducedSpaceArea
```

**Figure 16 User defined property set definition file used**

### 3.1.6 Georeference assessment – IfcGref/VCMap

**Initial Settings:**
To validate the georeferencing accuracy of the exported model, several tools were used: BIMVision (to inspect coordinates and federate IFCs to check relative positioning), the standalone RDF viewer (also to federate IFCs and check relative positioning), the IfcGref tool by TU Delft for geolocation verification, and the VCMap visualization engine.

**Inputs:**
The IFC files exported from Revit, corresponding to the building, the undeveloped plot, and the topography.

**Outputs:**
Confirmation of the correct placement of the model using IfcGref and VCMap.

**To Improve:**
Revit does not fully support reading or writing IFC georeferencing information, as it ignores key fields such as IfcMapConversion or IfcSite.RefLatitude/Longitude. Integration tools that allow automatic alignment of the model with GIS coordinates would be highly beneficial.

**Process Description:**
Once the project was exported to IFC, several checks were carried out to validate its correct placement. The building IFC was uploaded into VCMap and converted into a "Visualization Model", confirming that the model was correctly positioned on the city map. Additionally, the IfcGref tool was used by dragging the IFC file into its web interface. This validation confirmed that the geolocation metadata was present and properly formatted. After displaying the building in its context, it was verified that both the building and the files containing the initial information from previous steps were correctly placed.

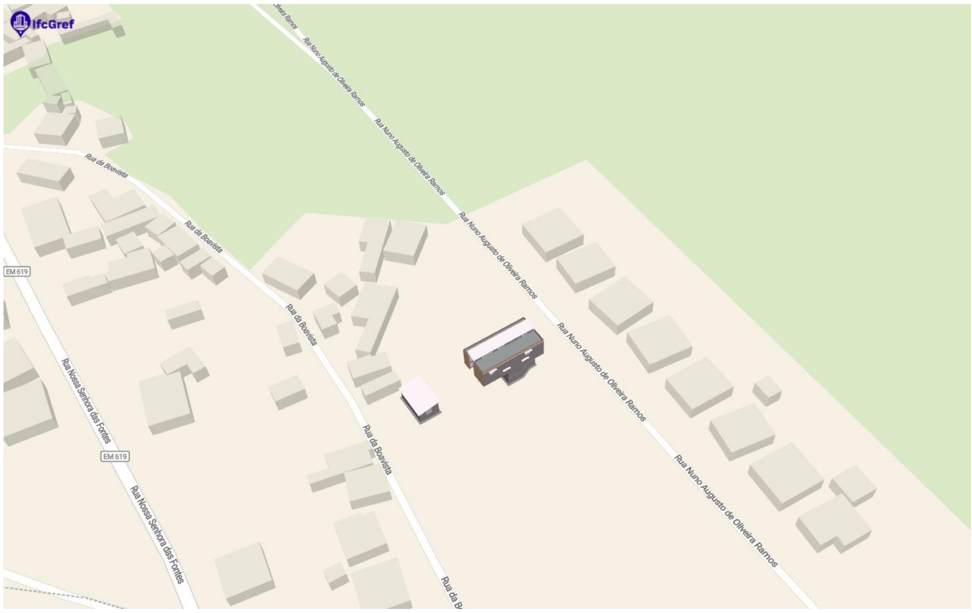



Figure 17 IfcGref geolocation assessment

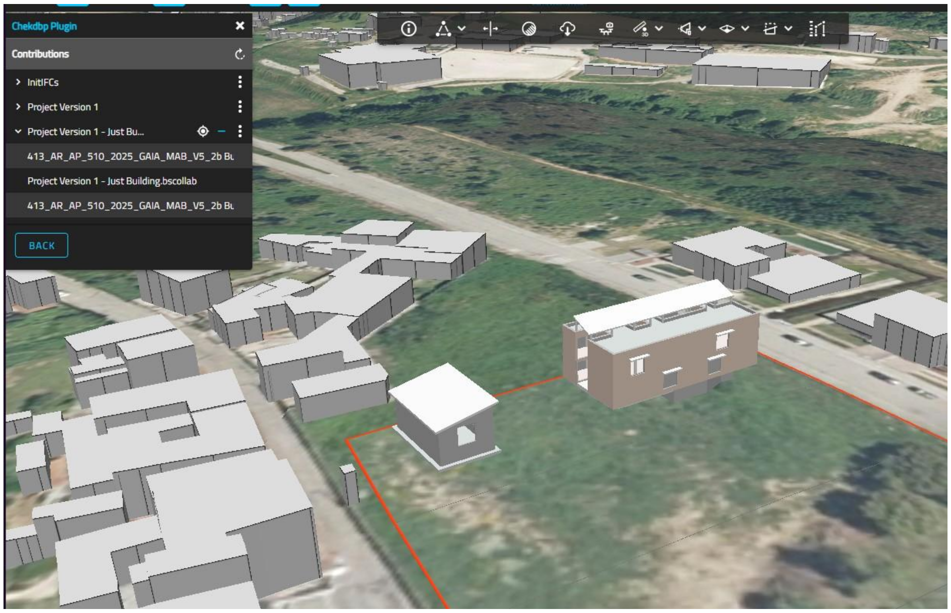



Figure 18 VCMap geolocation assessment

### 3.1.7 IFC validation – RDF's IfcViewer

**Settings:**

The tools used during this demo to perform validation checks on the generated IFC files were:

- EXPRESS validation, integrated in the RDF viewer, which verifies the structural integrity of the IFC file against the IFC schema (e.g., entity types, attribute consistency, data types).
- IDS Checker, also available in the RDF viewer, which checks for the presence, structure, and format of specific properties and objects defined in an Information Delivery Specification (IDS).

Both tools are designed to verify the structural and informational completeness of IFC files. However, their usefulness in the designer's workflow is limited—especially the first one.

**Inputs:**

The IFC file corresponding to the main building, generated in Revit after manually entering the parameters required by the IDS implemented in the DiRoots exporter.

**Outputs:**

- RDF EXPRESS Validation Report: While not directly actionable for most designers, this report helps ensure that the exported IFC is structurally compliant with the chosen schema (e.g., IFC4). It can be particularly useful for BIM managers or QA/QC roles to catch malformed entities or attribute errors before submission.
- IDS Checker Report: The tool flagged multiple missing parameters required by the municipality's IDS. Although most errors were related to absent data, the report clearly identified which parameters were missing, enabling targeted corrections. This made the IDS Checker a useful guide to align the model with regulatory data expectations.
-

**To Improve:**

- The EXPRESS validation could benefit from a clearer visual interface or summary targeted at designers—for example, flagging only critical issues or mapping them to relevant model elements.
- The IDS Checker could be improved by grouping issues by object type or property set, and offering links to documentation or example values. Still, its current output already provides clear guidance on missing data, which proved helpful during iterative model corrections.
- Export logs or dry-run previews during IFC generation (especially for DiRoots Exporter) would help detect missing parameters earlier in the process, reducing the need for post-export corrections.

**Process Description:**

IFC validation was approached from two perspectives. First, the EXPRESS validation tool in the RDF viewer was used to analyze the structural consistency of the file. While not optimized for complex production models, this tool can be particularly effective when used in development environments with smaller test files. It allows for precise inspection of export logic and schema compliance—an asset in contexts such as protocol standardization or plugin testing. In the case of full-scale project models, however, the process can become time-consuming and the output difficult to interpret for non-specialist users, reinforcing its value primarily for BIM software developers and technical QA workflows.

Second, the IDS Checker tool was used to verify the presence of required parameters. To run this check, it was necessary to request and download the specific IDS for the municipality of Gaia from the shared working environment. When applied to the signed IFC file, the report listed numerous missing parameters. Despite these, it was confirmed that the model successfully passed all urban compliance checks in CYPEURBAN and VCMap. This suggests that, at least in this case, the absence of some parameters did not prevent compliance with the implemented rules (which were fewer than those required by the IDS).

In conclusion, although the IDS check was not critical for this specific demo, it holds great potential, particularly if more extensive parameter requirements are enforced in the future. The ability to automatically load and validate those requirements through an IDS would significantly reduce effort and ensure documentation quality from the early stages of design.

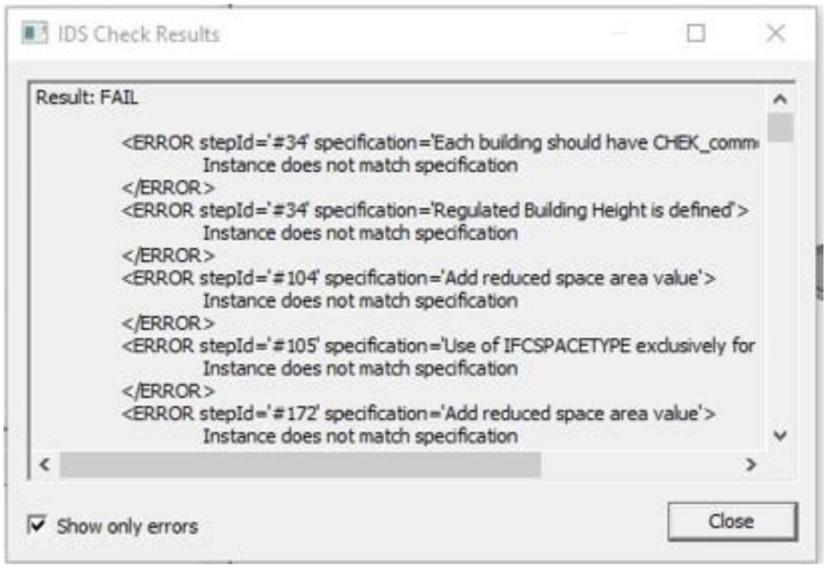



**Figure 19 RDF IDS Checker results**

### 3.1.8 Uploading the model to the CHEK platform

**Settings:**

The model was uploaded to the CHEK platform, understood as the Common Data Environment (CDE) implemented by CYPE and named BIMserver.center, which has served as the collaborative environment throughout the project. Although the upload process posed no complications and had already been performed earlier in this demonstration, it is briefly described here for completeness.

The upload was done manually through the BIMserver.center web portal. To facilitate later file management and federation processes, it was decided to create a separate contribution for each IFC file, rather than grouping them all together. The latter option, in fact, prevented the generation of a Visualization Model in VCMap, which clearly justified the chosen approach.

**Inputs:**

IFC files generated during the export phase:

- IFC of the building
- IFC of the undeveloped plot
- IFC of the topography
- IFC of the neighboring buildings

**Outputs:**

Four separate contributions in the project "DemoFinalScenario1_GAI" in BIMserver.center, each containing its corresponding IFC file:

- Project version 1 – Just Building
- Project version 1 – Just Landscaping
- Project version 1 – Just Topography
- Project version 1 – Just Neighboring

**To Improve:**

A more structured version control system would be useful, allowing contributions to be sorted both chronologically (currently the upload date is visible) and by content type. At present, all contributions appear mixed together, forcing users to rely on memory or manual criteria to identify each file's purpose.

It would also be beneficial to include functionality for sharing specific contributions with other stakeholders, such as municipalities. This would allow, for example, a designer-side contribution to be duplicated into a validator account, making it easier to share initial IFCs or the signed model. In this demo, due to the absence of such functionality within the CDE, files were shared externally and outside the official workflow.

**Process Description:**

Once the IFC files were generated and validated in terms of structure and georeferencing, they were uploaded to the previously created project in BIMserver.center, which had been tagged with the municipality's name (GAIA) to ensure proper indexing and subsequent visibility in tools like VCMap.

The files were uploaded as four separate contributions, one per IFC, to maintain a clear organization of the model components and to facilitate federation and processing within validation environments.

This approach also proved helpful for enabling individual digital signing of each file, their federation in different tools (such as CYPEURBAN or VCMap), and their reuse by municipal technicians for specific tasks (e.g., graphical validations or assessing building heights and areas).

Once uploaded, the models became available within the CHEK ecosystem and served as the foundation for the urban compliance checking process on the designer side, commonly referred to as pre-validation.

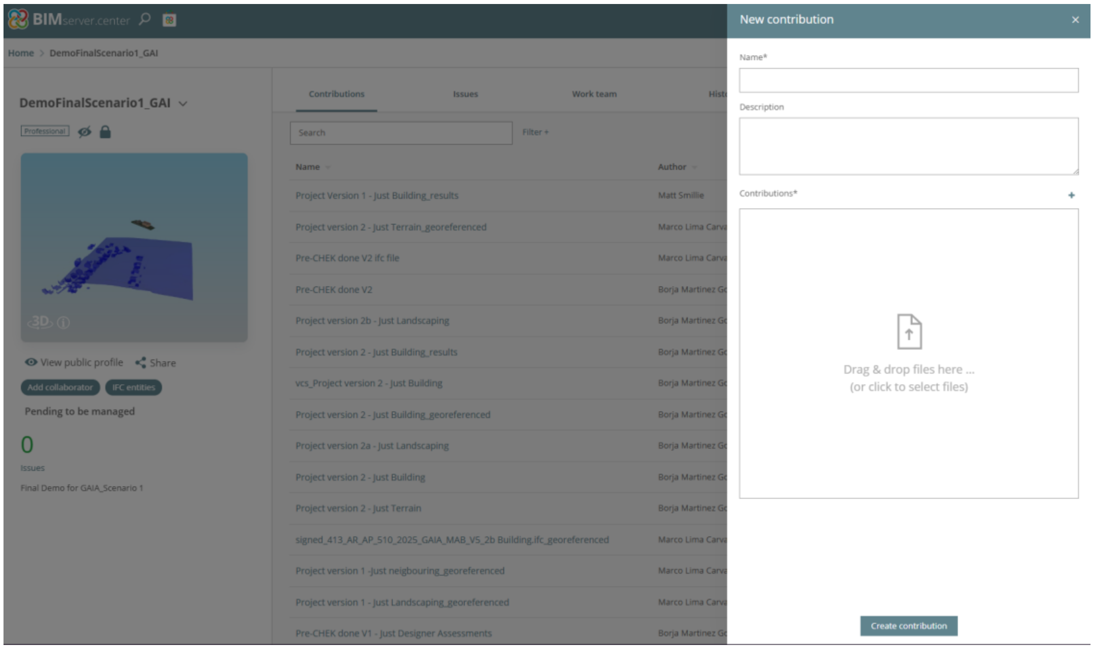



Figure 20 Performing a new contribution in the BIMServer.center site

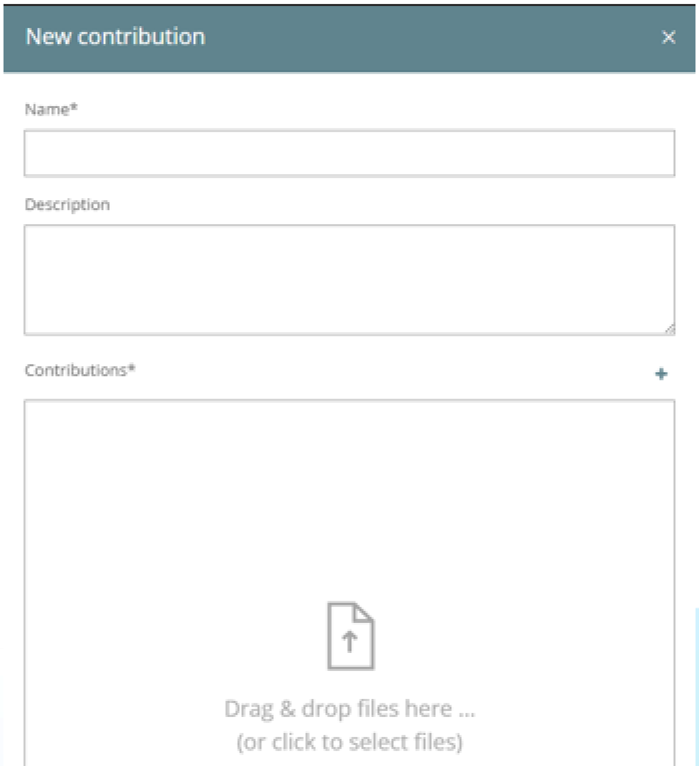



Figure 21 Performing a new contribution in the BIMServer.center site. Zoom to the form fields

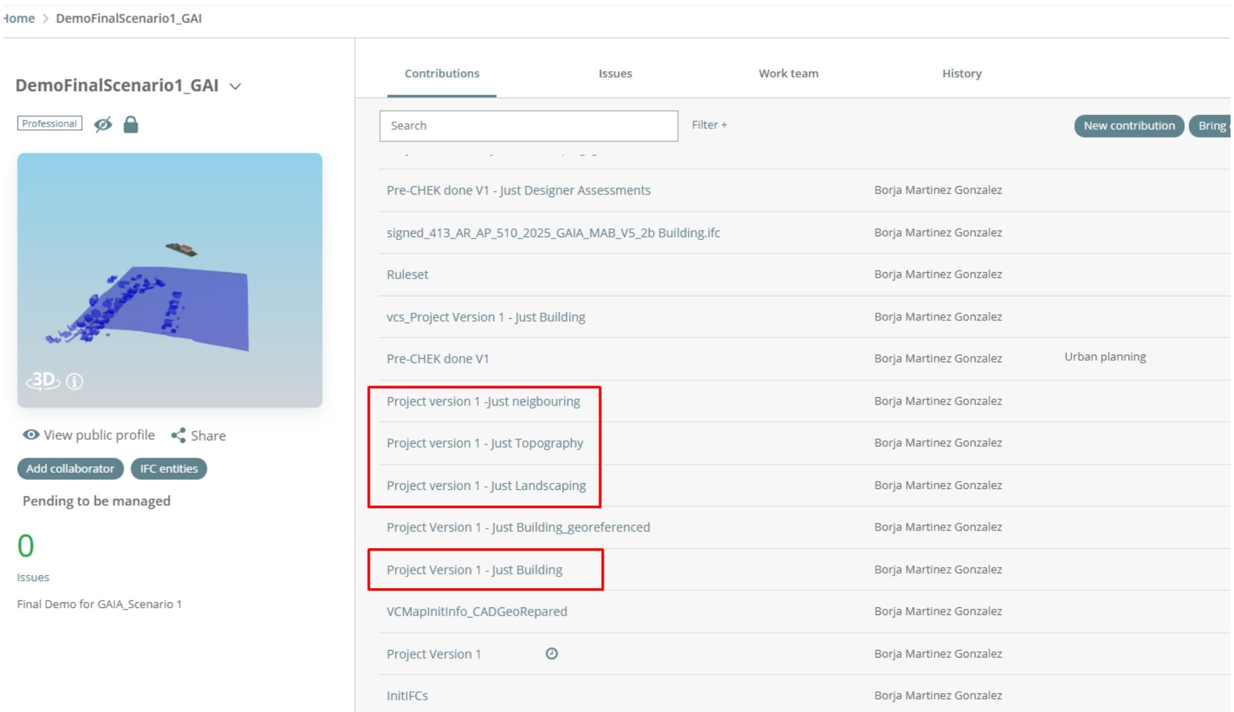


**Figure 22 Created contributions with the exported project (Version 1)**

### 3.1.9 CHEK pre-validation and reporting – CYPEURBAN

**Settings:**

After uploading the IFC files to the corresponding project in BIMserver.center, the pre-validation process of the model begins from the designer's side using the CYPEURBAN tool.

This process does not require advanced configurations, as the software works properly with its default settings. Therefore, specific installation instructions and initial setup are not detailed here, as they are documented in the technical guide titled "02 CYPEURBAN."

**Inputs:**

IFC project files already available in the CDE and accessed directly by CYPEURBAN:

- Building
- Undeveloped plot
- Topography (if used for geometric validations)
- Surroundings (although in this case, they were not required for any implemented regulation)

**Outputs:**

- Urban compliance report in PDF format
- IFC file generated by CYPEURBAN, containing auxiliary geometric elements used for validation
- GLTF file (visualization)
- A new contribution in BIMserver.center accessible both to the municipal role (Validation account) and in the designer profile.

**To Improve:**

The current federation system and visualization tools available to municipal validators present significant limitations. Although CYPEURBAN produces a full validation package—including a PDF report, a JSON summary visible on BIMserver.center, and an auxiliary IFC containing the graphical elements used during rule checks—these outputs are not fully interoperable on the validation side. CYPEURBAN does not currently allow loading or federating this auxiliary IFC from the municipality profile. When using alternative viewers (such as RDF's IfcViewer), federation is technically possible, but the association between validation geometries and their corresponding planning regulations is neither explicit nor intuitive, as the original semantic links from the designer's environment are lost.

As a workaround, validators must rely on static documents like the PDF or JSON report to interpret results, effectively stepping outside the CHEK ecosystem to understand and verify rule compliance. This gap hinders interactive validation and places a greater cognitive load on municipal staff.

Moreover, loading multiple IFC files into BIMserver.center requires them to be uploaded as separate contributions. If all files are grouped under a single contribution, federation fails to work correctly, and tools like CYPEURBAN are unable to selectively process the necessary elements. Therefore, to ensure functional federation and modular visualization, individual upload per file remains necessary.

**Process Description:**

Once CYPEURBAN is launched and the relevant IFC files are linked to the project, the user gains access to a graphical interface that displays the different layers of the model, allowing visual validation of urban regulations implemented in the software, depending on the municipality selected.

The validation process is organized under the "Checks" tab, which displays a list of all applicable urban regulations. Each regulation is marked with a symbol indicating its status:

- Red question mark: requires manual assessment by the designer, usually through graphical tools

- Green dash: regulation does not require assessment or has not yet been implemented
- Green checkmark: regulation evaluated and passed

For example, for the regulation "Minimum Plot Area," the process would be:

- The perimeter of the plot is graphically defined using the “Plot” tool
- If the drawn area does not meet the minimum configured threshold, a red X appears
- Clicking on the regulation opens a detailed result window
- If appropriate, the threshold can be modified and justified via the “Settings” tool
- Once the threshold is adjusted and justified, if the requirement is met, the boundary turns green and is marked with a green tick

This process is repeated for every regulation marked with a red question mark. Some checks require measurement of distances to plot boundaries, built areas, or building heights from terrain. The designer can update the model in Revit as needed, re-export it, and repeat the process until full compliance is achieved.
Once all checks are marked as validated, the model is considered to have passed the pre-validation phase. This iterative process ensures that the design complies with urban planning requirements before being officially submitted to the municipal authorities.
Once all regulations have been validated, the model is submitted using the “Share” button located in the upper-right corner of the interface.

Submission Steps:

- Click on “Share”: A window opens prompting the user to name the report and optionally add a brief description.
- Confirm the Submission: After filling in the required information, the report is automatically generated and exported.
- Confirmation and Contribution Creation: Once the export is complete, the system notifies the user and creates a new contribution in BIMserver.center, which includes:
    - The IFC file containing the validation geometry
    - A GLTF visualization file
    - A PDF report summarizing the results of all validation checks

This package becomes accessible to the validation role within the project. From this point, the municipality may review, assess, and, if necessary, issue a resolution or request for changes.

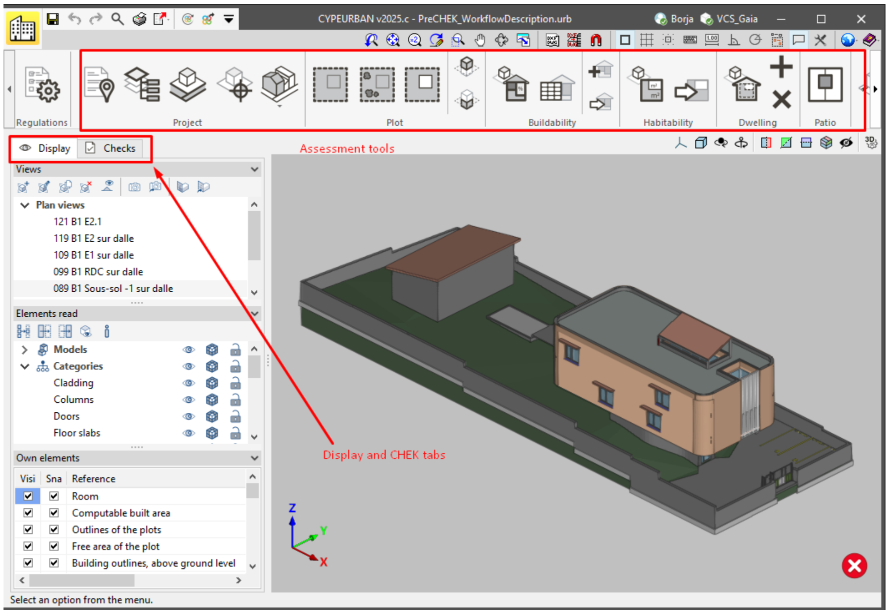



Figure 23 Display tab, shows available tools for visualization settings

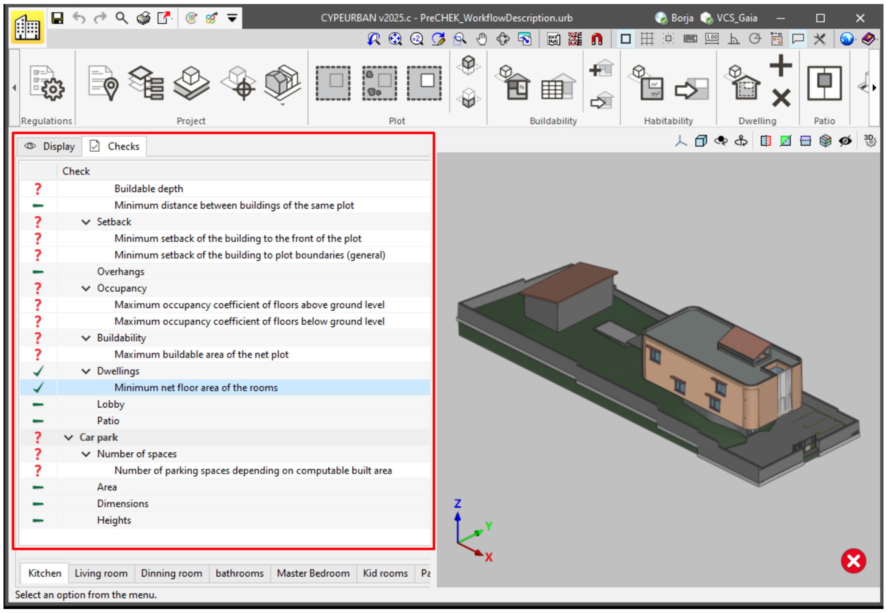



Figure 24 Checks tab, shows the list of regulations and status

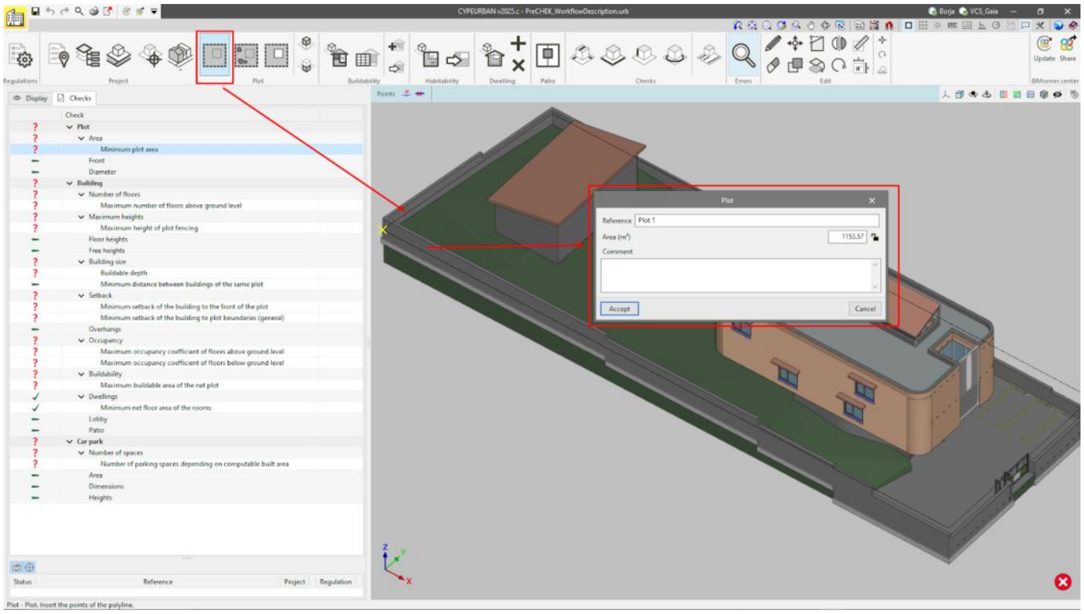


Figure 25 Tool to create the plot area for later automatic assessments

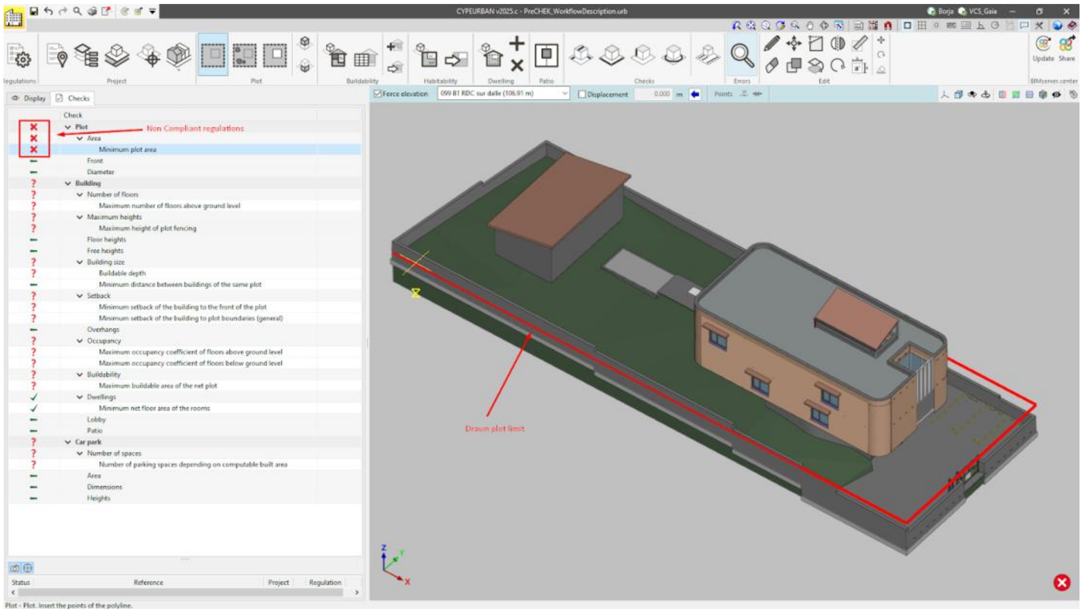



Figure 26 Red line created to assess minimum plot area, which does not comply

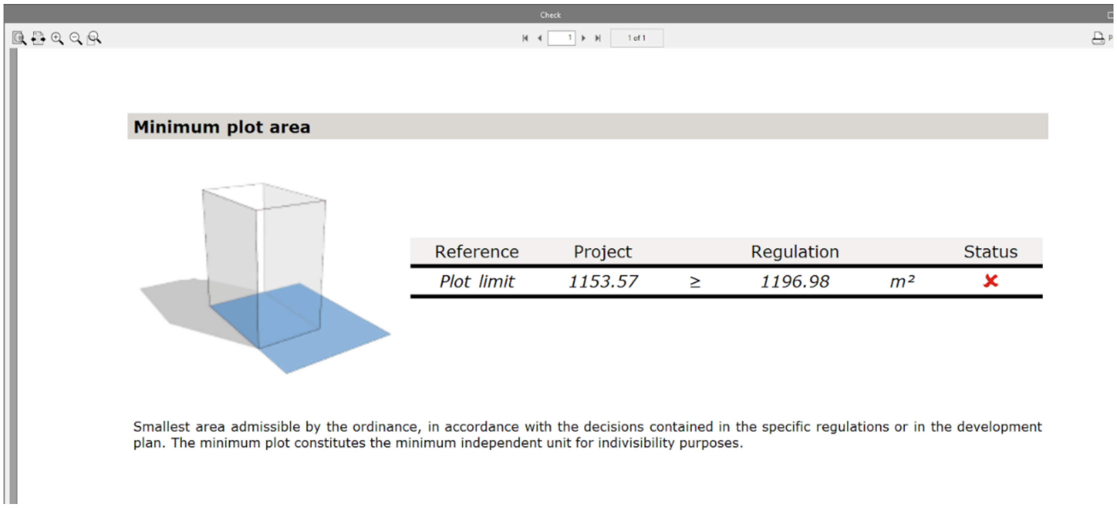



Figure 27 Showing details of incompliance to plan a solution

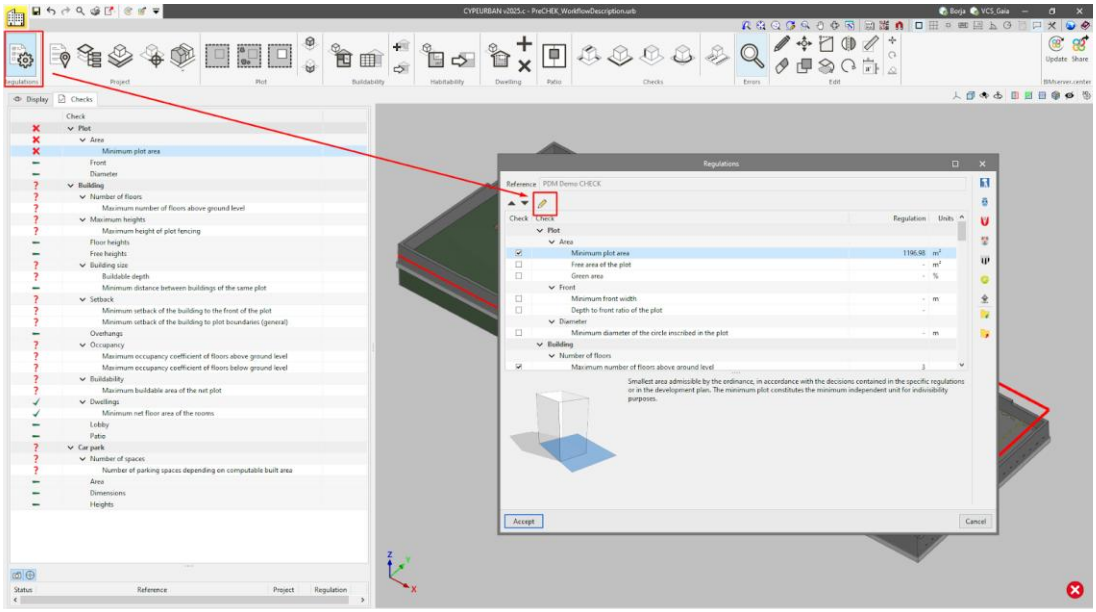


Figure 28 Procedure to edit threshold to “make the project comply”

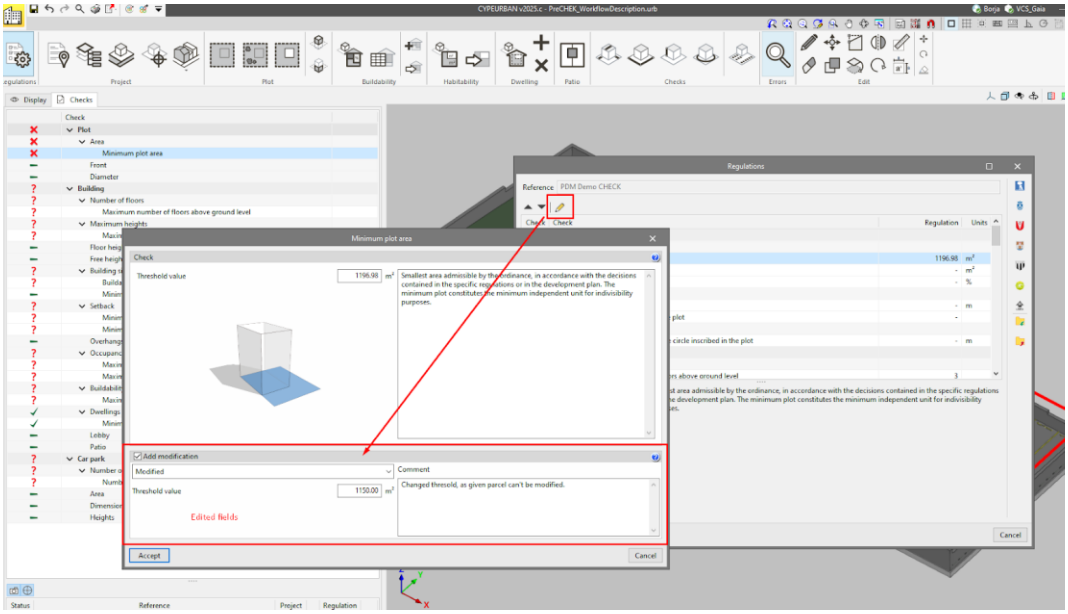


Figure 29 Editing the threshold to then negotiate with municipality

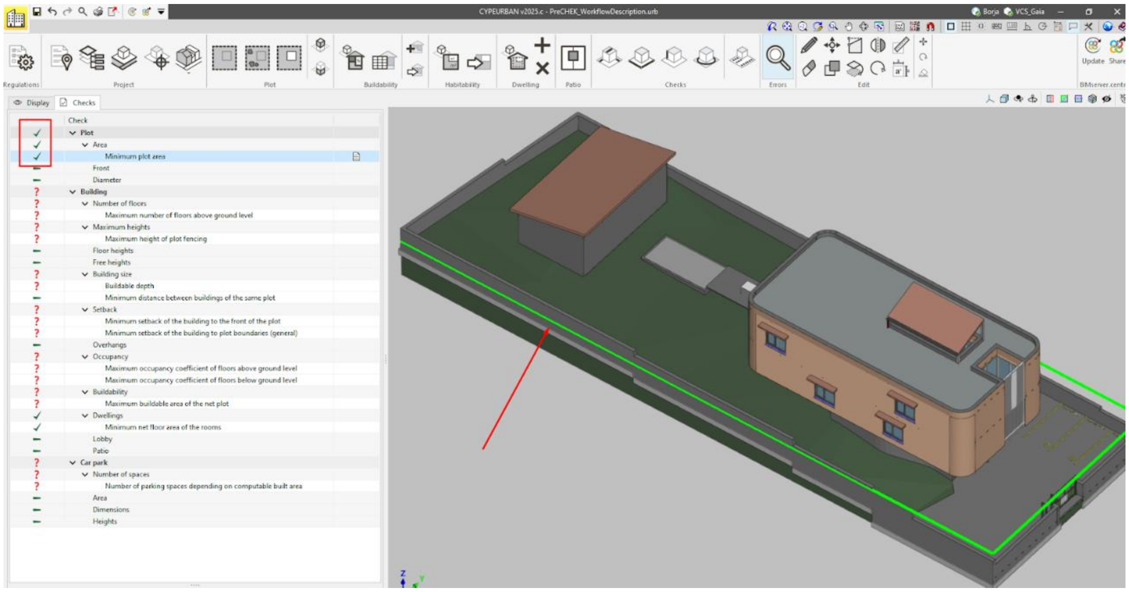


Figure 30 Result of assessment after editing the rule threshold

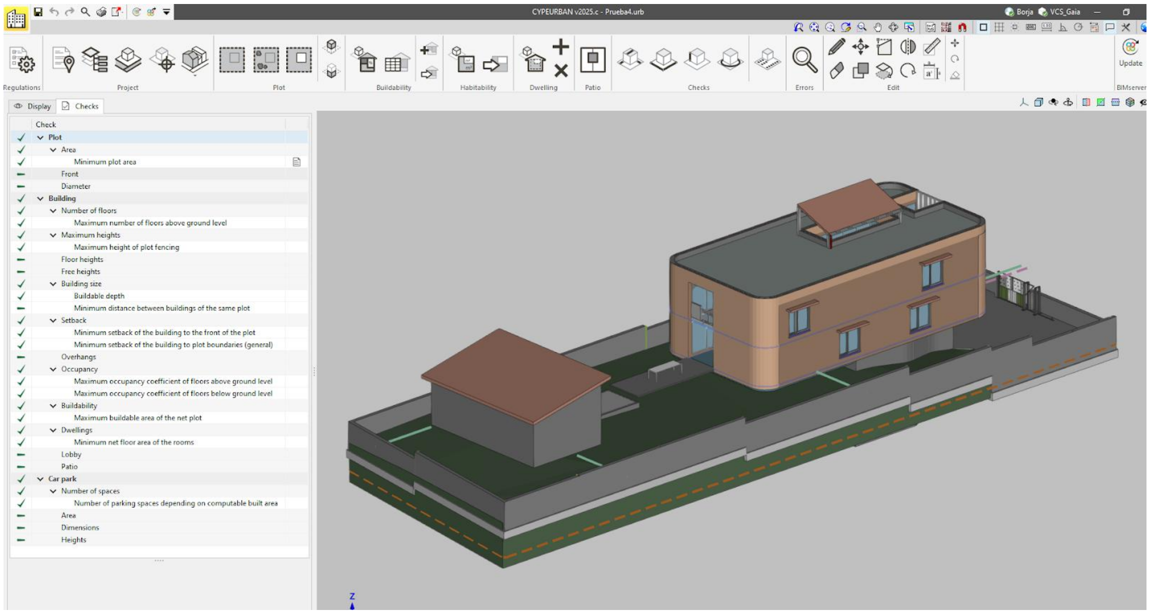



**Figure 31 Aspect of the check list after reviewing all requested regulations**

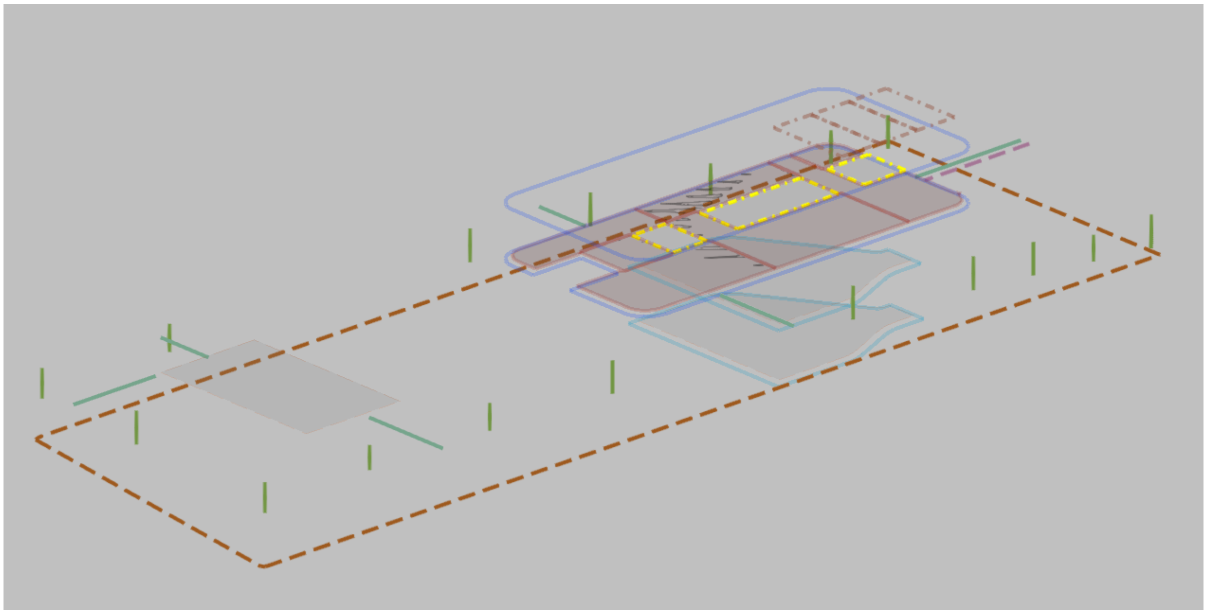


**Figure 32 Auxiliary elements, user created to let CYPEURBAN assess the project**

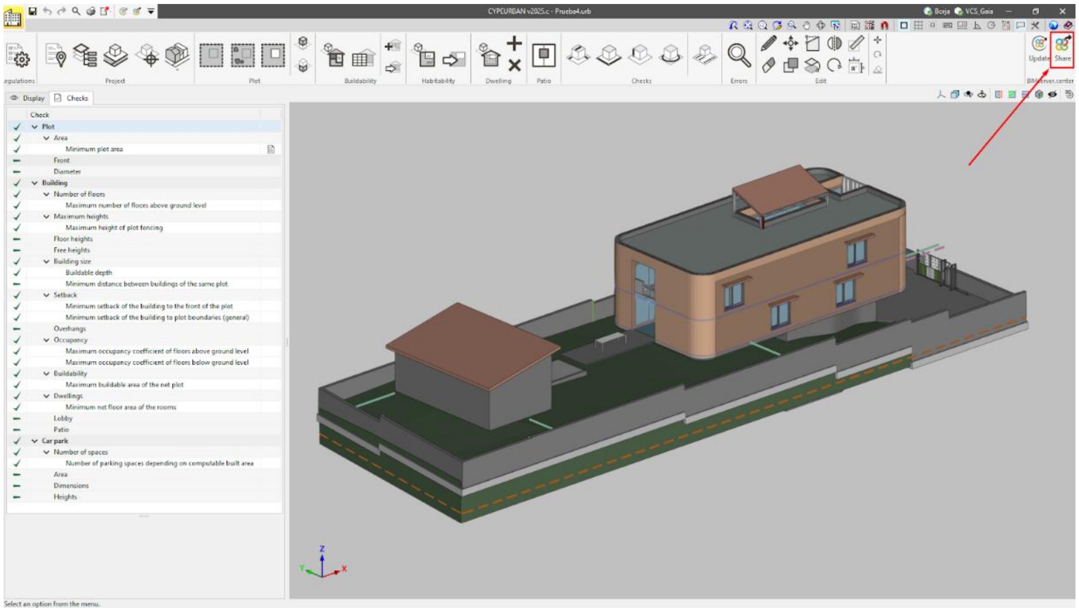


Figure 33 Sharing the results with the validation account

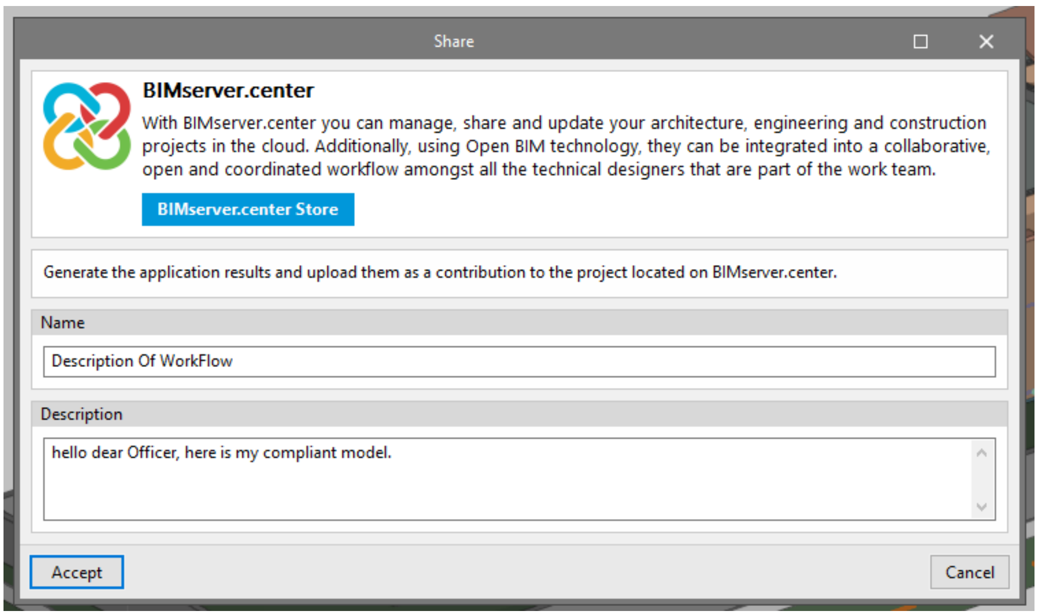



Figure 34 Naming the results and adding comments for clarity

### 3.1.10 CHEK pre-validation and reporting – VCMap

**Settings:**
Pre-validation with VCMap is carried out from the designer's environment, after uploading the building IFC as a standalone contribution to the BIMserver.center project, properly tagged as "GAIA" to ensure visibility in VCMap.
Unlike CYPEURBAN, VCMap does not require linking multiple files, as the platform already integrates all contextual information (terrain, neighboring buildings, urban regulations) from preloaded GIS databases. This simplifies the process and focuses validation solely on the designed building's BIM model.

**Inputs:**

- Building IFC (uploaded as a standalone contribution to the BIMserver.center project)

**Outputs:**

- Conversion to Visualization Model and Semantic Model
- Pre-check results provided as a JSON file
- Automatic creation of a new BIMserver.center contribution with the validation result, visible to both the designer and the validator accounts
- Graphical validation feedback displayed over the model for visual verification

**To Improve:**
A conversion error during the Semantic Model process (with no visible error message) was resolved after the development team increased the timeout setting. For complex models, either significantly longer timeouts or more powerful backend resources are required to ensure smooth processing.

**Process Description:**
After uploading the building IFC to BIMserver.center, the designer logs into VCMap using their CHEK corporate account. The project "DemoFinalScenario1_GAI" is selected from the project menu, and the available contributions are displayed.
The first step is to convert the building contribution into a Visualization Model, enabling its 3D display in VCMap. Once proper georeferencing is visually confirmed (by overlaying the model on the urban base map) the conversion to Semantic Model is initiated. This step is essential to activate automatic validation against the municipality's regulations.
After the Semantic Model is generated, a JSON file containing urban rules must be uploaded. This file, called a Ruleset, is provided by Virtual City Systems (VCS) and includes the coded regulations specific to GAIA.
With the Semantic Model and the Ruleset in place, validation is executed. In this demo, a setback regulation was flagged as non-compliant: VCMap measured the distance from the edge of the foundation slab instead of the façade, resulting in a distance of 2.75 m instead of the required 3 m. Although this was considered acceptable by the designer, the non-compliance was recorded as part of the test procedure.
After validation, a new contribution is automatically generated in BIMserver.center named Project version 1 – Just Building_results, containing the validation JSON file. While the file must be downloaded for inspection by the designer, reviewing the validation directly within the VCMap interface is far more convenient. On the validation side, the JSON can be displayed in a web-based table format, but this is not available on the designer side.
In summary, VCMap provides a more streamlined pre-validation process, as the urban model is already preconfigured. The designer only needs to upload the building IFC and follow the validation steps. The validation was successful, and the model was deemed ready for signing and submission to the municipality.


Figure 35 Converting the project into visualization model

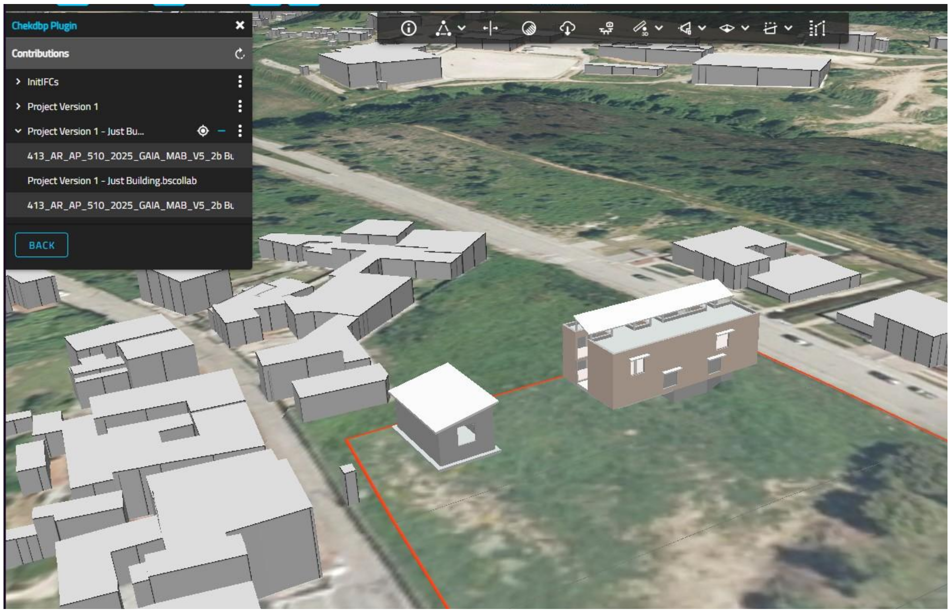



Figure 36 Visualization of the geometry on its place

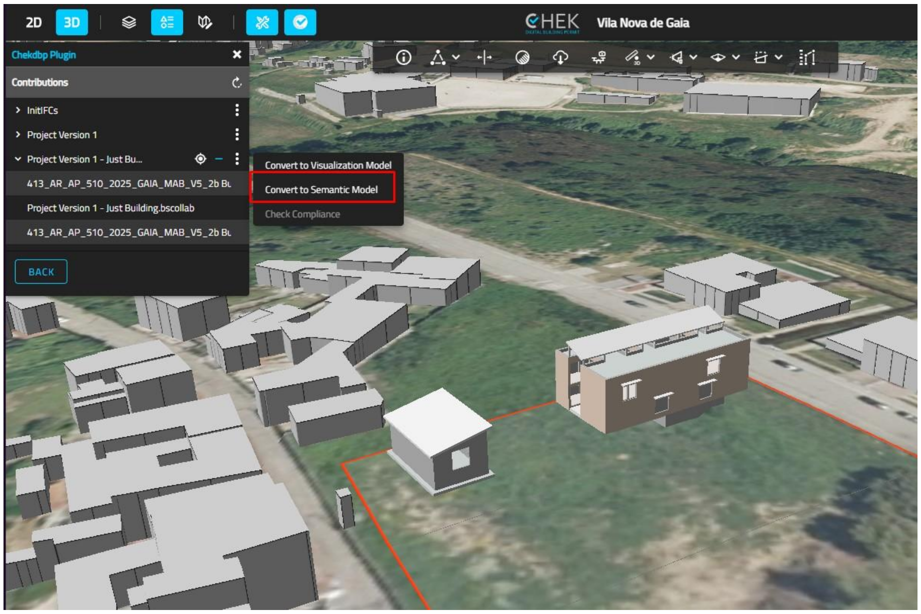



Figure 37 Converting into semantic model

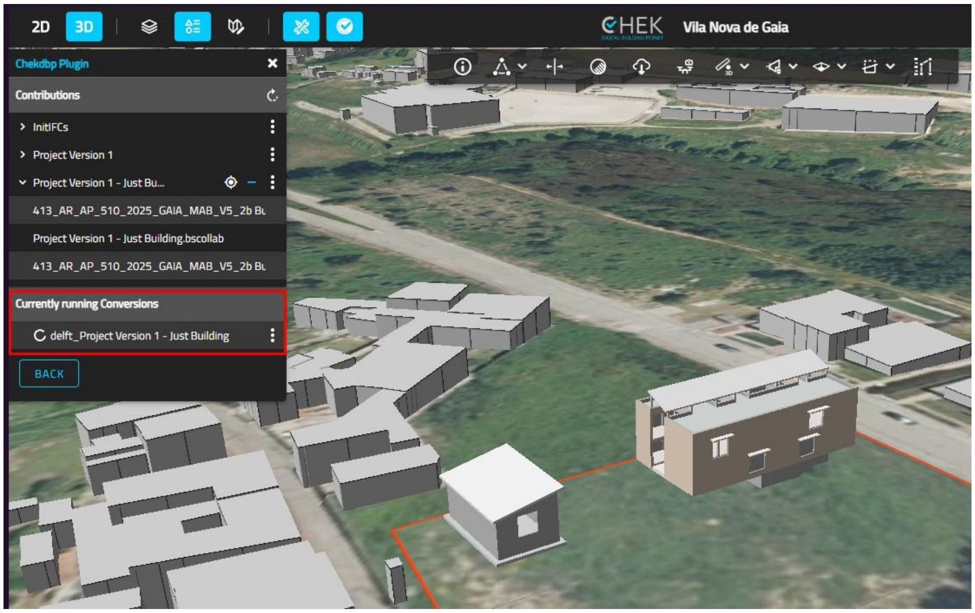



Figure 38 Conversion of semantic model ongoing

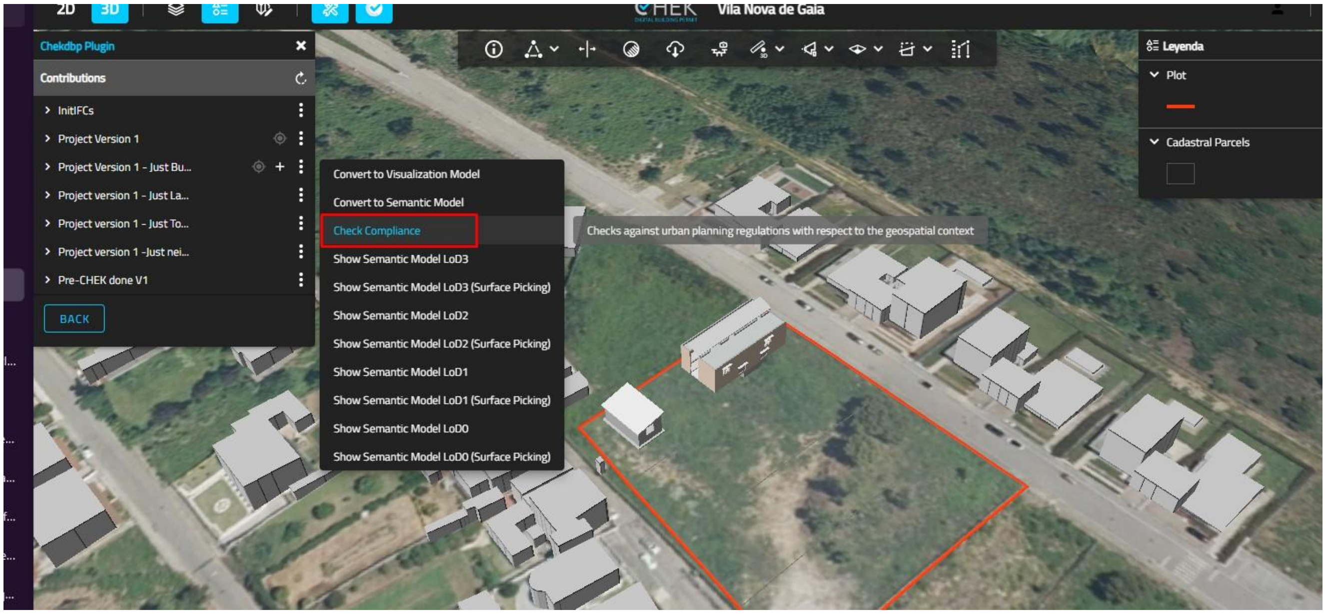



Figure 39 New options to perform the assessments appear after conversion

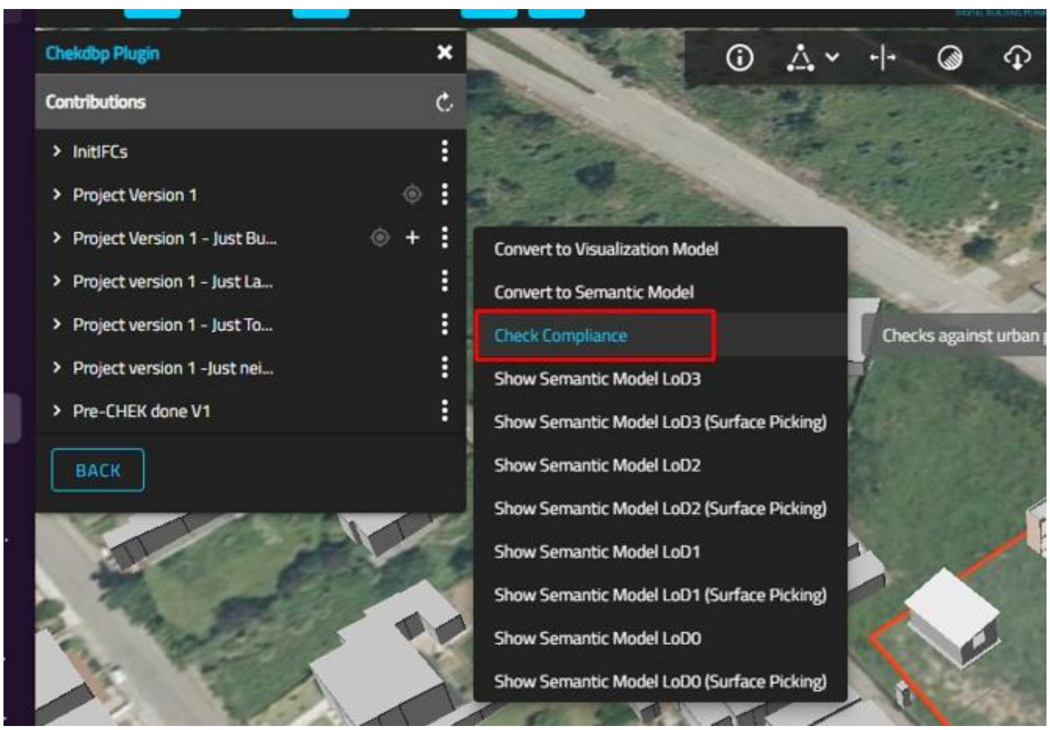



Figure 40 New options to perform the assessments appear after conversion. Zoom into the list

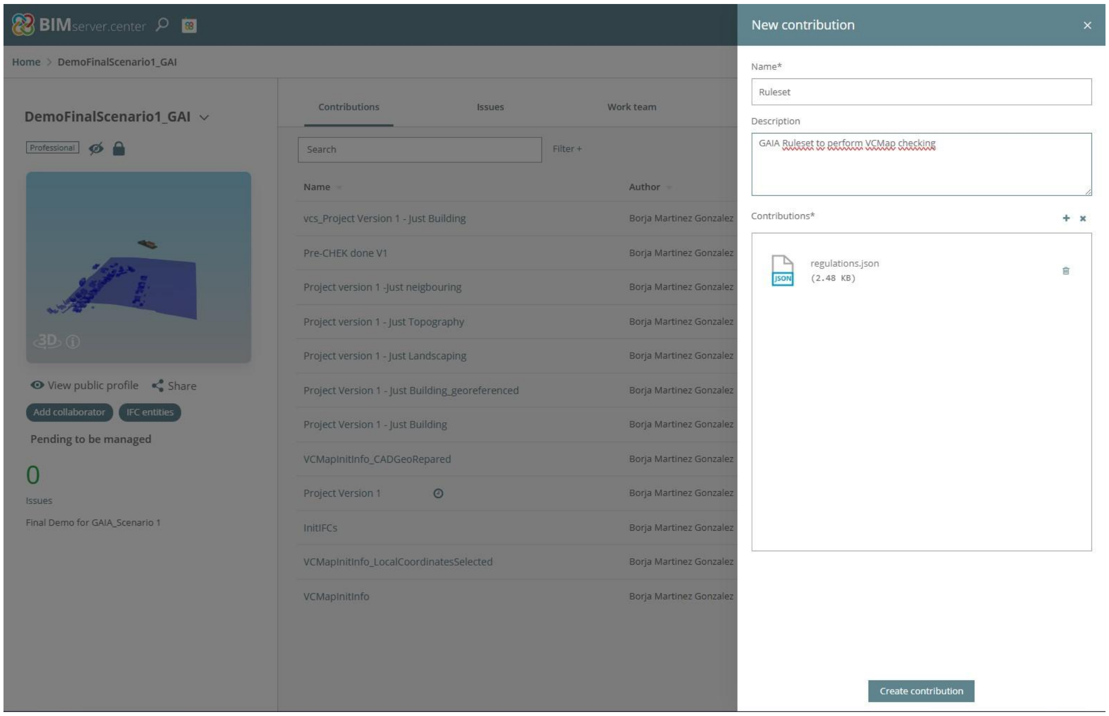


Figure 41 Ruleset needs to be loaded following conventions in advance

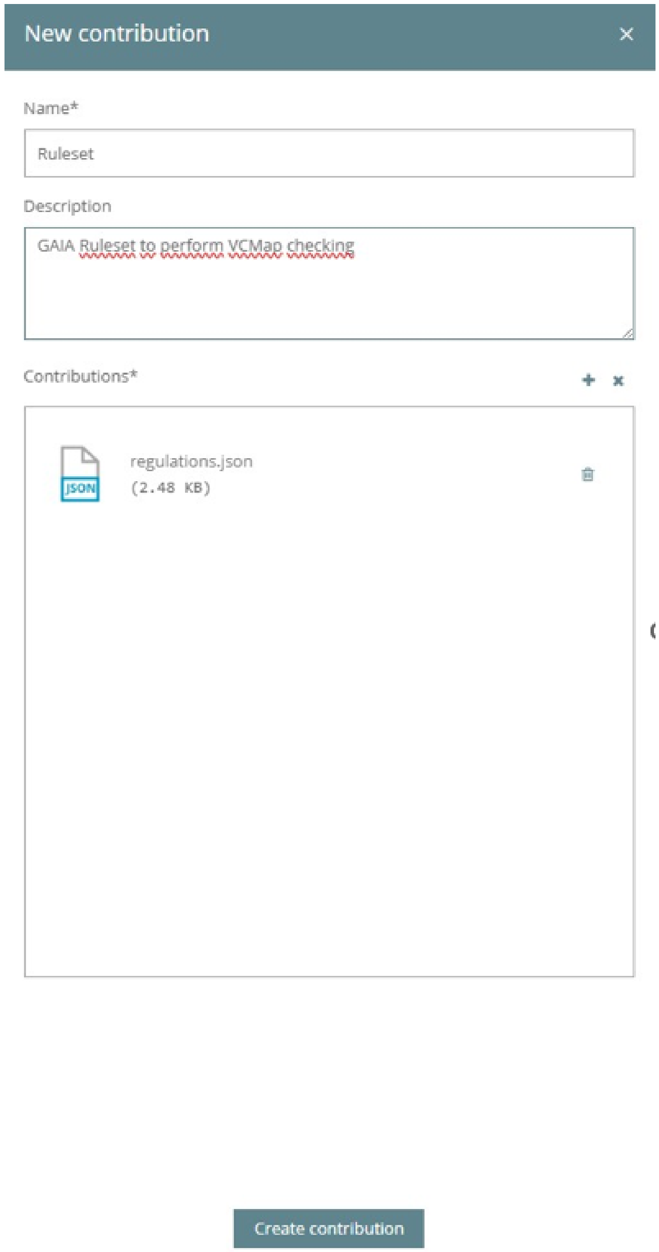



**Figure 42 Ruleset needs to be loaded following conventions in advance. Zoom into the form fields**

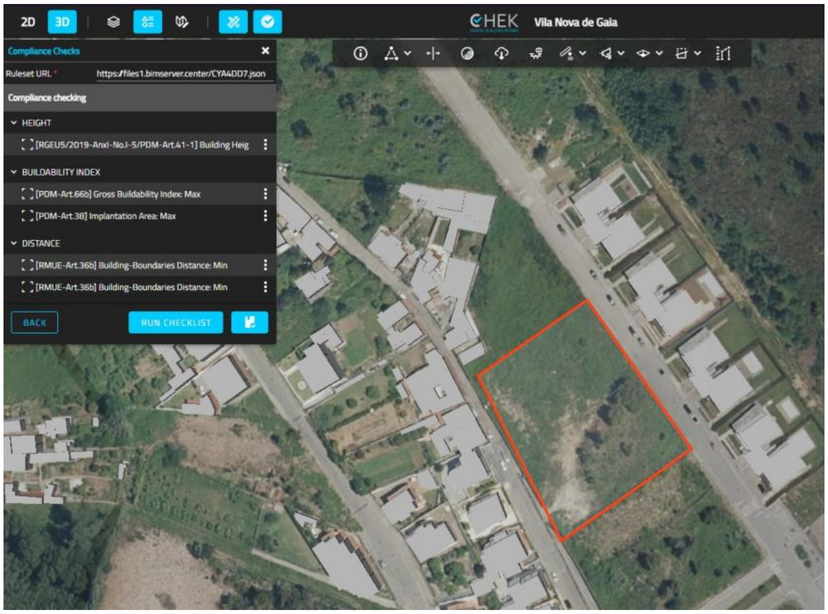


Figure 43 Ready to perform the automatic assessments with just a click

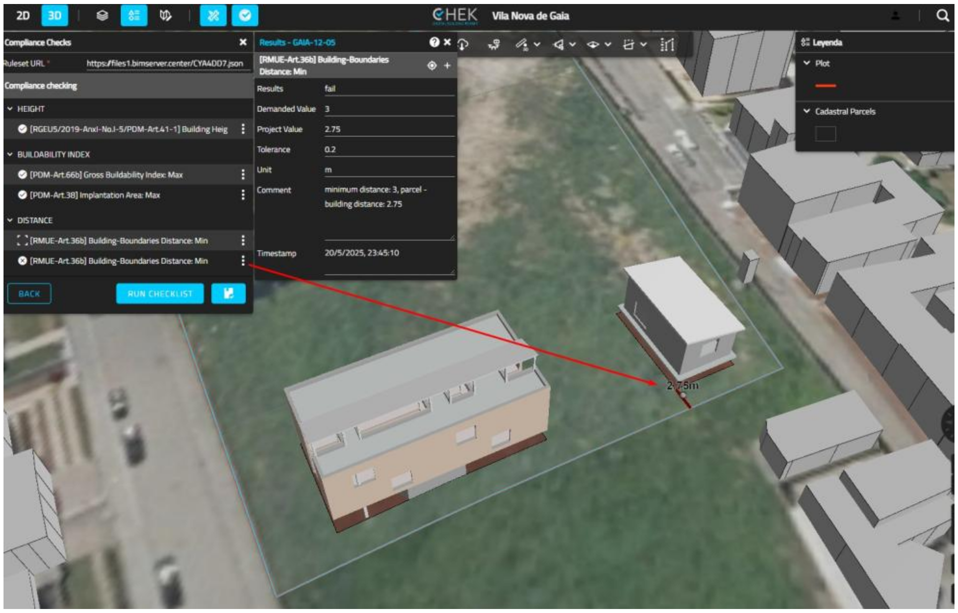


Figure 44 Results after assessments shown by the planform

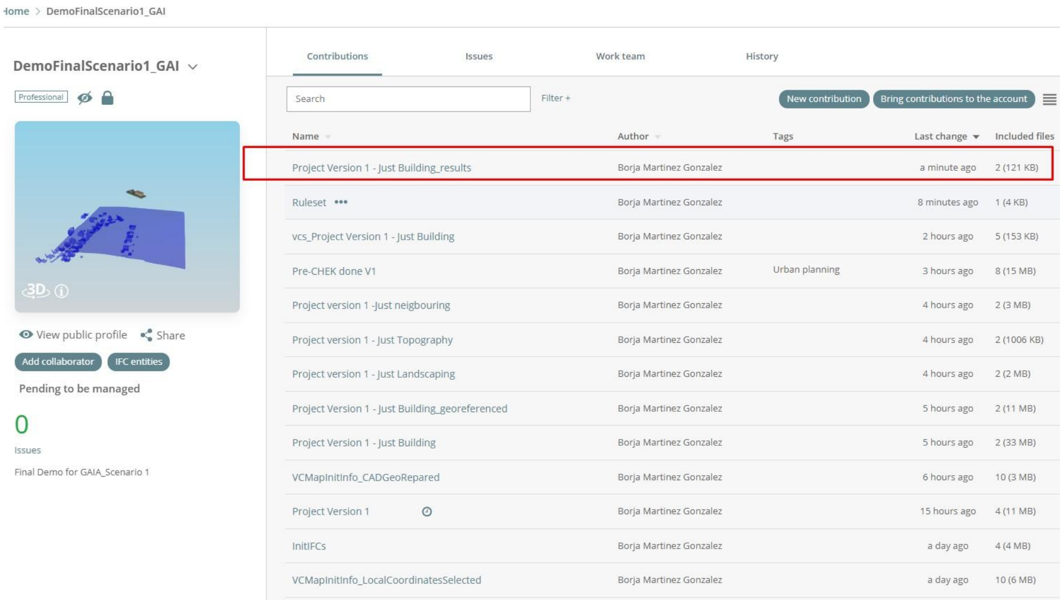



Figure 45 New contribution created by the tool after clicking report

### 3.1.11 Model Evolution during Software Development and Pilot Testing

During the development of the CHEK permitting tools and throughout the pilot phase in Vila Nova de Gaia, several iterations of the IFC model were produced to align with both technical feedback from software developers and the operational requirements of the validation tools. These changes were necessary to ensure compatibility, performance, and semantic clarity across the different tools in the CHEK ecosystem.

Key changes made to the model include:

- Geometry simplification for compatibility: Curtain walls and curved elements (walls and slabs) caused issues in multiple tools. These were replaced with planar components, including chamfers and angular simplifications, to improve compatibility and stability during validation.
- Parameter enrichment: New properties were created and assigned to relevant elements (e.g., the CHEK_IsMainEntrance parameter for doors), enabling validation against specific rules such as main entrance detection for building height checks.
- Coordinate system and EPSG code definition: Several iterations focused on aligning the IFC coordinate base (Survey Point) with real-world georeferencing, including consistent EPSG 3763 assignments and positioning adjustments to match GIS data layers.
- Model modularization: In later stages, the model was split into separate IFC files (building, undeveloped area, topography), each containing only the information relevant to its category. This facilitated more efficient loading, clearer rule application, and reduced the risk of semantic confusion during validation.

Following Figures illustrate the visual evolution of the IFC model from an early version with complex geometry to a later, validation-ready version with simplified elements and enriched metadata.

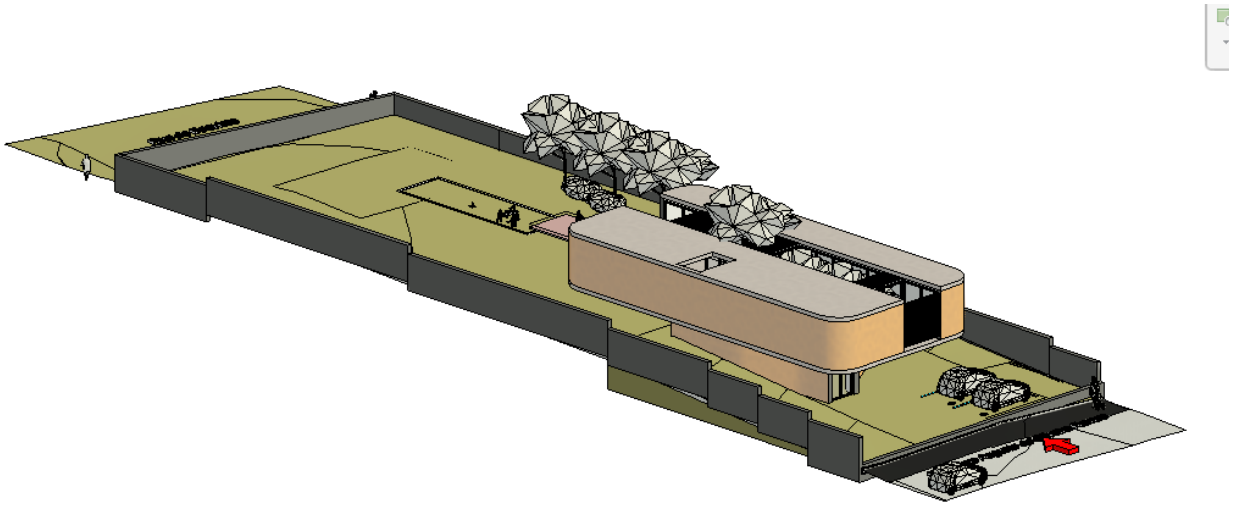


**Figure 46 GAIA's on its first version before software development and demos performance**

Figure 47 GAIA's on its last version after software development and demos performance

### 3.1.12 Digital signature of pre-checked IFC project – DiStellar

**Settings:**

Once the urban compliance validations were successfully completed from the designer's side (in this case using both CYPEURBAN and VCMap) the digital signature of the building's IFC file was carried out.

The signing process was performed using DiStellar, a web-based application developed by DiRoots, which ensures the integrity of the IFC file and prevents unauthorized modifications.

To use this tool, the following were required:

- An active DiStellar account, linked to the CHEK project environment.
- An Evotrust account, which enables electronic signatures through a two-step verification process, including mobile confirmation by the user.

**Inputs:**

- The validated IFC file of the building, typically the most recent version of the exported model.
- Access credentials for DiStellar and Evotrust accounts.

**Outputs:**

- A digitally signed IFC file, marked with a green validation badge in the DiStellar interface.
- A new contribution automatically created in BIMserver.center, visible within the project but only on the designer's side.

**To Improve:**

The IFC file is uploaded directly from the user's local drive, but ideally, it should be possible to select files already stored in the CDE.

Currently, it is not possible to send the signed IFC directly from DiStellar to the validation account in BIMserver.center. As a result, the designer must resort to sharing the file through external means (email, cloud services), which partially breaks the ideal CHEK CDE workflow.

A highly desirable improvement would be the implementation of a function to duplicate or redirect specific contributions to the validation account, or allow the user to explicitly select the recipient of the signed file when uploading from DiStellar.

**Process Description:**

The validated IFC file is uploaded to DiStellar via its web interface. After upload, a model summary is shown and the user is prompted to confirm the signing process.

A mobile notification is sent to the user to authorize the signature using their linked Evotrust account.

Once completed, the file receives a green checkmark indicating successful digital signing.

DiStellar then offers the option to automatically upload the signed version to BIMserver.center, generating a new contribution within the same project.

However, this contribution remains visible only to the designer, and cannot be accessed by the validation role in the current implementation.

This limitation proved problematic during the demo: municipal technicians could not directly access the signed model from their accounts. To work around this, the file was shared manually outside the CDE environment, which is not ideal from a data governance and traceability perspective.

Therefore, while the technical signature process is effective and functional, the cross-role sharing workflow (designer → validator) is not yet fully integrated within the CHEK platform.

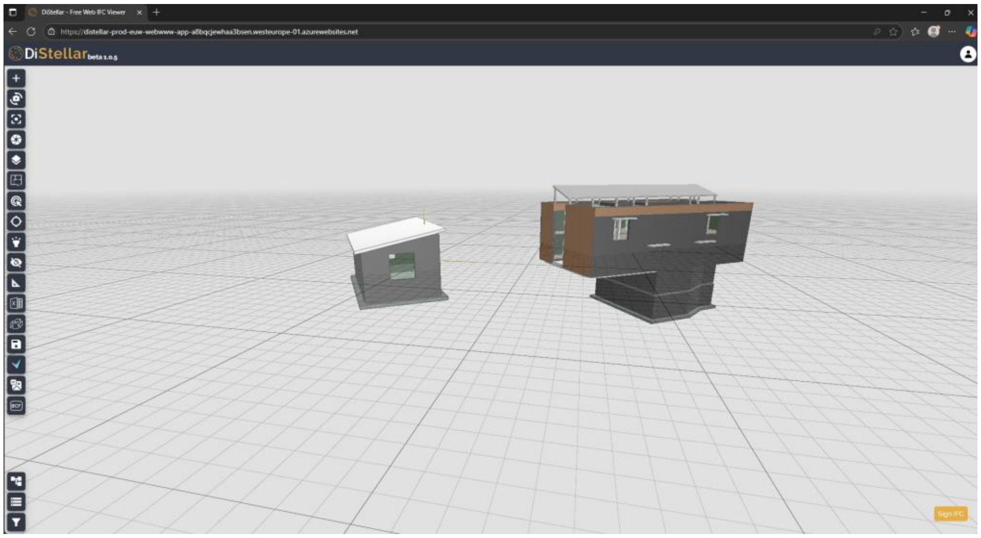



Figure 48 Project loaded in DiStellar ready to perform digital signature

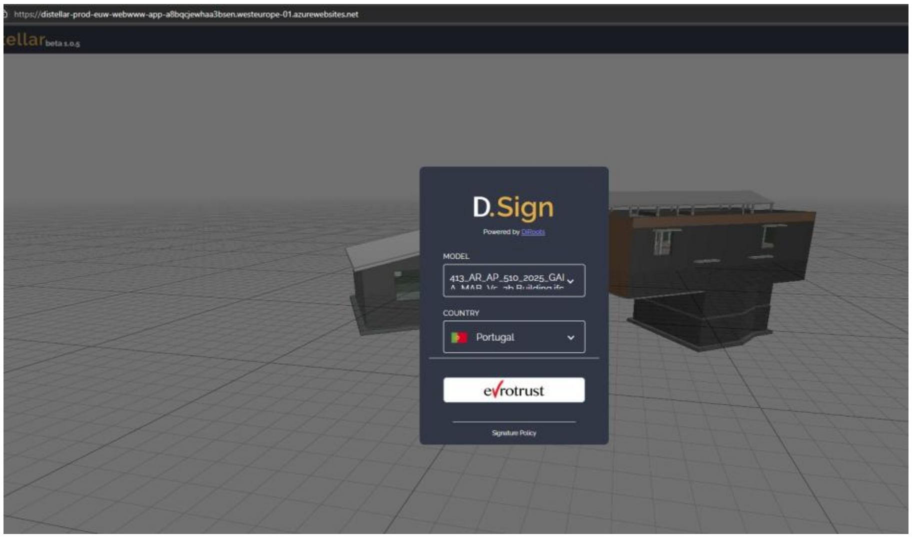



Figure 49 Connection to Evrotrust to sign the loaded IFC file

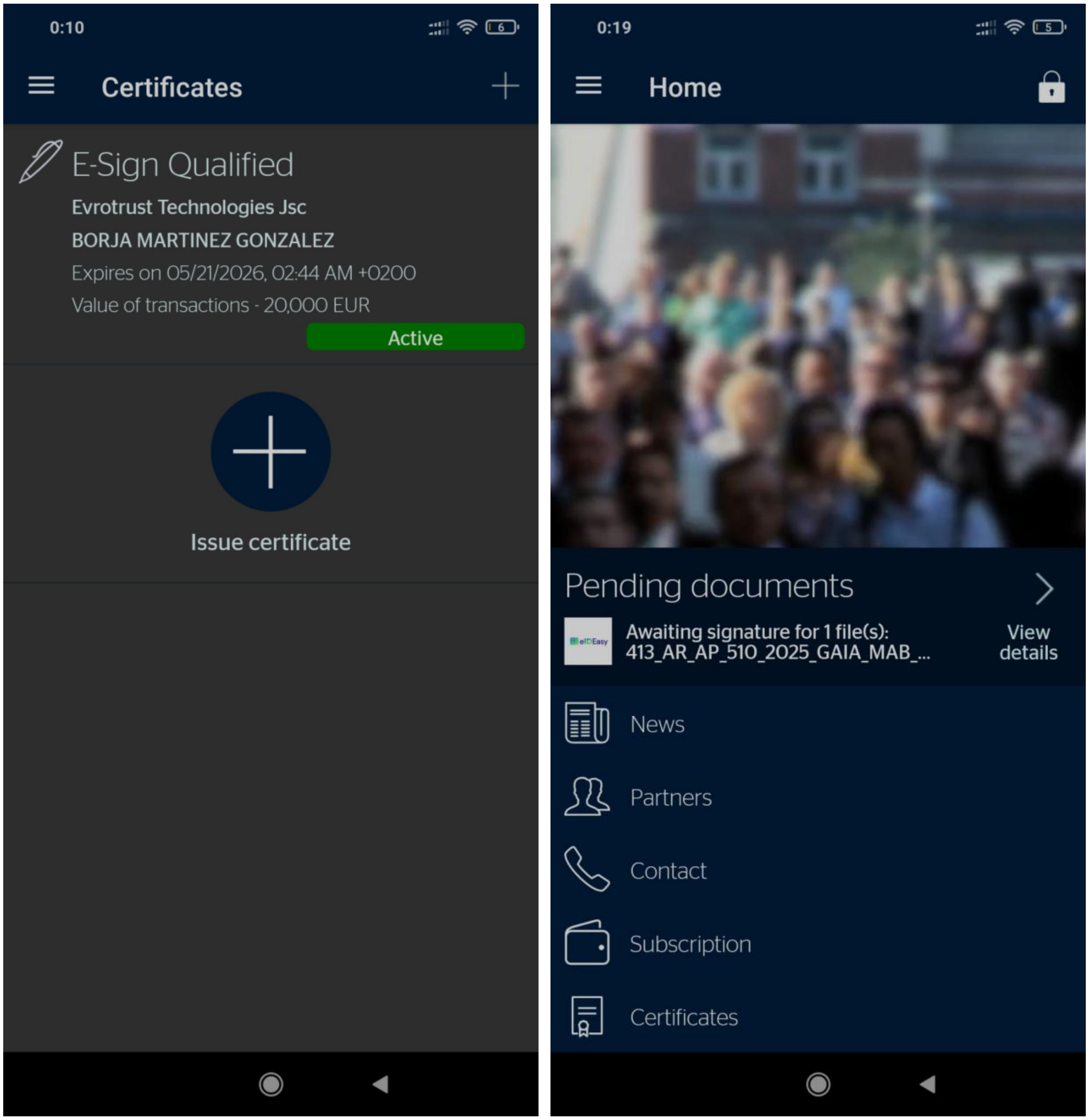



**Figure 50 Evrotrust visualization and pending signatures seen in the phone**

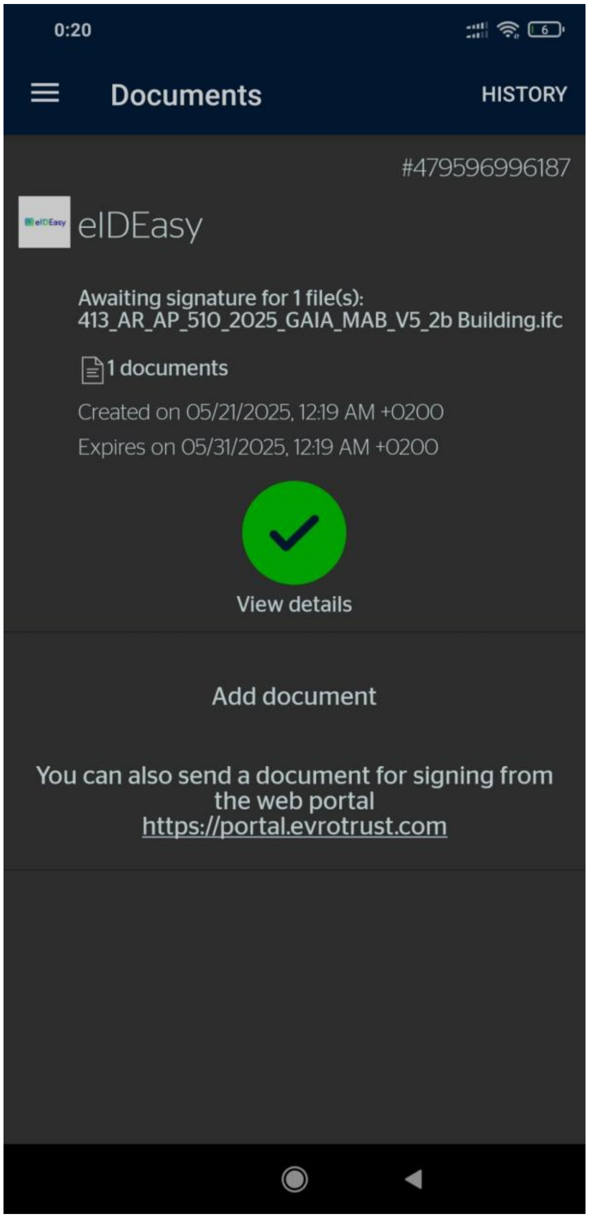



Figure 51 Exploring the pending signature, ready to sign

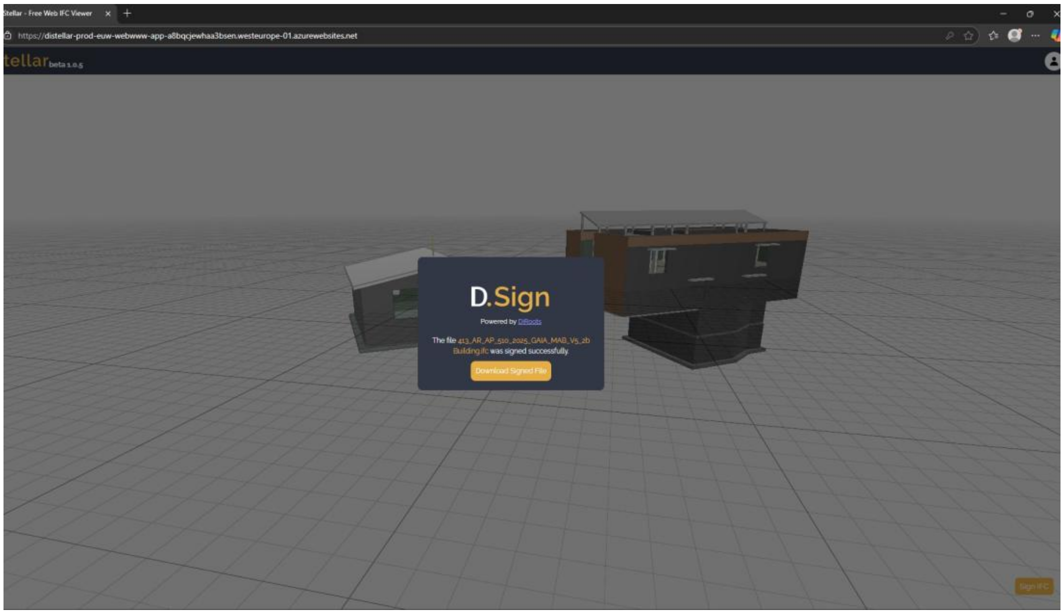



Figure 52 Successfully signed pop up, and possibility to download the signed file

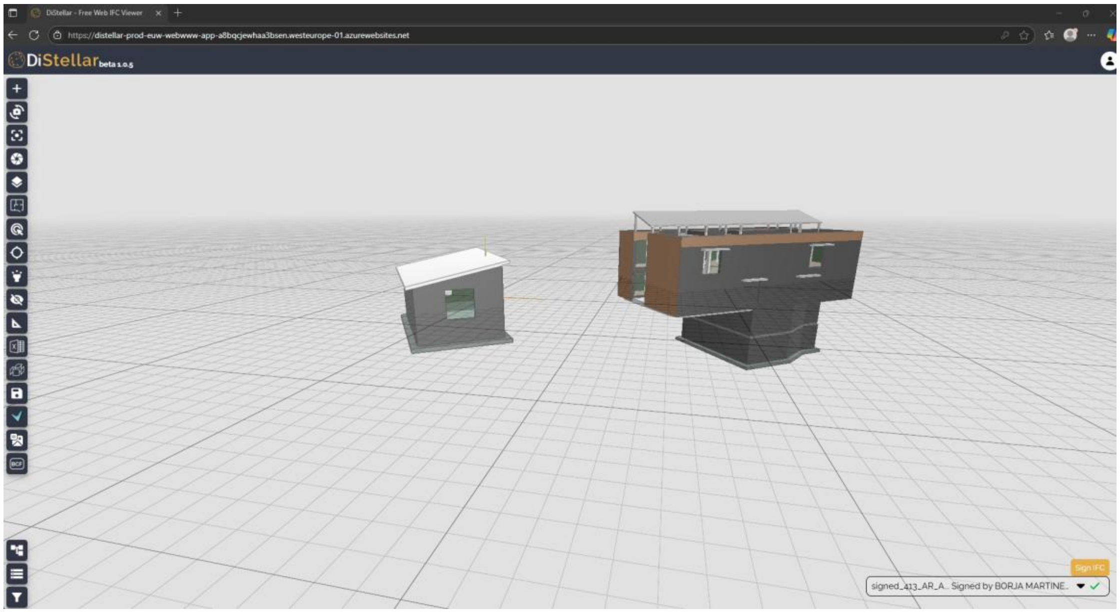



Figure 53 Exploring the signed file

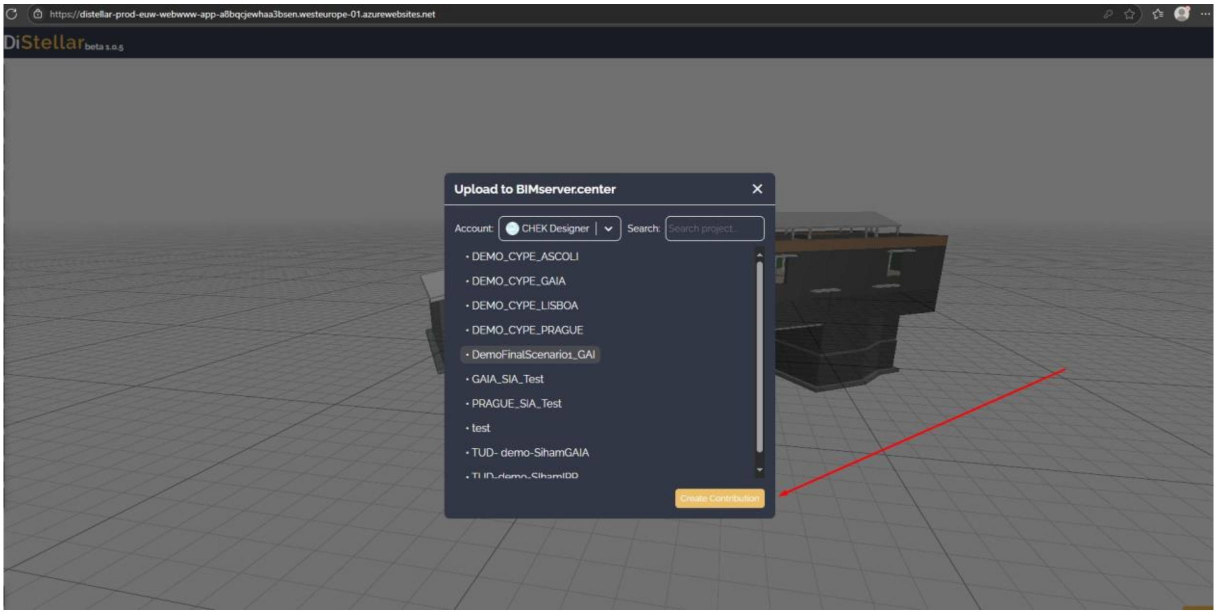



Figure 54 Sharing the signed file with BIMServer.Center

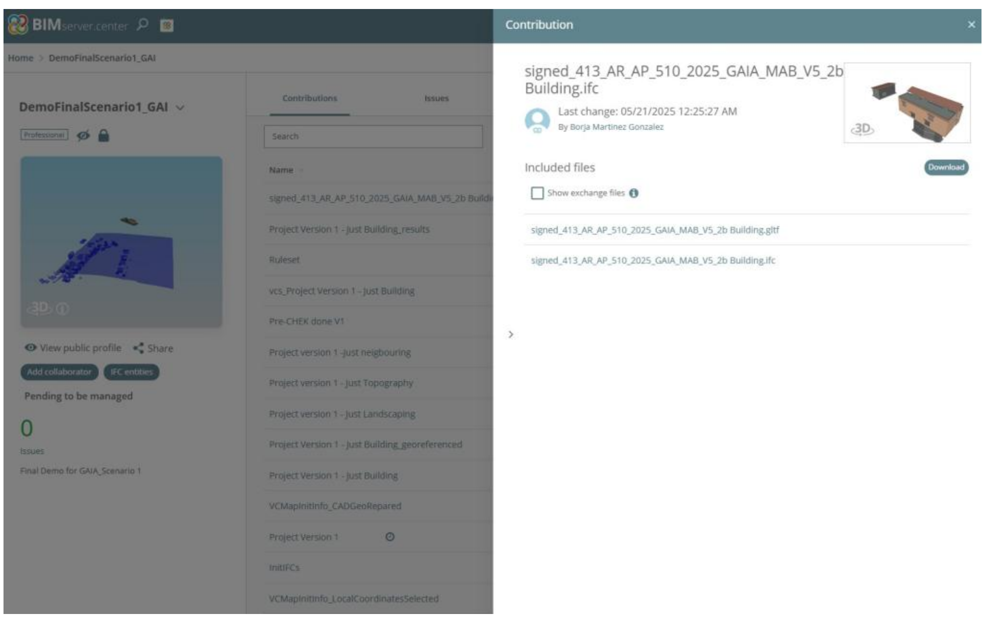



Figure 55 New contribution created by DiStellar in Designer account

### 3.1.13 CHEK permitting tools. Municipality side workflow review

**Settings:**
Once the designer completed the pre-validation process and digitally signed the IFC model, the Municipality team of Vila Nova de Gaia proceeded with their validation phase.
This step involved verifying whether the tools available on the municipal side (CYPEURBAN, VCMap, RDF viewers, and external viewers) were sufficient to reproduce the assessments already conducted by the designer and to issue a formal response. The process required access to the same files used during the pre-check phase, including the signed building model, IFC files for terrain and undeveloped plot, and validation reports.

**Inputs:**

- Digitally signed IFC of the building.
- IFC files of terrain and undeveloped plot.
- IFC containing validation geometry from CYPEURBAN.
- PDF report from CYPEURBAN.
- JSON report from VCMap.

**Outputs:**

- Formal feedback report from the municipality in Word/PDF format.
- Cross-checked results comparing municipal and designer validation.
- Internal testing results using CYPEURBAN and VCMap with municipal accounts.

**To Improve:**

- Municipal accounts reported that they cannot currently access or visualize signed IFCs via DiStellar or CYPEURBAN. Sharing must occur outside the CHEK platform, which disrupts the intended data governance workflow.
- The geometry IFC from CYPEURBAN was difficult for the municipality to interpret without direct access to the tool's interface.
- CYPEURBAN does not allow federation from validation accounts.
- VCMap returned some false positives due to incorrect base data or limitations in ruleset application.
- Cross-checking requires additional visualization capabilities within the CHEK ecosystem to support replication of checks.

**Process Description:**
The municipal team accessed the BIMserver.center project using their validation account and located the contributions shared by the designer. These included the IFC with auxiliary geometries from CYPEURBAN and the associated validation report in PDF format. Although the PDF was informative, the IFC file was challenging to interpret without the full CYPEURBAN environment.
To replicate the designer's validation and perform cross-checking, the municipality attempted to use multiple tools:

- BIMvision: Federation was limited to only two files, making full context comparison impossible.
- CYPEURBAN: Since this tool does not currently support the validator role, municipal users were unable to open or replicate assessments. To mitigate this, the designer shared the original .cyp file directly, enabling the municipality to re-execute validations from the designer's interface.
- RDF Viewer: Although it allowed multiple IFC uploads, visual output failed when three or more files were federated, likely due to geometry extents mismatching.

- VCMap: Initial tests led to false positives due to misalignment in plot limits. When cross-checked with the designer's interpretation, it was confirmed that the tool had used incorrect boundary references for compliance calculations. Despite this, the validation logic was successfully demonstrated.

Due to these limitations, the municipality was unable to fully execute a federated check with native tools. Nonetheless, they proceeded to assess the updated version of the Project, submitted after incorporating their feedback on Version 1. The final urban compliance report confirmed that all relevant parameters were satisfied. This included:

- Minimum plot area.
- Floor height and setback distances.
- Parking requirements.
- Buildable area and dwelling metrics.

To enhance their understanding and test the toolset, the municipal team also repeated part of the CYPEURBAN workflow using the provided source file, assuming the designer's role. This approach allowed them to confirm that classification of spaces must be performed by the designer and not the validator, a clarification for future pilot cases.

In conclusion, the municipal validation demonstrated the potential of the CHEK workflow, while also highlighting areas for improvement. Despite the workaround procedures and external data sharing, the municipality was able to complete the review and verify regulatory compliance, albeit with significant dependency on designer-side assistance. For full implementation, improvements in federation, signature accessibility, and cross-role interoperability are needed.

**APPLICABLE REGULATIONS**

PDM Demo CHECK

| PLOT CONDITIONS | Project | | Regulation | |
|---|---|---|---|---|
| Plot area (Parcela)[1] | 1153.54 | ≥ | 1153.54 | m² |
| **VOLUMETRIC PARAMETERS** | **Project** | | **Regulation** | |
| **Building height** | | | | |
| Maximum number of floors above ground level | 2 | ≤ | 3 | |
| Maximum height of plot fencing | | | | |
| Ref. Altura 1 | 1.80 | ≤ | 1.80 | m |
| Ref. Altura 2 | 1.43 | ≤ | 1.80 | m |
| Ref. Altura 3 | 1.80 | ≤ | 1.80 | m |
| Ref. Altura 4 | 1.80 | ≤ | 1.80 | m |
| Ref. Altura 5 | 1.80 | ≤ | 1.80 | m |
| Ref. Altura 6 | 1.80 | ≤ | 1.80 | m |
| Ref. Altura 7 | 1.34 | ≤ | 1.80 | m |
| Ref. Altura 8 | 1.64 | ≤ | 1.80 | m |
| Ref. Altura 9 | 1.62 | ≤ | 1.80 | m |
| Ref. Altura10 | 1.80 | ≤ | 1.80 | m |
| Ref. Altura11 | 1.80 | ≤ | 1.80 | m |
| Ref. Altura12 | 1.70 | ≤ | 1.80 | m |
| Ref. Altura13 | 1.80 | ≤ | 1.80 | m |
| Ref. Altura14 | 1.80 | ≤ | 1.80 | m |
| Ref. Altura15 | 1.48 | ≤ | 1.80 | m |
| Ref. Altura16 | 1.50 | ≤ | 1.80 | m |
| Ref. Altura17 | 1.80 | ≤ | 1.80 | m |
| **Position** | | | | |
| Distance between buildings of the same plot | No data | ≥ | No data | m |
| Minimum setback of the building to the front of the plot | | | | |
| Ref. Retranqueo 3 | 7.05 | ≥ | 7.00 | m |
| Minimum setback of the building to plot boundaries | | | | |



Figure 56 PDF report coming from CYPEURBAN in validation account

Using the IFCViewer-DirectX-C++_64bit.exe interface, it was possible to access the IFC file and apply the EXPRESS Scheme CHECKER plug-in.

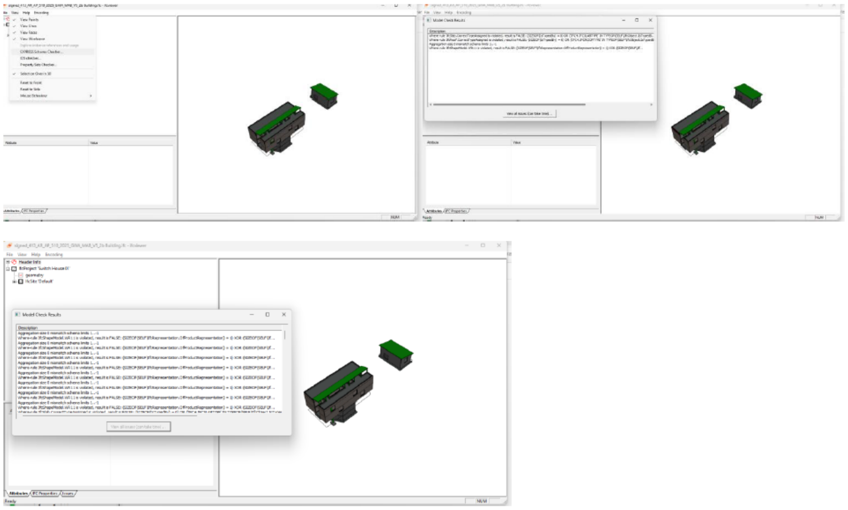


Figure 57 Checking the quality of the IFC file with RDF’s

**False Positive.**

It's chek with the wrong plot (red). It should be the yellow.

Cros cheking confirms the results given by the designer.

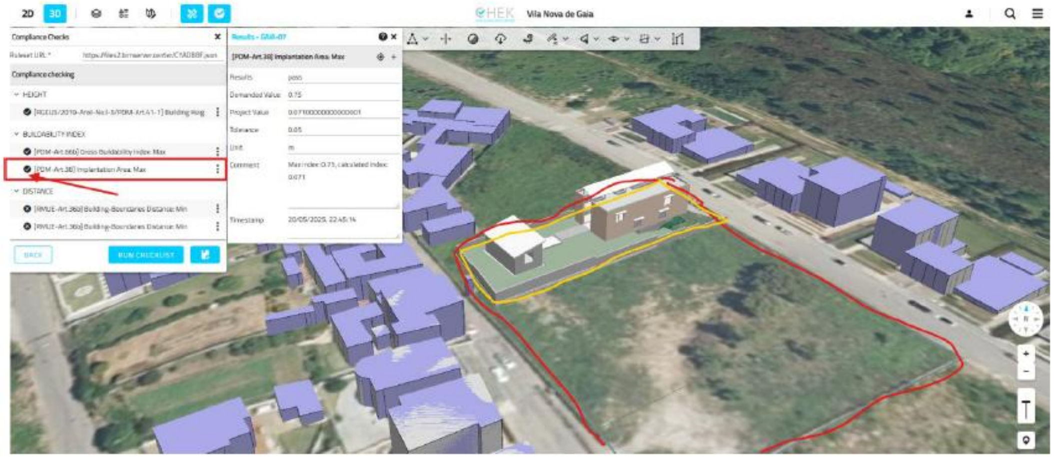


Figure 58 Checking VCMap report using the online tool

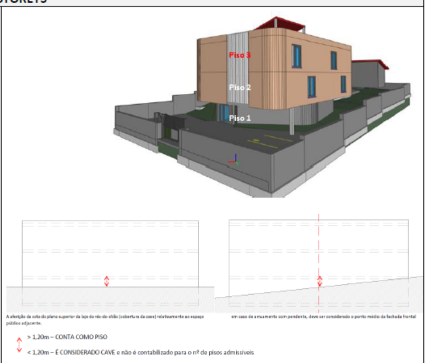
| CYPEURBAN REPORT | ANALYSIS BY THE TECHNICIAN TODAY | GRAPHIC SCHEMES |
|---|---|---|
| **MUNICIPAL MASTERPLAN REGULATION**<br>'Urbanised Areas for General Use', (common provisions described in articles 40 to 43) more specifically subcategory "Consolidated Urbanised Areas for Housing" (articles 55 to 57) | | |
| **USE** | | |
| No reference in the report. | Single-family housing | - |
| **OCUPATION** | | |
| **41,51%**<br>The total projection of the building must be considered, including basements (it is not possible to check whether this concept has been taken into account). | **41,51%**<br>The claim reflects an occupancy percentage of less than 75% of the total area of the property, respecting the provisions of Article 38(1). | - |
| **NUMBER OF STOREYS** | | |
| Above ground - 2<br>Below ground - 1<br><br>A basement (below ground) can only be considered if the elevation of the upper plane of the respective roof slab is on average no more than 1.2 metres above the public space or adjacent natural reference terrain (Article 5(1)(h) of the RPDM). | Above ground - 3<br>Below ground - 0<br><br>Apparently the dwelling consists of **3 floors above ground.** Under the terms of Article 57(2)(c), the 3rd floor above ground (set back) can only have a gross construction area of less than 50% of the gross area of the floor immediately below it (floor 2). In the case under study, it appears that floor 3 (set back) has a gross floor area equal to that of the floor immediately below it (floor 2), thus not complying with the provisions of Article 57(2)(c). |   |

Figure 59 Municipality feedback that motivated a new iteration

## 3.2 Lisbon

This section provides a detailed overview of the demonstration activities carried out in the Lisbon pilot within the scope of Task 6.2, focusing on the application of the CHEK digital workflow to a new building construction scenario. The aim was to test the adaptability of the CHEK tools when applied to new construction and to assess their performance in supporting a model-based, standards-driven building permit process.

The demonstration was based on a Multistorey residential building designed and modeled by ZWE with consideration of the local regulations, site context, construction technologies etc. The demo plot is in a central part of Lisbon, in vibrant surroundings.

A full description of the original project context, urban conditions, and baseline geometry can be found in Section 3.1.2 of Deliverable D6.1 “Plan for demonstration of CHEK Digital Building Permit process on demo sites”, which outlines the Lisbon demo pilot characteristics.

The new construction workflow followed the typical progression of a real design-to-permit process, beginning with the collection of site context, local regulation etc. and followed by model design, pre-validation, adaptation, validation, and submission. The model was developed in a standard BIM authoring environment using Revit 2025 as BIM authoring tool and exported in IFC 4 Add2 format.

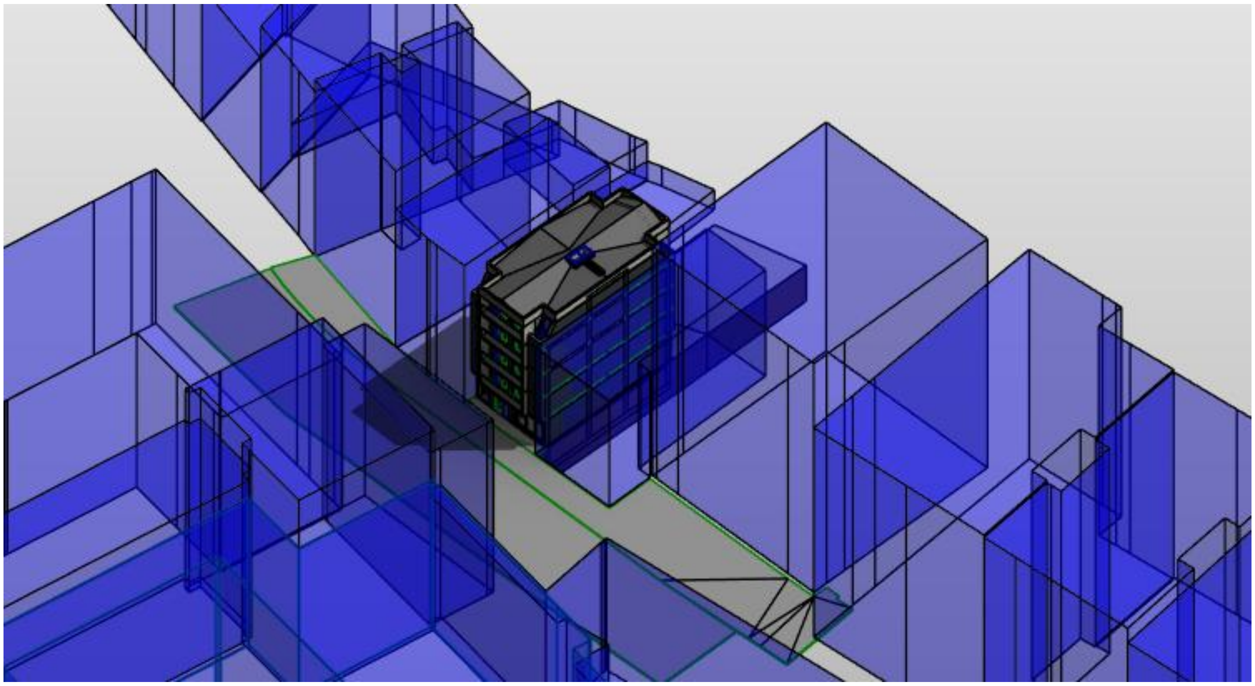


Figure 60 Final version for LISBON Scenario 1

The following tools from the CHEK digital toolkit were used to execute the workflow:

- CYPEURBAN (Cype): to perform rule-based spatial and regulatory checks against local planning conditions;
- VC Map (VCS): to perform rule-based spatial and regulatory checks against local planning conditions;
- IfcEngine (RDF): to validate IFC structure and schema compliance;
- CityGML2IFC (RDF): to export site CityGML files to IFC;
- IfcGref (TU Delft): to confirm georeferencing consistency of the IFC model;
- DiStellar plugin: to apply a digital signature to the validated model;
- BIMServer.Center (Cype): serving as the shared platform (CDE) for storing and managing model files, metadata, and validation outputs.

This scenario tested the ability of the tools to accommodate the challenges of new construction design workflows, addressing compliance with current building regulations.

The demonstration was conducted in collaboration with the Lisbon municipality, who provided regulatory context and validation feedback. The results confirmed that the workflow is applicable in new construction settings.

The Lisbon New Construction pilot contributed valuable insights into the flexibility and interoperability of the CHEK toolkit. It confirmed the viability of a digital building permitting approach to new construction projects.

The following subsection details the technical steps followed in this pilot and presents the outputs of the demonstration.

**Table 3 – Key Findings after performing demo scenario 1 on LISBON's pilot**

| Aspect | Finding |
|---|---|
| Workflow Fidelity | Closely followed a realistic permit process, from geospatial context acquisition to final submission. |
| Tool Integration | Effective use of full CHEK toolkit, showcasing tool interoperability within a CDE. |
| IFC Export | DiRoots Exporter worked correctly with custom MVD and IDS mapping in Revit 2025. |
| Georeferencing | Confirmed successfully using IfcGref; custom EPSG code was embedded during export. |
| Validation Checks | Both VCMap and CYPEURBAN flagged initial issues, which were resolved with model corrections. |
| Digital Signature | DiStellar allowed successful signing and re-upload of the final validated model. |
| Municipal Review | Validation results and IFCs were successfully shared with Lisbon municipality via the CDE. |

The Lisbon pilot confirmed the importance of iterative validation and model corrections to achieve regulatory compliance.

### 3.2.1 Creating new project using BIMServer.Center

Demonstration of the CHEK digital toolkit, starts with BIMServer.Center that serves as CHEK DBP platform where Designers create new project as central project repositorium for all project contributions and collaboration between Designers and Municipalities.

**Inputs**:

- No particular inputs

**Outputs:**

- Created New Project repositorium

**Process description:**

1. Designers logged in into BIMServer.Center with CHEK Designers account

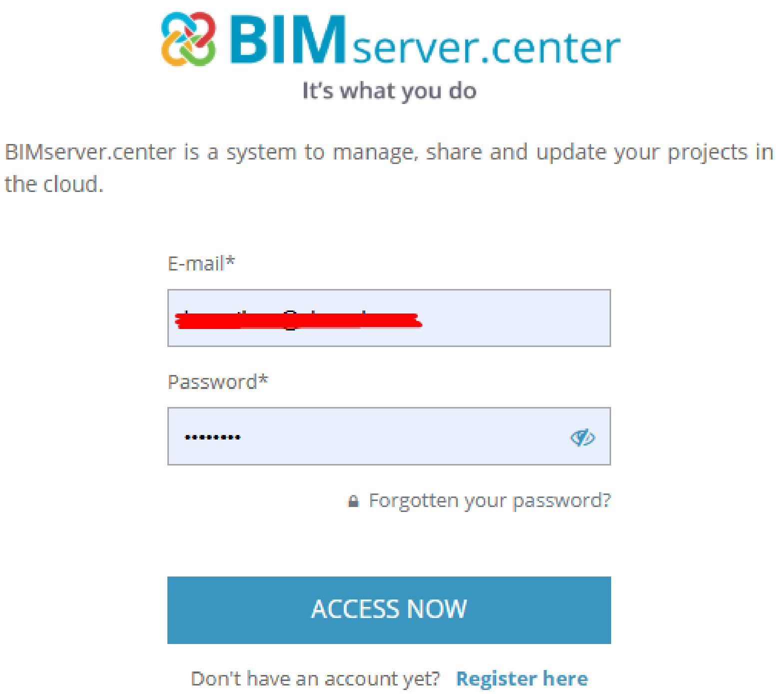



**Figure 61 Logging into BSC**

2. New Project was created

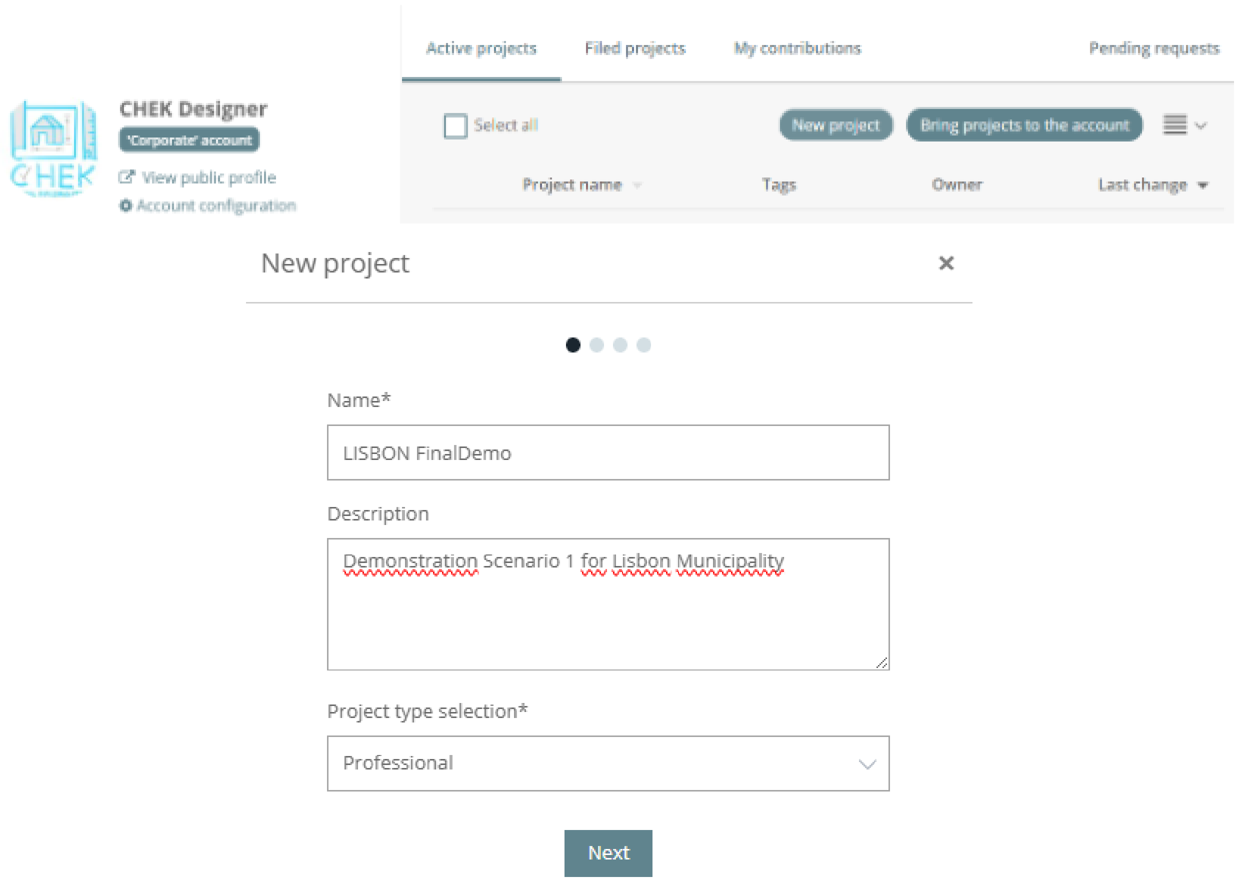



Figure 62 Project creation

3. Proper predefined Project Tag was assigned so checking application can automatically recognize the site location

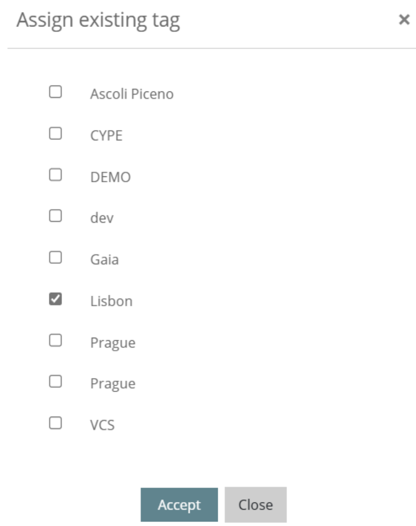



Figure 63 Tag Assignment

### 3.2.2 Gathering initial data - VCMap

After the project was created in BIMServer.Center, the demonstration continued with collecting the site data as 3D geometry for future use in BIM authoring tool.

**Inputs:**

- No particular inputs

**Outputs:**

- Surrounding models created

**Process description:**

1. Designers logged in into VC Map platform with CHEK Designers account


Figure 64 Logging into BSC in the VCMap Platform

2. After allowing VCMap to connect to BIMServer.Center, VCMap accessed the CHEK Designer's account and saved projects


Figure 65 selecting account in VCMap

3. The newly created project was connected to VC Map

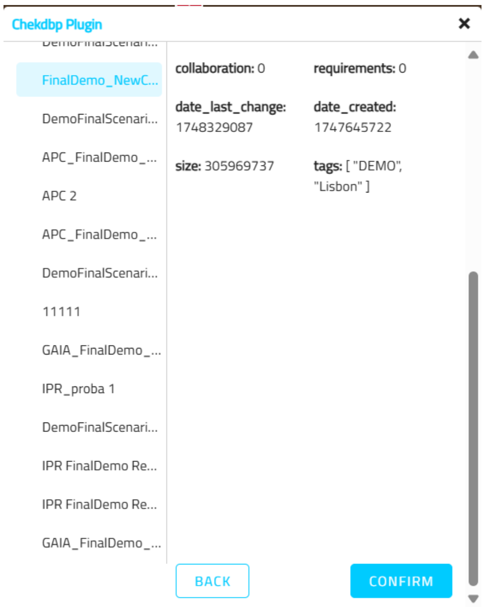



Figure 66 The project is available to work on it

4. The plot location was properly displayed in VC Map. When a new project is created within the CHEK framework and synchronized with BIMserver.center, the VCMap platform uses a project-level metadata tag (specifically, the municipality name) to determine the geographic area to display. In this case, the project was tagged with “Lisbon,” which allowed VCMap to center the view over the corresponding municipal boundary and display the relevant 3D city model. At this stage of development, the VCMap system does not require or use more granular identifiers such as cadastral references, street names, or specific parcel numbers. Instead, the logic relies on a predefined linkage between project tags (e.g., “Lisbon”) and a unique plot defined in advance by the technical partners, as outlined in Deliverable D6.1. This predefined linkage enables the automatic display of the relevant location in the 3D city model without requiring additional user input. While this approach is suitable for demonstration purposes and simplifies the user experience, it would not be scalable in real-world deployments where multiple plots may exist within the same municipality. In production environments, further development would be needed to allow for plot-specific selection—either through graphical tools (e.g., clicking on a parcel within a GIS interface) or via structured input fields (e.g., entering a cadastral ID or plot code). The current implementation prioritizes validation functionalities over parcel management, which is why such advanced input mechanisms have not yet been incorporated.

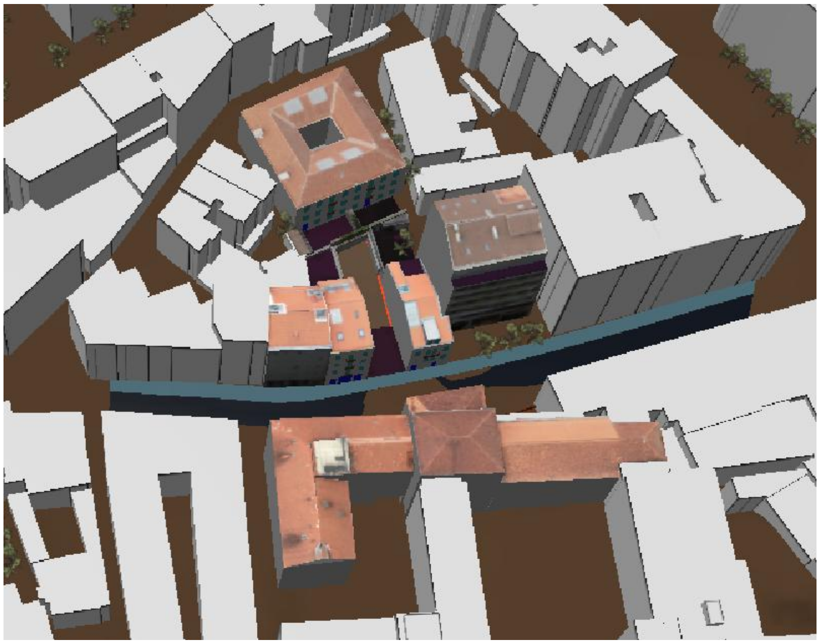


Figure 67 Plot allocation in the 3D city model

5. Export Tool in VC Map was used for exporting of the surrounding data

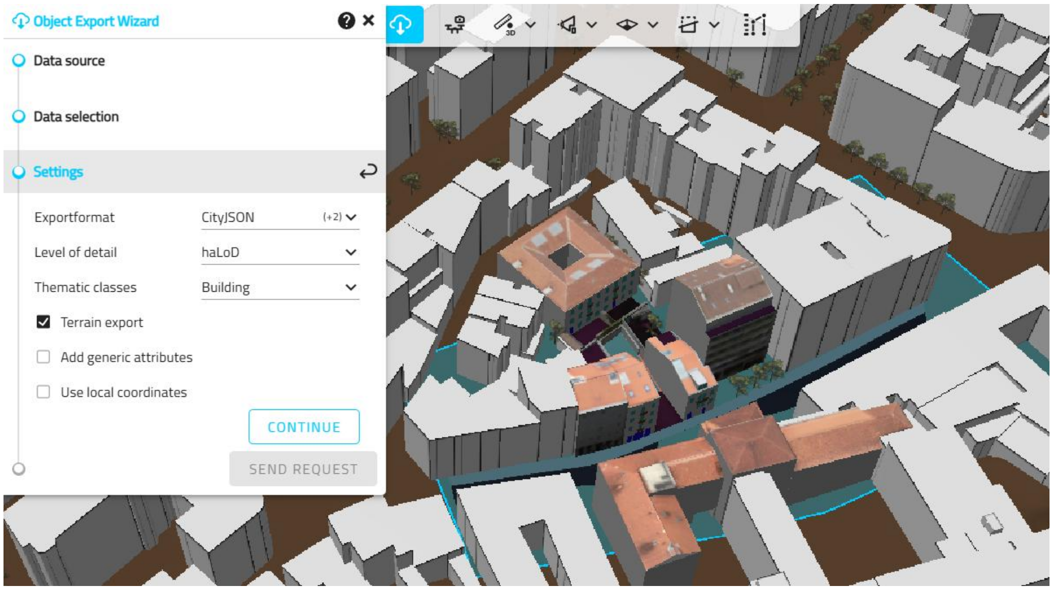



Figure 68 Start exporting process to get initial information

6. Surroundings file formats were selected for later usage in BIM Authoring tool

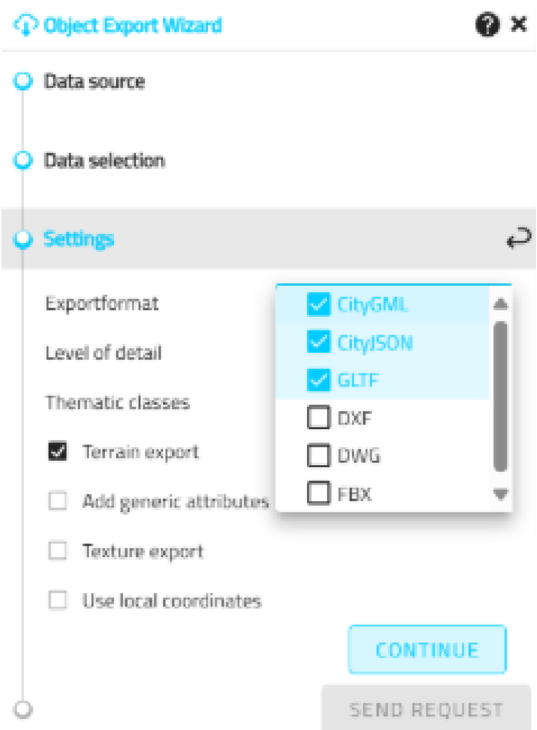



Figure 69 Select the file formats needed

7. After finalization, a confirmation was received that the export operation was successful
8. The exported models of the surroundings were exported directly to the project folder in BIMServer.Center as a new contribution

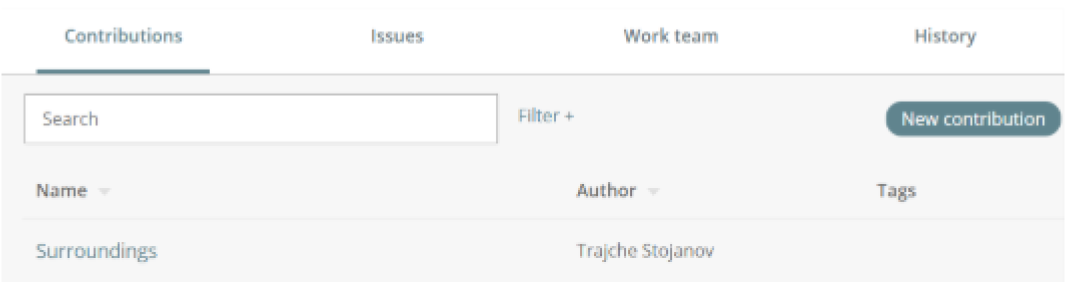



Figure 70 After sending the request, a new contribution in the CDE appears

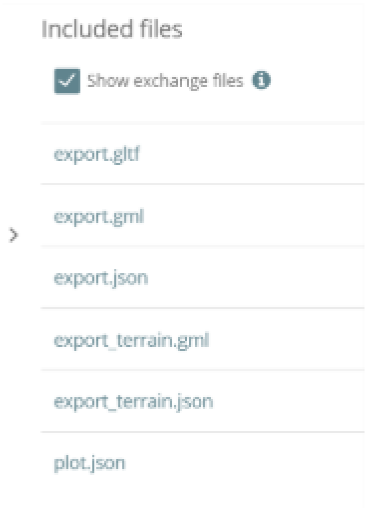



Figure 71 Exploring the new contribution from VCMap

9. Exported CityGML files were further converted into IFC for use in BIM authoring tool as described in the next paragraph

### 3.2.3 GIS to BIM conversion - CityGML2IFC

Exported GIS (surrounding buildings and terrain) models from VCMap were further converted from CityGML into IFC files via RDF's CityGML2IFC tool. This tool was run locally on Designers' computers and in essence transferred the GIS data into BIM.

**Inputs:**

- CityGML files

**Outputs:**

- New IFC files from CityGML files

**Process description:**

1. Run CityGML2IFC locally with buildings gml file loaded

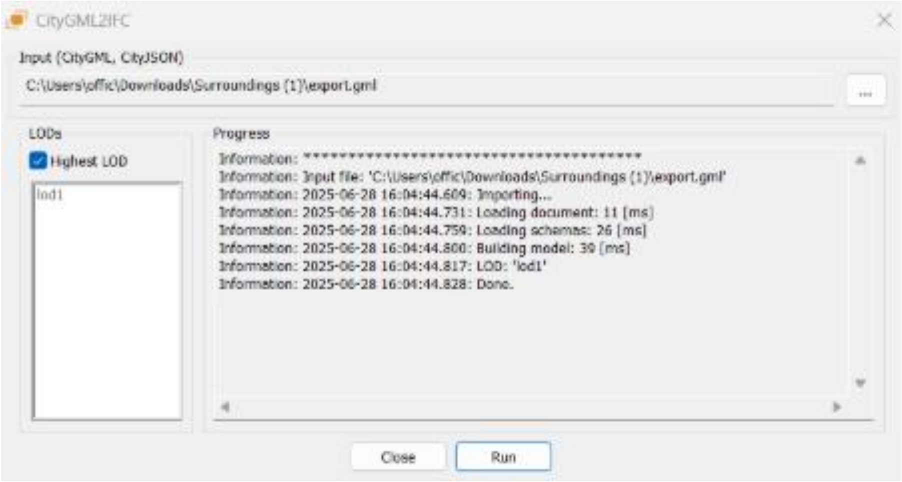



Figure 72 Converting the surroundings into an IFC file

2. Run CityGML2IFC locally with terrain gml file loaded

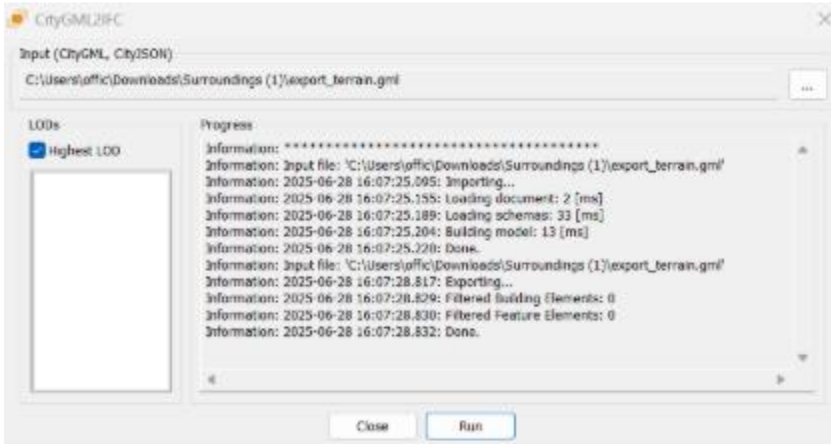



Figure 73 Converting the DTM into IFC format

3. The exported IFC files were located in the same folder where the gml files were uploaded from the CityGML2IFC converter.

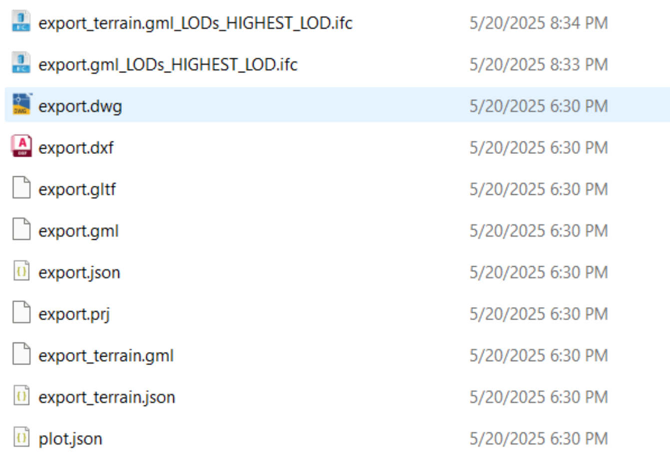



Figure 74 The result of the conversion appears in the same folder

4. The workflow continued in BIM authoring tool where the IFC models of the surrounding buildings and terrain were used.

### 3.2.4 Designing overview

Surroundings (terrain and surrounding buildings) were converted into IFC, because IFC is one of the supported file formats when working with Revit 2025 as BIM Authoring Tool of choice. In Revit, these IFC files are being utilized in the design process itself.

**Inputs:**

- Newly converted IFC files

**Outputs:**

- Fully georeferenced Revit file with surroundings

**Process description:**

1. A new file was opened in Autodesk Revit 2025, a BIM authoring tool used for this demo site.
2. Newly converted IFC models representing the surrounding buildings and terrain were linked using the Link IFC tool. The links were further bound into the Revit file and the Revit file was saved to serve as surroundings file.

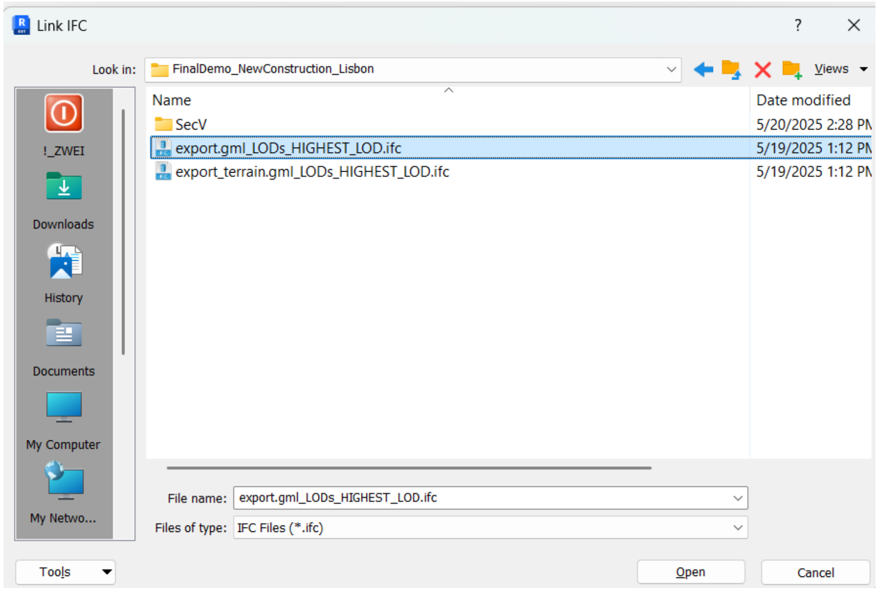


Figure 75 Selecting IFC references to link them in Revit

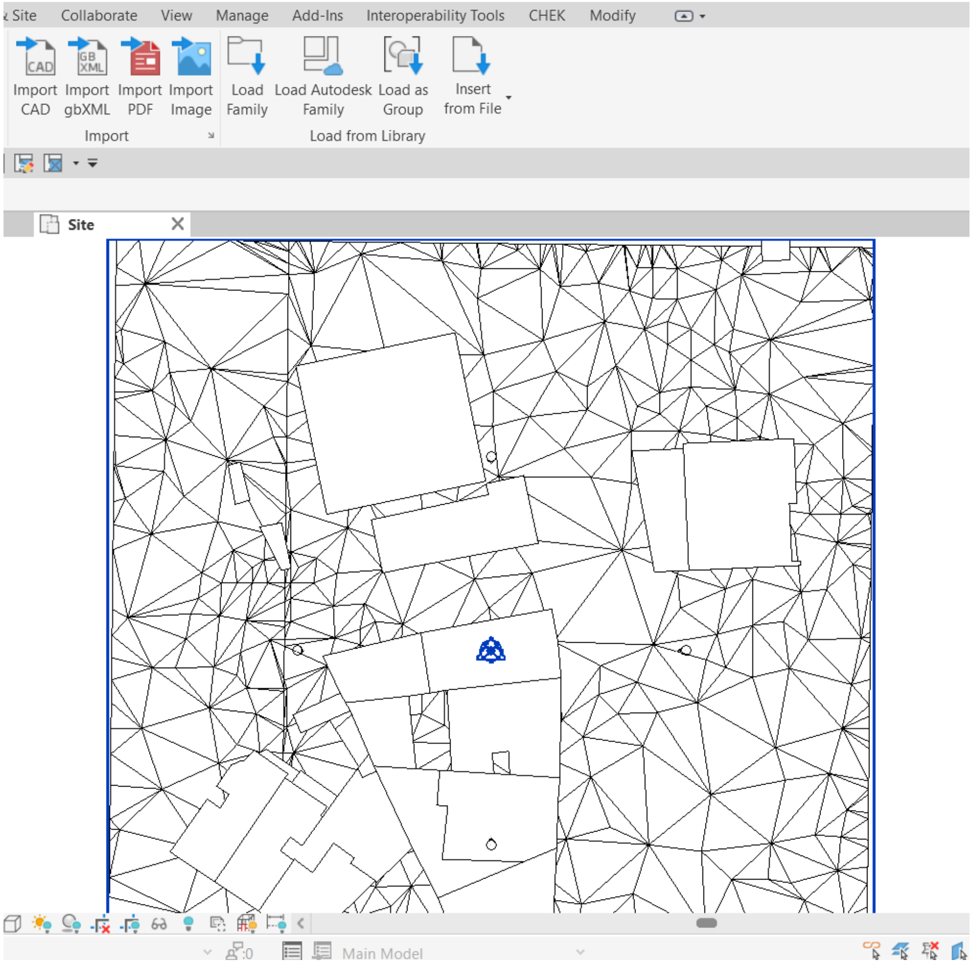



Figure 76 Linked information as shown in Revit

3. Georeferencing of the Revit file was done in order to reflect the realistic spatial context
4. The surroundings Revit file was linked into the Revit Building model

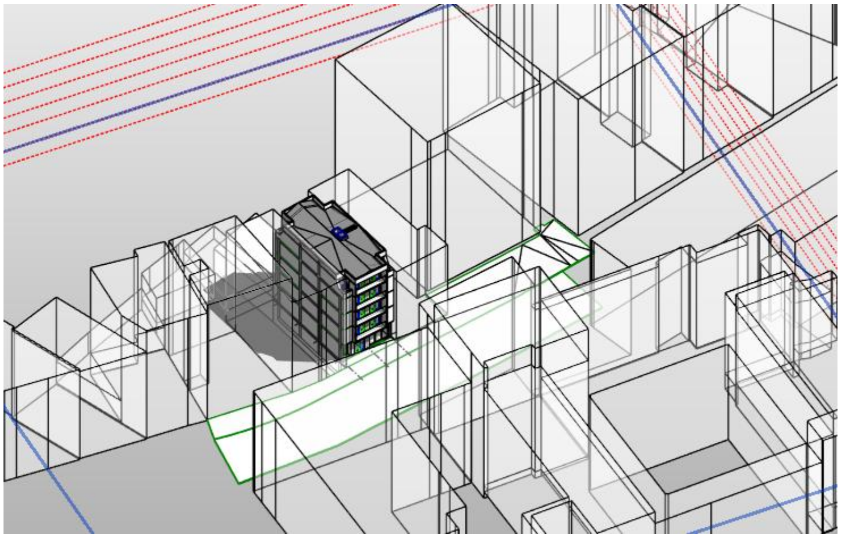


Figure 77 After fitting the initial IFC files, everithing seems to be on site

5. At this moment, the model was exported in IFC with Revit's built-in IFC exporter in order to validate the georeferencing of the model, prior to any additional design development. The part with georeference check in IfcGref tool is presented further in this deliverable. Additionally, the created custom IFC export contained proper georeferencing setup like EPSG code and was saved as custom MVD (Model View Definition).

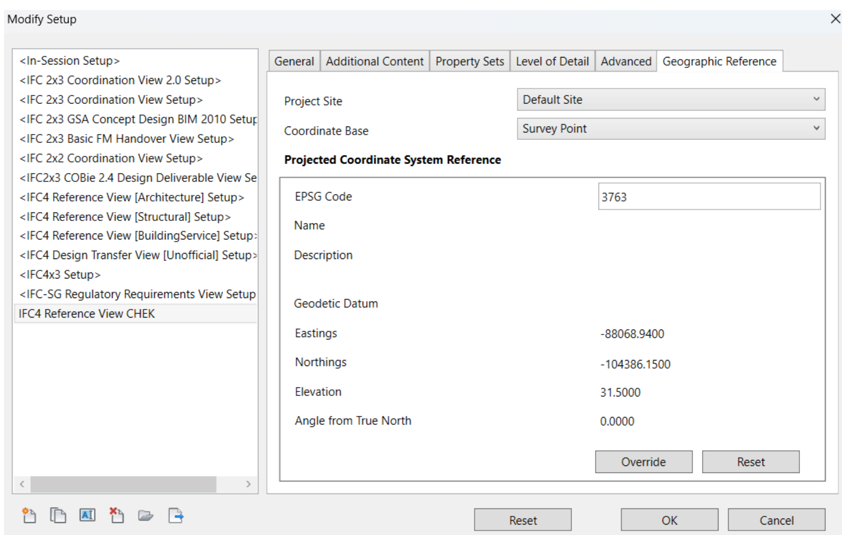



Figure 78 Setting up the built-in exporter to validate georeferencing

6. After a georeferencing check was validated, the design development continued until the model/project was completed.

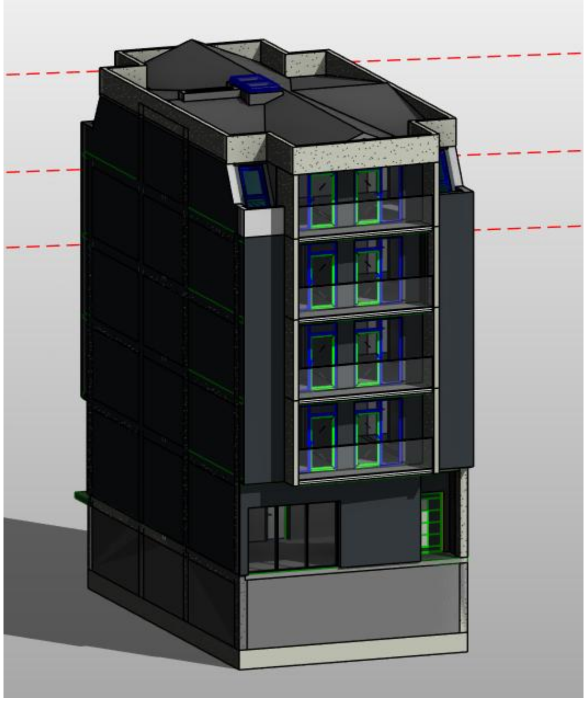


Figure 79 3D view after modeling the project

7. After modeling in Revit was done and relevant attributes were added, the model was exported in IFC with DiRoots IFC Exporter, presented further in this deliverable.

### 3.2.5 Exporting the model – DiRoots Plugin

When modeling in Revit as BIM authoring tool finished, export to IFC was done using the DiRoots plugin IFC Exporter. The DiRoots IFC exporter read the existing custom IFC setup (IFC4 MVD) in Revit and required correct attribute mapping so the required attributes will be transferred to IFC file.

**Inputs:**

- Finalized Revit model
- Custom made MVD inside Revit containing proper EPSG

**Outputs:**

- IFC file

**Process description:**

1. DiRoots IfcExporter was previously installed inside Revit 2025

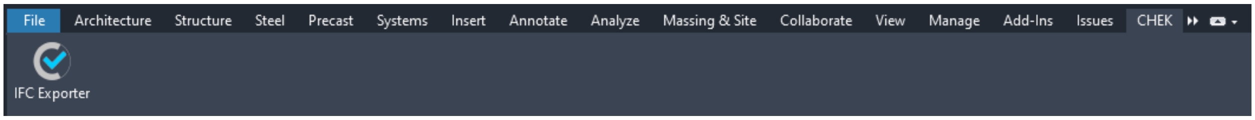



Figure 80 Tool icon to launch the exporter from DiRoots

2. In IFC Exporter, proper IDS was selected, along with IFC Export MVD. In the table, each required IFC property was mapped with corresponding Revit parameters.

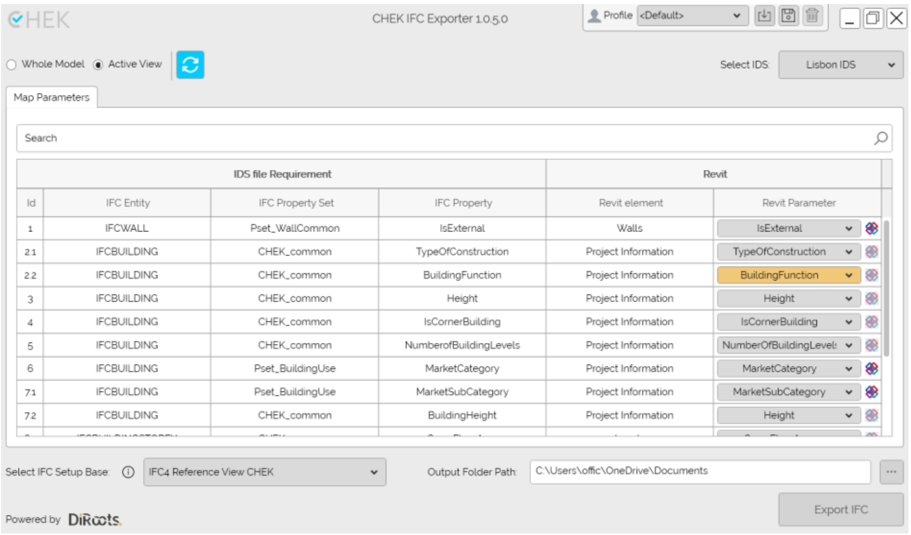



Figure 81 Set up of the exporter, mapping done

3. The DiRoots IFC Exporter created the project IFC model of the building that will be used further in the demonstration.

Figure 82 IFC model ready for demonstrations

### 3.2.6 Georeference assessment - IfcGref

After the project was exported to IFC, a georeferencing validation check was performed in IfcGref tool. IfcGref tool developed by TuDelft, is a web service that validates the proper georeferencing of the IFC files and offers additional tools such as visual inspection of the model on basemap.

**Inputs:**

- Georeferenced IFC model

**Outputs:**

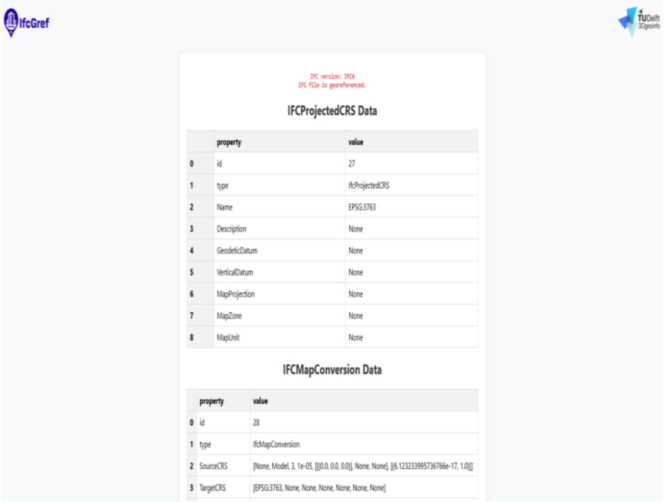
- Validated IFC model

**Process description:**

1. The IFC model of the building was uploaded to IfcGref


Figure 83 Ready for georeference assessment with IfcGref

2. IfcGref tool returned that the model is properly georeferenced


IfcGref

IFC version: IFC4
IFC file is georeferenced.

IFCProjectedCRS Data

| | property | value |
|---|---|---|
| 0 | id | 27 |
| 1 | type | IfcProjectedCRS |
| 2 | Name | EPSG:3763 |
| 3 | Description | None |
| 4 | GeodeticDatum | None |
| 5 | VerticalDatum | None |
| 6 | MapProjection | None |
| 7 | MapZone | None |
| 8 | MapUnit | None |

IFCMapConversion Data

| | property | value |
|---|---|---|
| 0 | id | 28 |
| 1 | type | IfcMapConversion |
| 2 | SourceCRS | [None, Model, 3, 1e-05, [[(0.0, 0.0, 0.0)]], None, None], [(6.123233995736766e-17, 1.0)]] |
| 3 | TargetCRS | [EPSG:3763, None, None, None, None, None, None] |

Figure 84 Successful georeference

### IFCMapConversion Data

| | property | value |
|---|---|---|
| 0 | id | 28 |
| 1 | type | IfcMapConversion |
| 2 | SourceCRS | [None, Model, 3, 1e-05, [[(0.0, 0.0, 0.0)]], None, None], [(6.123233995736766e-17, 1.0)]] |
| 3 | TargetCRS | [EPSG:3763, None, None, None, None, None, None] |
| 4 | Eastings | -88068.94 |
| 5 | Northings | -104386.15 |
| 6 | OrthogonalHeight | 31.5 |
| 7 | XAxisAbscissa | 1.0 |
| 8 | XAxisOrdinate | 0.0 |
| 9 | Scale | None |

Show on Map

Figure 85 Zoom to detailed data of the IfcGref report

3. The model was properly positioned on the map

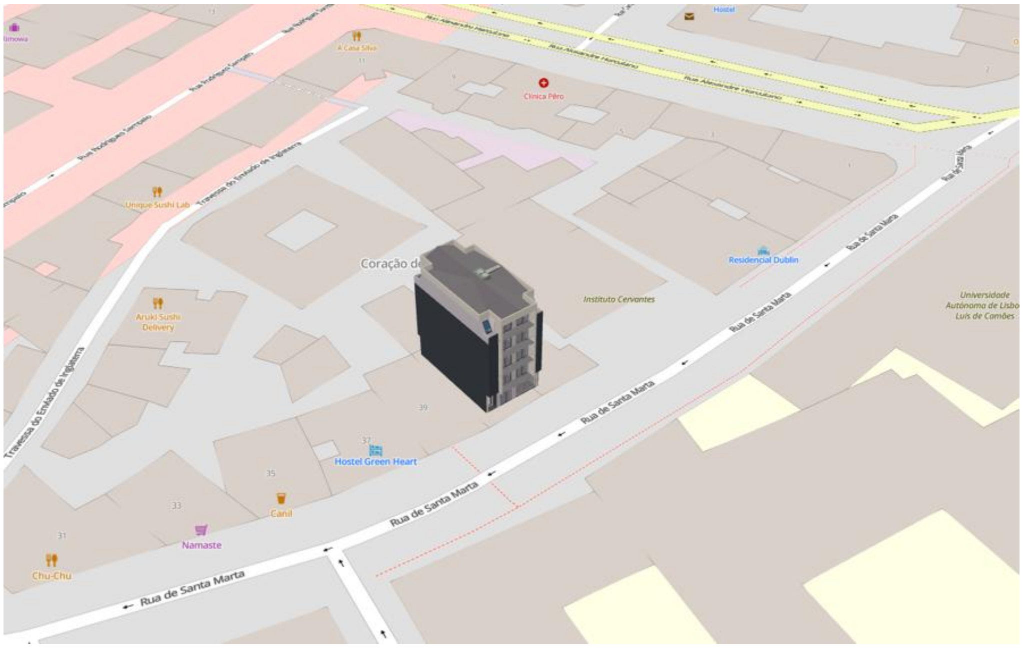



Figure 86 Graphical assessment in IfcGref

### 3.2.7 IFC validation – RDF's IfcViewer

To ensure validity of the IFC model data for further regulations compliance checks, the IFC model was checked against EXPRESS and IDS requirements. This check was performed using the RDF's tool IfcViewer, a portable desktop application.

**Inputs:**

- IFC model and Lisbon IDS file

**Outputs:**

- Validated IFC model against IDS and EXPRESS schema

**Process description:**

1. The IFC model of the building was opened with IfcViewer

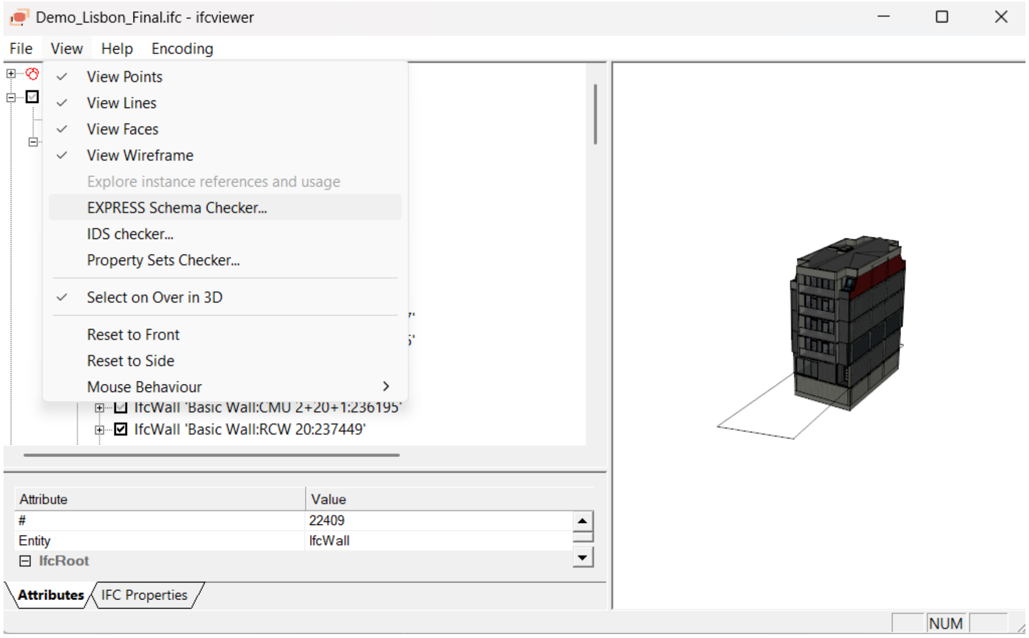



Figure 87 Ready to perform IFC quality assessment with RDF's

2. The EXPRESS Schema Checker returned the results


Figure 88 Report after running the EXPRESS Schema Checker

3. The IDS checker requested import of Gaia pilot specific IDS file and after it was imported returned the following results:

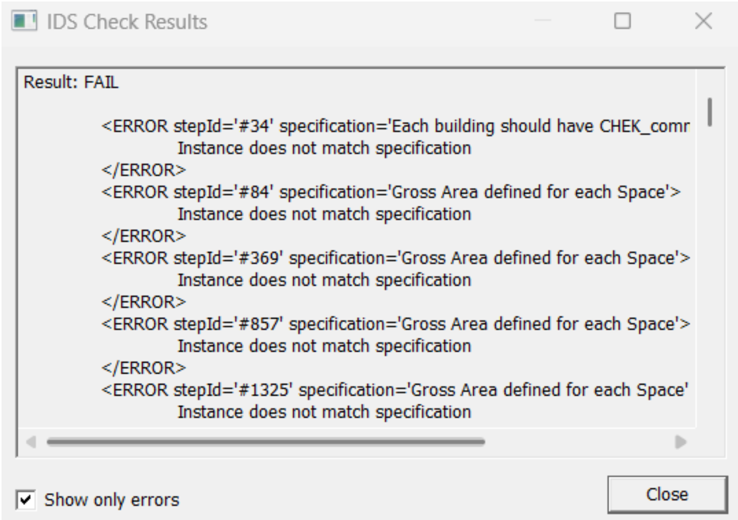



Figure 89 Report after running the IDS Checker

4. Both checkers returned some failed results.

### 3.2.8 Uploading the model to the CHEK platform - BIMServer.Center

IFC model was validated against georeferencing, EXPRESS schema and IDS requirements. Next step was to be uploaded as Contribution to the project folder on the CHEK DBP platform based on BIMServer.Center. This contribution was later connected to CYPEURBAN and VC Map for performing self check against predefined rules.

**Inputs:**

- IFC model

**Outputs:**

- Validated IFC model as contribution in BIMServer.Center

**Process description:**

1. New contribution was initiated in the project folder in BIMServer.Center

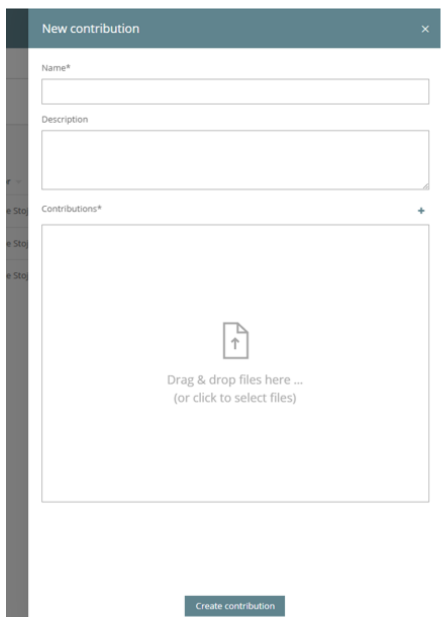



Figure 90 Creating the contribution in BSC to include the project in validated IFC format

2. After uploading the IFC model in the contribution, the platform automatically generated a GLTF version for visualization purposes. While the IFC format remains the core data structure for the CHEK workflow (including validation, regulation checking, and interoperability across tools such as CYPEURBAN and VCMap) the BIMserver.center platform automatically creates a lightweight GLTF representation upon upload. This GLTF model is not used for any form of compliance checking or validation. Its sole purpose is to facilitate faster online visualization within the Common Data Environment (CDE), allowing users to quickly preview the contribution geometry, typically limited to the outer envelope or basic shapes of the building. Internal elements and metadata are omitted in this representation to optimize performance. The original IFC file remains the authoritative source for all subsequent operations within the CHEK ecosystem.

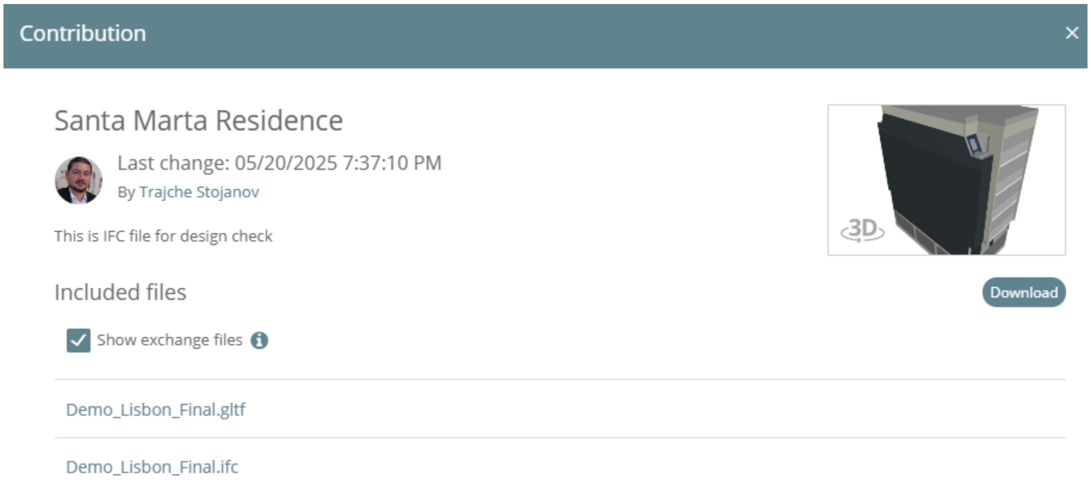



**Figure 91 GLTF automatic conversion in BSC to let visualize the project**

### 3.2.9 CHEK pre-validation, using tool VC Map

Prior to performing final checks in checking application, Designers did selfcheck of the IFC model in this stage. The self-check returned some failed checks. This pre-validation is very beneficial in self assessment of the model prior to submitting it for Review by the Municipalities.

**Inputs:**

- IFC model

**Outputs:**

- Validated IFC model as contribution in BIMServer.Center

**Process description:**

1. After Designers logon the VCMap platform and connected the BIMServer.Center account, the IFC model was converted to Visualization Model in order to be visualize

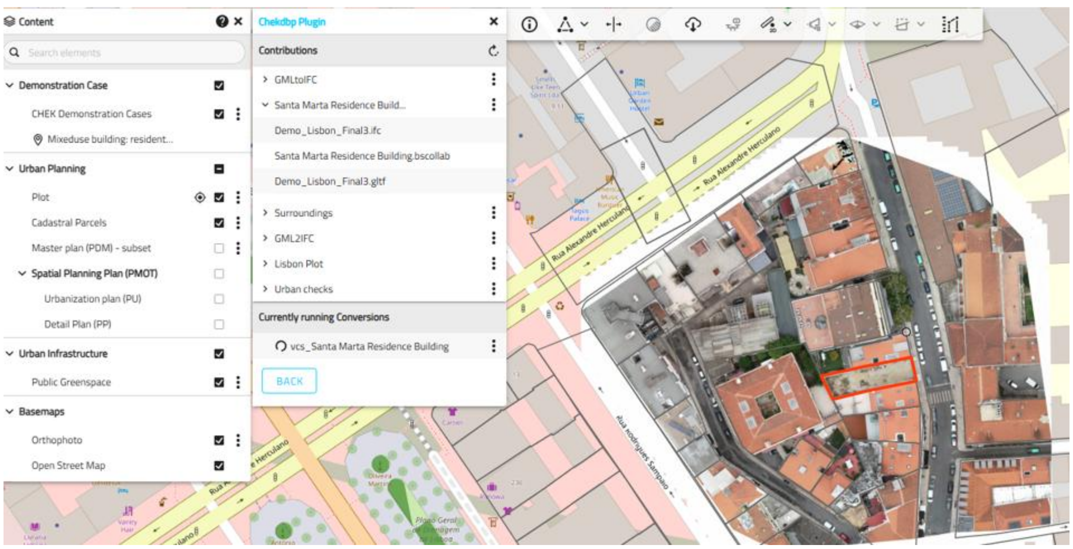



Figure 92 Visualization model conversion ongoing in VCMap

2. After converting the model into Visualization Model, conversion to Semantic Model was performed

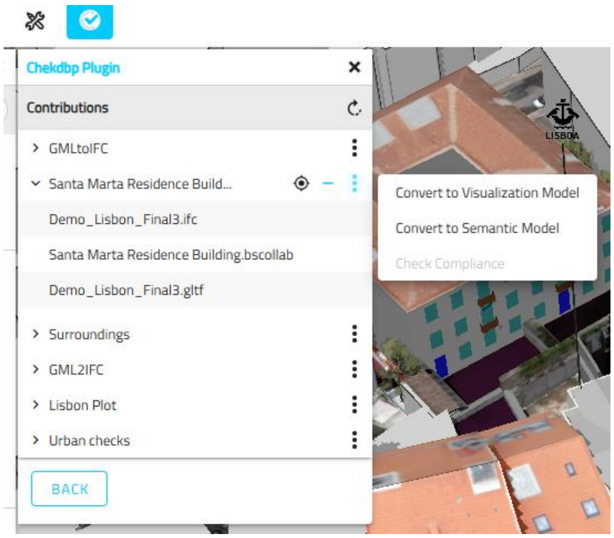



Figure 93 Ready to perform the visualization convert

3. With both conversions completed, the check compliance was performed

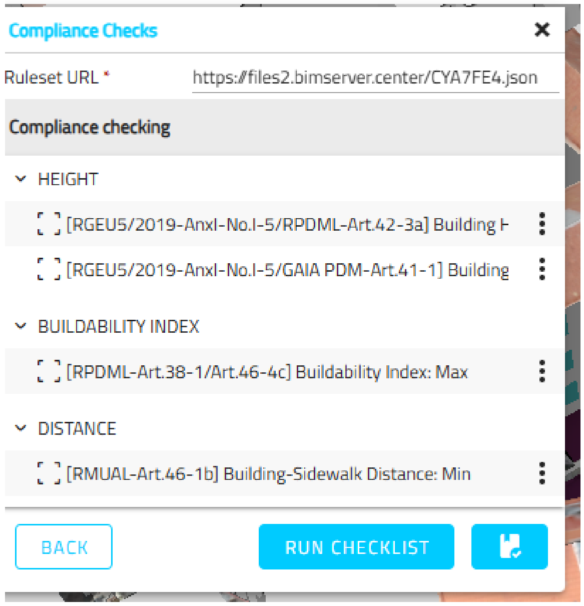



Figure 94 List of implemented regulations in VCMap for this pilot

4. The compliance check returned some failed checks

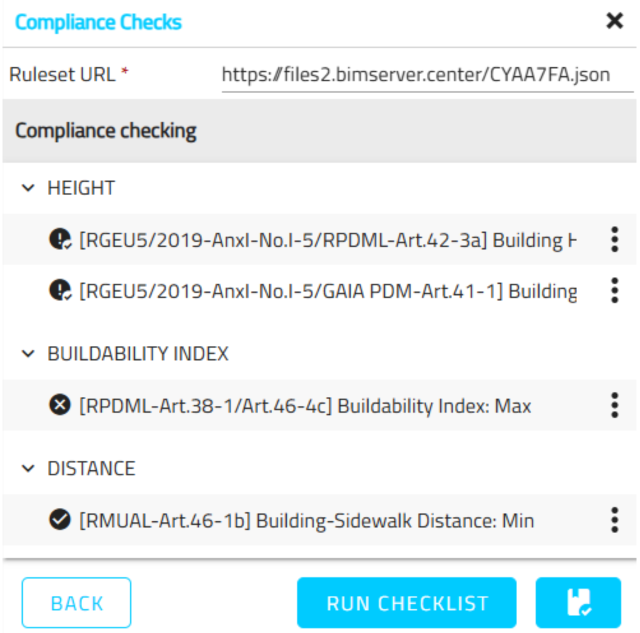



Figure 95 online report after running automatic the checklist

5. To have a successful project, designers made changes to the model in Revit as BIM authoring tool of choice.

### 3.2.10 CHEK pre-validation - CYPEURBAN

After the first set of compliance pre-check done in VC Map, Designers did self-check with CYPEURBAN tool too. The self-check returned some failed checks.

**Inputs:**

- IFC model

**Outputs:**

- Validated IFC model as contribution in BIMServer.Center

**Process description:**

1. Designers created a new project in CYPEURBAN and connected the BIMServer.Center account in order to have seamless flow of data

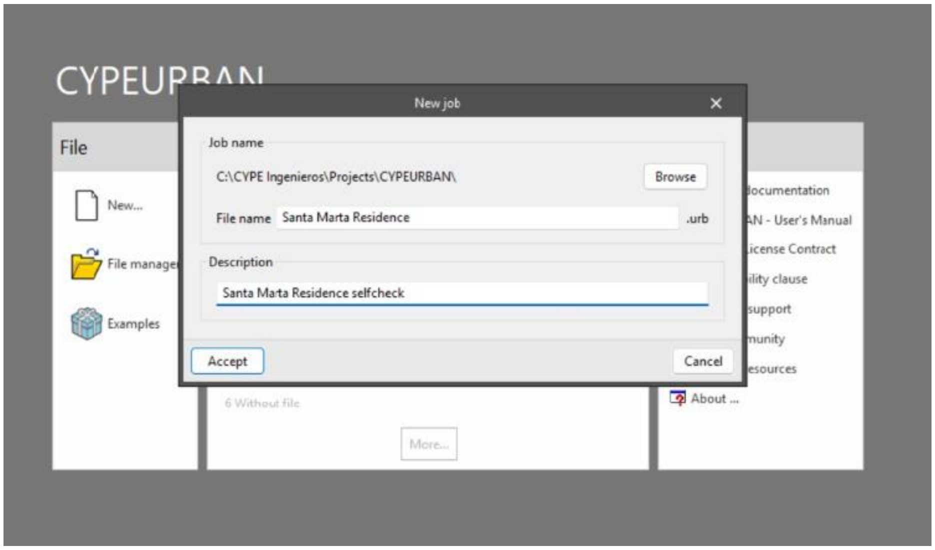



Figure 96 Creation a new project in user device, that will connect to CDE

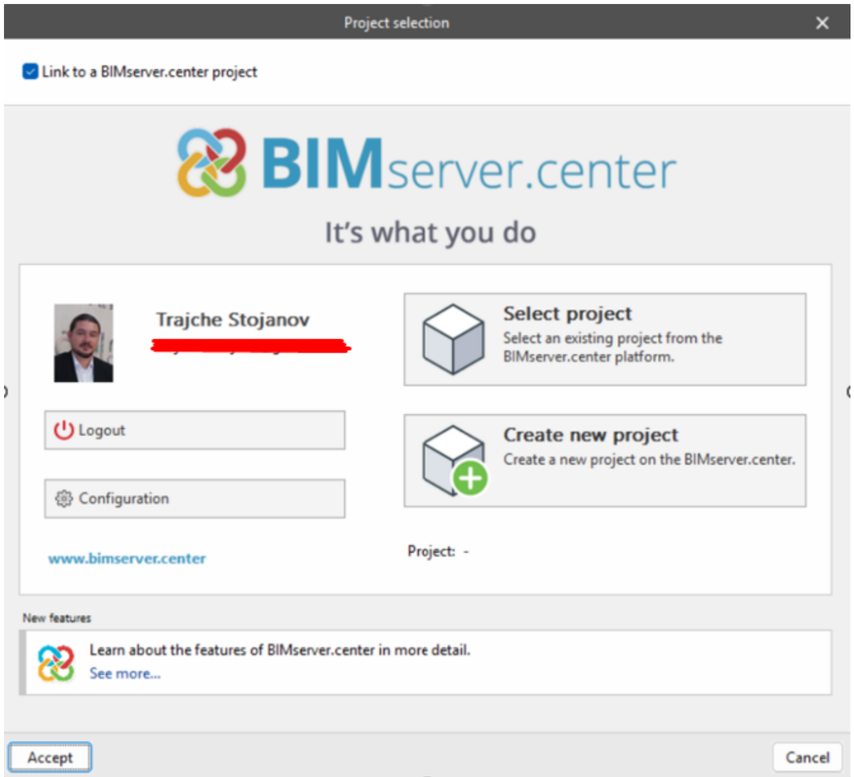


Figure 97 Logging into BSC, to enable project selection

2. The project files were opened

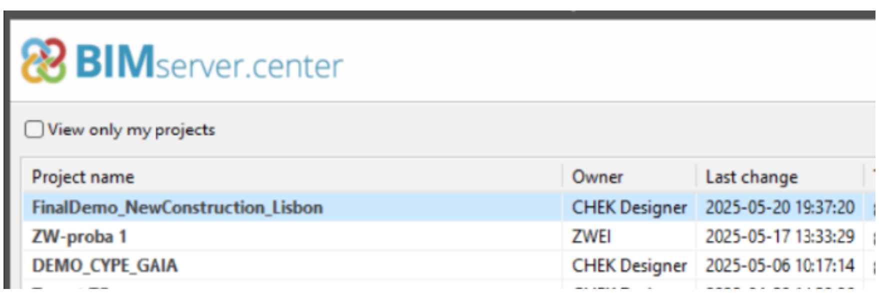


Figure 98 List of available projects in BSC, as CYPEURBAN shows it

3. Lisbon regulations checks were chosen

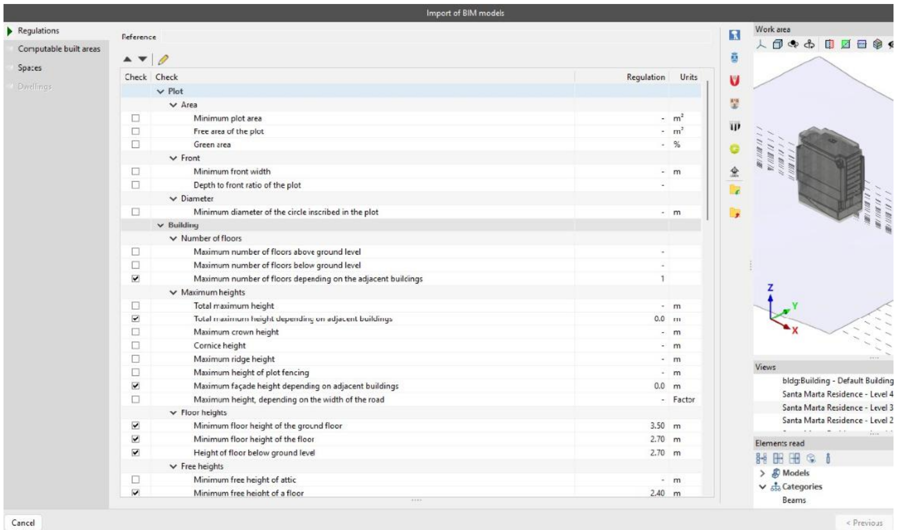



Figure 99 Selecting the municipality will show the list of regulations implemented

4. Certain model elements were properly defined, like rooms, building levels, setbacks etc.

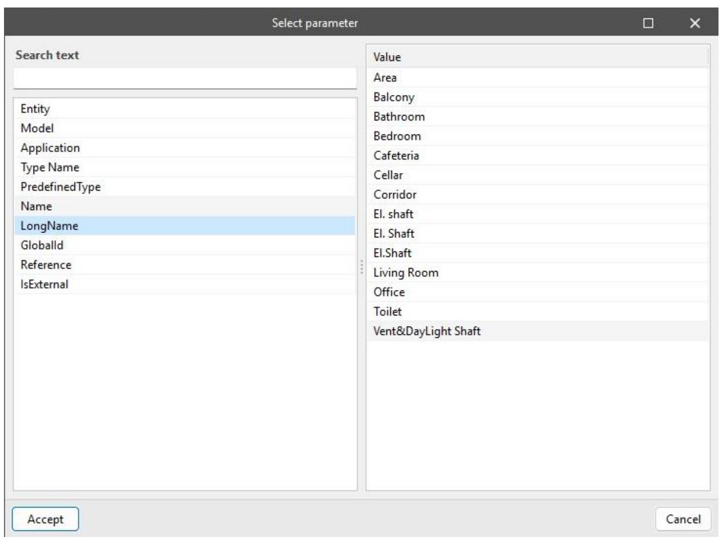



Figure 100 IfcSpaces mapping to let CYPEURBAN perform some checks

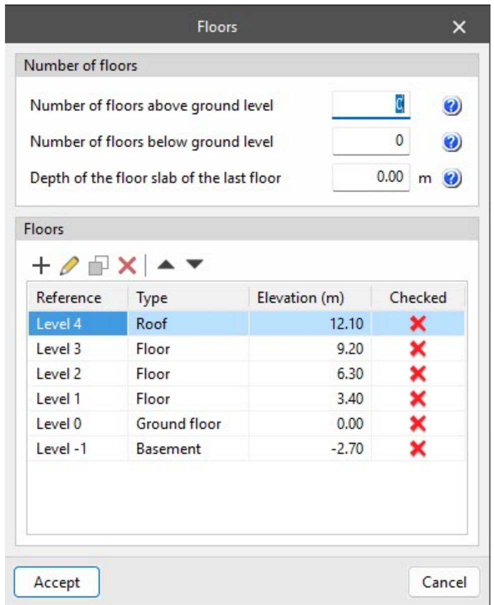



Figure 101 Editing the floor names to follow the software conventions

5. After setting up the project, the automatic code compliance check was initiated returning some failed checks

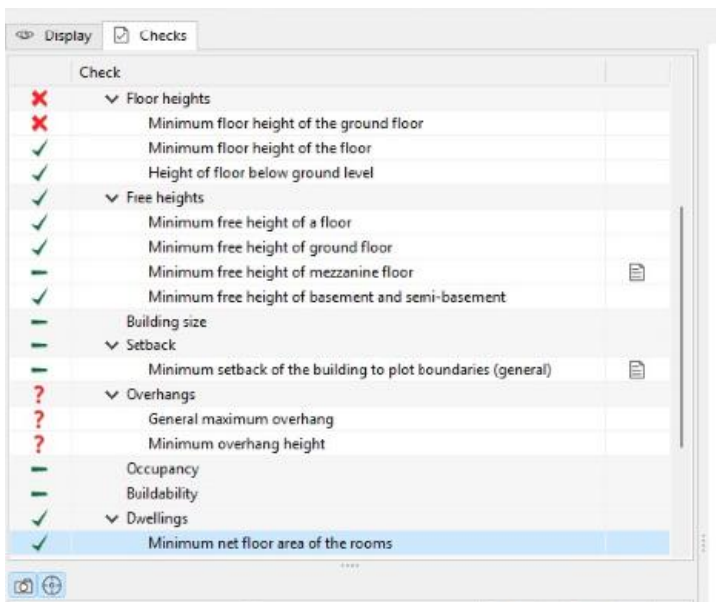



Figure 102 Aspect of check list during the assesments

6. The results of performed self-check in CYPEURBAN were used to correct the model in Revit

### 3.2.11 Model Evolution during Software Development and Pilot Testing

During the validation process for the Lisbon pilot, several adjustments were made to the original BIM model to comply with both the analog urban planning rules and the digital validation requirements defined by the CHEK environment. Most of the modifications focused on correcting minor discrepancies in level elevations, especially the ground floor height and overall building height, which were necessary to satisfy the constraints defined in the urban regulation dataset.

In addition to geometric changes, further refinements were introduced to ensure that the IFC model complied with the IDS (Information Delivery Specification) requirements and the expectations of the software developers. These included the addition and correction of parameters required for automatic validation in tools such as Verifi3D and CYPEURBAN, including custom property sets for level usage, occupancy, and plot-related metadata.

The corrected model was authored using Autodesk Revit 2025 and exported using the DiRoots IFC Exporter, ensuring improved alignment with the EXPRESS schema and enhancing interoperability with downstream tools in the CHEK ecosystem.

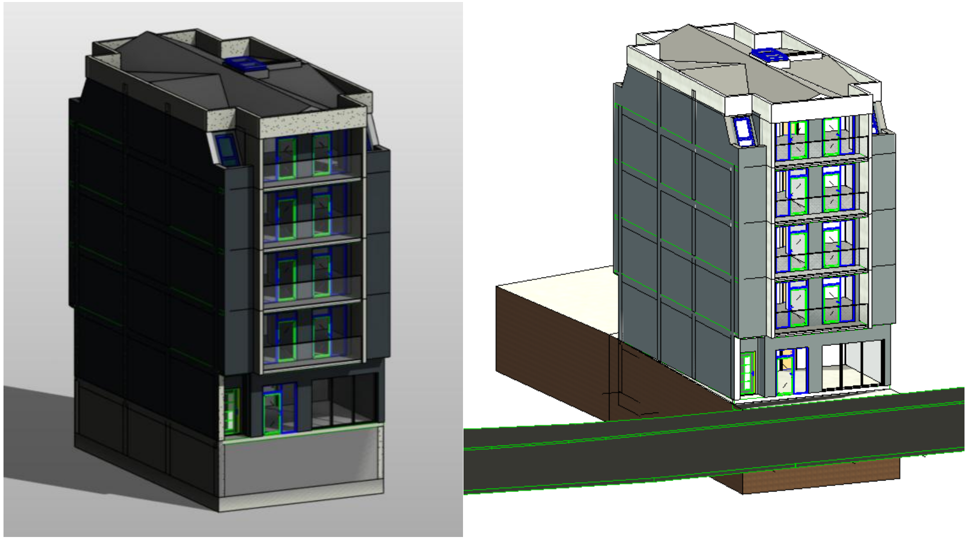


**Figure 103 LISBON's on its first version (left) before software development and demos performance, and on its last version (right) after the same process. Minor geometric changes where made.**

### 3.2.12 Digital signature of the IFC model - DiStellar

Updated IFC file was digitally signed in DiRoots DiStellar with Signature functionality that run on personal account connected with personal account on Designer's phone. The digital signature tool added additional information in the IFC file that can be assesed only by DiStellar app.

**Inputs:**

- IFC model

**Outputs:**

- Digitally signed IFC file

**Process description:**

1. The DiStellar app was opened and Designers logged in

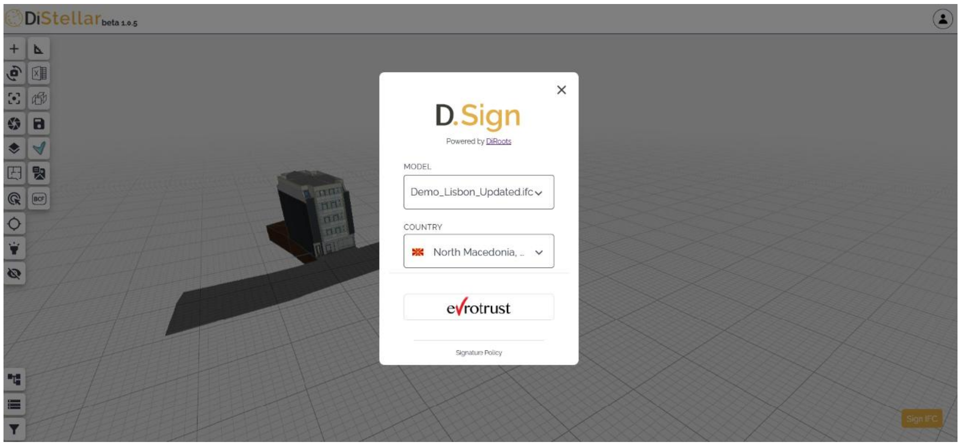



Figure 104 Starting the signing gadget in DiStellar

2. BIMServer.Center was connected

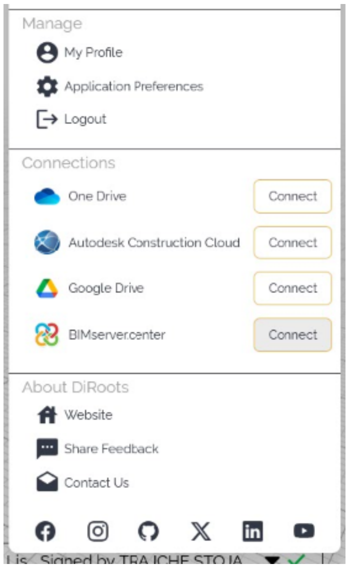



Figure 105 Cloud services available from the tool, among them BSC

3. The updated IFC model was uploaded and digitally signed

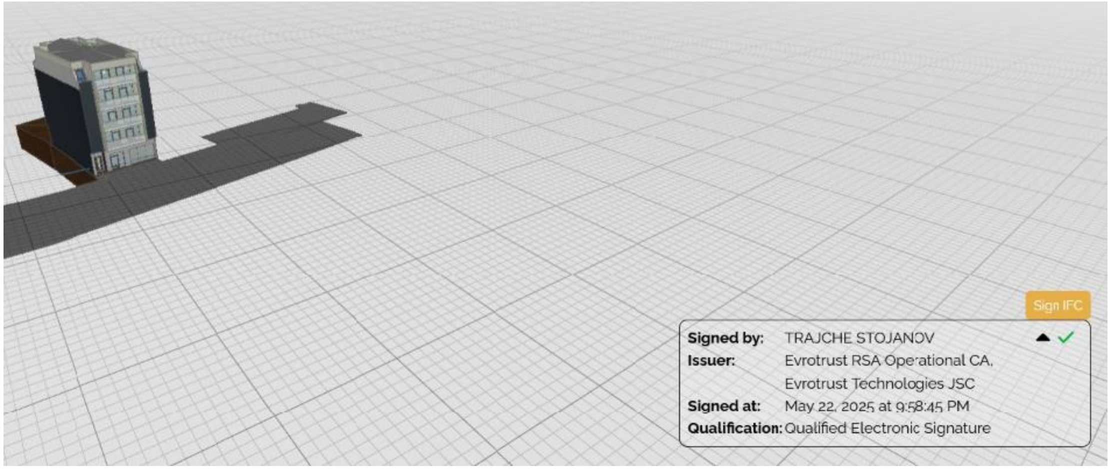



Figure 106 Uploaded and signed IFC file

4. Signed IFC model was uploaded to BIMServer.Center in project folder

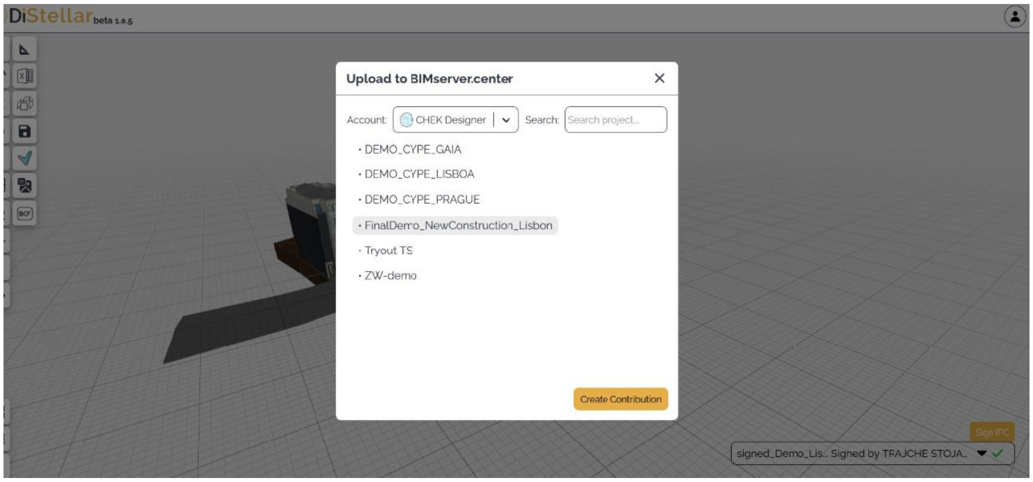



Figure 107 performing the upload of signed file into BIMserver.Center

## 3.2.13 CHEK final-validation and report to municipalities – VCMap/CYPEURBAN

The final step in Designers workflow was performing final validation (compliance check) of the IFC model and sharing the check report to Municipality of Lisbon via BIMServer.Center. The final validation was performed in VC Map and CYPEURBAN, repeating the steps described in items 9 and 10 of this case study. Not to repeat the same steps, in this stage we are describing the steps after the check is performed.

**Inputs:**

- Digitally signed IFC model

**Outputs:**

- Shared json files as a check results file

**Process description:**

1. In VCMap platform, the updated IFC model was converted to Visualization Model and later to Semantic Model. The Compliance checks were performed. The results were shared

2. The newly uploaded updated digitally signed IFC model was opened in CYPEURBAN and Lisbon regulation checks were performed

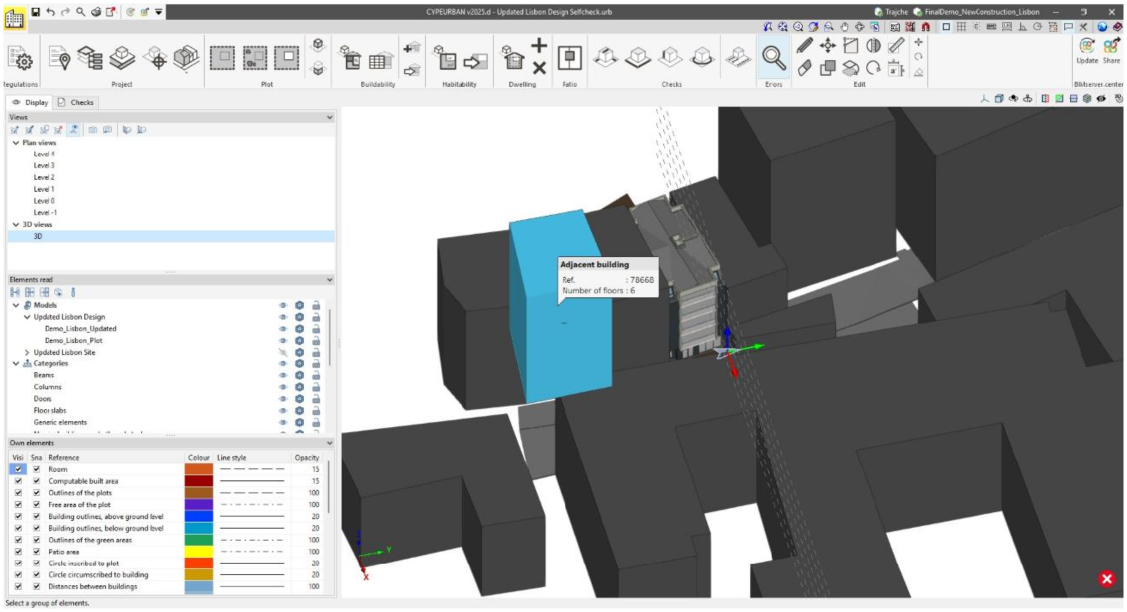


Figure 108 Performing cross-checking of the pilot using CYPEURBAN

3. The check results showed successful checks.

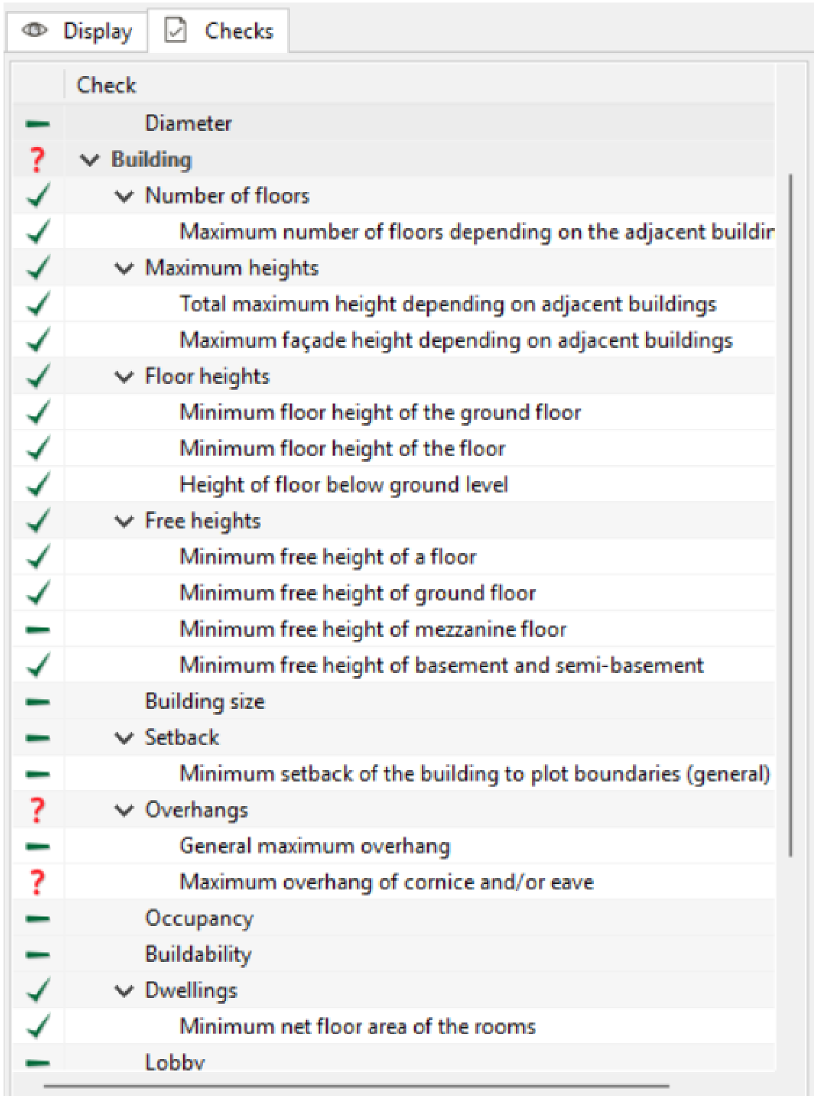



Figure 109 Results showing many successful checks

4. The results and report of performed checks were shared via BIMServer.Center to the Municipality of Lisbon for final review.

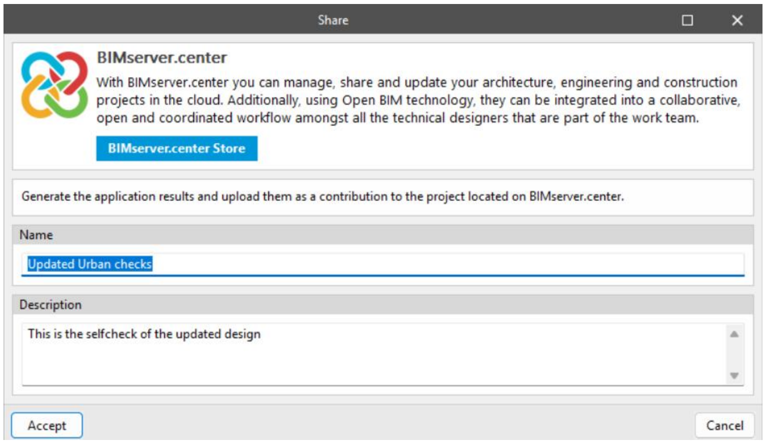
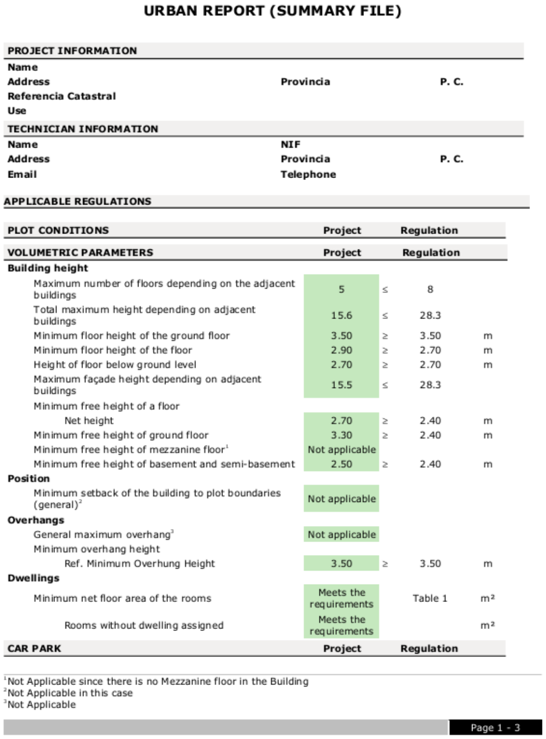



Figure 110 Sharing the report with municipalities via BSC



**URBAN REPORT (SUMMARY FILE)**

| | | | | | |
|---|---|---|---|---|---|
| **PROJECT INFORMATION** | | | | | |
| **Name** | | | | | |
| **Address** | **Provincia** | | **P. C.** | | |
| **Referencia Catastral** | | | | | |
| **Use** | | | | | |
| **TECHNICIAN INFORMATION** | | | | | |
| **Name** | **NIF** | | | | |
| **Address** | **Provincia** | | **P. C.** | | |
| **Email** | **Telephone** | | | | |
| **APPLICABLE REGULATIONS** | | | | | |
| **PLOT CONDITIONS** | **Project** | | **Regulation** | | |
| **VOLUMETRIC PARAMETERS** | **Project** | | **Regulation** | | |
| **Building height** | | | | | |
| Maximum number of floors depending on the adjacent buildings | 5 | ≤ | 8 | | |
| Total maximum height depending on adjacent buildings | 15.6 | ≤ | 28.3 | | |
| Minimum floor height of the ground floor | 3.50 | ≥ | 3.50 | m | |
| Minimum floor height of the floor | 2.90 | ≥ | 2.70 | m | |
| Height of floor below ground level | 2.70 | ≥ | 2.70 | m | |
| Maximum façade height depending on adjacent buildings | 15.5 | ≤ | 28.3 | | |
| Minimum free height of a floor | | | | | |
| Net height | 2.70 | ≥ | 2.40 | m | |
| Minimum free height of ground floor | 3.30 | ≥ | 2.40 | m | |
| Minimum free height of mezzanine floor[1] | Not applicable | | | | |
| Minimum free height of basement and semi-basement | 2.50 | ≥ | 2.40 | m | |
| **Position** | | | | | |
| Minimum setback of the building to plot boundaries (general)[2] | Not applicable | | | | |
| **Overhangs** | | | | | |
| General maximum overhang[3] | Not applicable | | | | |
| Minimum overhang height | | | | | |
| Ref. Minimum Overhung Height | 3.50 | ≥ | 3.50 | m | |
| **Dwellings** | | | | | |
| Minimum net floor area of the rooms | Meets the requirements | | Table 1 | m² | |
| Rooms without dwelling assigned | Meets the requirements | | | m² | |
| **CAR PARK** | **Project** | | **Regulation** | | |

[1] Not Applicable since there is no Mezzanine floor in the Building
[2] Not Applicable in this case
[3] Not Applicable

Page 1 - 3

Figure 111 How the PDF report from CYPEURBAN shows

### 3.2.14 CHEK permitting tools. Municipality side workflow review

After completion of the designer's workflow, the Municipality of Lisbon engaged in the official review of the submitted materials using their municipal account within the CHEK DBP platform hosted on BIMserver.center.

**Inputs:**

- Digitally signed IFC model uploaded by the designer (designer account login)
- Validation results from CYPEURBAN.
- Validation results from VCMap.
- Contribution files available in BIMserver.center (designer account login)

**Outputs:**

- Rule-by-rule assessment of compliance for CYPEURBAN and VCMap.
- Summary report issued by the Municipality of Lisbon detailing the correctness, usability, and limitations of the validation tools.

**Process Description:**

1. Municipal reviewers logged into their official CHEK Municipality account in BIMserver.center and accessed the project folder.
2. A formal "Request for Review" was received automatically through the platform following the designer's submission.
3. Reviewers used both CYPEURBAN and VCMap to cross-check the validation results, rule by rule, against the applicable Portuguese regulations (RGEU, RMUEL, PUALZE, etc.).
4. The reviewers assessed each clause's compliance status, determined whether it was correctly verified, and indicated if the software produced false positives or missed validations.
5. In CYPEURBAN, despite the tool's potential, numerous limitations were identified:
    i. Lack of direct link between the IFC model data and rule checking. Many checks required manual input that should have been automated.
    ii. False positives were frequent, especially in adjacency and height-related clauses.
    iii. Absence of clear, in-model 3D graphical feedback made validation difficult. Reviewers emphasized the importance of spatial representation akin to clash detection mechanisms.
    iv. Several clauses lacked reference to legal articles, reducing traceability.
    v. Many checks were either unavailable or failed to execute correctly despite being listed.
6. In VCMap, the validation workflow performed better:
    i. Reviewers validated building height against topographical survey data, confirming a minimal deviation (52 cm) and thus accepting the results.
    ii. However, other clauses such as Buildability Index and Setbacks were either incomplete or missing important references and interactive features.
    iii. VCMap's visualization was appreciated but requires improvement: suggestions included color-coded compliance feedback and clearer interface integration for legal clause identification.
7. Due to technical and usability issues across both tools, several review actions had to be done manually or outside of the intended automated workflow.
8. The final review summary, compiled by the municipality, concluded that while the tools show significant potential, they are currently in a "work in progress" state and require improvements in user experience, graphical representation, automatic parameter extraction, and rule traceability.

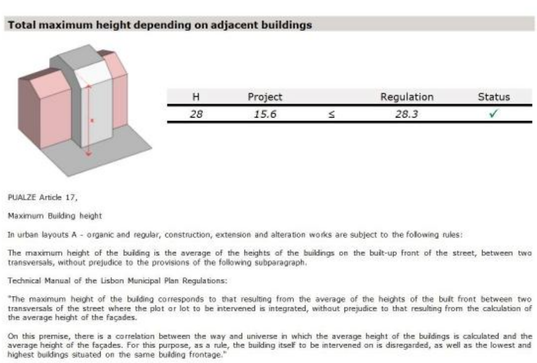
**Table 4 – Regulations Compliance Table (Lisbon Municipal Review)**

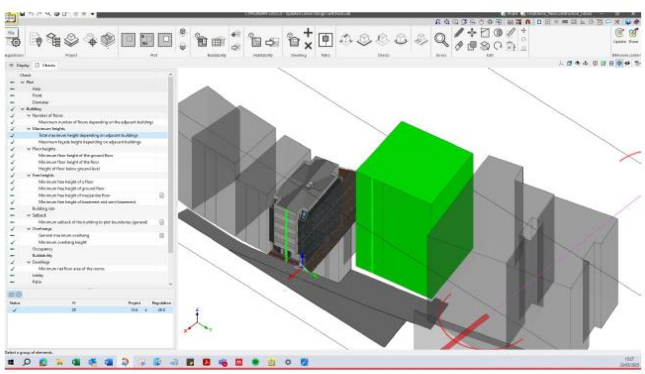
| Clause/Regulation | Software | Compliance Status | Comments |
|---|---|---|---|
| Art. 59 (Building Height) | VCMap | Compliant | Deviation of 52 cm, accepted by reviewers |
| Art. 70 (Setback to Street) | CYPEURBAN | Not verified | Missing link to geometry; manual check needed |
| Art. 75 (Buildability Index) | VCMap | Incomplete | Rule present but lacked value reference |
| Art. 81 (Adjacent Distances) | CYPEURBAN | False positive | Incorrectly flagged compliant geometry |
| Art. 91 (Fire Safety Parameters) | CYPEURBAN | Not Applicable | Listed, but not implemented in model or software |
| Art. 102 (Ground Floor Elevation) | VCMap | Verified | Visual confirmation in platform accepted |
| General Article References | Both | Inconsistent | Legal references missing or unclear in several cases |

**Recommendations from the Municipality:**

- Enhance graphical compliance visualization in 3D model viewers.
- Improve automated data extraction from IFCs to reduce manual entry.
- Ensure all clauses include legal references and are accessible even if marked as "not applicable" by designers.
- Strengthen interoperability between design tools and CYPEURBAN.
- Clarify expected file formats and workflows within BIMserver.center for municipalities.
-

The Lisbon validation process has highlighted the critical importance of municipal participation in refining the permitting tools and ensuring they meet real-world usability standards for local authorities.



The tool requires users to manually adjust the 3D view or generate elevations and sections to properly assess the condition under analysis (see image). It is critical to ensure a clear graphical perception and three-dimensional contextualisation of regulatory compliance or non-compliance directly within the 3D model environment.

**Figure 112 Example of municipality cross-checking. Building height assessments**

## 3.3 Prague

The pilot developed for the municipality of Prague falls under Scenario 1 – New Building Construction of the CHEK project. The pilot project consists of a newly constructed public educational facility (a primary school), described in more detail in section 3.1.4 of deliverable D6.1 "Plan for demonstration of CHEK Digital Building Permit process on demo sites".

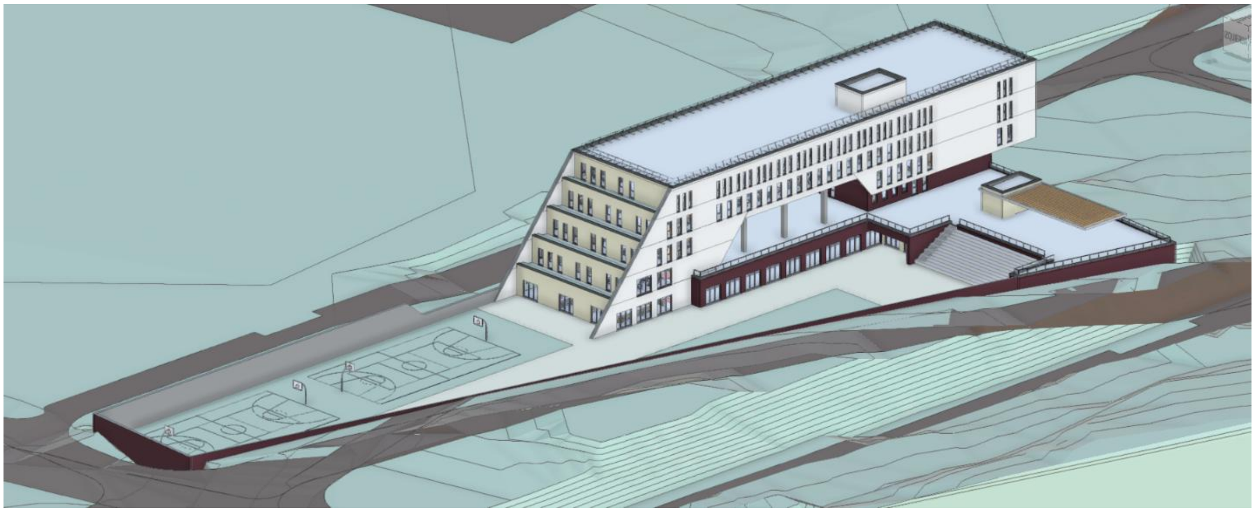


Figure 113 Final version for pilot scenario 1 Prague

The responsible designer was SIA Arquitects, who developed the BIM model using Autodesk Revit. Unlike the GAIA pilot, the official DiRoots plugin was successfully used in this case for exporting to IFC format, after resolving a conflict with an outdated plugin previously installed in Revit.
The model was integrated into the Common Data Environment (CDE) via the BIMserver.center platform, together with additional contributions corresponding to terrain and adjacent buildings. These were extracted from VCMap in CityGML format and later converted to IFC using the online converter developed by RDF.
The validation workflow included georeferencing verification (using IFCGref), structural compliance checks against the project's IDS (via IDS Checker), digital signing of the model (using DiStellar), and urban and building regulation validation through Verifi3D and VCMap. CYPEURBAN was not used in this pilot.
Several technical challenges were encountered during the demonstration, particularly regarding the use of municipal accounts within the CHEK ecosystem. In Verifi3D, validation on the municipality side was only possible using designer accounts of municipal technicians invited as collaborators of the design. In VCMap, generation of the semantic model required the processing timeout to be extended to two hours. Additionally, the signed IFC file could not be uploaded to the validator's environment, so it was delivered manually. These issues are described in detail in the following sections.

**Table 5 – Key Findings after performing demo scenario 1 on PRAGUE's pilot**

| Aspect | Finding |
|---|---|
| IFC Export | Successfully executed using DiRoots plugin after resolving conflicts with legacy exporters. |
| Parameter Mapping | IDS compliance was manually achieved using custom parameters and Dynamo scripts, for massive editing, in the case of windows. |
| Georeferencing | Accurately preserved through Revit + DiRoots, confirmed with IfcGref. |
| Validation | Multiple tools used: Verifi3D (2 checks passed), and VCMap (2/3 checks passed; 1 failed intentionally). |
| Municipal Review | Municipality needed to use designer accounts due to access restrictions; formal validation loop incomplete. |
| Workflow Gaps | Major interoperability and visibility issues between designer and municipal roles in the CHEK ecosystem. |
| Tool Stability | Semantic Model conversion in VCMap required timeout increase and geometry simplification. |

The Prague pilot exposed persistent challenges in account management, role-based access, and traceability across the CHEK ecosystem. Unlike other pilots, Prague demonstrated that even when validations are technically successful, the formal permitting process may still fail if interoperability and governance between stakeholders are not properly addressed. Future developments should focus not only on refining tools, but on closing the institutional and procedural gaps that prevent full digital validation loops.

### 3.3.1 Gathering initial data – VCMap

**Settings:**

- Project created in BIMserver.center under the name DemoFinalScenario1_IPR.
- It was correctly tagged with the keyword "Prague" to ensure visibility and automatic linkage with VCMap.

**Inputs:**

- None

**Outputs:**

- Exported contribution from VCMap named VCMapInitInfo, including:
  - CityGML files for terrain and adjacent buildings
  - DXF and DWG files containing terrain and surrounding buildings

**To Improve:**

- Same usability limitations previously reported in the GAIA demo apply here.

**Process Description:**

The project was first created in BIMserver.center using the standard setup already described in the GAIA demo. It was initially tagged as "Praga", which caused a visibility error in VCMap, as the system only recognizes English-language tags. Once this issue was identified, the tag was manually corrected to "Prague", which successfully established the link with the available GIS data.

From VCMap, the essential geographic data for the building design (the terrain and surrounding buildings) was downloaded. The export functions already known from previous use of VCMap were employed to obtain the data in CityGML format.

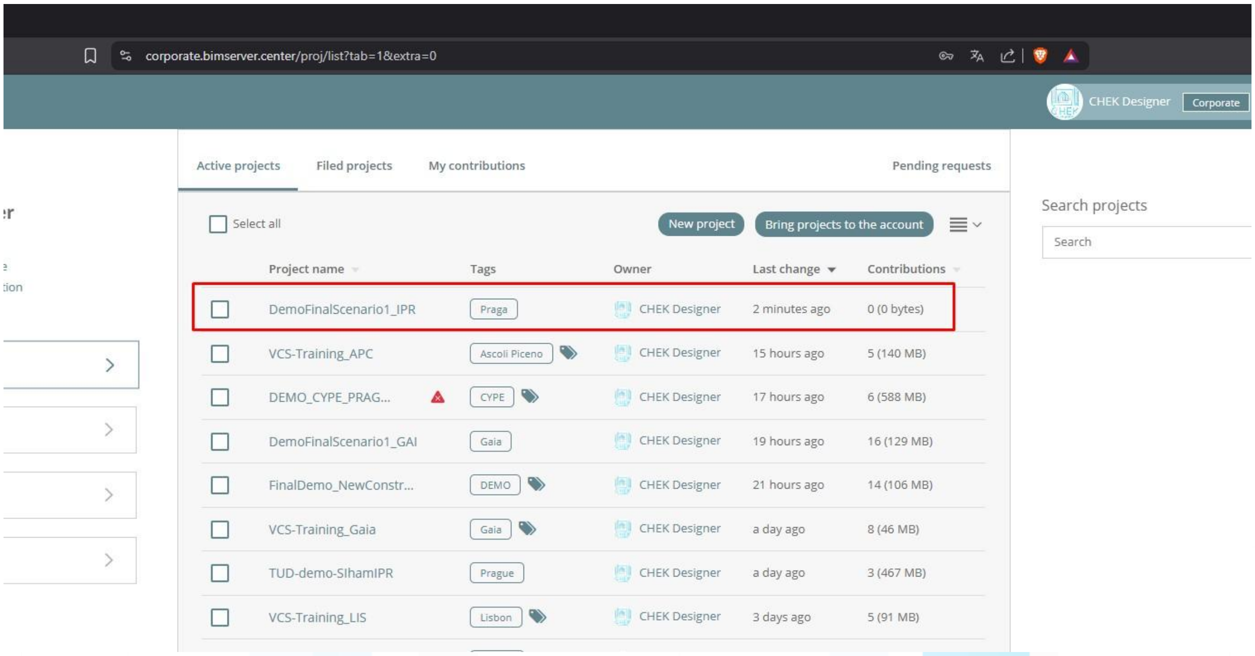



**Figure 114 Incorrect tagging of the project. Convention must be followed**

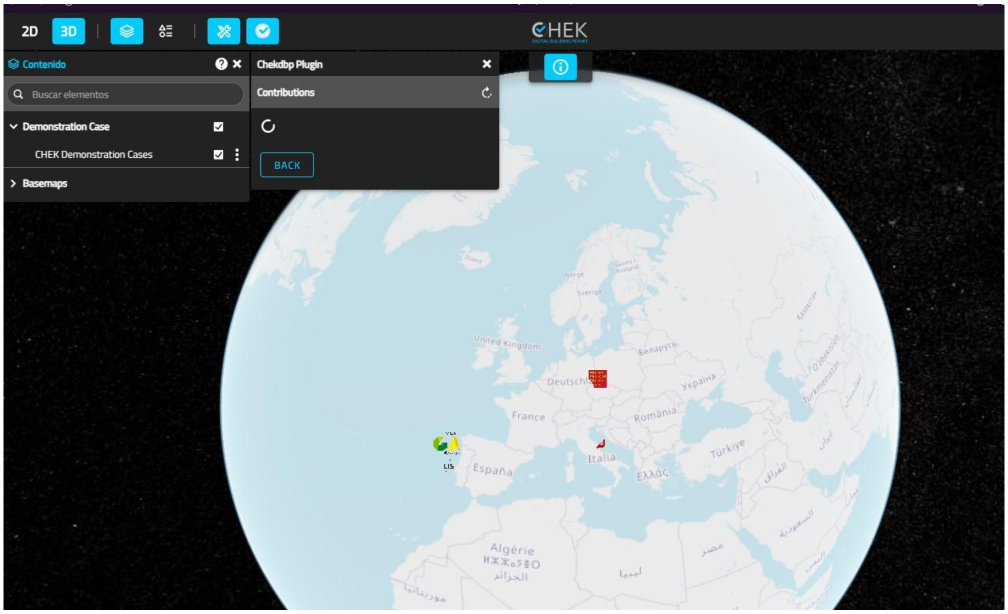


Figure 115 What VCMap shows if tagging is incorrect

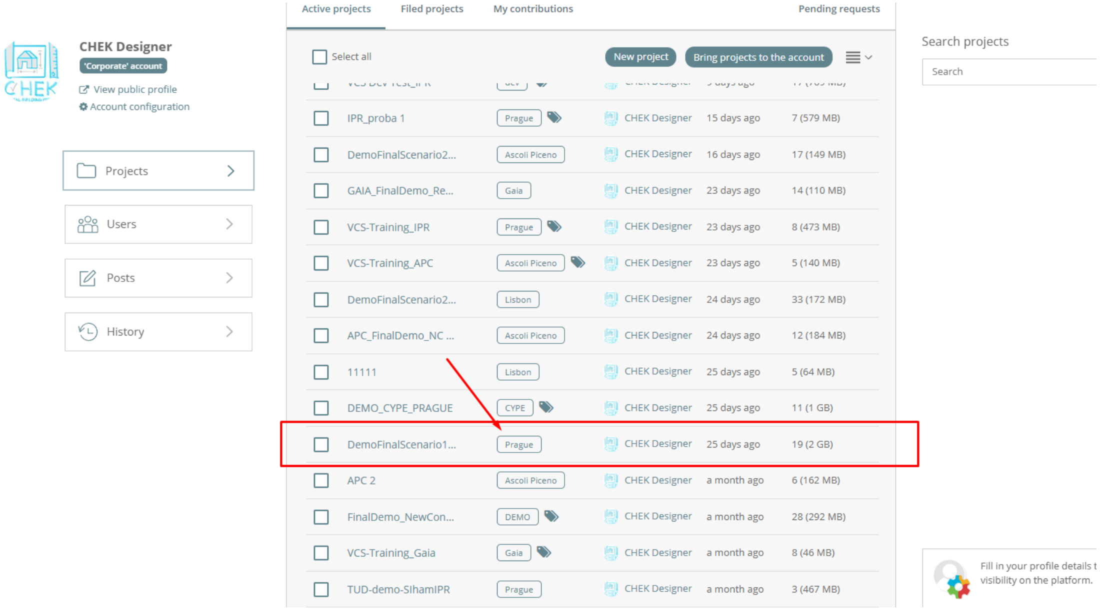


Figure 116 Correct tagging following the convention

### 3.3.2 GIS to BIM conversion – CityGML2IFC

**Settings:**

- Web-based version of the CityGML2IFC converter developed by RDF was used, instead of the standalone version employed in the GAIA demo.
- The conversion was performed directly online via: https://rdf.bg/CHEK/gml2ifc.html

**Inputs:**

- CityGML files generated in VCMap (export.gml and export_terrain.gml), corresponding to surrounding buildings and terrain.

**Outputs:**

Two georeferenced IFC files, uploadad as separate contributions into BIMServer.center, under the names:

- Init Info – Just Terrain
- Init Info – Just Neighbouring.

**To Improve:**

Although the web converter is more accessible and eliminates the need for software installation, it lacks visual confirmation or feedback mechanisms that would allow users to verify whether the exported IFC files are correctly georeferenced and spatially aligned. Currently, after conversion, users must rely on external tools (such as IFC viewers or CHEK validation tools like IFCGref) to confirm that the terrain and neighboring buildings are correctly located and properly federated. This additional step adds overhead and can introduce uncertainty—especially when working with minimal GML inputs. Integrating a lightweight visual preview or map-based confirmation within the converter interface would greatly enhance usability and confidence in the results.

**Process Description:**

Unlike the GAIA demo, where the standalone desktop version of the CityGML2IFC converter was used, the IPR demo adopted the web-based version. This choice simplified the process. No software installation or administrative permissions were required, which is a major advantage in environments where users may not have full access to the operating system.

The files export.gml and export_terrain.gml, previously downloaded from VCMap, were converted independently using the online tool. The operation was straightforward, with no need for specific configuration, and the results were generated instantly.

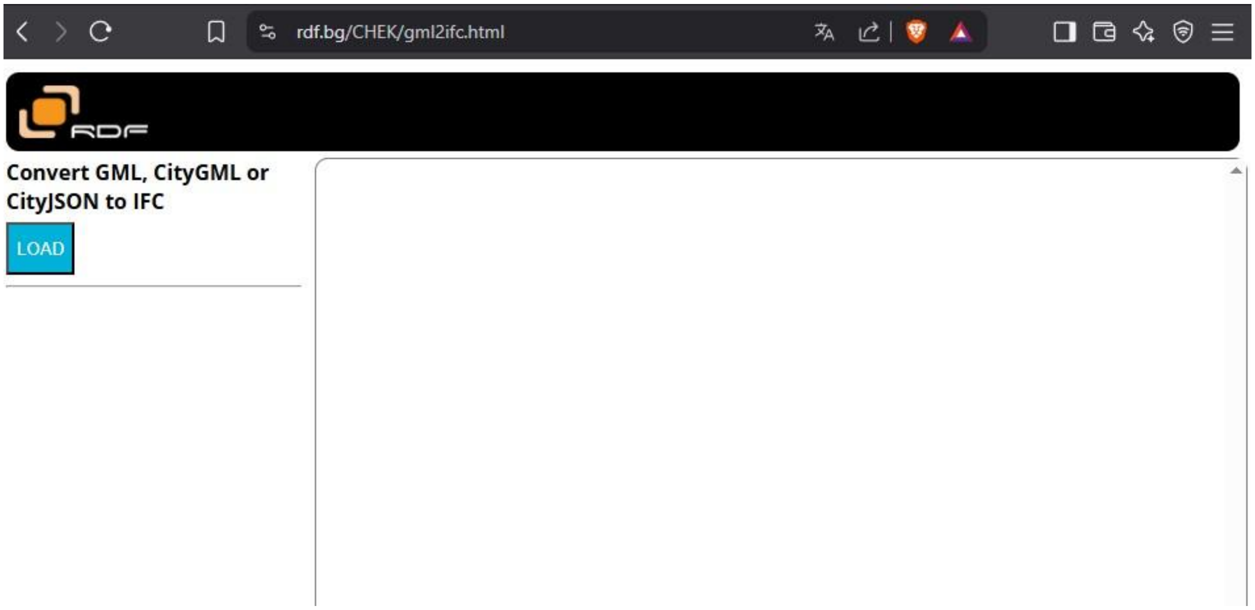



Figure 117 Web-based version of RDF's CityGML2IFC converter

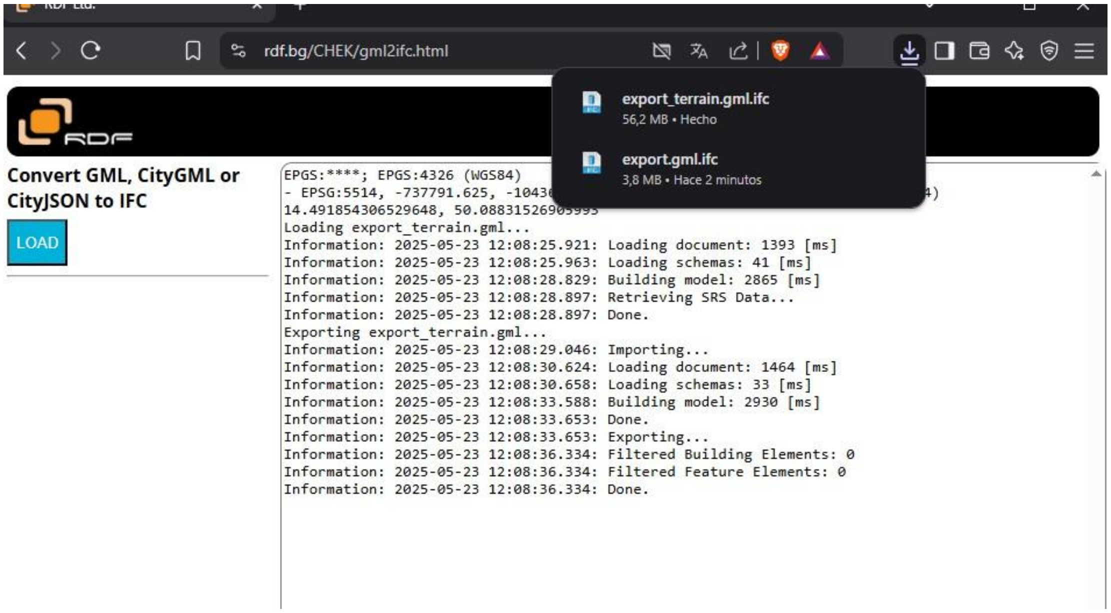



Figure 118 Display after converting the DTM into IFC

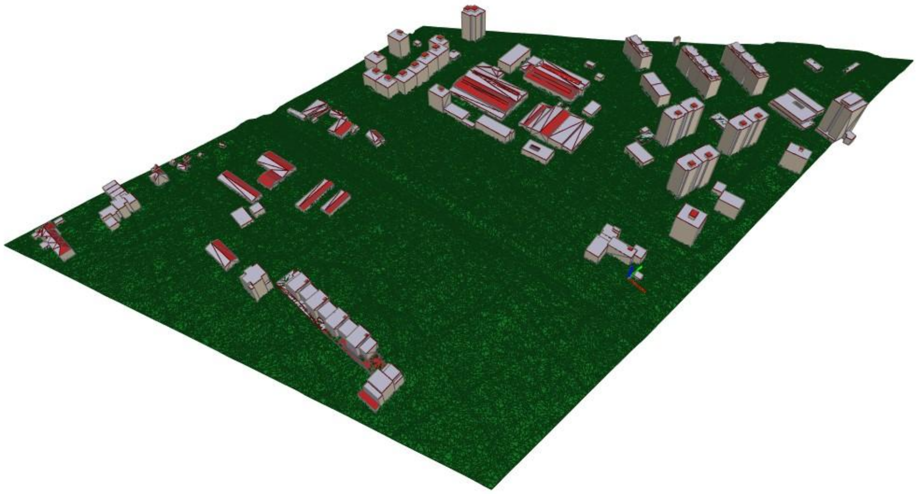


Figure 119 Successful federation of terrain and neighboring with RDF's

### 3.3.3 Designing overview

**Settings:**

- A single Revit (.RVT) file was created, containing both the building and the partially urbanized area, although the export was carried out in separate blocks as previously established.

**Inputs:**

- Georeferenced IFCs for the surrounding environment: terrain and adjacent buildings, used as visual references.
- Plot boundaries and regulatory context were known prior to software development and provided by the municipality.

**Outputs:**

- A complete Revit model including all necessary constructive elements for validation: spaces, doors, windows, roofs, walls, etc.
- Custom parameters were created to fulfill the specific requirements defined in the project's IDS.

**To Improve:**

- Manual creation and assignment of parameters in Revit is prone to errors.
- A tool capable of importing an IDS file and automatically generating the required parameters would be highly valuable.

**Process Description:**

The overall modeling workflow followed the same logic already described in the GAIA demo and will not be repeated here. However, the IPR case included some key differences worth highlighting.

One of the most important aspects was the incorporation of custom parameters defined in the IDS for this specific demo. To ensure compliance, Dynamo scripting was used to automate the assignment of values to a large number of windows within the model (a task that would have been extremely tedious to perform manually).

At the graphical level, several iterations were made to reduce geometric complexity, in response to issues later encountered during the Semantic Model conversion process in VCMap. Although these adjustments were not part of the initial modeling phase, they retroactively influenced decisions such as removing furniture, railings, and generic objects that were irrelevant to the implemented urban compliance checks.

### 3.3.4 Exporting the model – DiRoots Plugin

**Settings:**

- The export was carried out using the official DiRoots plugin for Revit.
- The model used filters to facilitate the separate export of the building (including IDS-required parameters) and the undeveloped portion of the plot.

**Inputs:**

- Native Revit model with all geometry and required parameters assigned.

**Outputs:**

Two IFC files uploaded as independent contributions to BIMserver.center:

- One containing the full building and its specific parameters
- Another for the urbanized but undeveloped area of the plot

**To Improve:**

- The plugin could include an option to import an IDS file (.ids), read its structure, and automatically generate the required parameters in the model (or at least notify the user about any missing ones).

**Process Description:**

The export process followed the general procedure already established in previous demos, but some technical obstacles were encountered in this case. Initially, the DiRoots plugin did not function correctly due to interference from the "IFC Override" exporter (an outdated Autodesk IFC exporter that conflicted with the plugin).
Since this legacy exporter could not be uninstalled using the standard application manager, its .addin file was manually renamed within the installation path:

C:\ProgramData\Autodesk\Revit\Addins\2025

to prevent Revit from loading it. This workaround allowed the DiRoots plugin to operate correctly.
Once this issue was resolved, two versions of the model were exported: one corresponding to the main building, including all parameters required by the IDS (as confirmed in the DiRoots exporter's display), and another representing the urbanized yet undeveloped portion of the plot. The export process ran smoothly, and the resulting files were validated through direct visualization and parameter checking using the RDF IDS Checker, which is further detailed in subsequent sections.

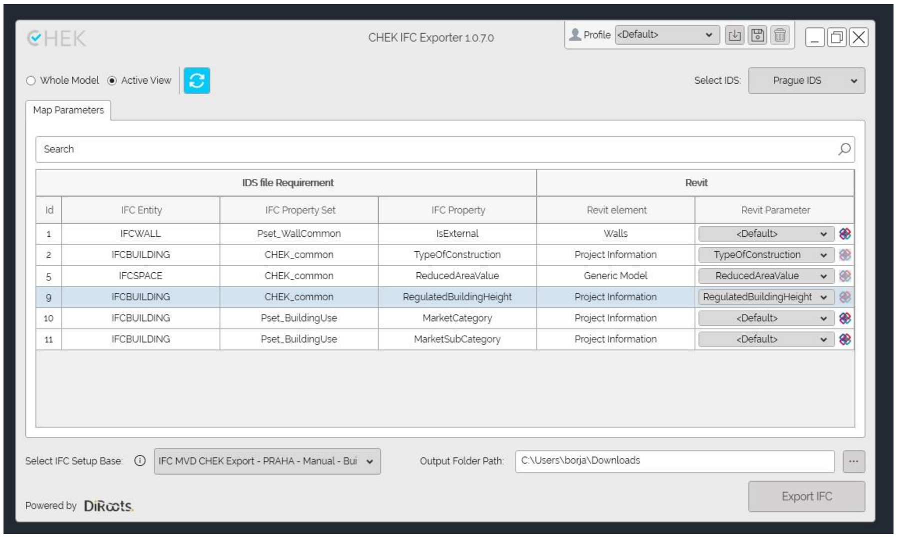



Figure 120 DiRoots plugin set up done

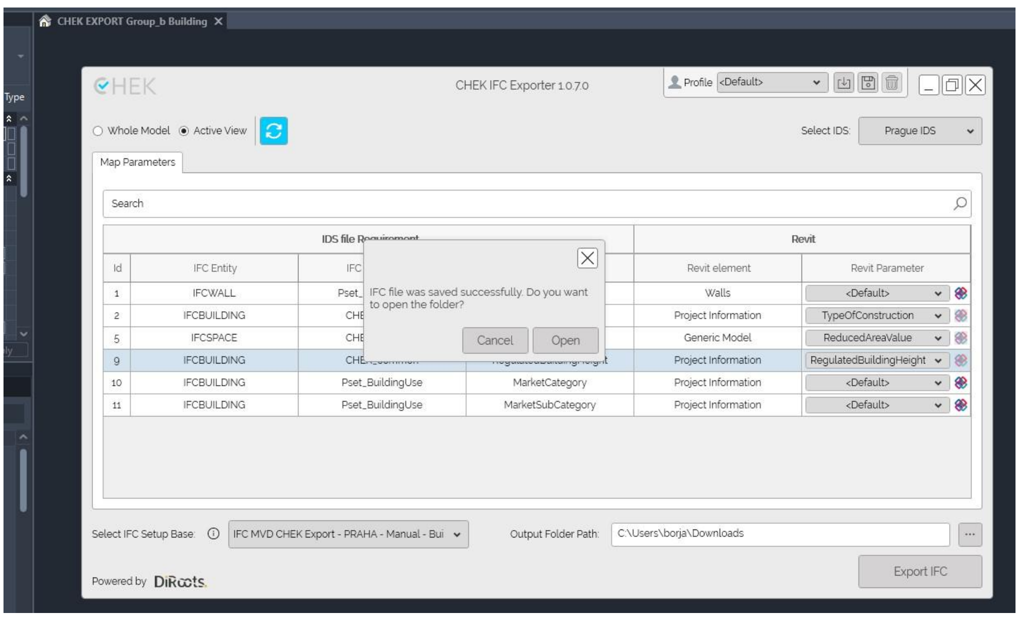



Figure 121 Exporting successful

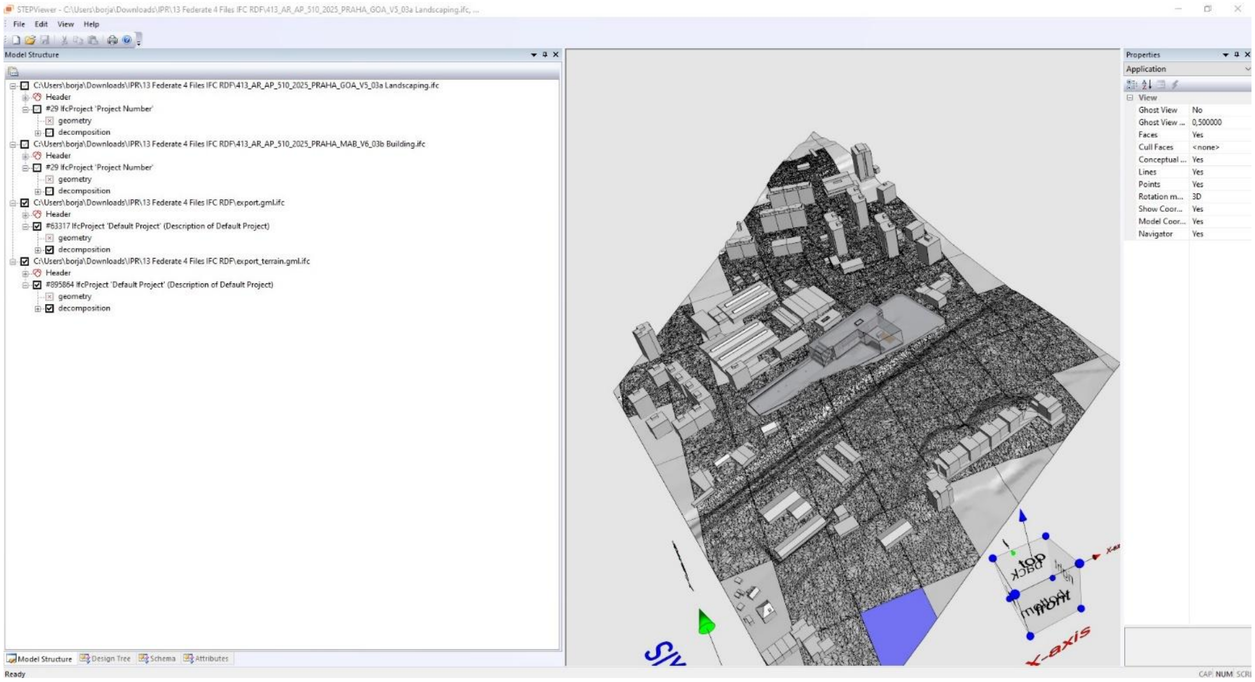



Figure 122 Federating al 4 IFC files, existing and project IFCs with RDF’s

### 3.3.5 Georeference assessment – IfcGref

**Settings:**

- The IFCGref tool developed by TU Delft was used as the primary validation method.
- The process was carried out after the IFC files were exported and uploaded to BIMserver.center.
- No additional checks were performed using other tools like BIMvision or VCMap, as IFCGref validation was deemed sufficient and reliable.

**Inputs:**

- IFC files generated in Revit: one for the building and one for the urbanized but undeveloped portion of the plot.

**Outputs:**

- Confirmation that both models were correctly georeferenced.

**To Improve:**

- Loading and validation times in IFCGref can be long for large models.
- A more integrated validation system within BIMserver.center or the export plugin itself would be beneficial.

**Process Description:**

As in the GAIA demo, georeference validation was performed using the IFCGref tool. This step was completed after the models were exported and uploaded to BIMserver.center as separate contributions.
Additional validation steps using other viewers were skipped, since the results provided by IFCGref were clear and satisfactory. The system confirmed that the model coordinates were accurate according to the EPSG 5514 spatial reference system, and that both the building and the urbanized undeveloped area were correctly located on the site.
The georeferencing defined in Revit and preserved by the DiRoots export plugin was fully maintained in the exported files.
It was noted that processing time in IFCGref can be relatively long, especially for heavy models. However, the tool functioned reliably and no technical errors were encountered.


**Figure 123 IfcGref geolocation assessment of initial information: Surroundings**


Figure 124 IfcGref geolocation assessment of initial information: Topography

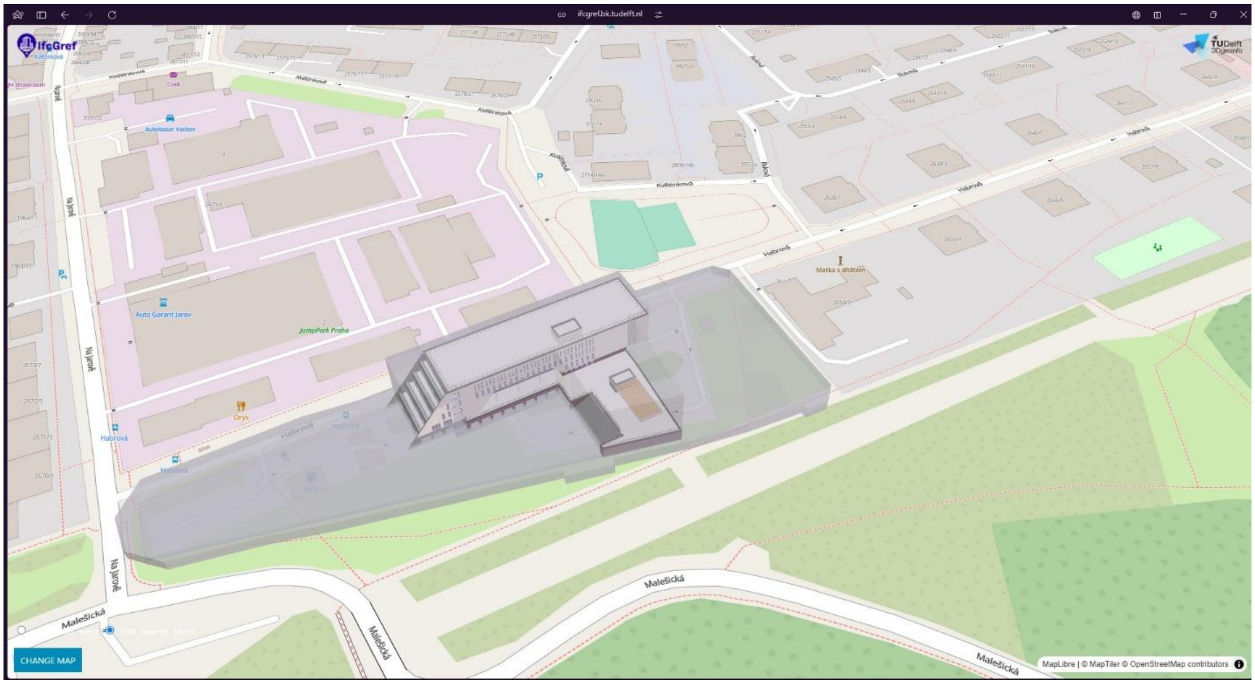



Figure 125 IfcGref geolocation assessment of demo project

### 3.3.6 IFC validation – RDF's IfcViewer

**Settings:**

- The IDS Checker developed by RDF was used as the main tool for validating the IFC structure against the Information Delivery Specification (IDS).
- The IDS file corresponding to the IPR project was retrieved from the shared consortium repository on Microsoft Teams.
- Validation was performed prior to signing and uploading the final IFC file to BIMserver.center.

**Inputs:**

- IFC file for the building, exported using the DiRoots plugin.
- .ids file specific to the Prague demo project.

**Outputs:**

- A detailed validation report indicating which required parameters were present, which were missing, and any potential structural errors.
- Subsequent adjustments in Revit (when possible) to correct identified issues.

**To Improve:**

- The IDS Checker does not provide corrective suggestions or direct mapping to Revit parameters, requiring manual interpretation by the designer.
- A direct integration with Revit would be beneficial to load the IDS and verify parameters directly within the modeling environment.

**Process Description:**

After the initial export of the IFC file from Revit, a first validation was carried out using the IDS Checker developed by RDF. The IDS file used was specific to the IPR case and was retrieved from the CHEK project's shared repository (Teams). This initial run revealed several errors related to missing parameters or mismatches in expected names and data types.

Although full compliance was not achieved in the IDS Checker, the process allowed for the identification and correction of most model deficiencies, and ensured a sufficient level of quality to proceed through the CHEK workflow without technical blocks.

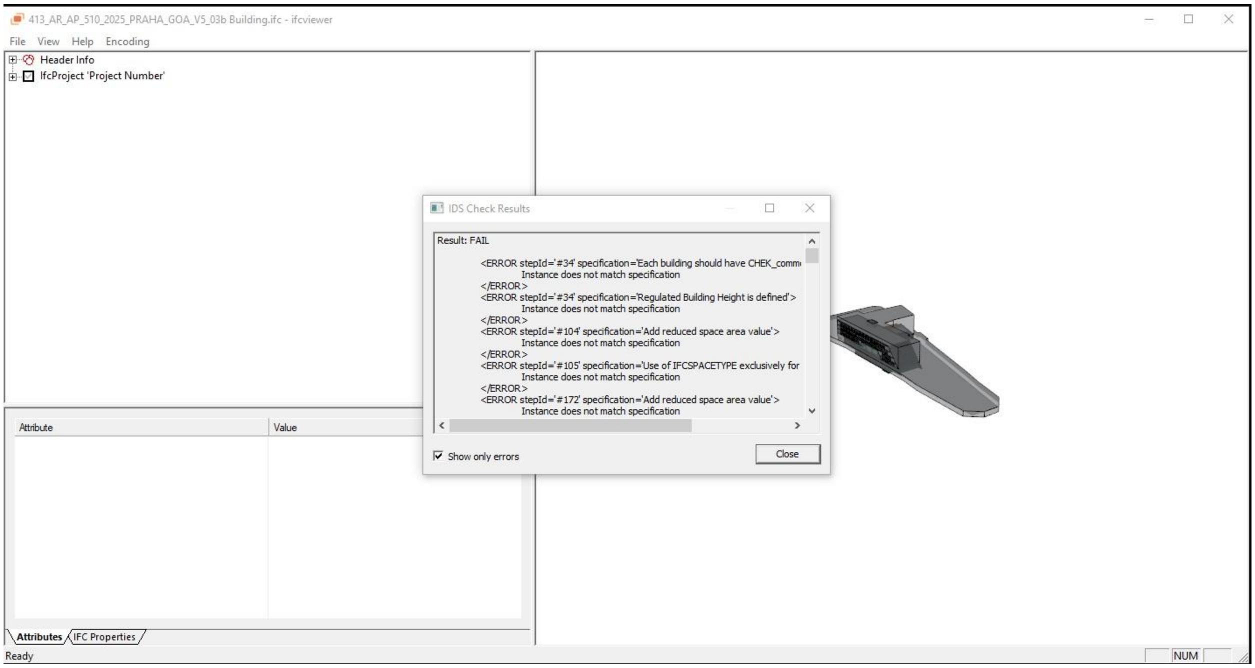



**Figure 126 RDF IDS Checker results**

### 3.3.7 Uploading the model to BIMServer.Center

**Settings:**

- Standard contribution upload functions in BIMserver.center were used from the designer profile.
- Contributions were kept separate: one for the building and one for the urbanized but undeveloped area.

**Inputs:**

- Previously exported and validated IFC files.

**Outputs:**

- Contributions accessible from tools connected to the CHEK ecosystem (Verifi3D, VCMap).
- Files available for visualization, validation, and signing.

**Process Description:**

The IFC files were uploaded to the CHEK platform via BIMserver.center, using the standard procedure already described in the GAIA demo. Each file was uploaded as a separate contribution, which facilitated traceability and ensured compatibility with verification tools such as Verifi3D and VCMap.

### 3.3.8 CHEK pre-validation – Verifi3D

**Settings:**

- The Verifi3D platform was used as the main pre-validation tool, directly connected to the project hosted in BIMserver.center.
- A new project (DemoFinalScenario1_IPR) was created within Verifi3D, and municipal technicians from Prague, along with the WP6 leader, were invited as collaborators.
- The connection between Verifi3D and BIMserver.center allowed automatic import of all previously uploaded contributions.

**Inputs:**

- All project IFC files, accessible from the connected CDE (BIMserver.center).
- Urban validation rules specific to Prague, in JSON format, shared via the consortium's Teams environment.

**Outputs:**

- Federated model visualization
- Execution of two validation rules: minimum ceiling height and elevator entry clearance
- Exported validation reports in Excel and CSV formats
- Manual contribution added to BIMserver.center with the results (Verifi3D Results)

**To Improve:**

- Errors were encountered when attempting to import the latest version of the rule set.
- The system does not allow automatic submission of results to the municipal validation account, limiting official traceability within the CHEK environment.

**Process Description:**

The pre-validation process using Verifi3D began with the creation of the corresponding project on the platform and its linkage to the BIMserver.center project. This connection allowed automatic import of all previously uploaded contributions, including terrain, surrounding buildings, and the building and landscape models.

Once the models were loaded, an attempt was made to import the most recent set of urban and building regulation rules specific to Prague, but compatibility errors were encountered. An earlier version of the rule set was used instead, which included two checks: minimum ceiling height in spaces and elevator entry clearance. Both rules were executed successfully and yielded 100% compliance. The error was fixed later, but the workflow kept the same, but with more compliant regulations.

The resulting reports were exported in both CSV and Excel formats and were uploaded manually as a separate contribution to BIMserver.center for review by the municipal team. This validation was also replicated by the municipality within their own Verifi3D environment, as they had been invited as project collaborators.

Overall, the Verifi3D pre-validation process was successfully completed, although some limitations affecting traceability and native communication with the municipality account were identified.

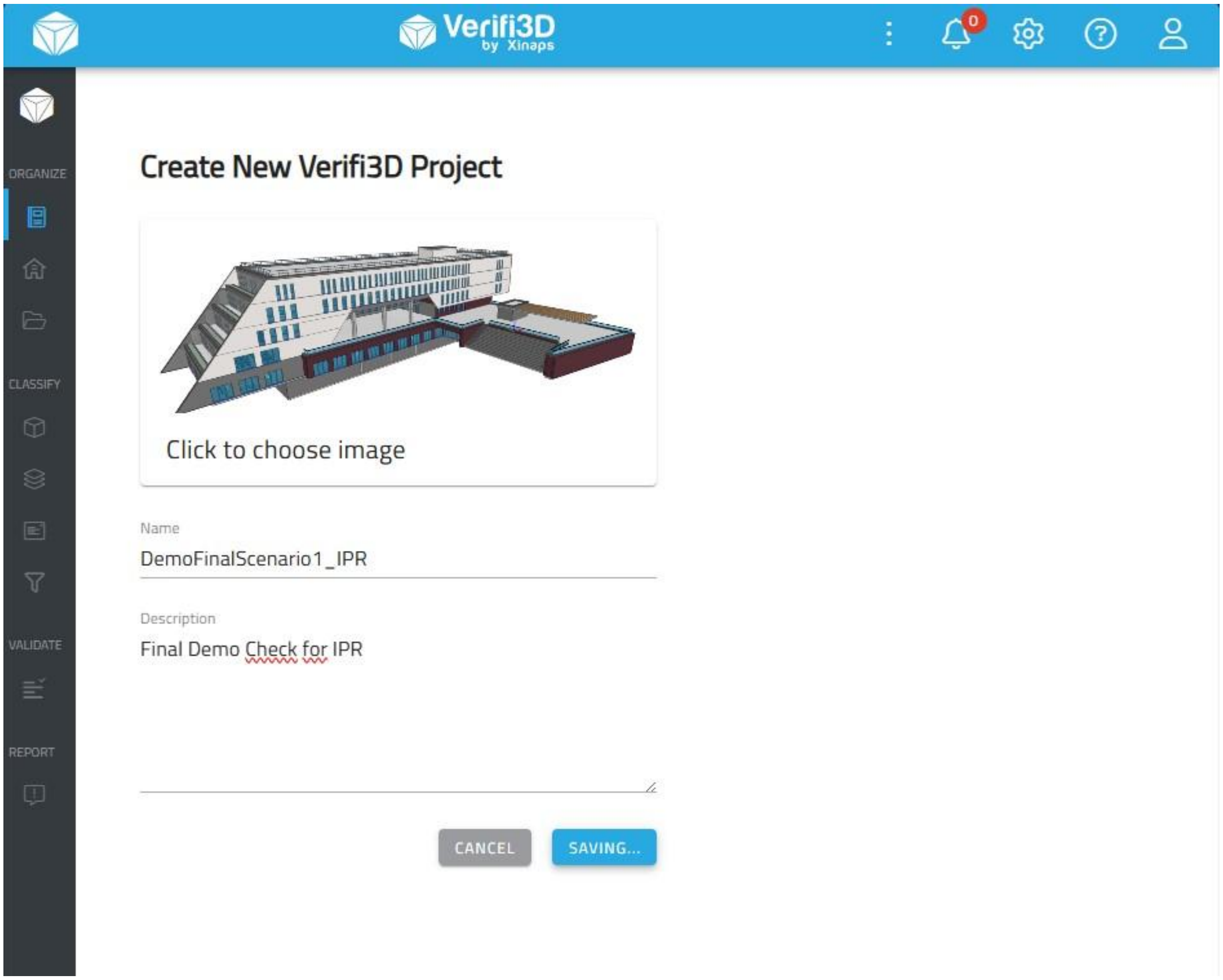



Figure 127 Verifi3D project creation

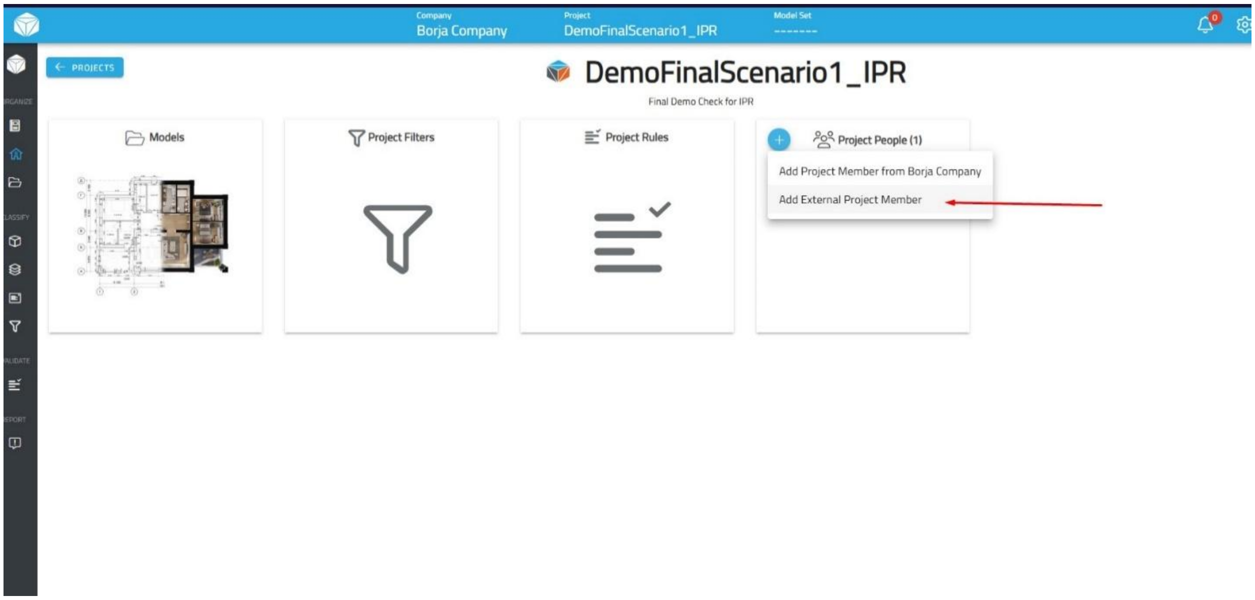



Figure 128 Adding partners into project (Municipality officers and WPL)

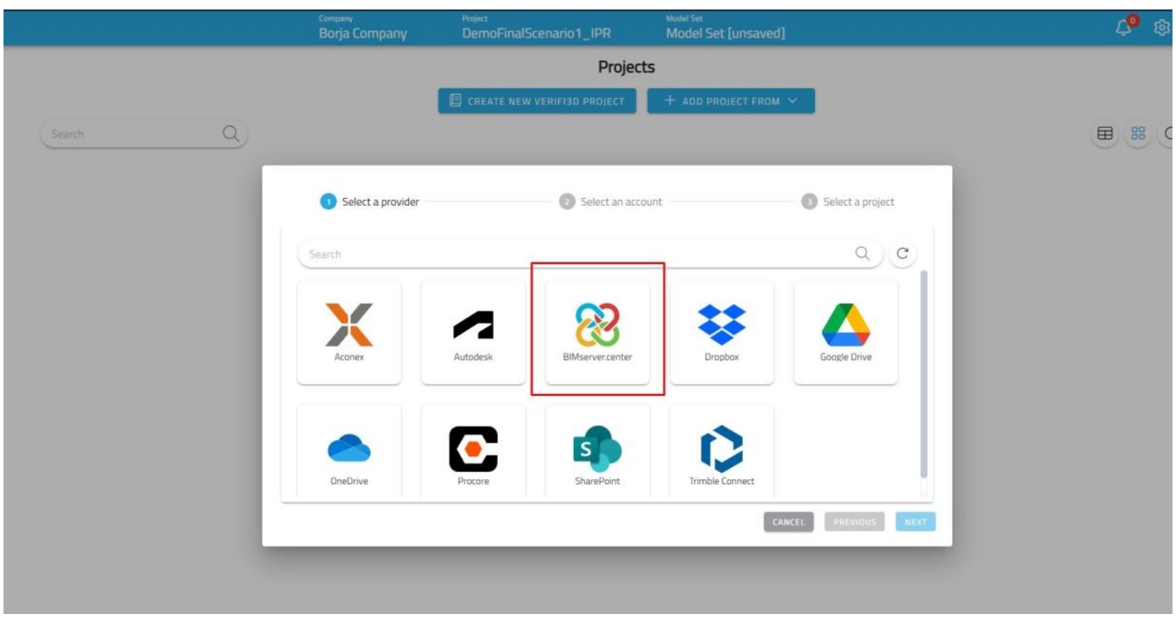



Figure 129 Linking to the project in the CDE

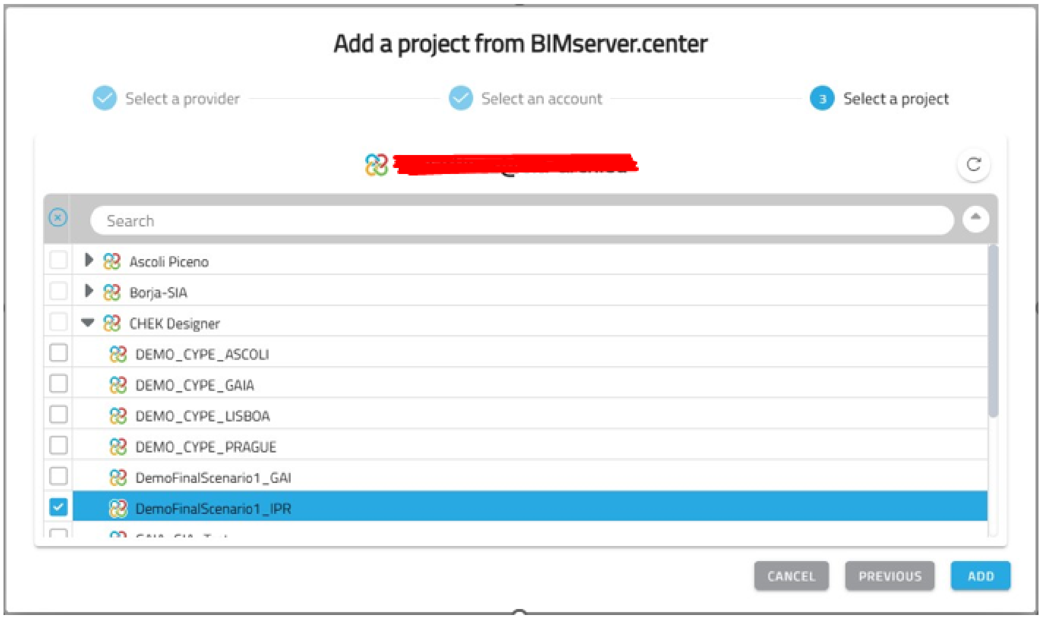



Figure 130 Selecting the project in BSC

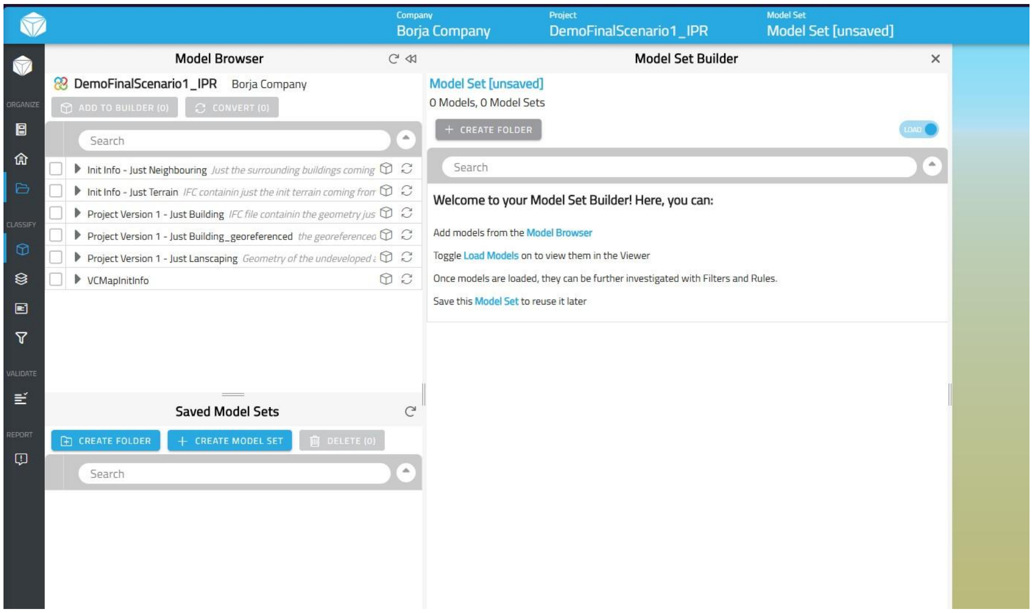



Figure 131 Showing all the contributions in the project, ready to add to builder

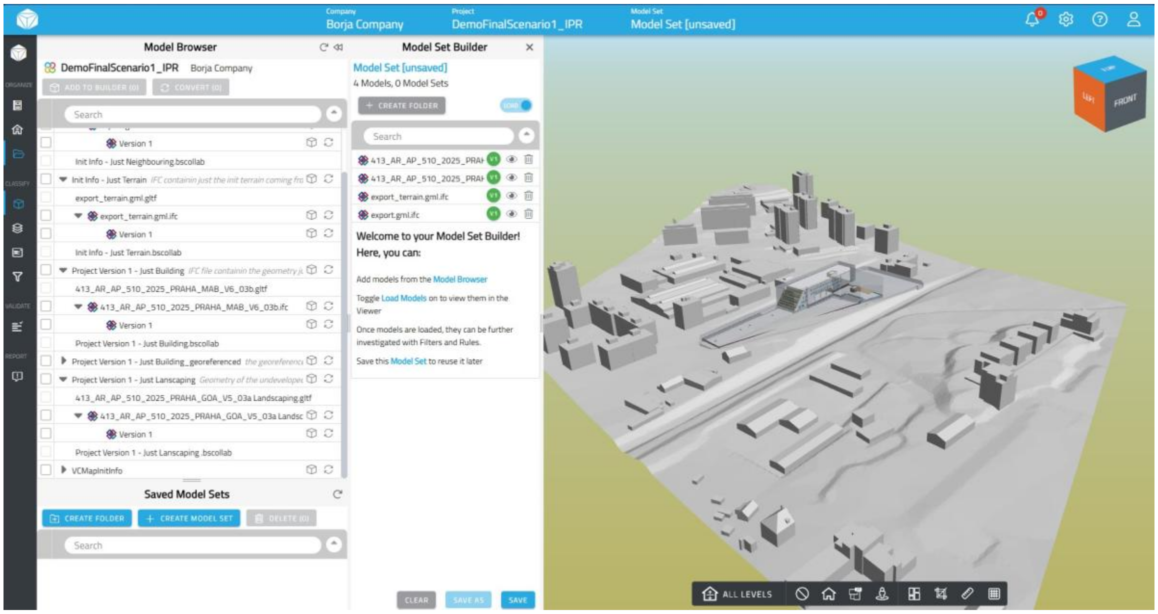



Figure 132 Needed contributions added to builder

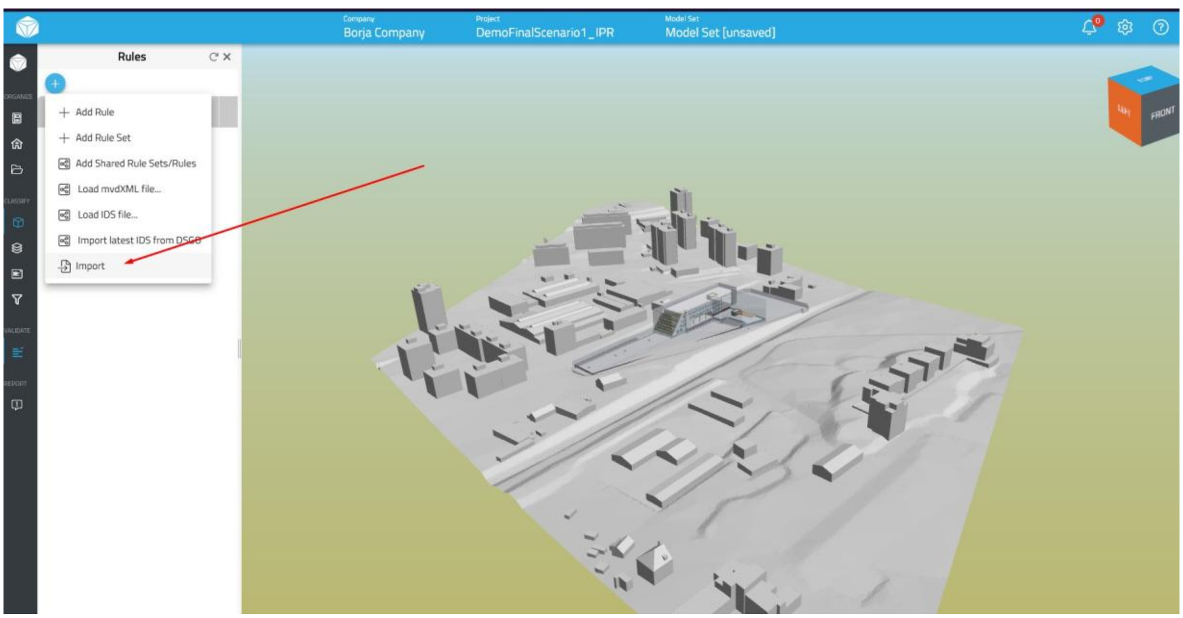



Figure 133 Importing ruleset with the implemented regulations

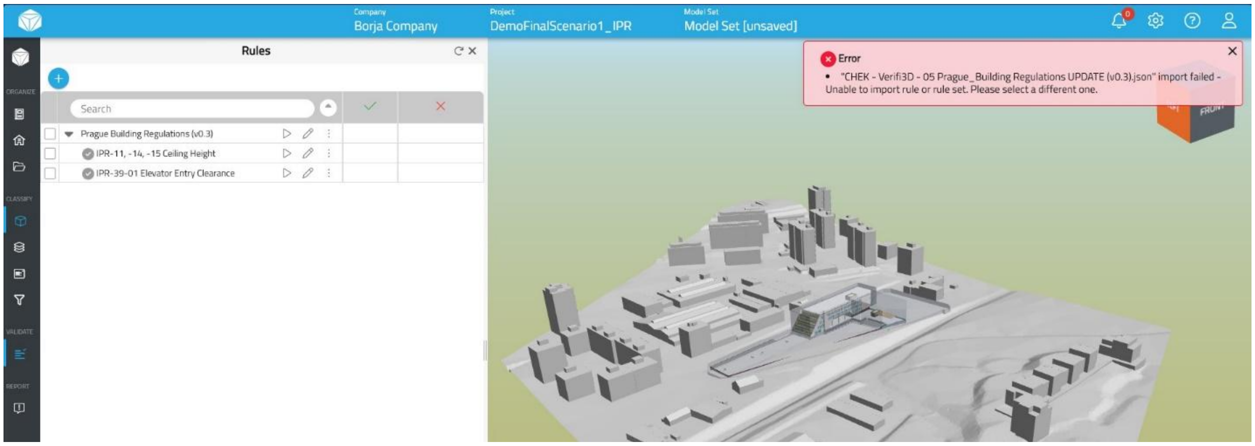



Figure 134 Error loading the latest ruleset. Partially loaded.

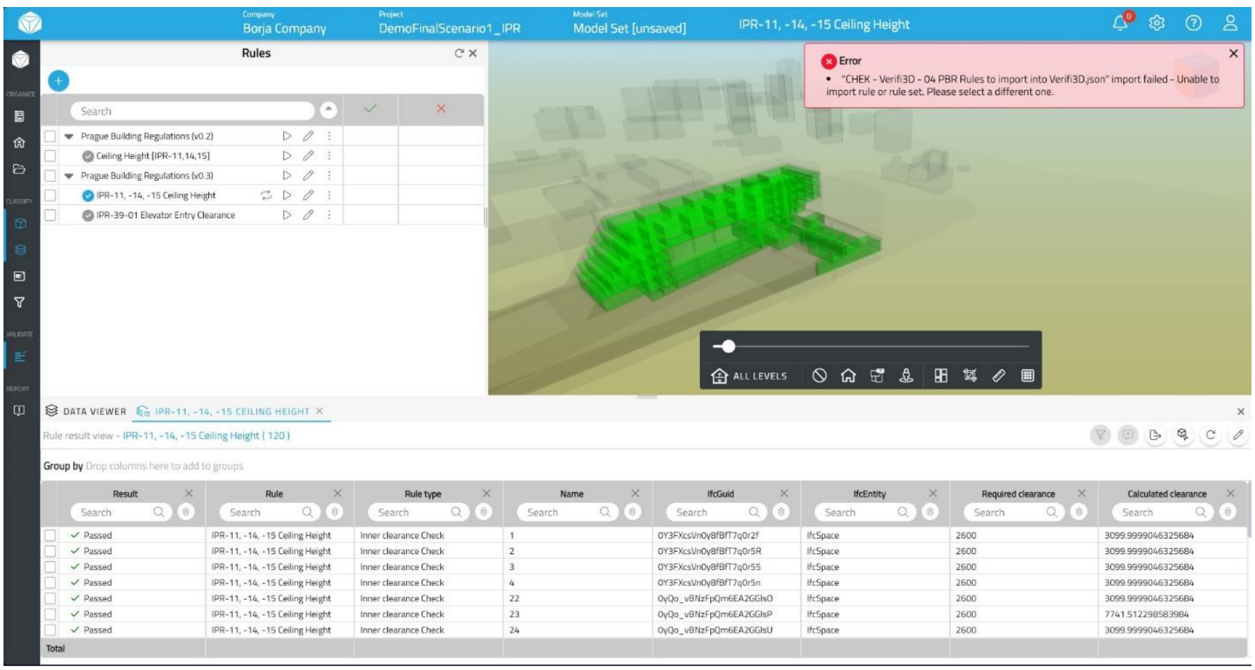
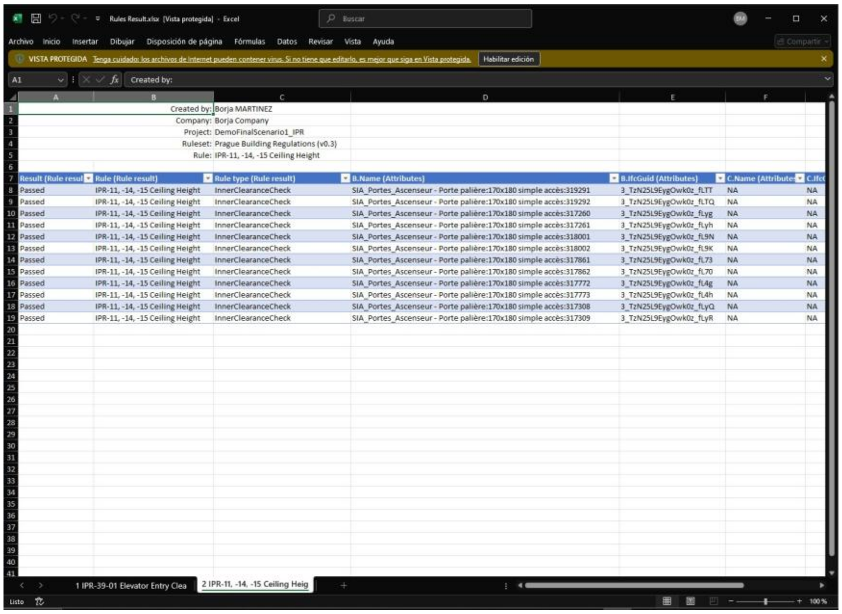
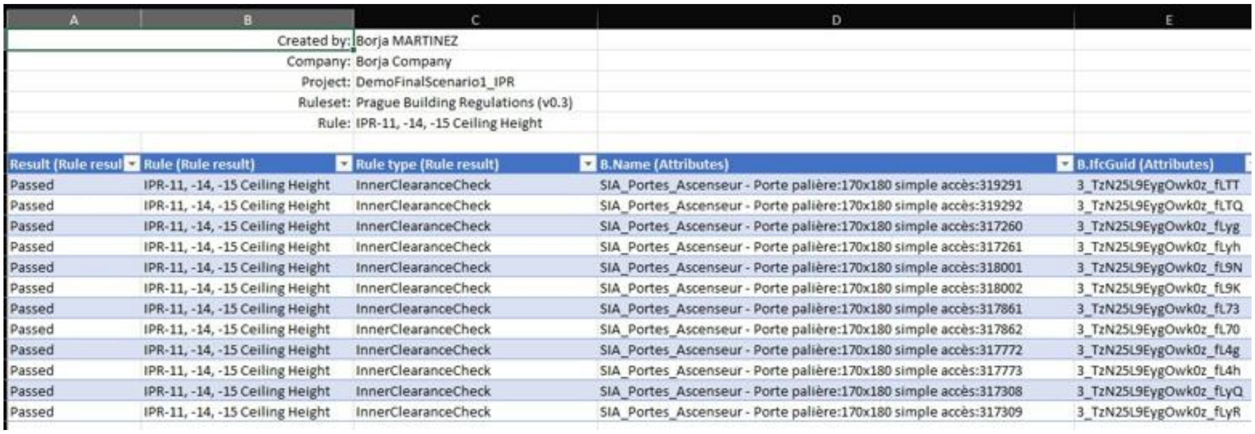



Figure 135 Same error with earlier version of ruleset. Run compliance check success



| | | | | | | |
|---|---|---|---|---|---|---|
| | Created by: | Borja MARTINEZ | | | | |
| | Company: | Borja Company | | | | |
| | Project: | DemoFinalScenario1_IPR | | | | |
| | Ruleset: | Prague Building Regulations (v0.3) | | | | |
| | Rule: | IPR-11, -14, -15 Ceiling Height | | | | |
| Result (Rule result) | Rule (Rule result) | Rule type (Rule result) | B.Name (Attributes) | B.IfcGuid (Attributes) | C.Name (Attributes) | C.IfcG |
| Passed | IPR-11, -14, -15 Ceiling Height | InnerClearanceCheck | SIA_Portes_Ascenseur - Porte palière:170x180 simple accès:319291 | 3_TzN25L9EygOwk0z_fLTT | NA | NA |
| Passed | IPR-11, -14, -15 Ceiling Height | InnerClearanceCheck | SIA_Portes_Ascenseur - Porte palière:170x180 simple accès:319292 | 3_TzN25L9EygOwk0z_fLTQ | NA | NA |
| Passed | IPR-11, -14, -15 Ceiling Height | InnerClearanceCheck | SIA_Portes_Ascenseur - Porte palière:170x180 simple accès:317260 | 3_TzN25L9EygOwk0z_fLyg | NA | NA |
| Passed | IPR-11, -14, -15 Ceiling Height | InnerClearanceCheck | SIA_Portes_Ascenseur - Porte palière:170x180 simple accès:317261 | 3_TzN25L9EygOwk0z_fLyh | NA | NA |
| Passed | IPR-11, -14, -15 Ceiling Height | InnerClearanceCheck | SIA_Portes_Ascenseur - Porte palière:170x180 simple accès:318001 | 3_TzN25L9EygOwk0z_fL9N | NA | NA |
| Passed | IPR-11, -14, -15 Ceiling Height | InnerClearanceCheck | SIA_Portes_Ascenseur - Porte palière:170x180 simple accès:318002 | 3_TzN25L9EygOwk0z_fL9K | NA | NA |
| Passed | IPR-11, -14, -15 Ceiling Height | InnerClearanceCheck | SIA_Portes_Ascenseur - Porte palière:170x180 simple accès:317861 | 3_TzN25L9EygOwk0z_fL73 | NA | NA |
| Passed | IPR-11, -14, -15 Ceiling Height | InnerClearanceCheck | SIA_Portes_Ascenseur - Porte palière:170x180 simple accès:317862 | 3_TzN25L9EygOwk0z_fL70 | NA | NA |
| Passed | IPR-11, -14, -15 Ceiling Height | InnerClearanceCheck | SIA_Portes_Ascenseur - Porte palière:170x180 simple accès:317772 | 3_TzN25L9EygOwk0z_fL4g | NA | NA |
| Passed | IPR-11, -14, -15 Ceiling Height | InnerClearanceCheck | SIA_Portes_Ascenseur - Porte palière:170x180 simple accès:317773 | 3_TzN25L9EygOwk0z_fL4h | NA | NA |
| Passed | IPR-11, -14, -15 Ceiling Height | InnerClearanceCheck | SIA_Portes_Ascenseur - Porte palière:170x180 simple accès:317308 | 3_TzN25L9EygOwk0z_fLyQ | NA | NA |
| Passed | IPR-11, -14, -15 Ceiling Height | InnerClearanceCheck | SIA_Portes_Ascenseur - Porte palière:170x180 simple accès:317309 | 3_TzN25L9EygOwk0z_fLyR | NA | NA |

Figure 136 Results in excel format



| | | | | |
|---|---|---|---|---|
| | Created by: | Borja MARTINEZ | | |
| | Company: | Borja Company | | |
| | Project: | DemoFinalScenario1_IPR | | |
| | Ruleset: | Prague Building Regulations (v0.3) | | |
| | Rule: | IPR-11, -14, -15 Ceiling Height | | |
| Result (Rule resul | Rule (Rule result) | Rule type (Rule result) | B.Name (Attributes) | B.IfcGuid (Attributes) |
| Passed | IPR-11, -14, -15 Ceiling Height | InnerClearanceCheck | SIA_Portes_Ascenseur - Porte palière:170x180 simple accès:319291 | 3_TzN25L9EygOwk0z_fLTT |
| Passed | IPR-11, -14, -15 Ceiling Height | InnerClearanceCheck | SIA_Portes_Ascenseur - Porte palière:170x180 simple accès:319292 | 3_TzN25L9EygOwk0z_fLTQ |
| Passed | IPR-11, -14, -15 Ceiling Height | InnerClearanceCheck | SIA_Portes_Ascenseur - Porte palière:170x180 simple accès:317260 | 3_TzN25L9EygOwk0z_fLyg |
| Passed | IPR-11, -14, -15 Ceiling Height | InnerClearanceCheck | SIA_Portes_Ascenseur - Porte palière:170x180 simple accès:317261 | 3_TzN25L9EygOwk0z_fLyh |
| Passed | IPR-11, -14, -15 Ceiling Height | InnerClearanceCheck | SIA_Portes_Ascenseur - Porte palière:170x180 simple accès:318001 | 3_TzN25L9EygOwk0z_fL9N |
| Passed | IPR-11, -14, -15 Ceiling Height | InnerClearanceCheck | SIA_Portes_Ascenseur - Porte palière:170x180 simple accès:318002 | 3_TzN25L9EygOwk0z_fL9K |
| Passed | IPR-11, -14, -15 Ceiling Height | InnerClearanceCheck | SIA_Portes_Ascenseur - Porte palière:170x180 simple accès:317861 | 3_TzN25L9EygOwk0z_fL73 |
| Passed | IPR-11, -14, -15 Ceiling Height | InnerClearanceCheck | SIA_Portes_Ascenseur - Porte palière:170x180 simple accès:317862 | 3_TzN25L9EygOwk0z_fL70 |
| Passed | IPR-11, -14, -15 Ceiling Height | InnerClearanceCheck | SIA_Portes_Ascenseur - Porte palière:170x180 simple accès:317772 | 3_TzN25L9EygOwk0z_fL4g |
| Passed | IPR-11, -14, -15 Ceiling Height | InnerClearanceCheck | SIA_Portes_Ascenseur - Porte palière:170x180 simple accès:317773 | 3_TzN25L9EygOwk0z_fL4h |
| Passed | IPR-11, -14, -15 Ceiling Height | InnerClearanceCheck | SIA_Portes_Ascenseur - Porte palière:170x180 simple accès:317308 | 3_TzN25L9EygOwk0z_fLyQ |
| Passed | IPR-11, -14, -15 Ceiling Height | InnerClearanceCheck | SIA_Portes_Ascenseur - Porte palière:170x180 simple accès:317309 | 3_TzN25L9EygOwk0z_fLyR |

Figure 137 Results in excel format. Zoom into report content

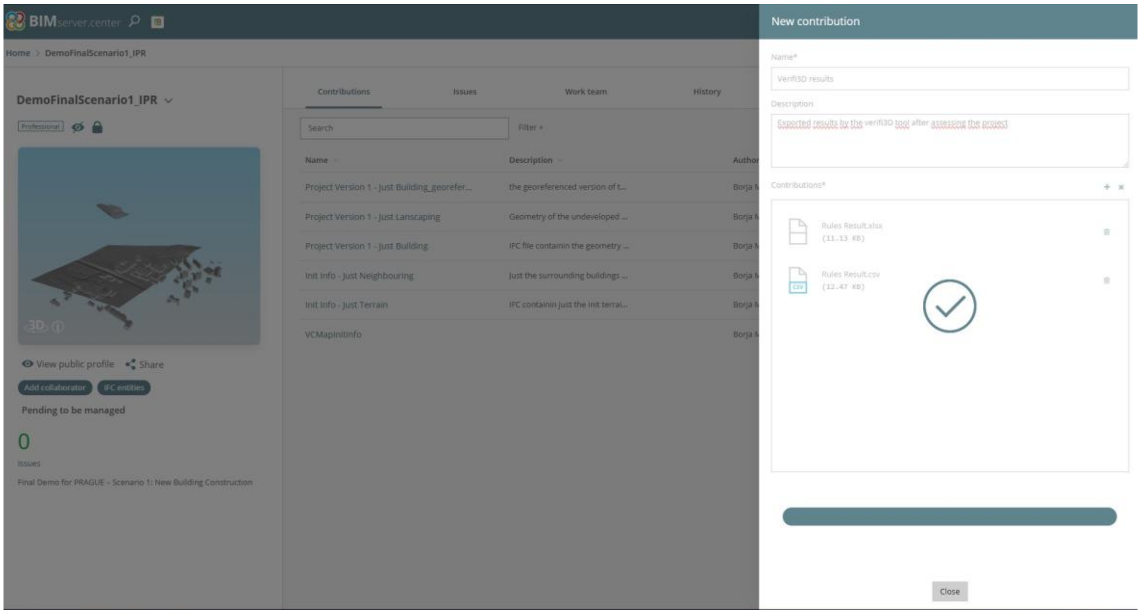



Figure 138 Creation of the contribution to save the results

### 3.3.9 CHEK pre-validation – VCMap

**Settings:**

- The VCMap tool was used for automatic urban compliance validation based on the Semantic Model generated from the building's IFC file.
- The contribution was selected from the graphical interface in VCMap and converted first to a Visualization Model, then to a Semantic Model.
- The default 1-hour timeout was extended to 2 hours by the developers to allow the conversion process to complete.
- The validation test was executed directly from the designer's profile in VCMap.

**Inputs:**

- IFC file of the building exported from Revit and read from the CDE.
- Ruleset provided by the developer and shared via Teams.

**Outputs:**

- Semantic Model successfully generated.
- Urban compliance validation with the following result:
- 2 out of 3 rules were satisfied
- 1 rule failed (distance to plot boundary), intentionally designed to test the system's behavior
- Internal validation record visible within the project (though not automatically transferred to the municipal account).

**To Improve:**

- Conversion time is very long (even with the extended 2-hour timeout) reducing the system's efficiency.
- No progress bar is shown during the Semantic Model conversion.
- The municipality does not gain access to the project until a validation is executed from the designer side, limiting early collaboration.

**Process Description:**

In the IPR demo, VCMap was used to automatically check the IFC model's compliance with the urban planning regulations of the municipality. As in the GAIA case, the process required converting the IFC into a Semantic Model first. However, this time the model's higher geometric complexity caused several conversion failures.

To address this, multiple simplified versions of the model were created by progressively removing railings, furniture, and other non-essential elements, seeking a stable configuration. Even with these changes, some models still failed to reach Semantic Model status. Eventually, the VCSystems development team increased the processing timeout from 1 to 2 hours, which allowed the conversion to complete successfully.

Once the Semantic Model was generated, the urban validation test was executed. Out of the three encoded rules, two were fully satisfied. The third, related to the building's distance to the plot boundary, failed intentionally: the model featured a deliberate cantilever to exceed the boundary line and test whether the system would detect it. The system did, confirming its robustness.

It should be noted that the validation report was not automatically visible to the municipality's validation account, as access to the project is only granted once a validation is triggered from the designer side. This limitation hinders early collaboration and role-based synchronization.

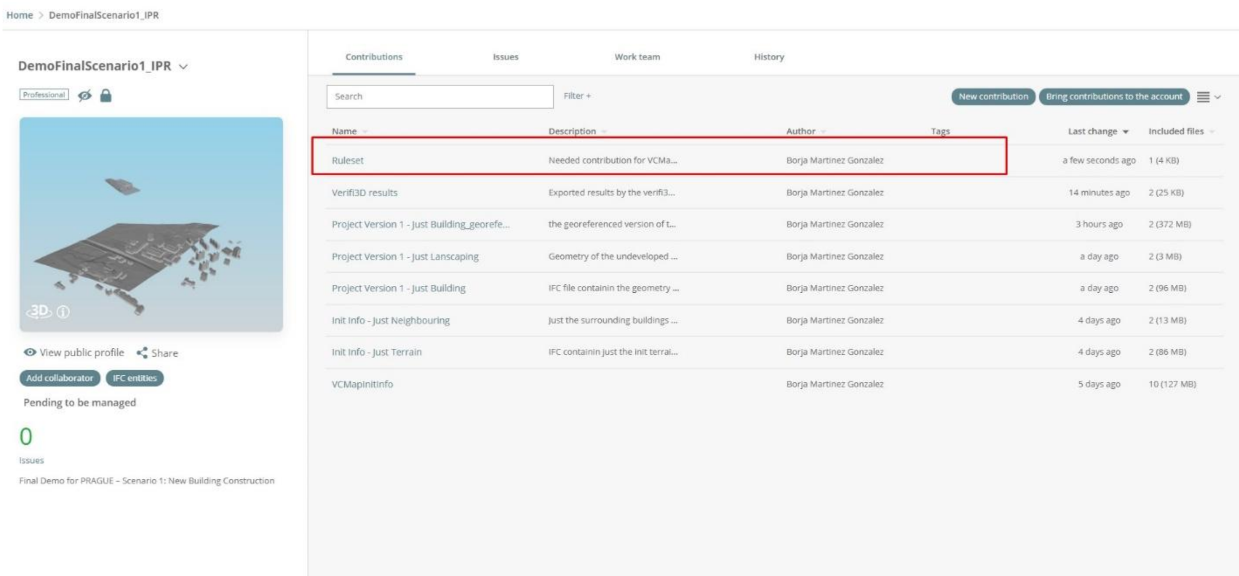



Figure 139 Ruleset contribution for VCMap


Figure 140 Removed noncritical elements: Railings, to ease semantic conversion

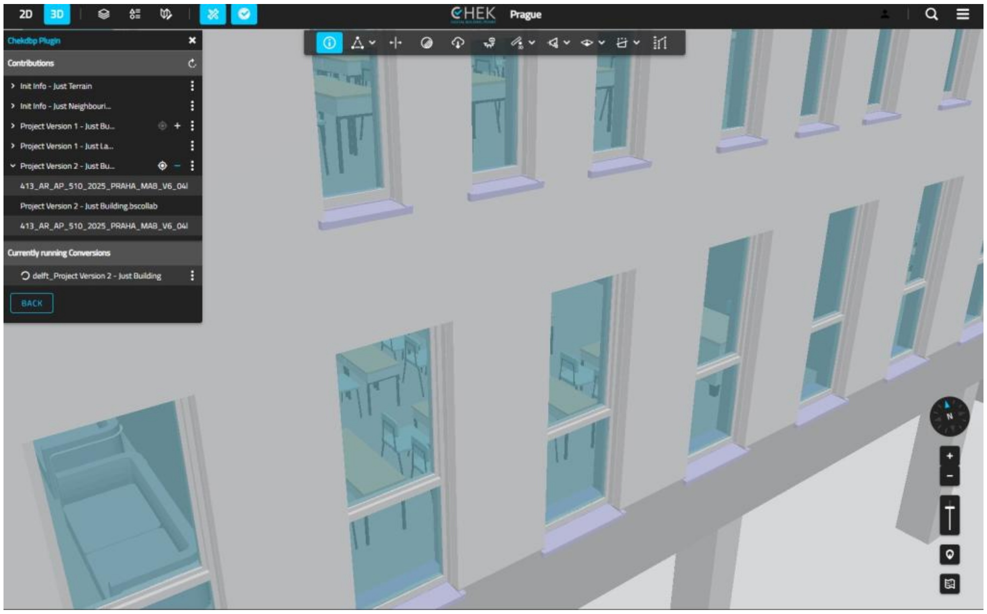



Figure 141 Furniture is also noncritical, was removed later

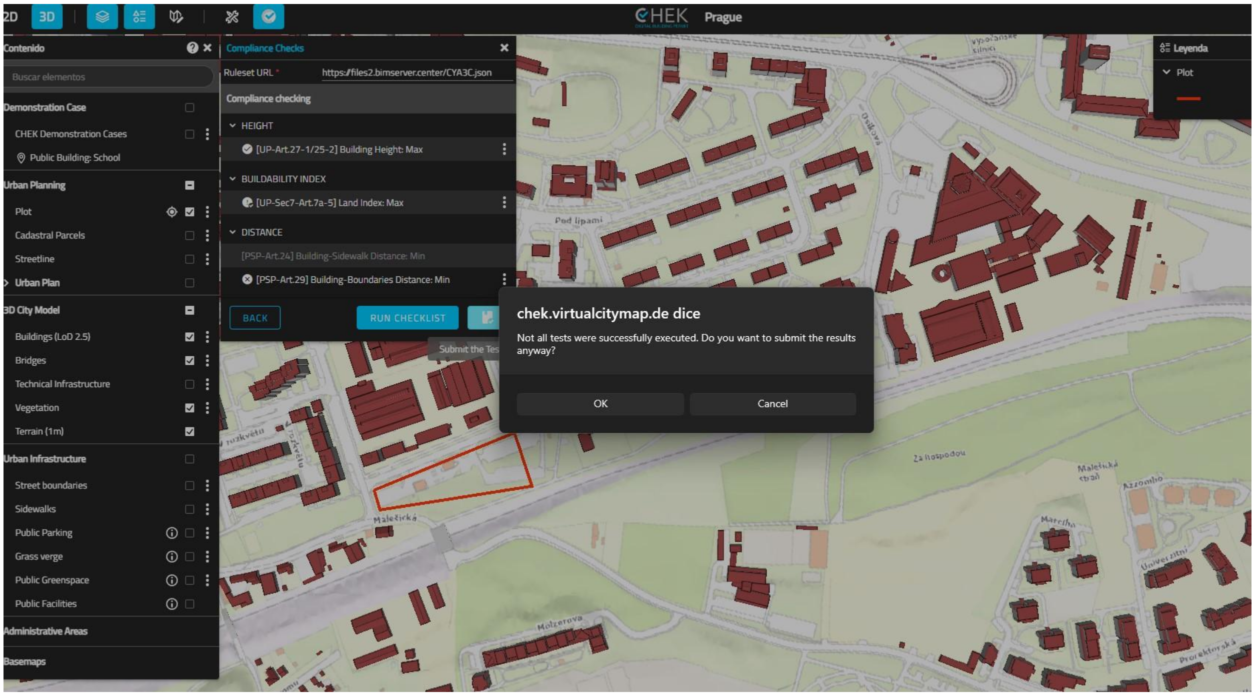



Figure 142 Sending the report to BSC

### 3.3.10 Model Evolution during Software Development and Pilot Testing

Throughout the CHEK pilot in Prague, a large number of IFC exports were generated and tested to verify and refine key aspects of the data pipeline. These exports were progressively adjusted based on requirements from the CHEK toolkit, feedback from developer partners (VCS, TUD, Xinaps), and validation results obtained with VCMap and Verifi3D. A total of over 40 IFC files were produced during the course of the pilot.

Early versions (V1.x) focused on correcting georeferencing errors and consolidating the basic building geometry. Several iterations were necessary to align the model to EPSG 5514 and Survey Point origin, as required by VCMap and TUD converters. Notably, some of these early exports presented unexpected vertical offsets or errors during conversion, likely due to 2D elements or schema inconsistencies. These issues led to the identification of limitations in the Revit IFC Exporter, which was later complemented with the DiRoots plugin in selected versions.

From version V4.x onwards, the model was progressively enriched with required elements (e.g., surroundings, terrain, yard boundaries), structured levels, and parameters for IDS and rule checking. Some versions were split to isolate specific portions of the project (building only, surroundings only), or to test different export strategies (Revit native vs DiRoots). A key milestone was version V4_5, which combined valid georeferencing, acceptable simplification, and compliance with both VCMap and TUD requirements. This became the working base model for further validation.

In parallel, test exports were produced to assess signature workflows with DiStellar and to evaluate IDS/EXPRESS validation performance. These steps helped refine naming conventions, parameter mapping, and compatibility across tools in the CHEK toolkit. In the final phase (V5.x), the model was modularized into separate IFCs for building, landscaping, and city context, each one progressively enhanced with formatted level names, custom parameters, and optimized schema structure.

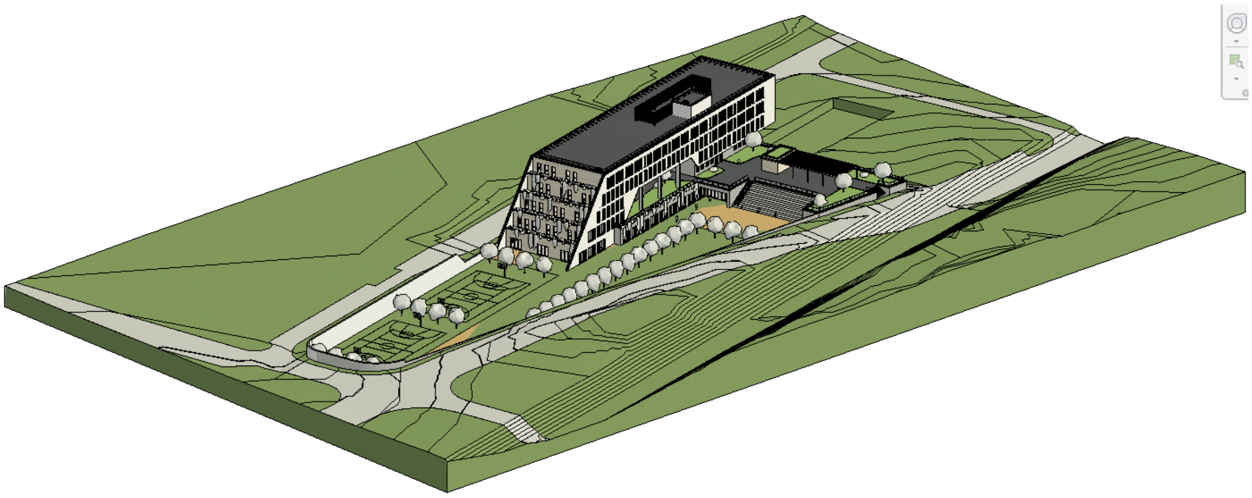


Figure 143 PRAGUE's on its first version before software development and demos performance

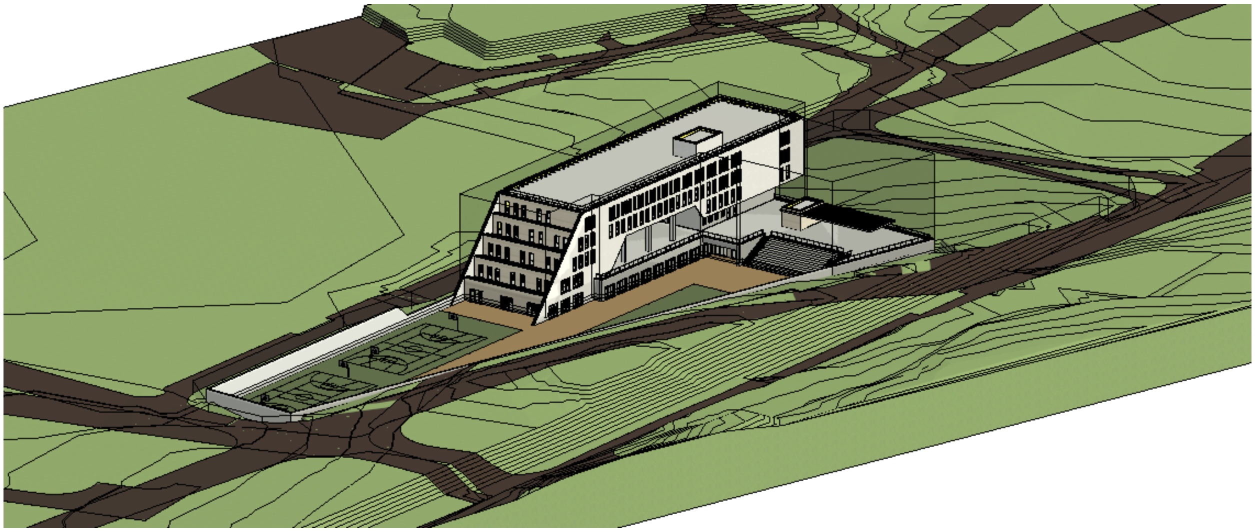


Figure 144 PRAGUE's on its last version after software development and demos performance

### 3.3.11 Digital signature of pre-checked IFC project – DiStellar

**Settings:**

- The IFC file was signed using the DiStellar tool, following the same procedure as in the GAIA demo.
- The file was signed only after confirming it had passed all quality checks in Verifi3D and was properly georeferenced and structurally sound.

**Inputs:**

- IFC file for the building, technically and regulatory validated.
- Digital signature provided by DiRoots, upon explicit request from the designer.

**Outputs:**

- Signed IFC file, uploaded as a new contribution in BIMserver.center.
- Additional copy manually sent to the municipality via direct messaging due to current visibility limitations between user roles on the platform.

**To Improve:**

- Signature management in DiStellar should allow users to request additional signature tokens directly from within the tool.
- Signed files should be uploadable directly to the municipal validation environment, avoiding manual steps that compromise traceability.

**Process Description:**

The IFC signing phase in the IPR demo followed the same procedure previously established in the GAIA case, with a few nuances related to DiRoots support and the current platform role management.

After completing all prior validations (IDS, georeferencing, Verifi3D, and VCMap), the designer requested additional signature tokens from DiRoots, as the existing quota had been exhausted. The DiRoots team responded promptly and provided the required signatures.

The file was successfully signed using the DiStellar tool. However, due to existing limitations in the platform's role-based visibility, the signed file did not automatically appear in the municipality's validation account. As a temporary workaround, the file was compressed and sent directly to the municipal team via messaging to allow them to proceed with their reviews.

Beyond the procedural execution, this step highlighted the importance of establishing a direct, role-aware pathway for transferring signed documents between the designer and the validator within the CHEK ecosystem.

### 3.3.12 CHEK permitting tools. Municipality side workflow review

**Settings:**

- BIMserver.center validation platform
- Cross-check validation by the municipality of Prague was attempted using the two expected tools: Verifi3D and VCMap.
- Real municipal accounts with the CHEK Municipality role were used, but many encountered issues related to permissions and visibility.
- In several cases, the designer account of the lead reviewer (Lucie Kovarikova) was used as a functional workaround.

**Inputs:**

- Signed IFC file of the building.
- Contributions uploaded by the designer to BIMserver.center.
- Urban and building rules loaded in Verifi3D and VCMap.

**Outputs:**

- Partial validation of rules in Verifi3D from the municipal side (with errors in rule import) using a designer account (linked to Lucie Kovarikova).
- Complete validation in VCMap.
- Results were shared manually between the designer and the municipality due to a lack of effective connection between accounts and tools.

**To Improve:**

- Municipal accounts cannot directly access projects created by designers unless a validation has already been triggered.
- It is not possible to upload signed files from the designer profile to the municipality's environment, which limits traceability.
- The "Review" tab and the ability to generate new issues in CDE are often disabled.
- The tools do not provide clear definitions of the rules or parameters being evaluated, making validation harder for municipal reviewers.

**Process Description:**

From days 3 to 5 of the demo, the municipality of Prague conducted validation tests using the tools provided within the CHEK environment.

Before initiating the municipal validation, the building's IFC model had been digitally signed using the DiStellar application developed by DiRoots. This process relied on the external Evrotrust platform to issue a Qualified Electronic Signature (QES), ensuring the authenticity and integrity of the file for downstream validation steps.

The process was affected by technical limitations, particularly in relation to user permissions and visibility between designer and municipality accounts in BIMserver.center.

In the case of Verifi3D, although the lead reviewer was able to import the model from her designer account and execute validation rules, users with purely municipal roles could not access the project or import models. Additional issues were found in the rule set import process, which prevented several rules from being executed. Differences in results between the designer and the municipality were attributed to how the export process works: the designer exported a

consolidated report, while the municipality exported each rule result individually – the results were different. When municipality used also consolidated report, the results were the same as designer's, but false negative.
With VCMap, the urban validation test was successfully performed. However, the system did not clearly display which parameters were being evaluated and offered no editing options for the municipality. The platform also lacked clarity on which model among multiple contributions should be reviewed, so colaboration with designer was needed and the reported values visible in BIMserver.center did not always match the values in VCMap, which complicated accurate validation.
As for BIMserver.center, critical limitations were noted: users could not create new issues, the "Review" tab was not visible for some accounts. As a result, the official validation loop remains incomplete or not fully functional.
Overall, while the technical validation of the model was completed, the formal validation from the municipality side was not entirely viable, highlighting the urgent need to improve role management, permissions, data synchronization, and traceability across the CHEK ecosystem.

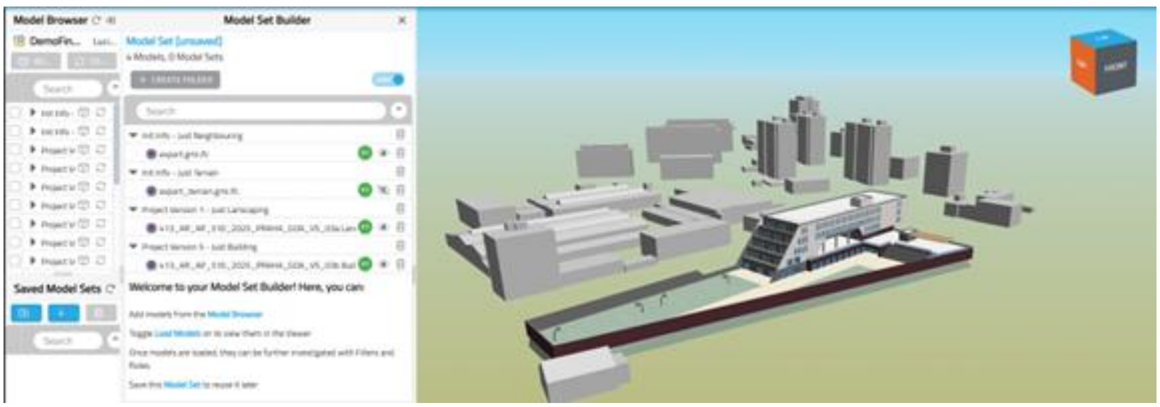



**Figure 145 Municipality federation of models. Entering as partner.**


**Figure 146 Running the 2 available regulations. Passed**

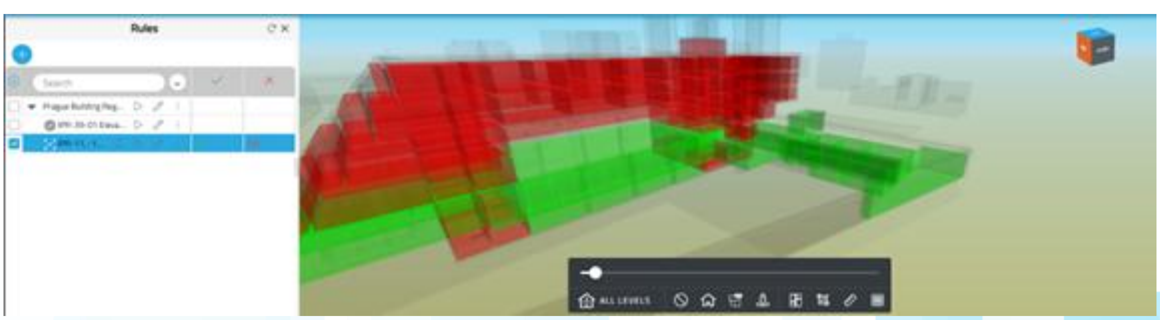


Figure 147 Edited regulations to force uncompliance

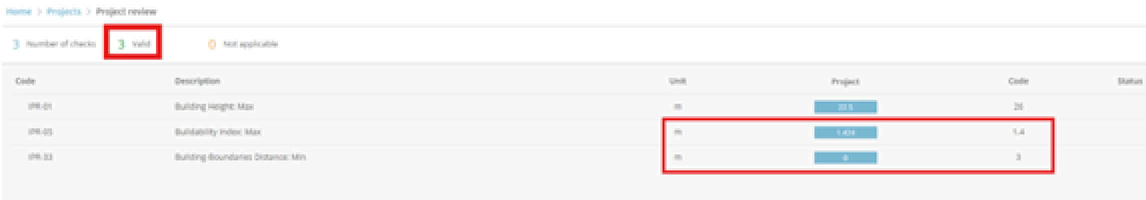


Figure 148 VCMap report on validation side (BIMserver.center)

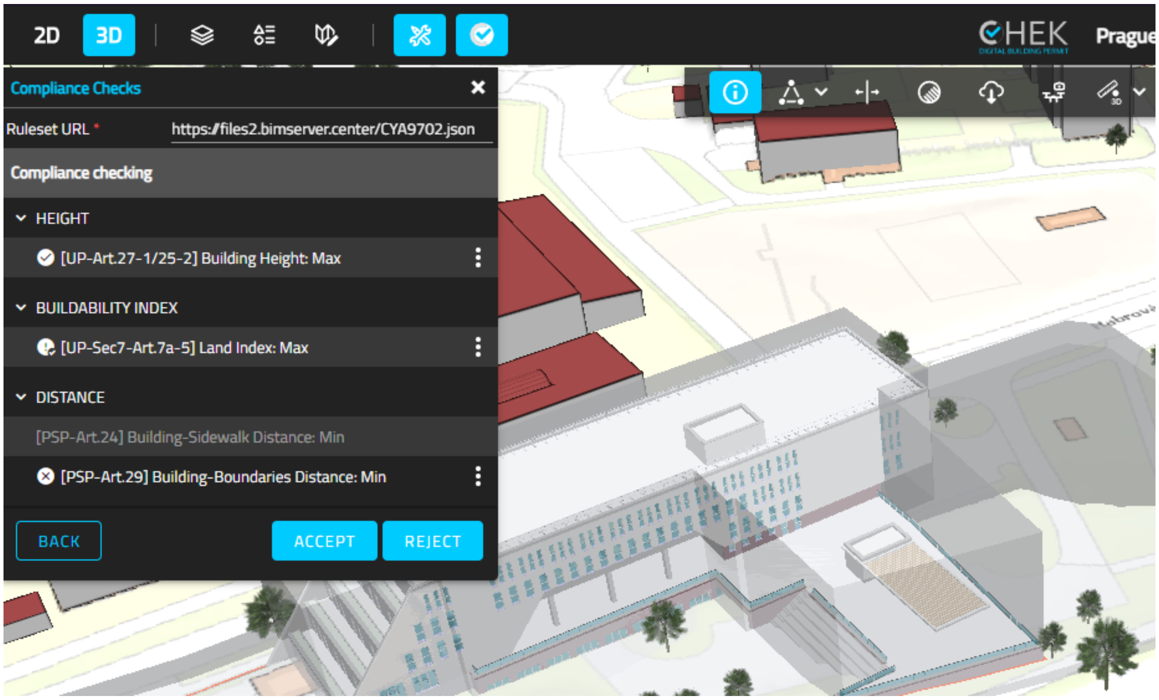



Figure 149 VCMap report on VCMap validation side


Figure 150 Review tab Issue

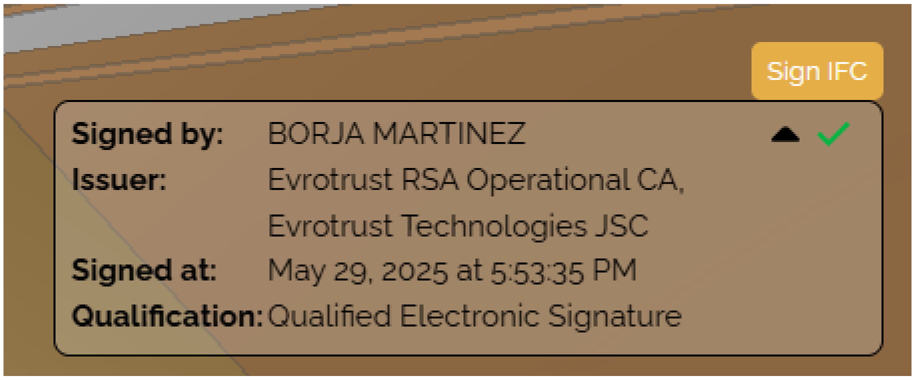



Figure 151 IFC model signature checked

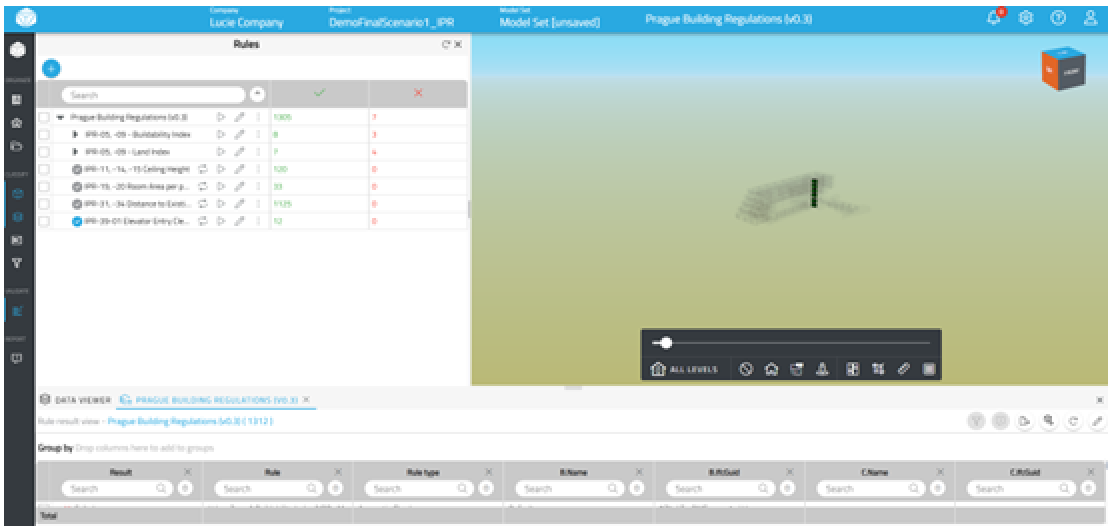



Figure 152 Verifi3D Ruleset loading fixed

## 3.4 Ascoli Piceno

This section provides a detailed overview of the demonstration activities carried out in the Ascoli Piceno pilot within the scope of Task 6.2, focusing on the application of the CHEK digital workflow to a new construction scenario. The aim was to test the adaptability of the CHEK tools when applied to new construction and to assess their performance in supporting a model-based, standards-driven building permit process.

The demonstration was based on a mix-use building designed and modeled by ZWE with consideration of the local regulations, site context, construction technologies etc. The demo plot is located in Via Genova 4-6, in the Porta Maggiore district of Ascoli Piceno, Italy.

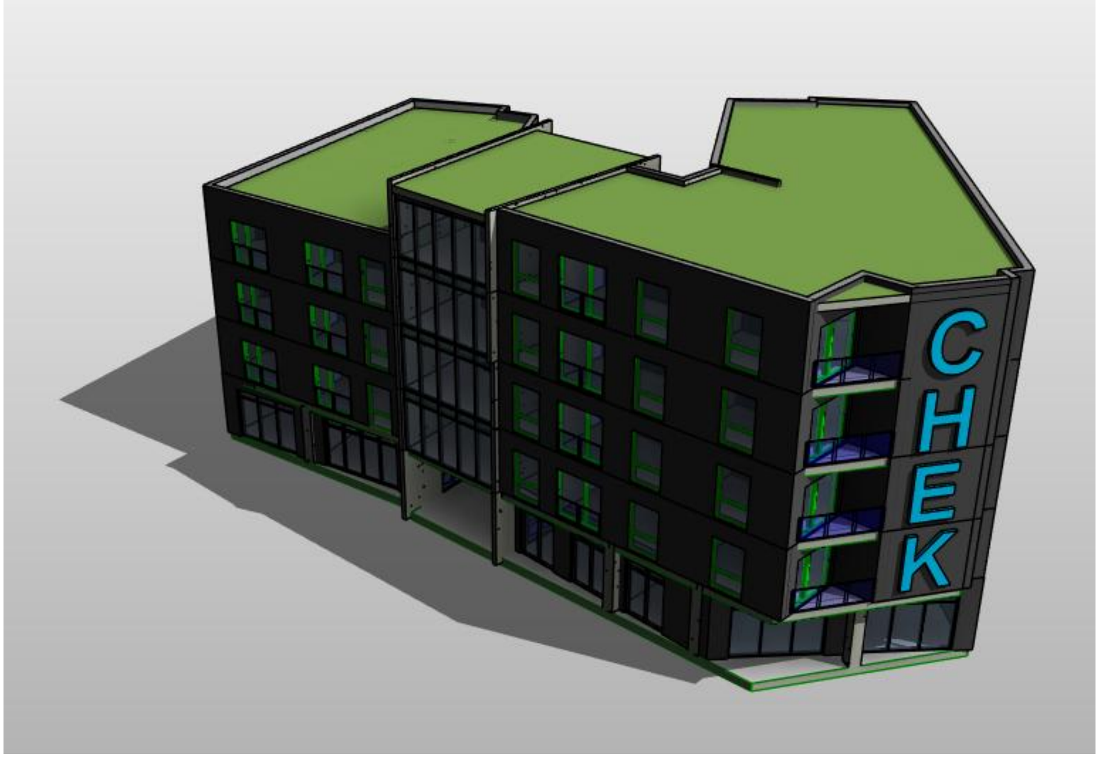



**Figure 153 Final version for ASCOLI PICENO's Scenario 1**

A full description of the original project context, urban conditions, and baseline geometry can be found in Section 3.1.2 of Deliverable D6.1 "Plan for demonstration of CHEK Digital Building Permit process on demo sites", which outlines the Ascoli Piceno demo pilot characteristics.

The new construction workflow followed the typical progression of a real design-to-permit process, beginning with the collection of site context, local regulation etc. and followed by model design, pre-validation, adaptation, validation, and submission. The model was developed in a standard BIM authoring environment using Revit 2025 as BIM authoring tool and exported in IFC 4 Add2 format.

The following tools from the CHEK digital toolkit were used to execute the workflow:

- Verifi3D (Xinaps): to perform rule-based spatial and regulatory checks against local planning conditions;
- VC Map (VCS): to perform rule-based spatial and regulatory checks against local planning conditions;
- IfcEngine (RDF): to validate IFC structure and schema compliance;
- CityGML2IFC (RDF): to export site CityGML files to IFC;
- IfcGref (TU Delft): to confirm georeferencing consistency of the IFC model;

- DiStellar plugin: to apply a digital signature to the validated model;
- BIMServer.Center (Cype): serving as the shared platform (CDE) for storing and managing model files, metadata, and validation outputs.

This scenario tested the ability of the tools to accommodate the challenges of new construction design workflows, addressing compliance with current building regulations.

The demonstration was conducted in collaboration with the Lisbon municipality, who provided regulatory context and validation feedback. The results confirmed that the workflow is applicable in new construction settings.

The Ascoli Piceno (APC) New Construction pilot contributed valuable insights into the flexibility and interoperability of the CHEK toolkit. It confirmed the viability of a digital building permitting approach to new construction projects.

The following subsection details the technical steps followed in this pilot and presents the outputs of the demonstration.

**Table 6 – Key Findings after performing demo scenario 1 on APC's pilot**

| Aspect | Finding |
|---|---|
| Toolchain Coverage | All major CHEK tools were successfully used in a complete DBP loop, including both pre-validation and final validation stages. |
| Data Conversion | The workflow confirmed reliable conversion from GIS to BIM using CityGML2IFC, with consistent geometry and spatial referencing. |
| Georeferencing | The georeferencing process was confirmed through IfcGref, with EPSG data embedded and verified through visual and metadata checks. |
| IFC Validation | IDS and EXPRESS schema checks identified minor issues, prompting model corrections in Revit and re-export via DiRoots Exporter. |
| Iterative Design Corrections | The pre-validation feedback from VCMap triggered meaningful design updates (e.g., building height), showing practical integration between design and compliance. |
| Digital Signature | The DiStellar plugin was used without issues, and the signed file was correctly recognized by the municipality in BIMServer.Center. |
| Cross-validation | Both VCMap and Verifi3D returned mixed results, underscoring the importance of using multiple validation engines for comprehensive coverage. |
| Municipality Review | The municipality validated the IFC signature and reports successfully, confirming the transparency and traceability of the CHEK DBP workflow. |

The Ascoli Piceno pilot, unlike previous pilots, stood out for its iterative loop between design correction and compliance validation, which was completed without major technical setbacks. It also showed that dual validation using VCMap and Verifi3D can provide richer feedback, but requires careful result interpretation and harmonization.

### 3.4.1 Creating new project using BIMServer.Center

Demonstration of the CHEK digital toolkit, starts with BIMServer.Center that serves as CHEK DBP platform where Designers create new project as central project repositorium for all project contributions and collaboration between Designers and Municipalities.

**Inputs**:

- No particular inputs

**Outputs:**

- Created New Project repositorium

**Process description:**

1. Designers logged in into BIMServer.Center with CHEK Designers account

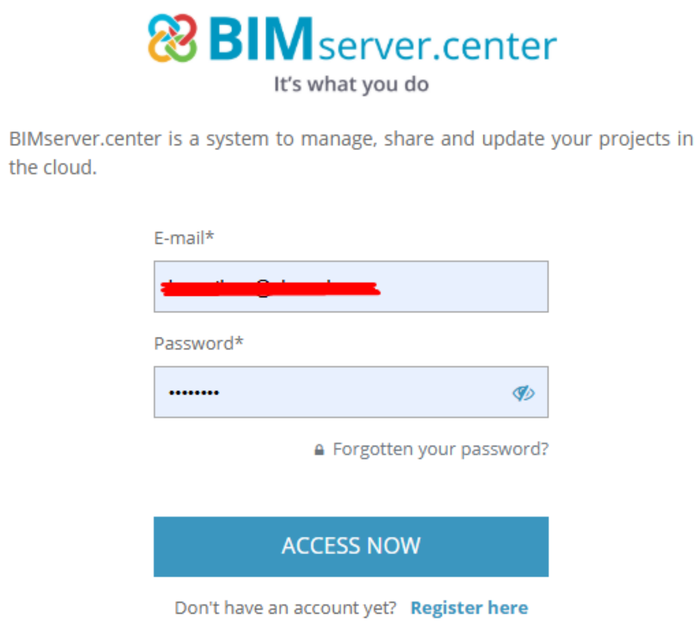



Figure 154 Logging into BSC designer's account

4. New Project was created

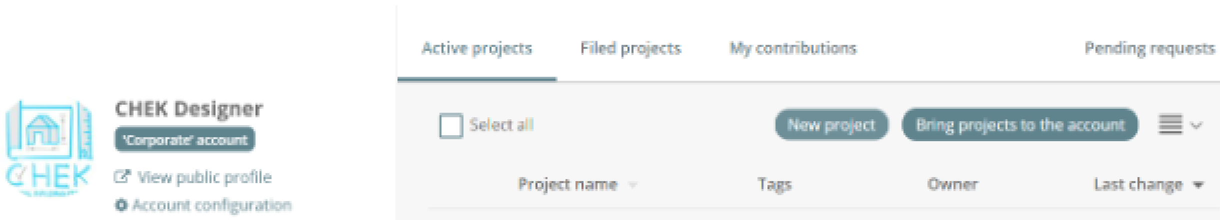



Figure 155 The new project must be created in the CDE

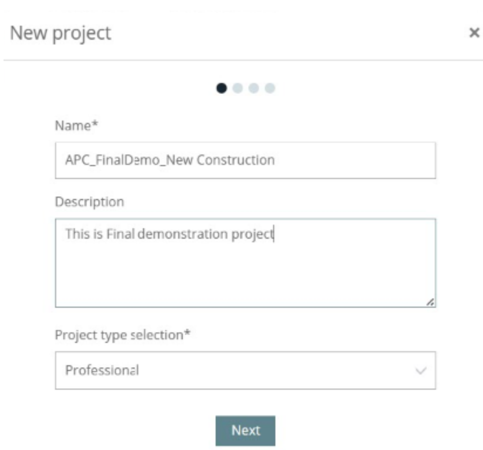



Figure 156 Clear name and description filled

5. Proper predefined Project Tag was assigned so checking application can automatically recognize the site location

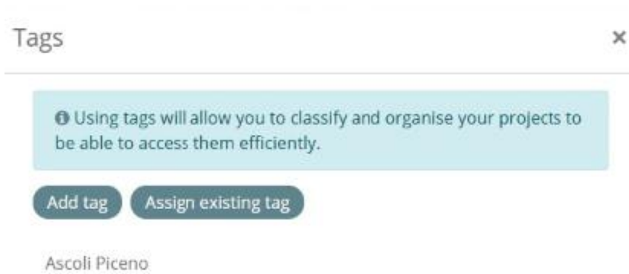



Figure 157 Correctly tagging the project to share contributions with other CHEK tools

### 3.4.2 Gathering initial data - VCMap

After the project was created in BIMServer.Center, the demonstration continued with collecting the site data as 3d geometry for future use in BIM authoring tool.

**Inputs:**

- No particular inputs

**Outputs:**

- Surrounding models created

**Process description:**

1. Designers logged in into VC Map platform with CHEK Designers account

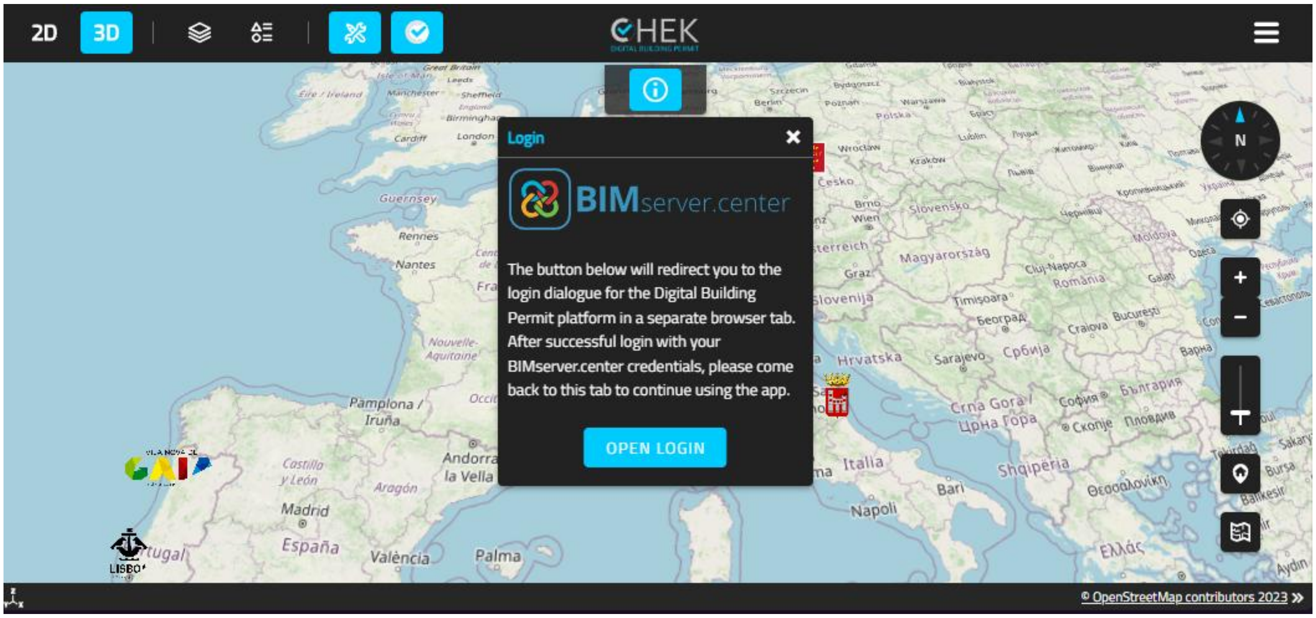



Figure 158 Connecting VCMap to BSC

2. After allowing VCMap to connect to BIMServer.Center, VCMap accessed the CHEK Designer's account and saved projects


Figure 159 Selecting designer's account

3. The newly created project was connected to VC Map

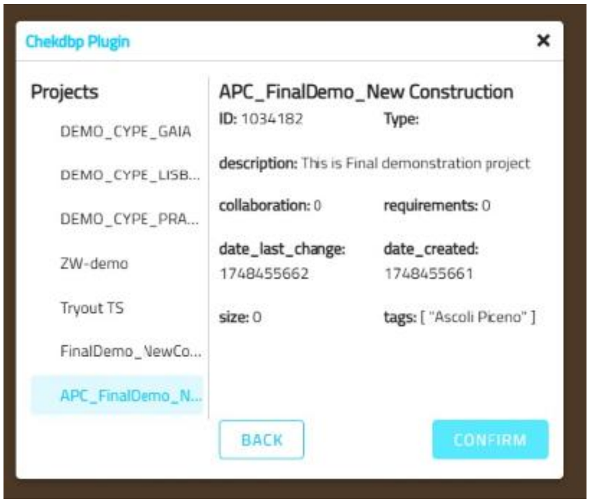



Figure 160 Metadata associated to the project, including tags

4. The plot location was properly displayed in VC Map

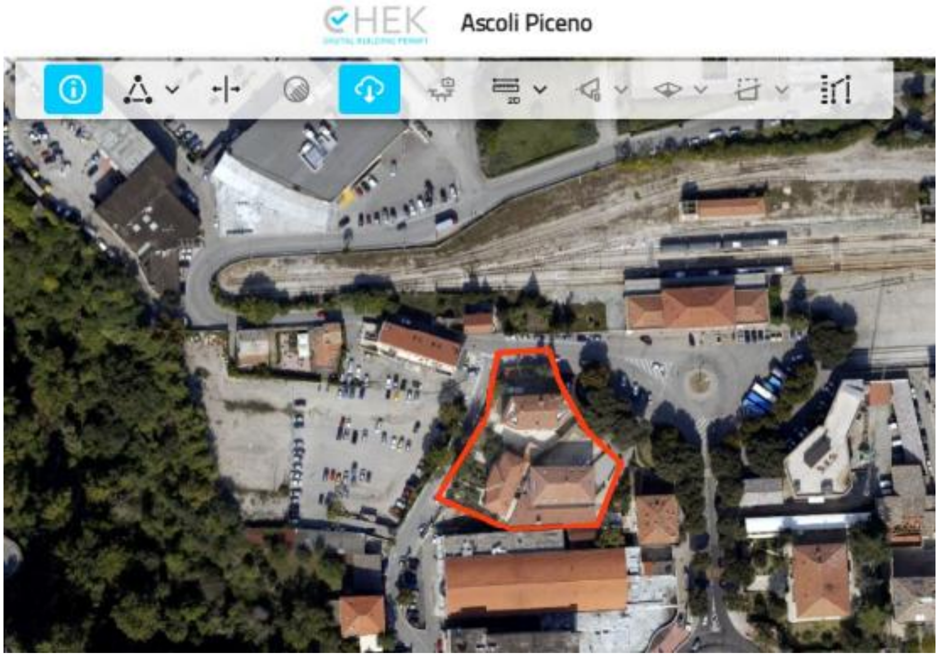



Figure 161 Seeing the plot in VCMap enables begin the exporting step for later design

5. Export Tool in VC Map was used for exporting of the surrounding data by using Area selection tool and by selecting various export file formats, object types etc.

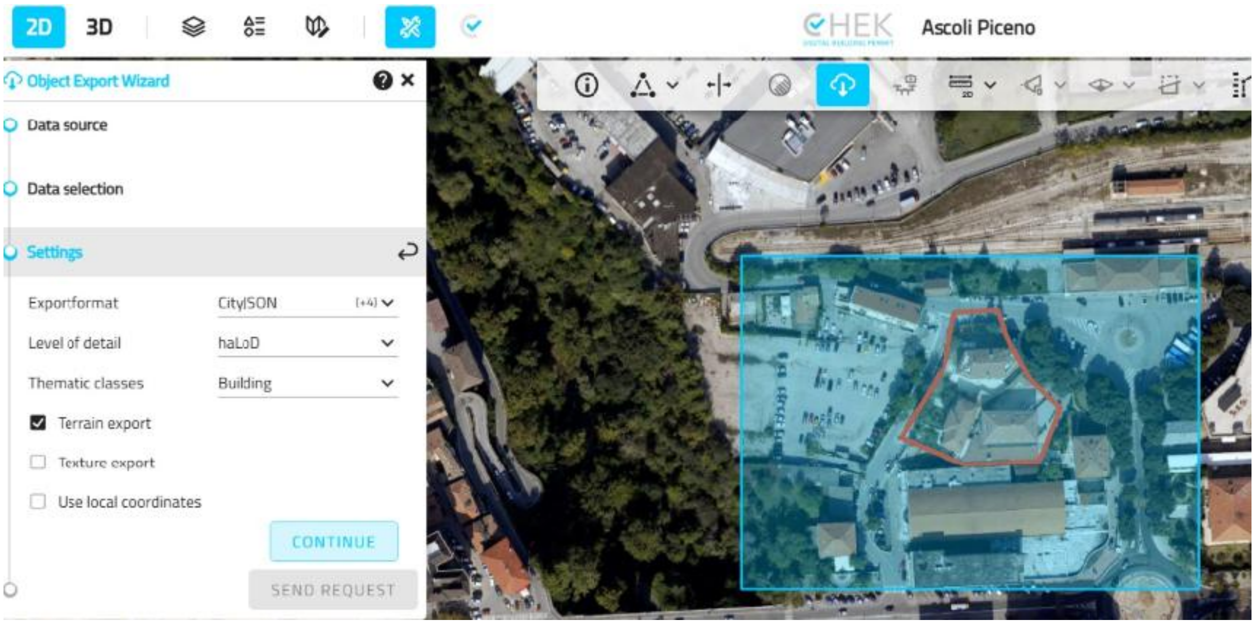



Figure 162 Blue rectangle selects the neighbor buildings to include in the export

6. After finalization, a confirmation was received that the export operation was successful
7. The exported models of the surroundings were exported directly to the project folder in BIMServer.Center as a new contribution

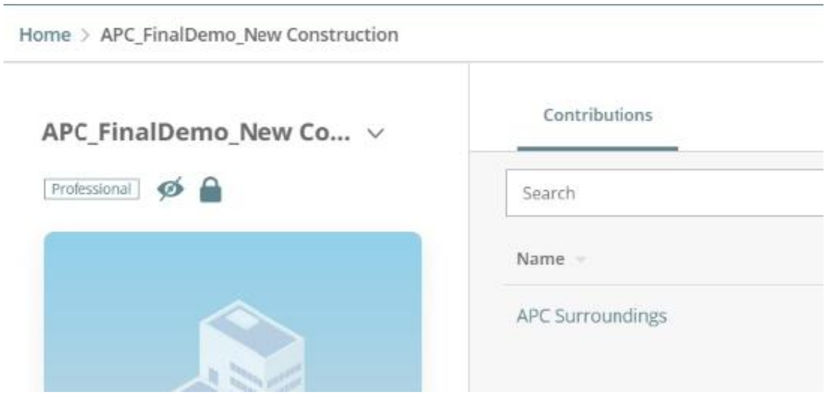



Figure 163 The expected contribution appears successfully in BSC

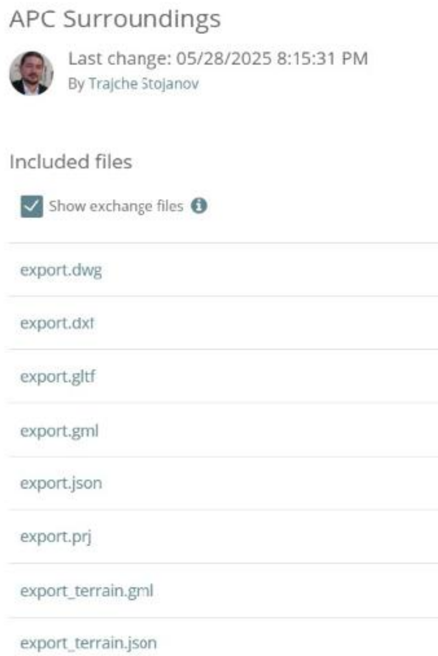



**Figure 164 Exploring the content of the recently created contribution**

8. Exported CityGML files were further converted into IFC for use in BIM authoring tool as described in the next paragraph

### 3.4.3 GIS to BIM conversion - CityGML2IFC

Exported GIS (surrounding buildings and terrain) models from VCMap were further converted from CityGML into IFC files via RDF's CityGML2IFC tool. This tool was run locally on Designers' computers and in essence transferred the GIS data into BIM.

**Inputs:**

- CityGML files

**Outputs:**

- New IFC files from CityGML files

**Process description:**

1. Run CityGML2IFC locally with buildings gml file loaded

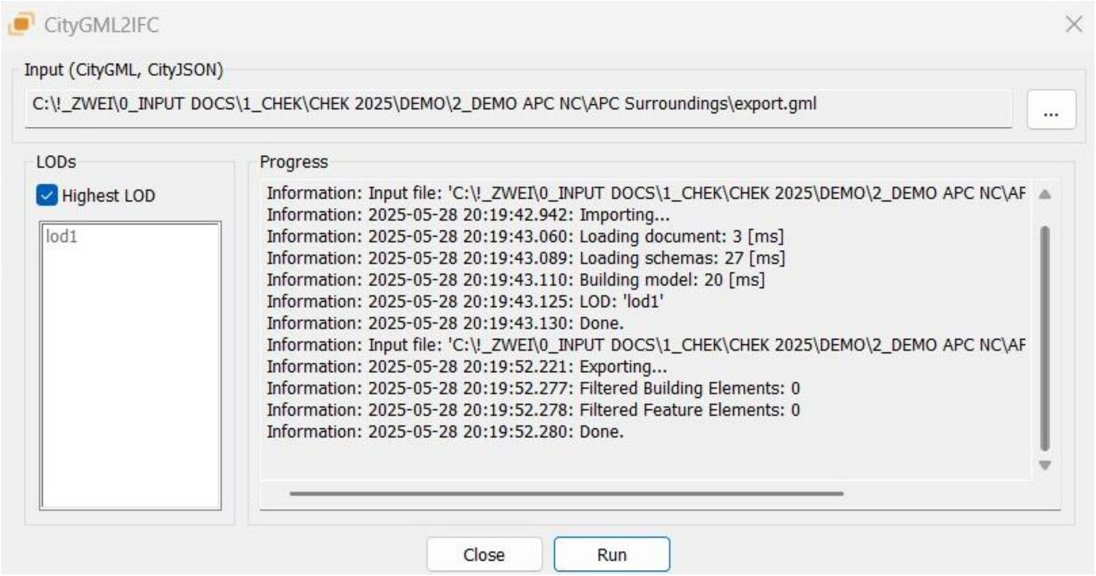



**Figure 165 Running the GIS to BIM converter for the surrounding buildings**

2. Run CityGML2IFC locally with terrain GML file loaded

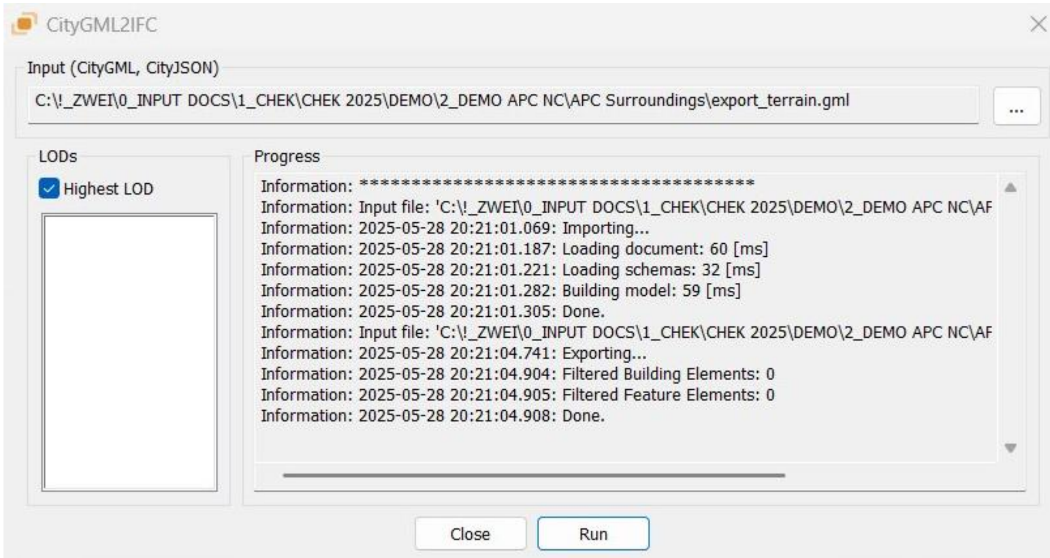



Figure 166 Running the GIS to BIM converter for the DTM

3. The exported IFC files were located in the same folder where the *.GML files were uploaded from the CityGML2IFC converter.

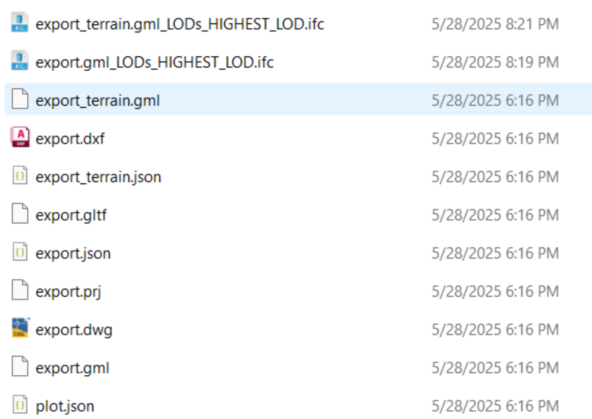



Figure 167 Converted files stored in the same folder as the sources

4. The workflow continued in BIM authoring tool where the IFC models of the surrounding buildings and terrain were used.

### 3.4.4 Designing overview

Surroundings (terrain and surrounding buildings) were converted into IFC, because IFC is one of the supported file formats when working with Revit 2025 as BIM Authoring Tool of choice. In Revit, these IFC files are being utilized in the design process itself.

**Inputs:**

- Newly converted IFC files

**Outputs:**

- Fully georeferenced Revit file with surroundings

**Process description:**

1. A new file was opened in Autodesk Revit 2025, a BIM authoring tool used for this demo site.
2. Newly converted IFC models representing the surrounding buildings and terrain were linked using the Link IFC tool. The links were further bound into the Revit file and the Revit file was saved to serve as surroundings file.

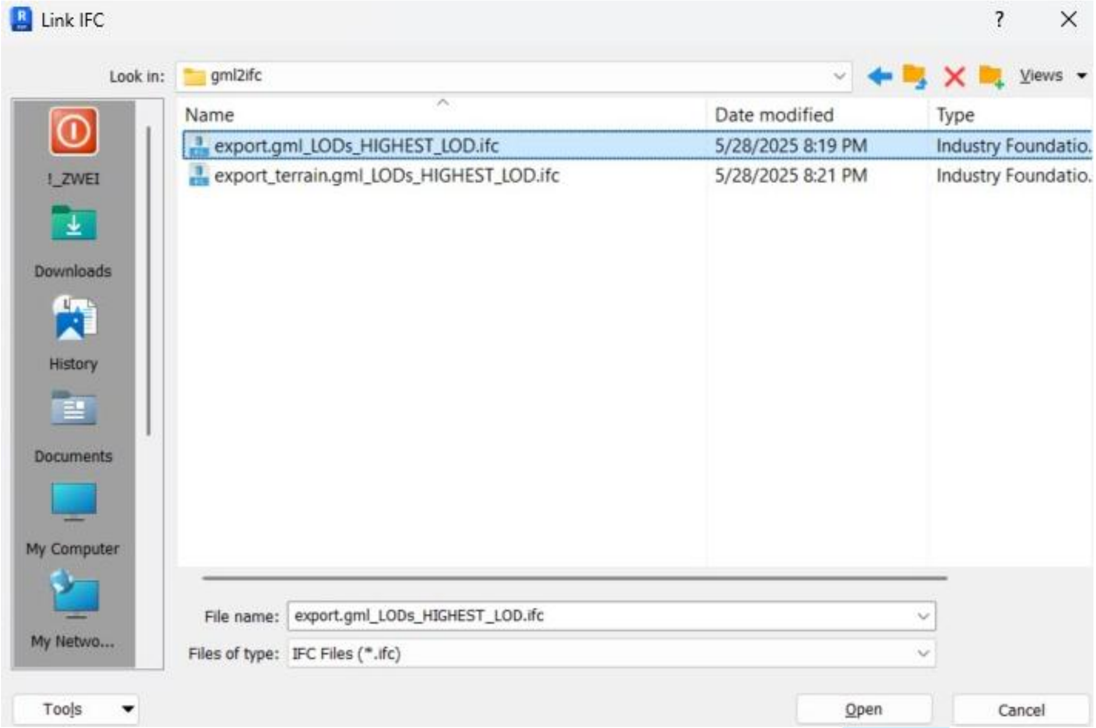


Figure 168 Importing the initial IFC data for later design in vendor software

3. Georeferencing of the Revit file was done in order to reflect the realistic spatial context
4. The surroundings Revit file was linked into the Revit Building model

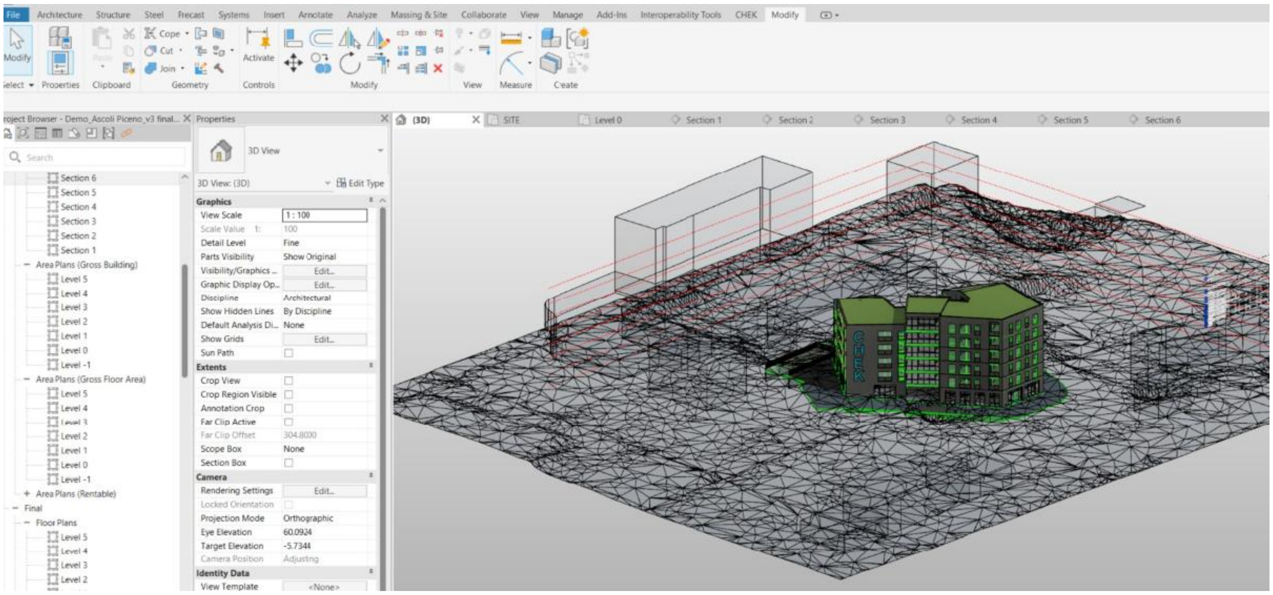


Figure 169 Imported surroundings and DTM as appear in Revit

5. At this moment, the model was exported in IFC with Revit's built-in IFC exporter in order to validate the georeferencing of the model, prior to any additional design development. The part with georeference check in IfcGref tool is presented further in this deliverable. Additionally, the created custom IFC export contained proper georeferencing setup like EPSG code and was saved as custom MVD (Model View Definition).

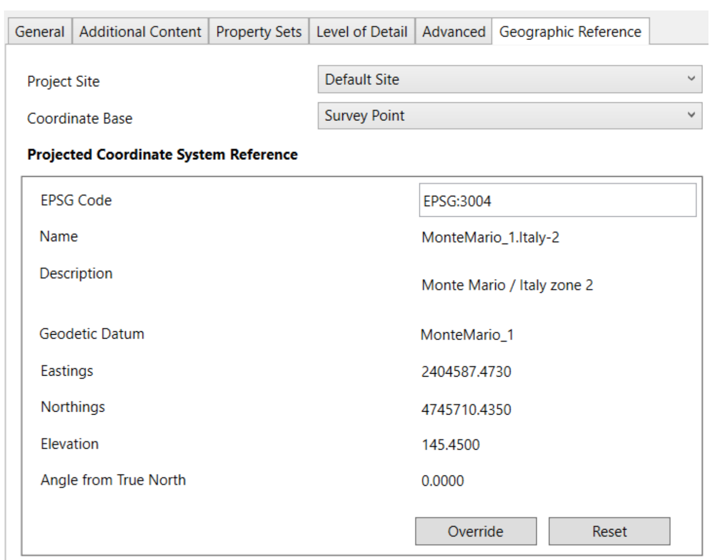



Figure 170 Exporting the design. Georeference settings

6. After a georeferencing check was validated, the design development continued until the model/project was completed.

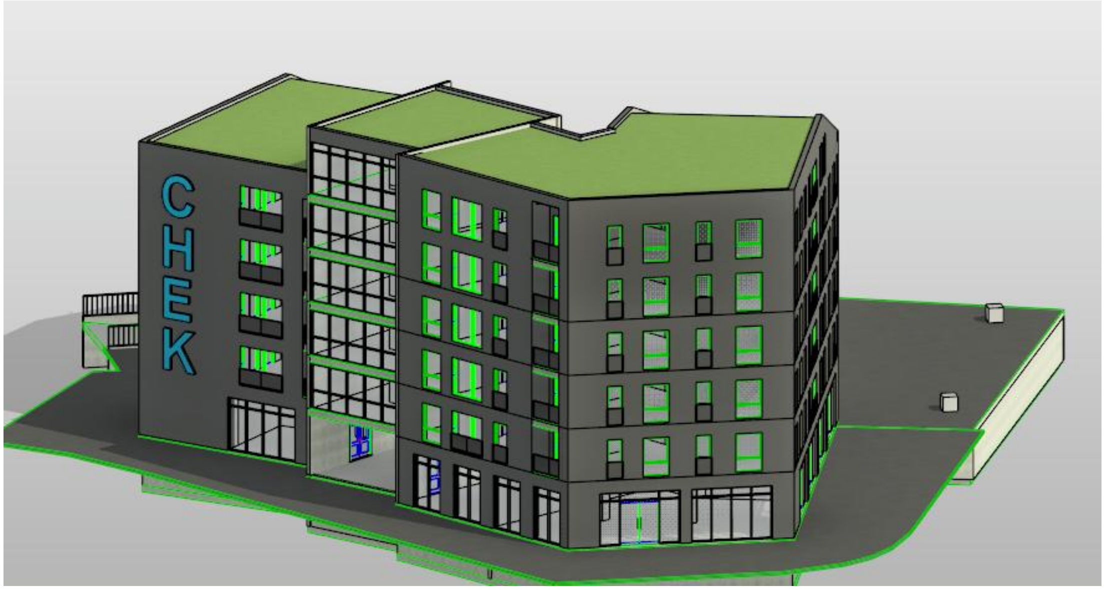



Figure 171 Final design ready for georeferencing assessments

7. After modeling in Revit was done and relevant attributes were added, the model was exported in IFC with DiRoots IFC Exporter, presented further in this deliverable.

### 3.4.5 Exporting the model – DiRoots Plugin

When modeling in Revit as BIM authoring tool finished, export to IFC was done using the DiRoots plugin IFC Exporter. The DiRoots IFC exporter read the existing custom IFC setup (IFC4 MVD) in Revit and required correct attribute mapping so the required attributes will be transferred to IFC file.

**Inputs:**

- Finalized Revit model
- Custom made MVD inside Revit containing proper EPSG

**Outputs:**

- IFC file

**Process description:**

1. DiRoots IfcExporter was previously installed inside Revit 2025

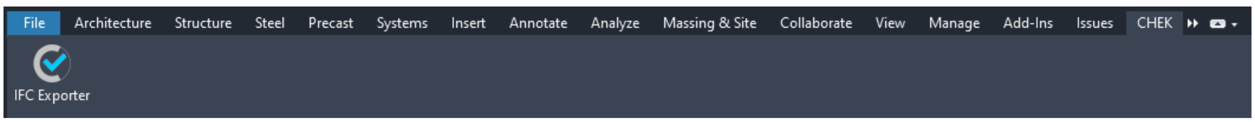



**Figure 172 CHEK toolkit exporting tool by DiRoots**

2. In IFC Exporter, proper IDS was selected, along with IFC Export MVD. In the table, each required IFC property was mapped with corresponding Revit parameters

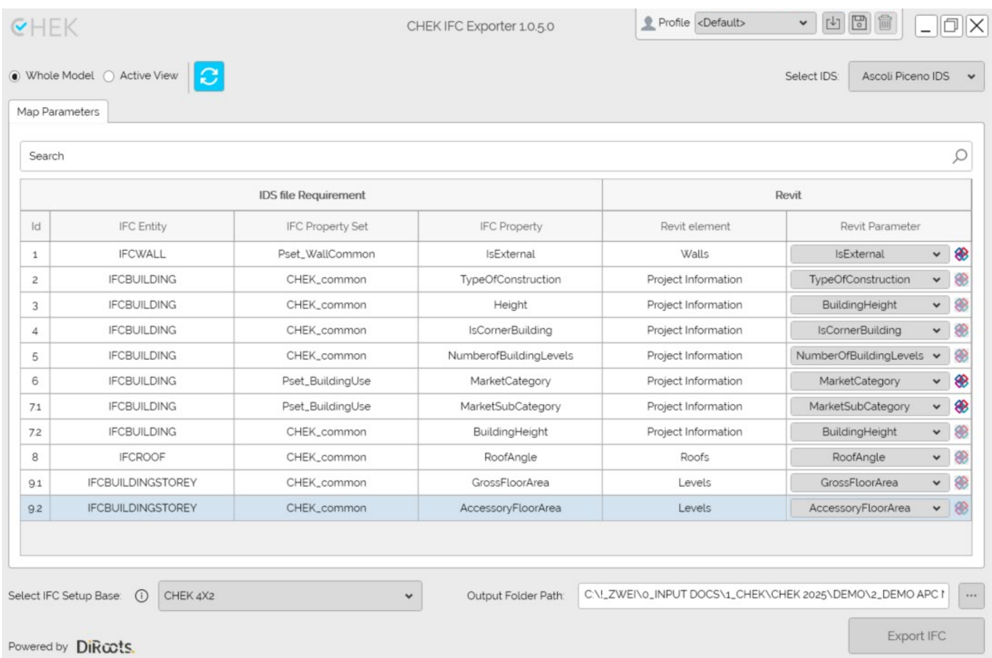



**Figure 173 DiRoots exporter set up, finished after mapping required parameters**

3. The DiRoots IFC Exporter created the project IFC model of the building that will be used further in the demonstration.

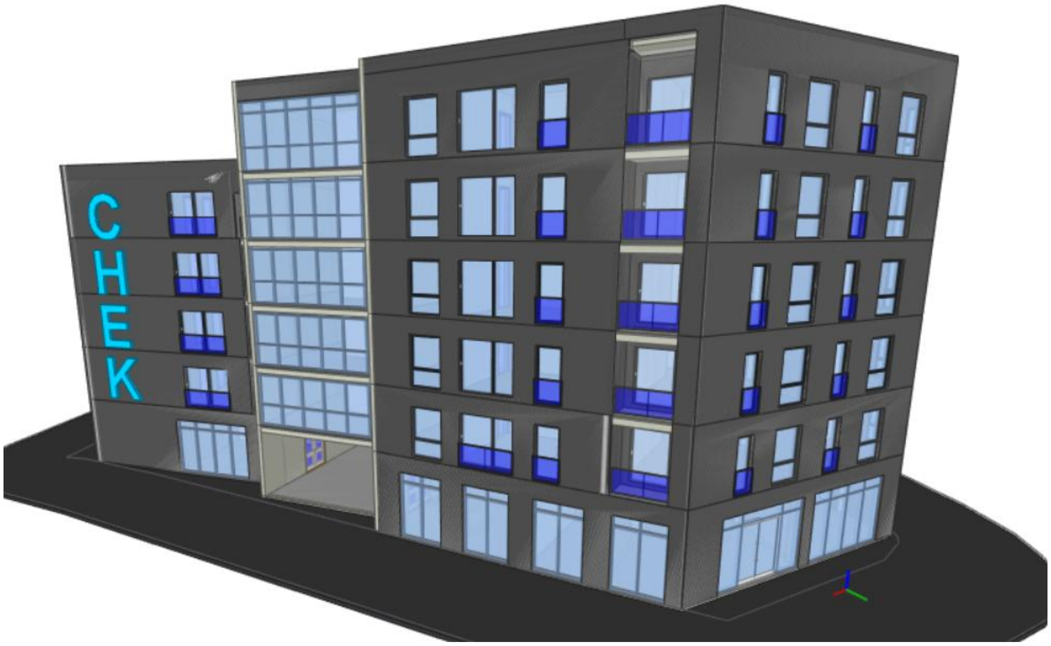



Figure 174 Resulting IFC file including parameters required by the IDS

### 3.4.6 Georeference assessment - IfcGref

After the project was exported to IFC, a georeferencing validation check was performed in IfcGref tool. IfcGref tool developed by TuDelft, is a web service that validates the proper georeferencing of the IFC files and offers additional tools such as visual inspection of the model on basemap.

**Inputs:**

- Georeferenced IFC model

**Outputs:**

- Validated IFC model

**Process description:**

1. The IFC model of the building was uploaded to IfcGref

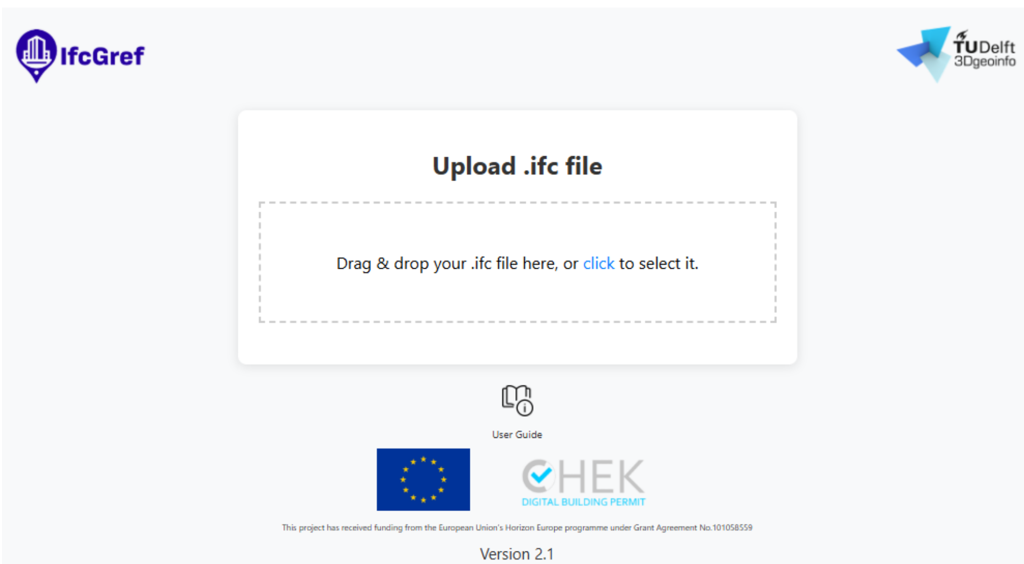



Figure 175 IfcGref tool ready to check a new IFC file

2. IfcGref tool returned that the model is properly georeferenced

IfcGref

TUDelft 3Dgeoinfo

IFC version: IFC4
IFC file is georeferenced.

### IFCProjectedCRS Data

| | property | value |
|---|---|---|
| **0** | id | 28 |
| **1** | type | IfcProjectedCRS |
| **2** | Name | EPSG:3004 |
| **3** | Description | Monte Mario / Italy zone 2 |
| **4** | GeodeticDatum | MonteMario_1 |
| **5** | VerticalDatum | None |
| **6** | MapProjection | None |
| **7** | MapZone | None |
| **8** | MapUnit | [None, LENGTHUNIT, None, METRE] |

### IFCMapConversion Data

| | property | value |
|---|---|---|
| **0** | id | 29 |
| **1** | type | IfcMapConversion |
| **2** | SourceCRS | [None, Model, 3, 1e-05, [[(0.0, 0.0, 0.0)], None, None], [(6.123233995736766e-17, 1.0)]] |
| **3** | TargetCRS | [EPSG:3004, Monte Mario / Italy zone 2, MonteMario_1, None, None, None, [None, LENGTHUNIT, None, METRE]] |
| **4** | Eastings | 2404587.473 |
| **5** | Northings | 4745710.435 |
| **6** | OrthogonalHeight | 144.8 |
| **7** | XAxisAbscissa | 1.0 |
| **8** | XAxisOrdinate | 0.0 |
| **9** | Scale | None |

Show on Map

**Figure 176 IfcGref displays that the IFC is georeferenced. Graphical assessment still needed**

3. The model was properly positioned on the map

Figure 177 Graphical georeferencing assessment in IfcGref

### 3.4.7 IFC validation – RDF's IfcViewer

To ensure validity of the IFC model data for further regulations compliance checks, the IFC model was checked against EXPRESS and IDS requirements. This check was performed using the RDF's tool IfcViewer, a portable desktop application.

**Inputs:**

- IFC model and Lisbon IDS file

**Outputs:**

- Validated IFC model against IDS and EXPRESS schema

**Process description:**

1. The IFC model of the building was opened with IfcViewer

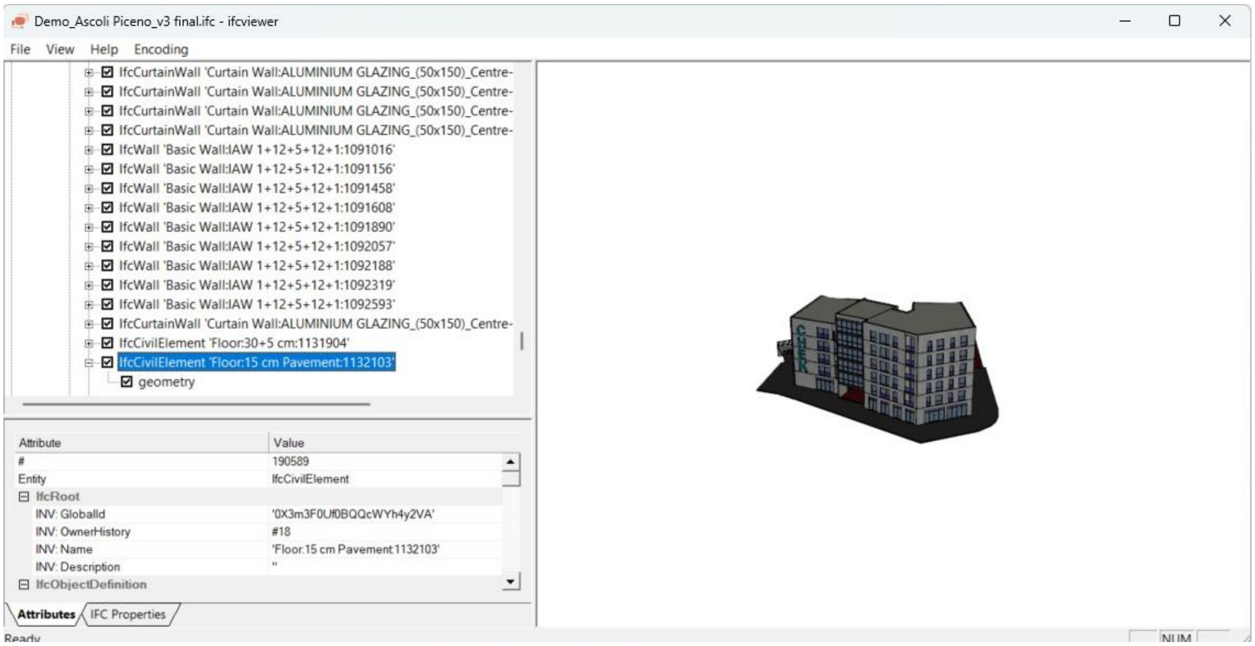



Figure 178 RDF's viewer lets performing the IFC quality regarding IDS and EXPRESS schema

2. The EXPRESS Schema Checker returned the results

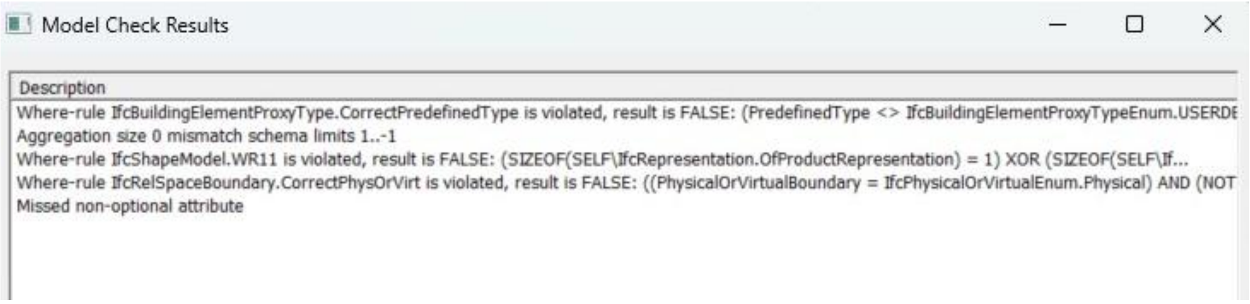



**Figure 179 EXPRESS validation report**

3. The IDS checker requested import of Gaia pilot specific IDS file and after it was imported returned the following results:

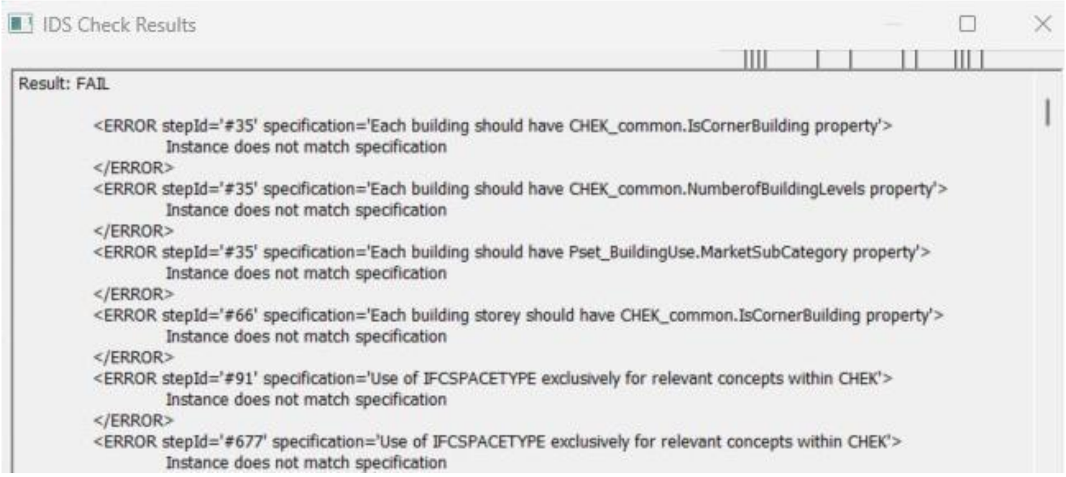


**Figure 180 IDS Checker report**

4. Both checkers returned some failed results.

### 3.4.8 Uploading the model to the CHEK platform using tool BIMServer.Center

IFC model was validated against georeferencing, EXPRESS schema and IDS requirements. Next step was to be uploaded as Contribution to the project folder on the CHEK DBP platform based on BIMServer.Center. This contribution was later connected to CYPEURBAN and VC Map for performing self check against predefined rules.

**Inputs:**

- IFC model

**Outputs:**

- Validated IFC model as contribution in BIMServer.Center

**Process description:**

1. New contribution was initiated in the project folder in BIMServer.Center

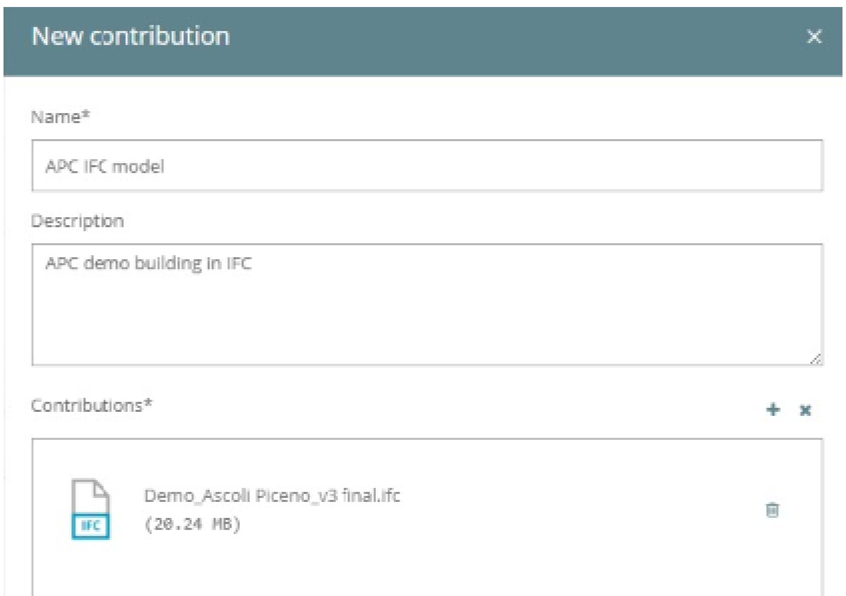



Figure 181 Designer's creation of the contribution with format validated IFC file

2. After uploading the IFC model in the contribution, the platform automatically generated a GLTF version for visualization purposes.

### 3.4.9 CHEK pre-validation - VCMap

Prior to performing final checks in checking application, Designers did self check of the IFC model in this stage. The self-check returned some failed checks. This pre-validation is very beneficial in self-assessment of the model prior to submitting it for Review by the Municipalities.

**Inputs:**

- IFC model
- Ruleset file with predefined rules

**Outputs:**

- Validated IFC model as contribution in BIMServer.Center

**Process description:**

1. After Designers logon the VCMap platform and connected the BIMServer.Center account, the IFC model was converted to Visualization Model in order to be visualized

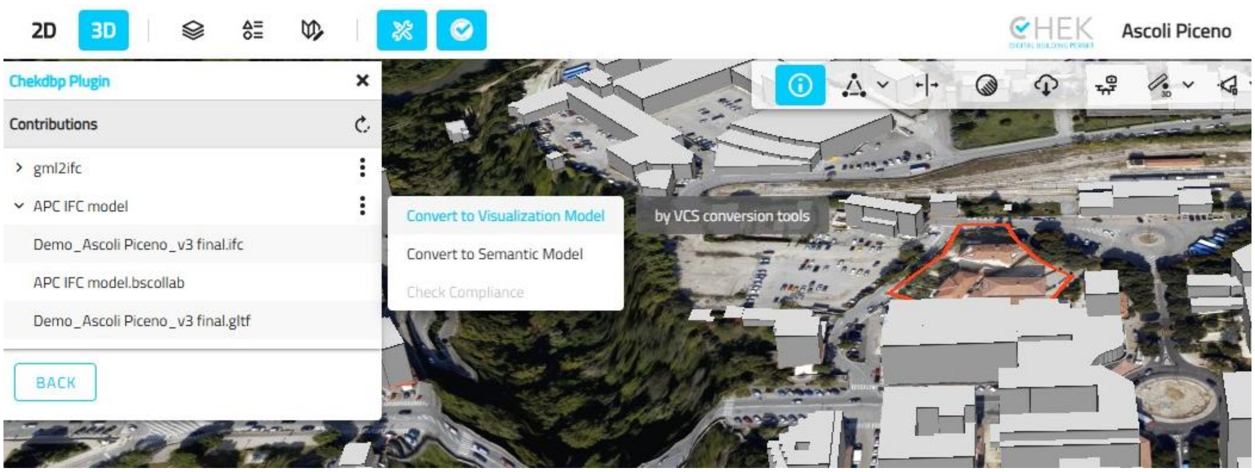



Figure 182 Converting into visualization model in VCMap

2. After converting the model into Visualization Model, conversion to Semantic Model was performed

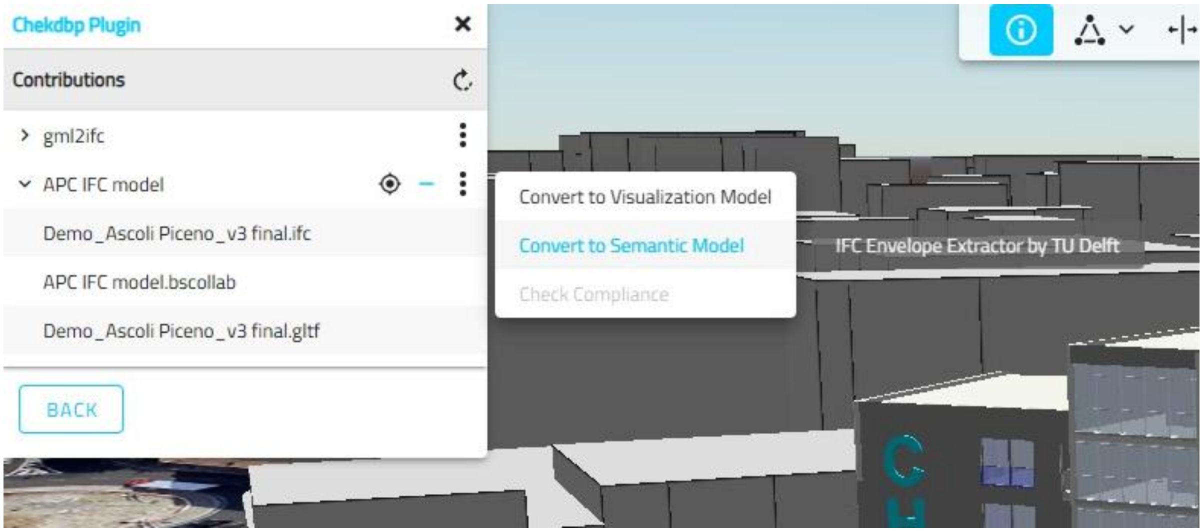



Figure 183 Converting into semantic model for later regulation assessments

3. With both conversions completed, the check compliance was performed

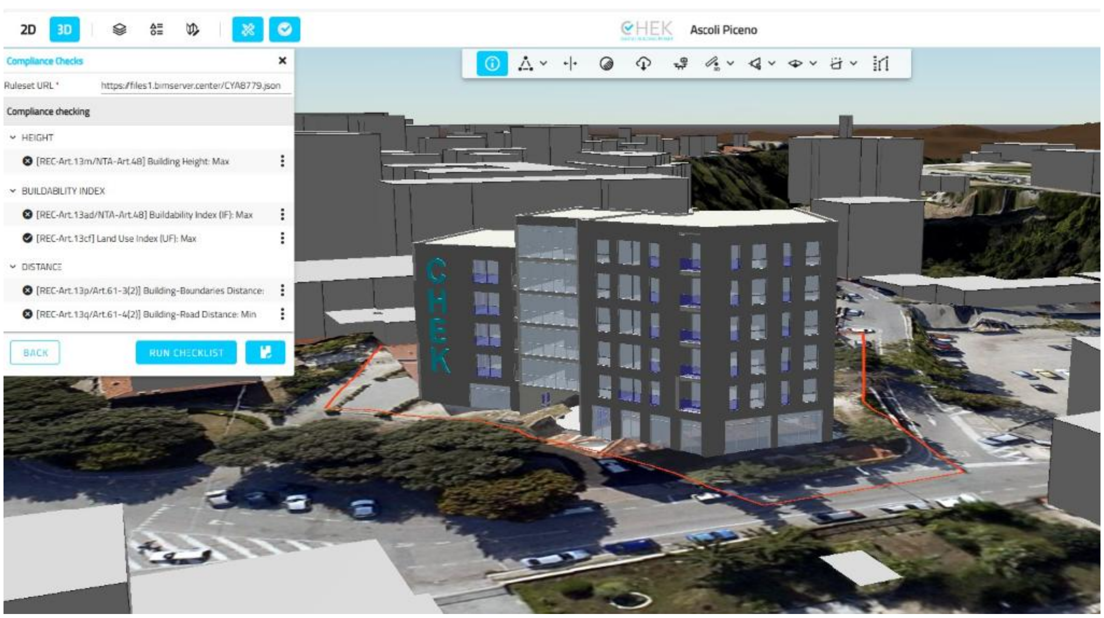



Figure 184 After performing automatic assessments the left menu shows the results

4. The compliance check returned some failed checks

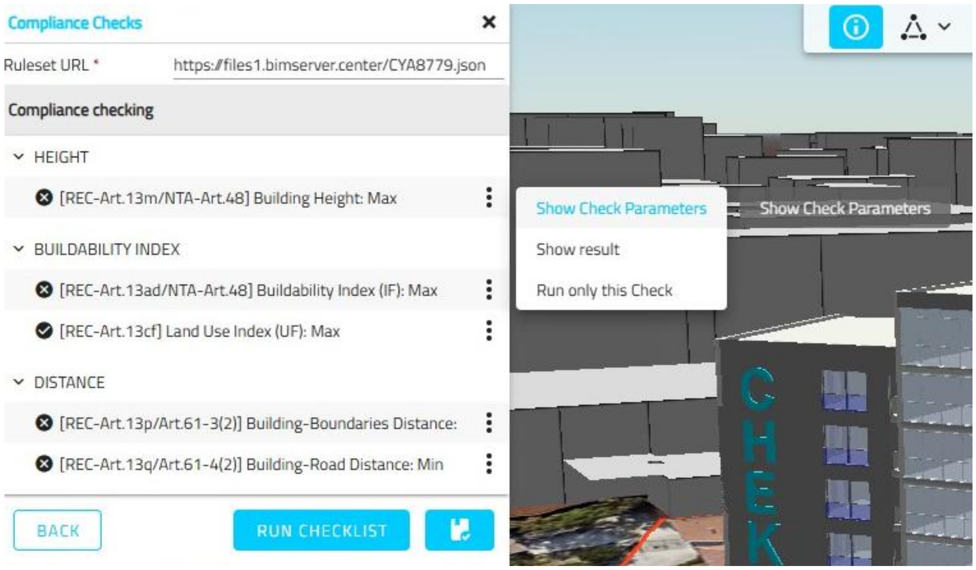



Figure 185 Not all the assessments are compliant, but the report can be sent

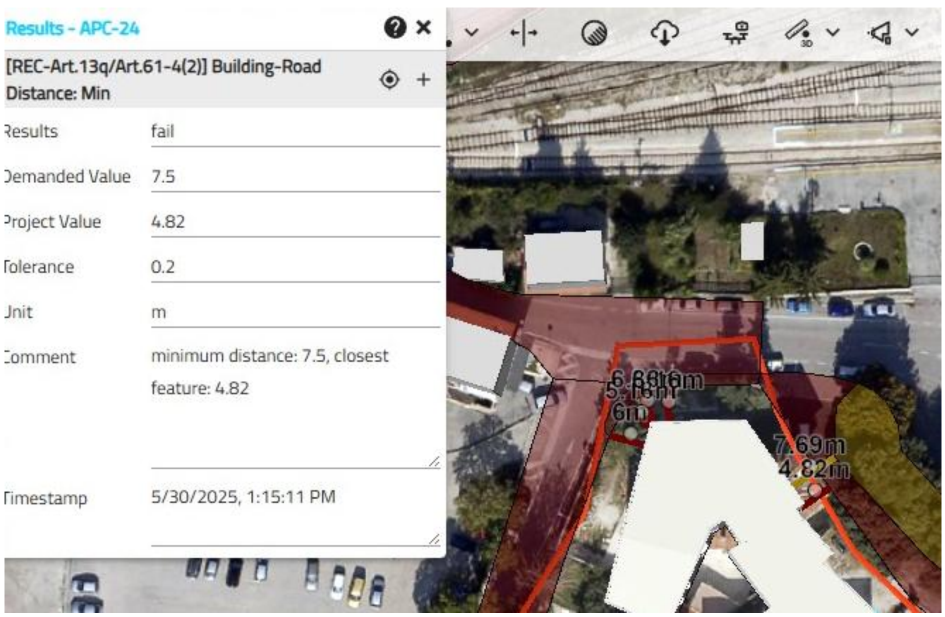



Figure 186 Going deeper in each assessment

5. To have a successful project, designers made changes to the model in Revit as BIM authoring tool of choice.

### 3.4.10 Model Evolution during Software Development and Pilot Testing

During the validation phase for the Ascoli Piceno pilot, significant changes were applied to the original BIM model to achieve compliance with both the analog urban planning checks and the automatic validation performed in VCMap. The updates were based on the outcomes of preliminary assessments, which identified various issues related to building height, volumetry, and land occupation.

Key modifications included a reduction of the overall building volume by removing one complete storey, reducing the building footprint to better match the regulatory constraints, and completely eliminating the basement level. The roof was also simplified by removing the skylight and adjusting its geometry to ease model interpretation and alignment with the validation rules.

These changes were implemented in Autodesk Revit 2025 and aimed to produce a cleaner, more regulation-compliant model that could be successfully exported to IFC using the DiRoots IFC Exporter. The resulting model was then used for further testing and validation across the CHEK ecosystem.


**Figure 187 APC's on its first version before software development and demos performance**

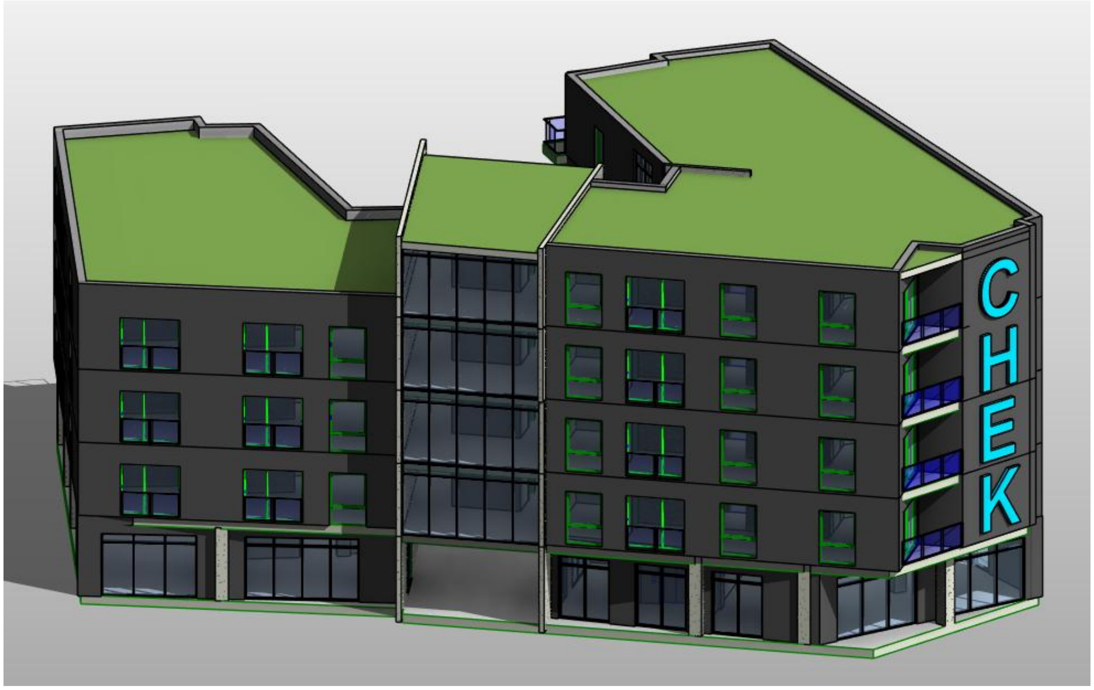



Figure 188 APC's on its last version after software development and demos performance

### 3.4.11 Digital signature - DiStellar

Updated IFC file was digitally signed in DiRoots DiStellar with Signature functionality that run on personal account connected with personal account on Designer's phone. The digital signature tool added additional information in the IFC file that can be assesed only by DiStellar app.

**Inputs:**

- IFC model

**Outputs:**

- Digitally signed IFC file

**Process description:**

1. The DiStellar app was opened and Designers logged in

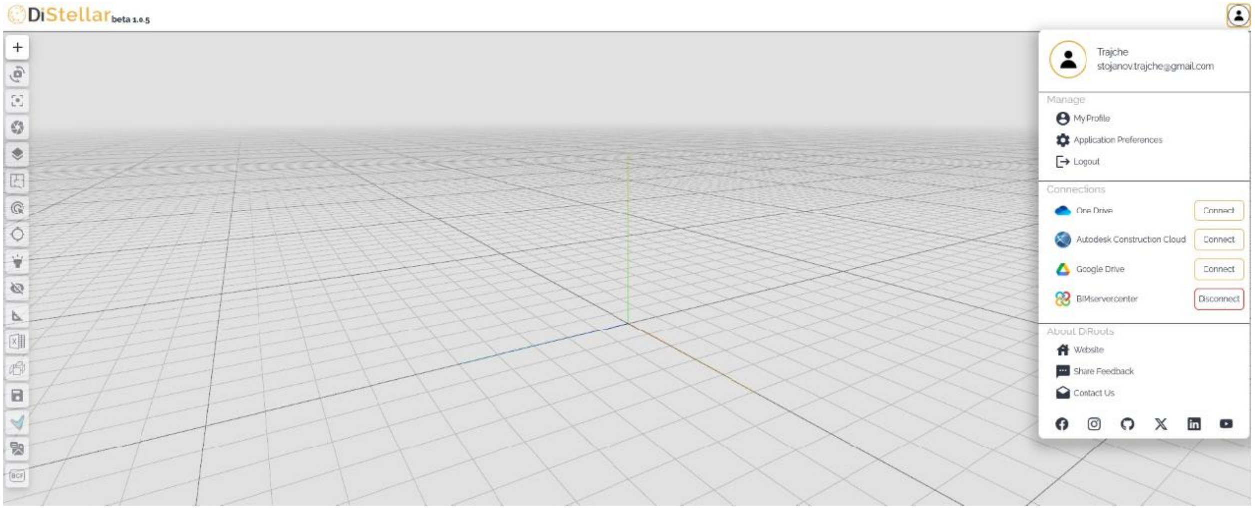



Figure 189 Ready to load the modified IFC file

2. BIMServer.Center was connected

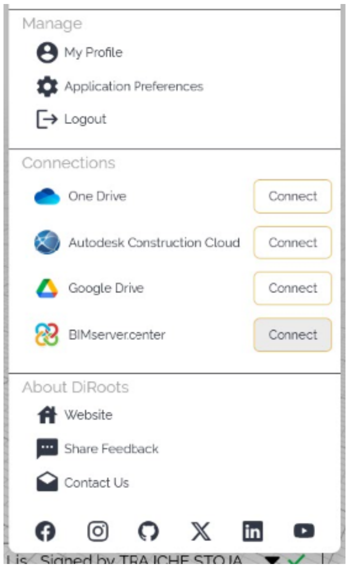



Figure 190 Zoom into the menu in DiStellar

3. The updated IFC model was uploaded and digitally signed

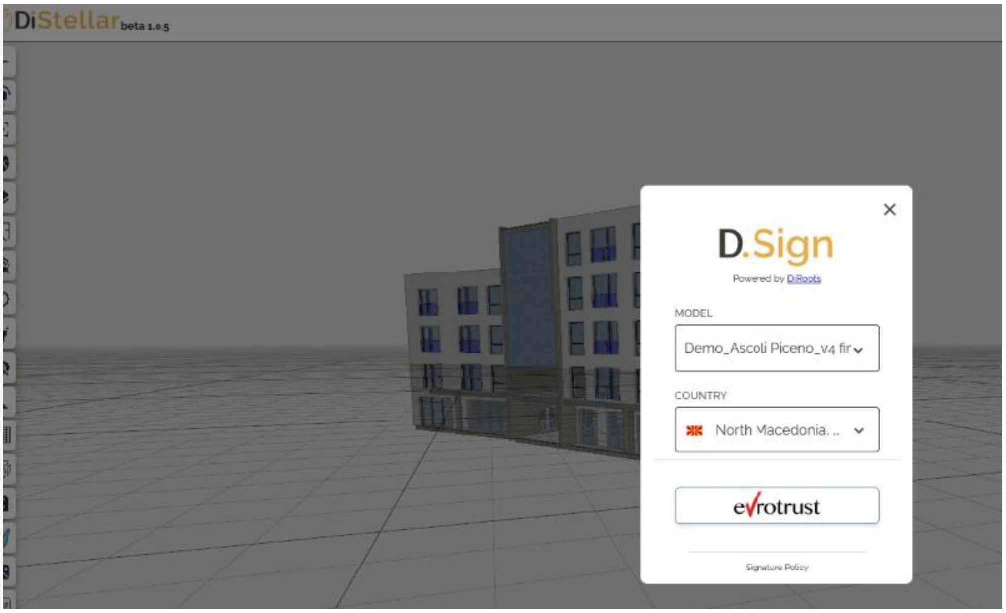



Figure 191 Performing the digital signature

4. Signed IFC model was uploaded to BIMServer.Center in project folder

### 3.4.12 CHEK final-validation and report to municipalities - VCMap

The final step in Designers workflow was performing final validation (compliance check) of the IFC model and sharing the check report to Municipality of APC via BIMServer.Center. The final validation was performed in VC Map, repeating the steps described in item 9 of this case study. Not to repeat the same steps, in this stage we are describing the steps after the check is performed.

**Inputs:**

- Digitally signed IFC model
- Ruleset of predefined checks

**Outputs:**

- Shared json files as a check results file

**Process description:**

1. In VCMap platform, the updated IFC model was converted to Visualization Model and later to Semantic Model. The Compliance checks were performed, and results were shared in BIMServer.Center

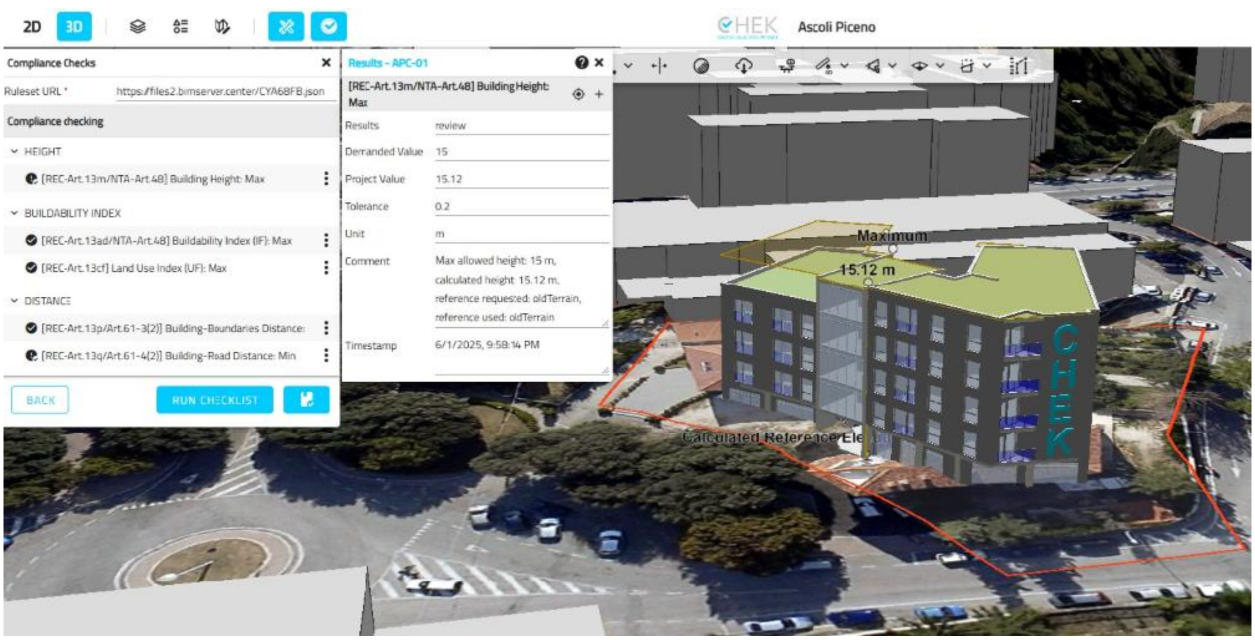



**Figure 192 Second iteration of the assessments using VCMap**

2. The check results showed successful checks.

### 3.4.13 CHEK final-validation and report to municipalities - Verifi3D

After final validation done in VC Map, the IFC model was checked with Verifi3D app too. Both applications check various rules. The results of the check were shared with the Municipalitiy of APC.

**Inputs:**

- Digitally signed IFC model
- Ruleset file

**Outputs:**

- Shared json files as a check results file

**Process description:**

1. Designers logged on Verifi3D and connected the BIMServerCenter account

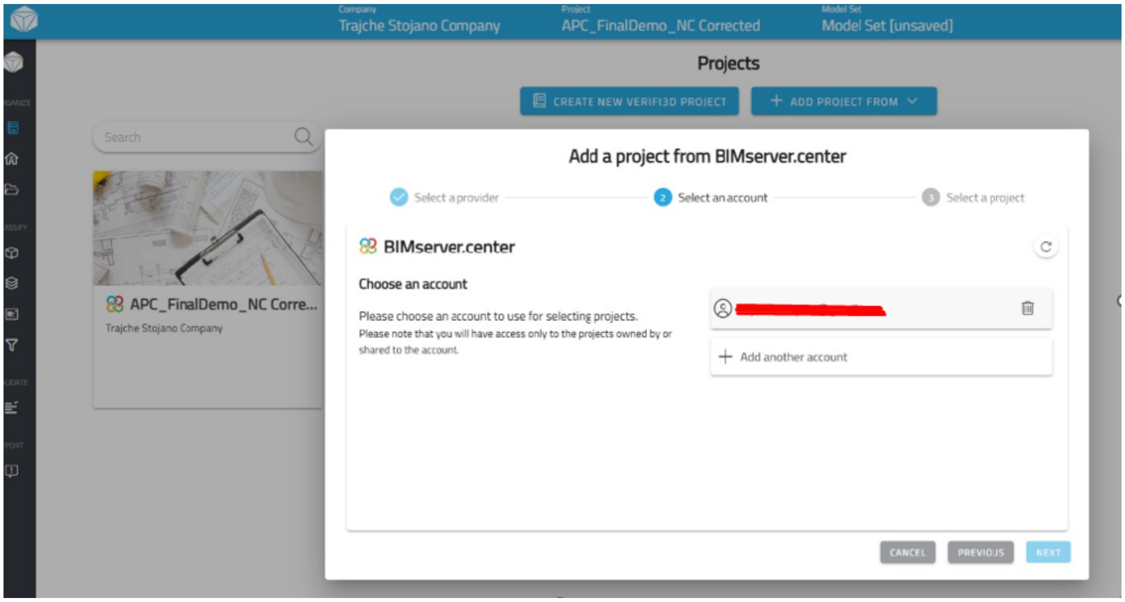



Figure 193 Connecting with BSC to load the project in Verifi3D

2. Signed IFC model was opened

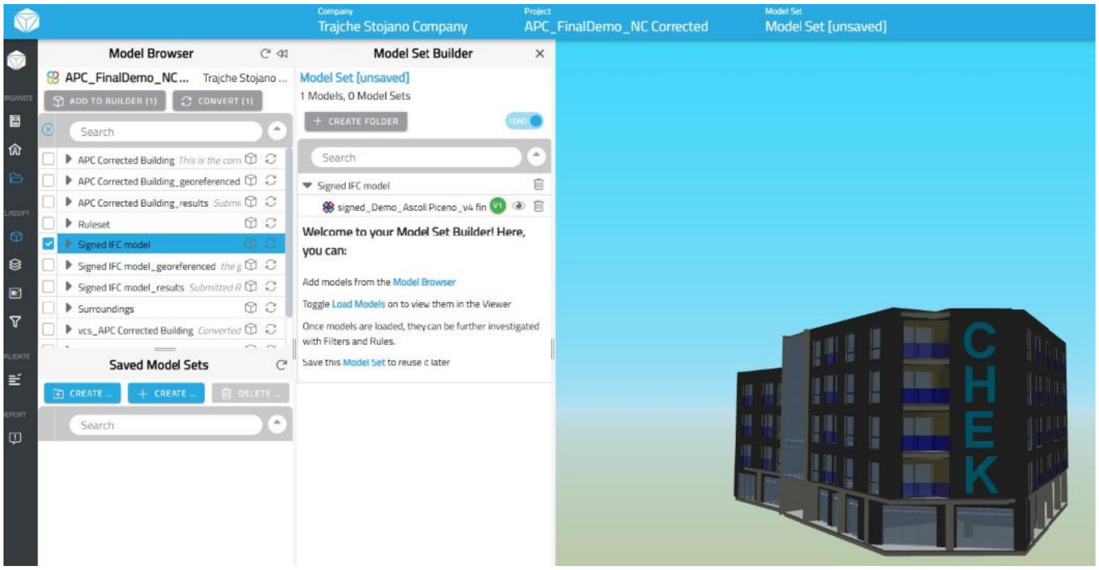



Figure 194 Loading in to the builder the signed file

3. The ruleset file was imported in order checks to be performed

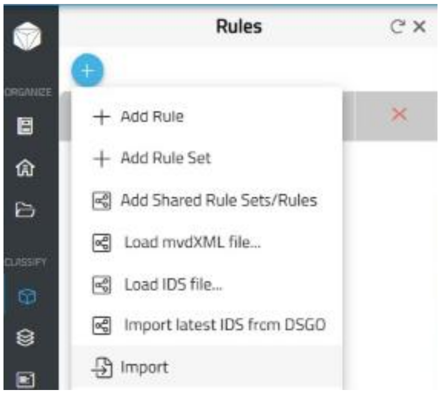



Figure 195 Ruleset import menu

4. Automatic checks gave mixed results

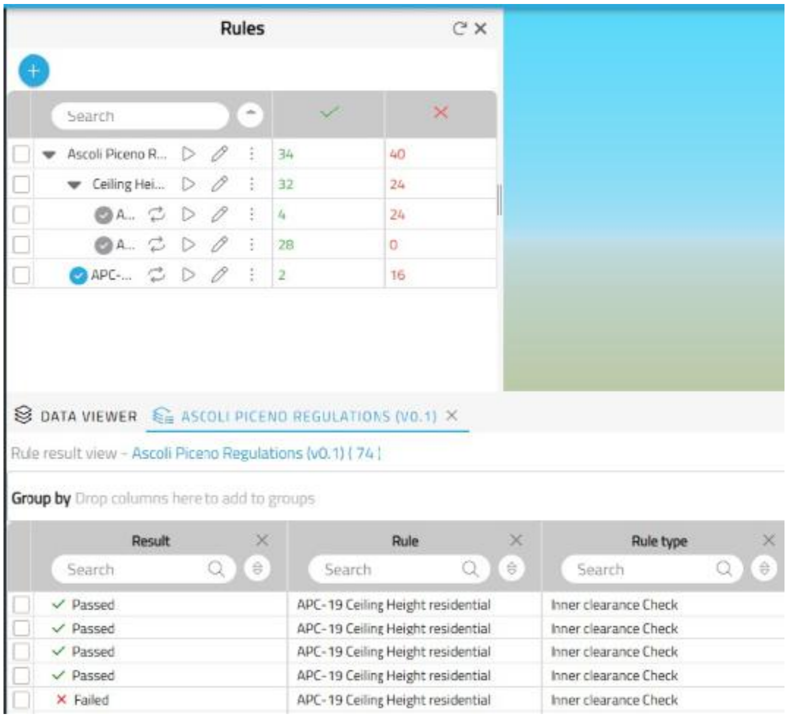



Figure 196 Results after performing the assessments in Verifi3D

5. The results were exported in xlsx and csv file formats

### 3.4.14 CHEK permitting tools. Municipality side workflow review

After completion of the designer's workflow, the Municipality of Ascoli Piceno received automatically a report for review of the submitted results from VCMap. In the case of verifi3D results where shared via email or contribution in the CDE, but from designer side.

**Settings:**

- BIMserver.center validation platform available
- Municipal validation performed using Verifi3D (Designer view) and VCMap (Validation account)
- Both CHEK Municipality/Designer accounts were used.
- Feedback was provided via the CHEK stakeholder questionnaire and regulation assessment sheets

**Inputs:**

- Digitally signed IFC model (Designer Account)
- Validation report / check results from VCMap (Validation account)
- Validation report / check results from Verifi3D (Designer account or via e-mail)
- Contribution files in BIMServer.Center

**Outputs:**

- Cross-checked review results from both tools
- Internal summary report in spreadsheet format with rule-by-rule evaluation
- Qualitative feedback regarding usability, clarity and technical challenges

**Process Description:**

Between days 4 and 5 of the CHEK demonstration, the technical staff from the Municipality of Ascoli Piceno carried out an independent validation of the building model and related contributions, using both Verifi3D and VCMap.

In VCMap, all five predefined rules were successfully applied. These included spatial and dimensional verifications such as minimum plot area, maximum number of floors, setback requirements and building distances. All checks passed without issue, although two of them are reported that the results generated by the software where not correct, so they can be classified as false positives:

- [REC-Art.13ad/NTA-Art.48] Territorial Buildability Index: Max
- [REC-Art.13cf] Gross Area Index: Max
- 

The municipality reported regarding this that they were not able to check the reported value with the checking tool.

In Verifi3D, three rules were tested. One passed, while two returned failed results, primarily related to missing or mismapped parameters. The differences between tool outputs were discussed with the designer, and were partially attributed to discrepancies in data interpretation and export workflows.

Validation steps also included review of the digitally signed IFC model, which was confirmed as authentic via DiStellar and compatible with the external platform Evrotrust.

All validation activities were complemented by a structured feedback process. The APC team filled in a detailed Excel-based questionnaire provided by the CHEK consortium. This included fields of evaluation and allowed each technician to share direct observations on usability, performance and recommendations.

The following table summarizes the set of regulations tested by the municipality, as extracted from their evaluation spreadsheet:

Table 7 – APC's Regulation Review using VCMap

| Rule Name | Rule Reference | Pre-Check Result | Cross Check Confirmation | Comments |
|---|---|---|---|---|
| Height | [REC-Art.13m/NTA-Art.48] Building Height: Max | Passed | Yes | Checked the maximum hight in CYPEUrban |
| Buildability Index | [REC-Art.13ad/NTA-Art.48] Territorial Buildability Index: Max | Passed | No | We didn't know how to check this value and with what tool |
| Buildability Index | [REC-Art.13cf] Gross Area Index: Max | Passed | No | We didn't know how to check this value and with what tool |
| Distance | [REC-Art.13p/Art.61-3(2)] Building-Boundaries Distance: Min | Passed | Yes | With VCMaps, but it was not an easy task because there is no snap in Vcmaps. A snap function would be very welcome. Additionally we weren't able to see the surfaces, but only the 3D model, so understanding the points from which we should take the measurements was rather hard |
| Distance | [REC-Art.13q/Art.61-4(2)] Building-Road Distance: Min | Passed | Yes | |

Table 8 – APC's Regulation Review using Verifi3D

| Rule Name | Rule Reference | Pre-Check Result | Cross Check Confirmation | Comments |
|---|---|---|---|---|
| Ceiling Height residential | APC-19 | Not passed | Yes | Heights checked in Verifi3d |
| | APC-19 -211 | Passed | Yes | |
| Elevator Door Clearance | APC-34 8,1,12,c | Not passed | Yes | Distances checked in Verifi3d |

**Recommendations from Municipality of Ascoli Piceno:**

- Improve rule traceability: Reviewers requested more intuitive linking between geometry and regulatory checks, especially for those less familiar with BIM environments.
- Enhance transparency of validation logic: Users suggested adding visual cues or explanations to clarify why specific rules passed or failed.
- Streamline user interface: While functional, the tools were reported to be somewhat rigid and not fully optimized for users without BIM backgrounds.
- Facilitate issue creation and collaboration: Better integration between designer and municipality roles is needed for tracking, commenting, and reporting issues inside the platform.

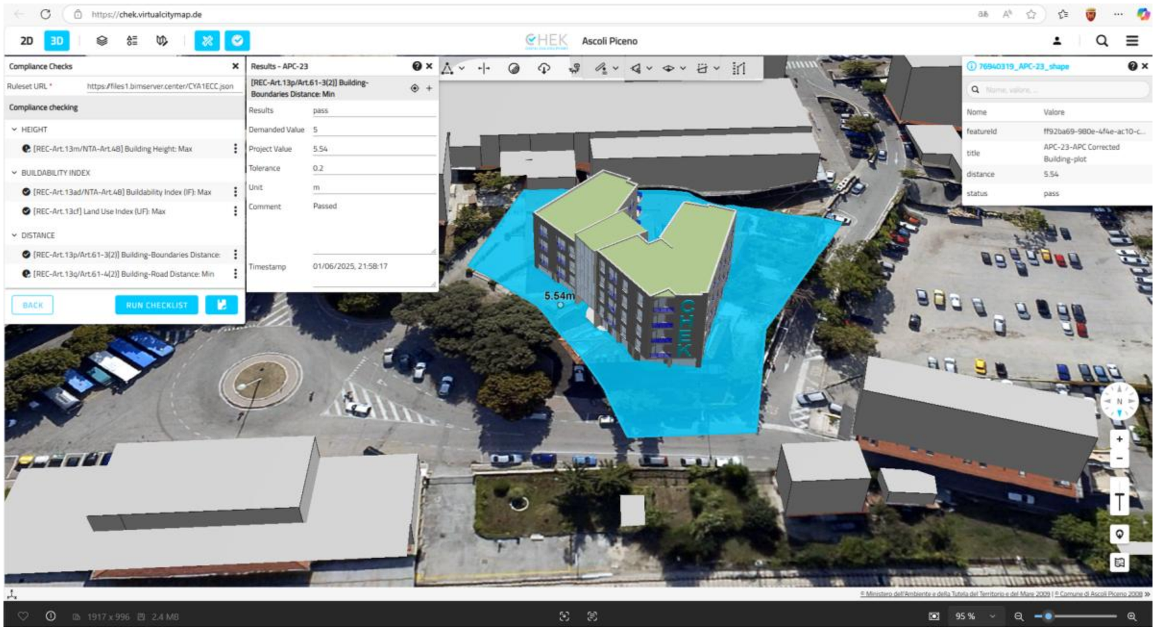



Figure 197 Municipality account checks passed in VCMap

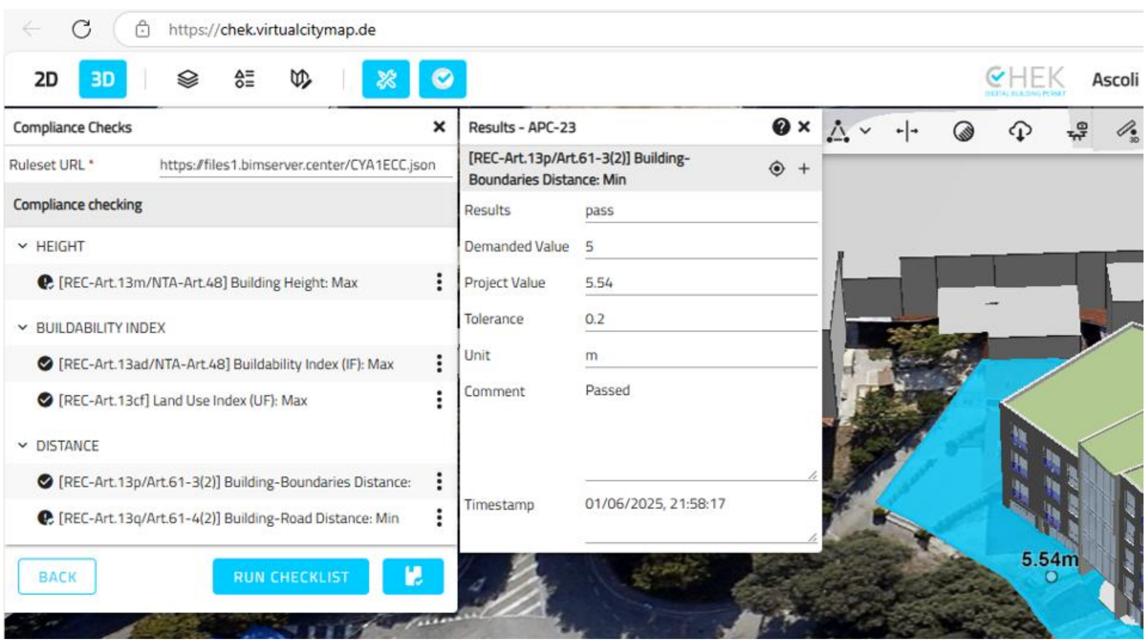



Figure 198 Municipality account checks passed in VCMap. Zoom into the Report

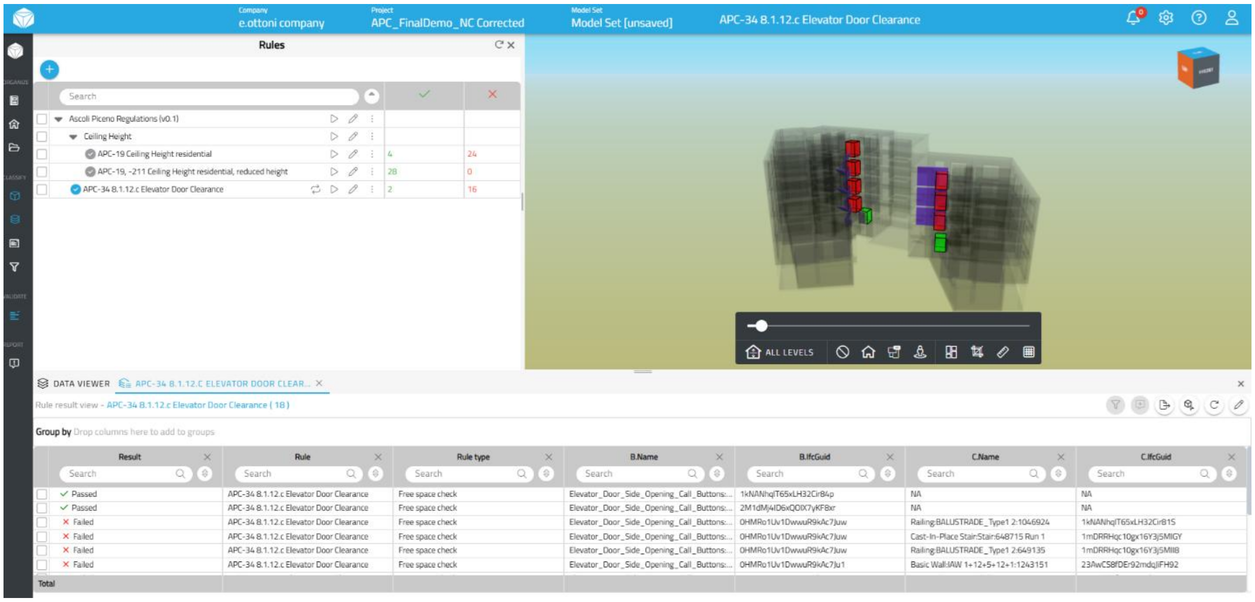



Figure 199 Municipality account checks results in Verifi3D. Showing lift clearance not passed.

# 4. Conclusion

The work carried out in the pilot demonstrations described in this deliverable, corresponding to Scenario 1 – New Building Construction, has made it possible to validate in real conditions the main hypothesis of the CHEK project: that it is feasible to establish an integrated digital workflow, based on open standards, connecting urban planning with BIM design and its automated validation by municipalities.

Throughout the execution of both cases, it has been demonstrated that the tools within the CHEK ecosystem (VCMap, Verifi3D, IDS Checker, IFCGref, CYPEURBAN, DiStellar) support a structured cycle of design–validation–signature with reasonable traceability, both from the designer and municipality side. It has also become clear that the process is replicable in different municipal contexts, as shown by its application in four cities with diverse urban frameworks and technical environments.

The most relevant findings include:

- Technical validation of IFC files can be achieved through open and automated tools, provided that IDS requirements are respected and modeling is handled properly from early stages.
- The current tools are functional for validation on the designer's side but present major limitations on the municipal side—especially concerning permissions, visibility, signature traceability, and role synchronization.
- IFC export from proprietary design software has proven effective, as long as it is complemented by quality control tools such as the IDS Checker and dedicated plugins like DiRoots.

Among the limitations identified, also potential areas for improvement and exploration:

- Municipal accounts do not have immediate access to projects without a prior action by the designer, which complicates early collaboration.
- The validation process is not fully closed, as the municipality currently cannot formally reject or return a model to the designer.
- Management of signed contributions and communication between roles still requires manual actions outside the platform.

Despite these limitations, the results confirm that the proposed framework is valid, operational, and scalable. The modular structure of the toolkit allows its scalability to other municipalities, both by customizing urban regulation rules and by loading new IDS files to adapt the workflow to different regulatory frameworks.

Furthermore, although only Revit was used as the design software in the pilots, the open standards-based approach (IFC, IDS) paves the way for incorporating other BIM tools in future phases of the project or in real-world professional environments.

# 5. Annex I. Detailed List of Regulations Implemented in CHEK Demonstration Scenario 1

## 5.1 VILANOVA DE GAI - CYPEURBAN

Table 9 – Implemented regulations for GAIA by CYPEURBAN

| Assessment | Articles | Rule Identifier |
|---|---|---|
| Plot - Area | [PDM-Art.38] Minimum Plot Area | GAIA-07 |
| Building - Number of floors | [RMUE Gaia - Art. 44] Maximum number of floors above level | GAIA-02-01 |
| Max- Plot Fence height | [RMUE - Art.44] Maximum Height of plot fencing | GAIA- 03-01 |
| Building - Size | [PDM Art. 43] Buildable depth | GAIA-11-01, GAIA-11-02, GAIA-11-03 |
| Building - Distance | [RMUE - Art 36] Minimum distance between buildings of the same plot | GAIA-12-10 |
| Building - Front Setback | [PDM - Art. 42] Minimum setback of the building to the front of the plot | GAIA-08 |
| Building - Setback | [RMUE - Art 36] Minimum setback of the building to plot boundaries (general) | GAIA-12-04/GAIA-12-05 |
| Building - Index coefficient | [PDM - Art 66b] Maximum occupancy coefficient of floors above ground level | GAIA-04 |
| Building - Index coefficient | [PDM - Art 66b] Maximum occupancy coefficient of floors below ground level | GAIA-04 |
| Building - Buildability | [PDM -Art 66, 73,82] Maximum buildable area of the net plot | GAIA-05 |
| Building - Dwellings | [RGEU - Art. 66] Minimum net floor area of the rooms | GAIA-13 |
| Car Park - Number of Spaces | [PDM Art. 122] Number of parking spaces depending on computable built area | GAIA-09 |

## 5.2 VILANOVA DE GAIA - VCMAP

Table 10 – Implemented regulations for GAIA by VCMAP

| Assessment | Articles | Rule Identifier |
|---|---|---|
| Height | [PDM-Art.41-1] Building Height: Max | GAIA-01-01 |
| Buildability Index | [PDM-Art.66b] Gross Buildability Index: Max | GAIA-04, GAIA-05 |
| Buildability Index | [PDM-Art.38] Implantation Area: Max | GAIA-07 |
| Distance | [RMUE-Art.36b] Building-Boundaries Distance: Min | GAIA-12-04 |
| Distance | [RMUE-Art.36c] Building-Boundaries Distance: Min | GAIA-12-05 |

## 5.3 LISBON - CYPEURBAN

**Table 11 – Implemented regulations for LISBON by CYPEURBAN**

| Assessment | Articles | Rule Identifier |
|---|---|---|
| Building - Number of floors | [PUALZE - Art. 17P2(c) (c1)] Maximum number of floors depending on the adjacent buildings | LIS-02-01 |
| Building - Maximum Heights | [PUALZE - Art. 17P2] Total maximum height depending on adjacent buildings | LIS-04-01 |
| Building - Maximum Heights | [PUALZE Article 17 (d)] Maximum facade height depending on adjacent buildings | LIS-04-01 |
| Building - Floor Heights | [(1) RGEU, Article 65, P 1, 2, 3 ,4 (2) RMUEL Article 45 P1.)] Minimum floor height of the ground floor. | |
| Building - Floor Heights | [RGEU, Article 65, P 1, 2, 3,4] Minimum floor height of the floor | |
| Building - Floor Heights | [RGEU, Article 65, P 1, 2, 3,4] Height of floor below ground level | |
| Building - Floor Heights | [RGEU, Article 65, P 1, 2, 3,4] Minimum free height of a floor | |
| Building - Floor Heights | [RGEU, Article 65, P 1, 2, 3,4] Minimum free height of ground floor | |
| Building - Floor Heights | [REMUEL 34] Minimum free height of mezzanine floor | |
| Building - Floor Heights | [ RGEU - Art. 77] Minimum free height of basement and semi-basement | |
| Building - Setback | [] Minimum setback of the building to plot boundaries (general) | |
| Building - Overhangs | [ RMUEL - Art. 46p1a] General maximum overhang | LIS-09-02 |
| Building - Overhangs | [RMUEL - Art. 46p1a] Minimum overhang height | LIS-09-01 |
| Building - Dwellings | [RGEU - Art. 66] Minimum net floor area of the rooms | LIS |

## 5.4 LISBON - VCMAP

Table 12 – Implemented regulations for LISBON by VCMAP

| Assessment | Articles | Rule Identifier |
|---|---|---|
| Height | [RGEU-Art.I-5/RPDML-Art.42.3] Building Height: Max | GAIA-LIS-01/LIS-01 |
| Buildability Index | [RPDML - Art. -Art.38-1/Art.46-4c] Buildability Index: Max | LIS-05, LIS-06 |
| Distance | [RMUAL - Art.46-1b] Building-Sidewalk Distance: Min | LIS-10 |

## 5.5 PRAGUE – VERIFI3D

Table 13 – Implemented regulations for PRAGUE by VERIFI3D

| Assessment | Articles | Rule Identifier |
|---|---|---|
| Buildability Index | [Annex 1_Urban Plan] Buildability Index | IPR-05, -09 - |
| Buildability Index | [Annex 1_Urban Plan] Land Index | IPR-05, -09 - |
| Height | [ Art. 12m_PSP2018 - Art. 44 (2)_PSP2018 - Art. 44 (4)_PSP2018] Ceiling Height | IPR-11, -14, -15 |
| Building - Occupancy | [Art. 3, paragraph 1] Room Area per pupil | IPR-19, -20 |
| Distance | [Art.28 (1)_PSP2018 - Annex 1_PSP2018] Distance to Existing Buildings | IPR-31, -34 |
| Distance | [Annex 1(3)_PSP2018] Elevator Entry Clearance | IPR-39-01 |

## 5.6 PRAGUE - VCMAP

Table 14 – Implemented regulations for PRAGUE by VCMAP

| Assessment | Articles | Rule Identifier |
|---|---|---|
| Height | [UP-Art.27-1/25-2] Building Height: Max | IPR-01, IPR-03 |
| Buildability Index | [UP-Sec7-Art.7a-5] Land Index: Max | IPR-05, IPR-07, IPR-09 |
| Distance | [PSP-Art.29] Building-Boundaries Distance: Min | IPR-33 |

## 5.7 ASCOLI PICENO – VERIFI3D

Table 15 – Implemented regulations for ASCOLI PICENO by VERIFI3D

| Assessment | Articles | Rule Identifier |
|---|---|---|
| Ceiling Height residential | [Art.3_DM 75 5 luglio 1975] APC-19 | APC-19 |
| Ceiling Height residential, red height | [Art.1_DM 75 5 luglio 1975] APC-19 -211 | APC-19 -211 |
| Elevator Door Clearance | APC-34 8,1,12,c | APC-34 8,1,12,c |

## 5.8 ASCOLI PICENO - VCMAP

Table 16 – Implemented regulations for ASCOLI PICENO by VERIFI3D

| Assessment | Articles | Rule Identifier |
|---|---|---|
| Height | [REC-Art.13m/NTA-Art.48] Building Height: Max | APC-01, APC-03, APC-05 |
| Buildability Index | [REC-Art.13ad/NTA-Art.48] Territorial Buildability Index: Max | APC-08, APC-09, APC-10 |
| Buildability Index | [REC-Art.13cf] Gross Area Index: Max | APC-14 |
| Distance | [REC-Art.13p/Art.61-3(2)] Building-Boundaries Distance: Min | APC-23 |
| Distance | [REC-Art.13q/Art.61-4(2)] Building-Road Distance: Min | APC-24 |

# 6. References

## List of Figures

Figure 1 Workflow description and involved partners....9
Figure 2 Simple graph showing regulations implemented per municipality....11
Figure 3 Municipalities involved, and pilots developed....12
Figure 4 Final version for GAIA Scenario 1....13
Figure 5 Creation of the project and tagging it to enable visibility in VCMap....16
Figure 6 Using “Export Tool” to fetch initial data needed for design....16
Figure 7 Automatic contribution created by VCMap in BIMServer.Center....17
Figure 8 Converting surroundings from a GML to an IFC file, with RDF’s....20
Figure 9 Federating both terrain and surroundings with STEPViewer by RDF’s....20
Figure 10 Importing Surroundings IFC. Georeference is lost in Revit import....22
Figure 11 Reading coordinates of the imported IFC file to later move to its position. ....22
Figure 12 Displacing the IFC file by subtraction of coordinates....23
Figure 13 Result after moving Surroundings IFC to its place....23
Figure 14 DiRoots Plugin set up ready to export the project....25
Figure 15 Export settings while using native exporting tools....25
Figure 16 User defined property set definition file used....26
Figure 17 IfcGref geolocation assessment....28
Figure 18 VCMap geolocation assessment....28
Figure 19 RDF IDS Checker results....30
Figure 20 Performing a new contribution in the BIMServer.center site....32
Figure 21 Performing a new contribution in the BIMServer.center site. Zoom to the form fields....32
Figure 22 Created contributions with the exported project (Version 1)....33
Figure 23 Display tab, shows available tools for visualization settings....36
Figure 24 Checks tab, shows the list of regulations and status....36
Figure 25 Tool to create the plot area for later automatic assessments....37
Figure 26 Red line created to assess minimum plot area, which does not comply....37
Figure 27 Showing details of incompliance to plan a solution....38
Figure 28 Procedure to edit threshold to “make the project comply”....38
Figure 29 Editing the threshold to then negotiate with municipality....39
Figure 30 Result of assessment after editing the rule threshold....39
Figure 31 Aspect of the check list after reviewing all requested regulations....40
Figure 32 Auxiliary elements, user created to let CYPEURBAN assess the project....40
Figure 33 Sharing the results with the validation account....41
Figure 34 Naming the results and adding comments for clarity....41
Figure 35 Converting the project into visualization model....43
Figure 36 Visualization of the geometry on its place....43
Figure 37 Converting into semantic model....44
Figure 38 Conversion of semantic model ongoing....44
Figure 39 New options to perform the assessments appear after conversion....45
Figure 40 New options to perform the assessments appear after conversion. Zoom into the list....45
Figure 41 Ruleset needs to be loaded following conventions in advance....46

Figure 42 Ruleset needs to be loaded following conventions in advance. Zoom into the form fields....47
Figure 43 Ready to perform the automatic assessments with just a click....48
Figure 44 Results after assessments shown by the planform....48
Figure 45 New contribution created by the tool after clicking report....49
Figure 46 GAIA's on its first version before software development and demos performance....50
Figure 47 GAIA's on its last version after software development and demos performance....51
Figure 48 Project loaded in DiStellar ready to perform digital signature....53
Figure 49 Connection to Evrotrust to sign the loaded IFC file....53
Figure 50 Evrotrust visualization and pending signatures seen in the phone....54
Figure 51 Exploring the pending signature, ready to sign....55
Figure 52 Successfully signed pop up, and possibility to download the signed file....56
Figure 53 Exploring the signed file....56
Figure 54 Sharing the signed file with BIMServer.Center....57
Figure 55 New contribution created by DiStellar in Designer account....57
Figure 56 PDF report coming from CYPEURBAN in validation account....60
Figure 57 Checking the quality of the IFC file with RDF's....60
Figure 58 Checking VCMap report using the online tool....61
Figure 59 Municipality feedback that motivated a new iteration....61
Figure 60 Final version for LISBON Scenario 1....62
Figure 61 Logging into BSC....64
Figure 62 Project creation....65
Figure 63 Tag Assignment....66
Figure 64 Logging into BSC in the VCMap Platform....67
Figure 65 selecting account in VCMap....67
Figure 66 The project is available to work on it....68
Figure 67 Plot allocation in the 3D city model....69
Figure 68 Start exporting process to get initial information....69
Figure 69 Select the file formats needed....70
Figure 70 After sending the request, a new contribution in the CDE appears....71
Figure 71 Exploring the new contribution from VCMap....71
Figure 72 Converting the surroundings into an IFC file....72
Figure 73 Converting the DTM into IFC format....73
Figure 74 The result of the conversion appears in the same folder....73
Figure 75 Selecting IFC references to link them in Revit....74
Figure 76 Linked information as shown in Revit....75
Figure 77 After fitting the initial IFC files, everithing seems to be on site....76
Figure 78 Setting up the built-in exporter to validate georeferencing....76
Figure 79 3D view after modeling the project....77
Figure 80 Tool icon to launch the exporter from DiRoots....78
Figure 81 Set up of the exporter, mapping done....78
Figure 82 IFC model ready for demonstrations....79
Figure 83 Ready for georeference assessment with IfcGref....80
Figure 84 Successful georeference....81
Figure 85 Zoom to detailed data of the IfcGref report....81
Figure 86 Graphical assessment in IfcGref....82
Figure 87 Ready to perform IFC quality assessment with RDF's....83

Figure 88 Report after running the EXPRESS Schema Checker ....84
Figure 89 Report after running the IDS Checker ....84
Figure 90 Creating the contribution in BSC to include the project in validated IFC format ....85
Figure 91 GLTF automatic conversion in BSC to let visualize the project ....86
Figure 92 Visualization model conversion ongoing in VCMap ....87
Figure 93 Ready to perform the visualization convert ....88
Figure 94 List of implemented regulations in VCMap for this pilot ....88
Figure 95 online report after running automatic the checklist ....89
Figure 96 Creation a new project in user device, that will connect to CDE ....90
Figure 97 Logging into BSC, to enable project selection ....91
Figure 98 List of available projects in BSC, as CYPEURBAN shows it ....91
Figure 99 Selecting the municipality will show the list of regulations implemented ....92
Figure 100 IfcSpaces mapping to let CYPEURBAN perform some checks ....92
Figure 101 Editing the floor names to follow the software conventions ....93
Figure 102 Aspect of check list during the assesments ....93
Figure 103 LISBON's on its first version (left) before software development and demos performance, and on its last version (right) after the same process. Minor geometric changes where made. ....94
Figure 104 Starting the signing gadget in DiStellar ....95
Figure 105 Cloud services available from the tool, among them BSC ....96
Figure 106 Uploaded and signed IFC file ....96
Figure 107 performing the upload of signed file into BIMserver.Center ....97
Figure 108 Performing cross-checking of the pilot using CYPEURBAN ....98
Figure 109 Results showing many successful checks ....99
Figure 110 Sharing the report with municipalities via BSC ....100
Figure 111 How the PDF report from CYPEURBAN shows ....100
Figure 112 Example of municipality cross-checking. Building height assessments ....102
Figure 113 Final version for pilot scenario 1 Prague ....103
Figure 114 Incorrect tagging of the project. Convention must be followed ....105
Figure 115 What VCMap shows if tagging is incorrect ....106
Figure 116 Correct tagging following the convention ....106
Figure 117 Web-based version of RDF's CityGML2IFC converter ....108
Figure 118 Display after converting the DTM into IFC ....108
Figure 119 Successful federation of terrain and neighboring with RDF's ....109
Figure 120 DiRoots plugin set up done ....112
Figure 121 Exporting successful ....112
Figure 122 Federating al 4 IFC files, existing and project IFCs with RDF's ....113
Figure 123 IfcGref geolocation assessment of initial information: Surroundings ....114
Figure 124 IfcGref geolocation assessment of initial information: Topography ....115
Figure 125 IfcGref geolocation assessment of demo project ....115
Figure 126 RDF IDS Checker results ....117
Figure 127 Verifi3D project creation ....120
Figure 128 Adding partners into project (Municipality officers and WPL) ....121
Figure 129 Linking to the project in the CDE ....121
Figure 130 Selecting the project in BSC ....122
Figure 131 Showing all the contributions in the project, ready to add to builder ....122
Figure 132 Needed contributions added to builder ....123

Figure 133 Importing ruleset with the implemented regulations ....123
Figure 134 Error loading the latest ruleset. Partially loaded. ....124
Figure 135 Same error with earlier version of ruleset. Run compliance check success ....124
Figure 136 Results in excel format ....125
Figure 137 Results in excel format. Zoom into report content ....125
Figure 138 Creation of the contribution to save the results ....126
Figure 139 Ruleset contribution for VCMap ....128
Figure 140 Removed noncritical elements: Railings, to ease semantic conversion ....128
Figure 141 Furniture is also noncritical, was removed later ....129
Figure 142 Sending the report to BSC ....129
Figure 143 PRAGUE's on its first version before software development and demos performance ....130
Figure 144 PRAGUE's on its last version after software development and demos performance ....131
Figure 145 Municipality federation of models. Entering as partner. ....134
Figure 146 Running the 2 available regulations. Passed ....134
Figure 147 Edited regulations to force uncompliance ....135
Figure 148 VCMap report on validation side (BIMserver.center) ....135
Figure 149 VCMap report on VCMap validation side ....135
Figure 150 Review tab Issue ....135
Figure 151 IFC model signature checked ....136
Figure 152 Verifi3D Ruleset loading fixed ....136
Figure 153 Final version for ASCOLI PICENO's Scenario 1 ....137
Figure 154 Logging into BSC designer's account ....139
Figure 155 The new project must be created in the CDE ....140
Figure 156 Clear name and description filled ....140
Figure 157 Correctly tagging the project to share contributions with other CHEK tools ....140
Figure 158 Connecting VCMap to BSC ....141
Figure 159 Selecting designer's account ....142
Figure 160 Metadata associated to the project, including tags ....143
Figure 161 Seeing the plot in VCMap enables begin the exporting step for later design ....143
Figure 162 Blue rectangle selects the neighbor buildings to include in the export ....144
Figure 163 The expected contribution appears successfully in BSC ....144
Figure 164 Exploring the content of the recently created contribution ....145
Figure 165 Running the GIS to BIM converter for the surrounding buildings ....146
Figure 166 Running the GIS to BIM converter for the DTM ....147
Figure 167 Converted files stored in the same folder as the sources ....147
Figure 168 Importing the initial IFC data for later design in vendor software ....148
Figure 169 Imported surroundings and DTM as appear in Revit ....149
Figure 170 Exporting the design. Georeference settings ....149
Figure 171 Final design ready for georeferencing assessments ....150
Figure 172 CHEK toolkit exporting tool by DiRoots ....151
Figure 173 DiRoots exporter set up, finished after mapping required parameters ....151
Figure 174 Resulting IFC file including parameters required by the IDS ....152
Figure 175 IfcGref tool ready to check a new IFC file ....153
Figure 176 IfcGref displays that the IFC is georeferenced. Graphical assessment still needed ....154
Figure 177 Graphical georeferencing assessment in IfcGref ....155
Figure 178 RDF's viewer lets performing the IFC quality regarding IDS and EXPRESS schema ....156

Figure 179 EXPRESS validation report ....157
Figure 180 IDS Checker report ....157
Figure 181 Designer's creation of the contribution with format validated IFC file....158
Figure 182 Converting into visualization model in VCMap....159
Figure 183 Converting into semantic model for later regulation assessments....160
Figure 184 After performing automatic assessments the left menu shows the results ....160
Figure 185 Not all the assessments are compliant, but the report can be sent....161
Figure 186 Going deeper in each assessment....161
Figure 187 APC's on its first version before software development and demos performance ....162
Figure 188 APC's on its last version after software development and demos performance ....163
Figure 189 Ready to load the modified IFC file....164
Figure 190 Zoom into the menu in DiStellar....165
Figure 191 Performing the digital signature ....165
Figure 192 Second iteration of the assessments using VCMap....166
Figure 193 Connecting with BSC to load the project in Verifi3D ....167
Figure 194 Loading in to the builder the signed file....168
Figure 195 Ruleset import menu....168
Figure 196 Results after performing the assessments in Verifi3D ....169
Figure 197 Municipality account checks passed in VCMap ....172
Figure 198 Municipality account checks passed in VCMap. Zoom into the Report....172
Figure 199 Municipality account checks results in Verifi3D. Showing lift clearance not passed. ....173

## List of Tables

Table 1 – Summary Table of Demonstration Activities ....12
Table 2 – Key Findings after performing demo scenario 1 on GAIA's pilot....14
Table 3 – Key Findings after performing demo scenario 1 on LISBON's pilot ....63
Table 4 – Regulations Compliance Table (Lisbon Municipal Review)....102
Table 5 – Key Findings after performing demo scenario 1 on PRAGUE's pilot ....104
Table 6 – Key Findings after performing demo scenario 1 on APC's pilot....138
Table 7 – APC's Regulation Review using VCMap....171
Table 8 – APC's Regulation Review using Verifi3D....171
Table 9 – Implemented regulations for GAIA by CYPEURBAN ....175
Table 10 – Implemented regulations for GAIA by VCMAP....176
Table 11 – Implemented regulations for LISBON by CYPEURBAN ....177
Table 12 – Implemented regulations for LISBON by VCMAP....178
Table 13 – Implemented regulations for PRAGUE by VERIFI3D....179
Table 14 – Implemented regulations for PRAGUE by VCMAP ....180
Table 15 – Implemented regulations for ASCOLI PICENO by VERIFI3D....181
Table 16 – Implemented regulations for ASCOLI PICENO by VERIFI3D....182

## List of used abbreviations

| | | |
|---|---|---|
| DoA | - | Description of the Action |
| EC | - | European Commission |
| EU | - | European Union |
| GA | - | Grant Agreement |
| WP | - | Work Package |
| WPL | - | Work Package Leader |
| BIM | - | Building Information Modelling |
| GIS | - | Geographic Information System |
| TUD | - | Delft University of Technology |
| CDE | - | Common Data Environment |
| DTM | - | Digital Terrain Model |
| BSC | - | BIMServer.Center |
| VCS | - | Virtual City Systems |