Change toolkit for digital building permit

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Contents

1. Executive Summary

This deliverable, titled "Development of Checking Software Based on IFC", acts as a report for the development and integration of desktop-based and web-based tools for urbanism and accessibility validation as part of the CHEK project. These tools—CYPEURBAN, CYPE Accessibility and CYPE Architecture all desktop applications, and Verify 3D, a web-based solution—are designed to support the digitalisation of the building permit process, focusing on automating urban planning and accessibility compliance. By utilising Building Information Modelling (BIM) and Geographic Information System (GIS) data, these software tools optimise collaboration between municipalities, designers, and other stakeholders, ensuring more efficient, transparent, and accurate validation processes.

CYPEURBAN enables urban planners and designers to load IFC-based BIM models and perform zoning and land-use regulation checks. The tool supports the automated validation of building projects against local planning requirements, improving efficiency and reducing human error. CYPEURBAN is accessible through the following link: CYPEURBAN – CYPE Software. CYPE Accessibility is dedicated to evaluating building accessibility. It verifies elements such as circulation routes, entrances, ramps, and accessible bathrooms according to national and regional standards. Its integration into CYPE Architecture enhances early-stage accessibility compliance directly within the design process. Access more information at: CYPE Accessibility – CYPE Software. Both tools have been integrated within CYPE Architecture, CYPE's free BIM modeler, to enable compliance of urbanism and accessibility checks during design phase, creating a more efficient and collaborative workflow: CYPE Architecture – CYPE Software

Verifi3D is a BIM model checker in the cloud. It shows and checks models directly in the browser on the local machine, with the automated setup, up-to-date live connections, and computational power of scalable cloud resources. Verifi3D's cloud workflow integrates with a wide choice of Common Data Environments and issue trackers used in the industry. With the CHEK project, BIMserver.center has been made available as well. Several new Rule Types have been created for the CHEK project, and used to creation of Rule Sets according to the Prague Building Regulations. These rule sets can be customized and shared between users in the cloud. Since Verif3D supports both open standards and proprietary platforms, the rules can even be parametrized to directly check the formats of authoring tools, allowing designers to check their work in process without having to convert to IFC and to commit to submitting to the municipalities' platform. In this way, Verifi3D's integrated setup simplifies adoption by the industry and brings freedom of choice to both municipalities and designers.

Overall, this deliverable demonstrates the effectiveness of these tools in digitalising the building permit process and the impact of their integration into the DBP platform. The combination of CYPE Architecture, and Verify 3D provides a complete solution for managing complex regulatory requirements related to urbanism and accessibility. As the CHEK project continues to evolve, these tools will play an essential role in improving the efficiency and transparency of building permit processes, helping municipalities and designers optimise their workflows and ensure regulatory compliance in a more collaborative and connected environment.

2. Introduction

This deliverable presents the development and integration of a set of desktop-based and web-based tools for urbanism and accessibility validation as part of the CHEK project. It details the functionalities of two key software solutions—CYPEURBAN/CYPE Accessibility (desktop-based) and Verify 3D (web-based)—specifically developed to support the digitalisation of building permit processes with a focus on urban planning and accessibility compliance. These tools, designed to integrate with the Digital Building Permit (DBP) platform, utilise Building Information Modelling (BIM) and Geographic Information System (GIS) data to automate validation processes. The aim is to provide a clear understanding of these software tools, their integration into the platform, and their role in promoting the efficiency and transparency of the building permit process.

2.1 Purpose of the deliverable

The purpose of this deliverable is to document and communicate the development, improvement, and integration of the desktop and web-based tools into the DBP platform within the CHEK project. This includes outlining existing and new functionalities developed to meet the needs of regulatory bodies, urban planners, and municipalities, showing how these improvements facilitate a more effective compliance-checking process. Additionally, this deliverable serves as a resource for understanding how these tools interact with the DBP platform's workflow, providing insights into their role in streamlining the urbanism and accessibility validation processes, and laying the groundwork for further improvements and future developments in the CHEK project.

2.2 Deliverable structure

The rest of this deliverable is structured into the following sections:

- **Section 3, "Context",** provides framework for the development of these tools, situating them within the broader scope of the CHEK project and summarising relevant aspects from D4.3 (the process and data management platform) and D4.4 (the Open API and its role in software integration).
- **Section 4, "Desktop-based software: CYPEURBAN/Open BIM Accessibity",** details the desktop-based solution, including its existing features, the connection with the DBP platform, the new functionalities developed for this project and the integration under CYPE Architecture
- **Section 5, "Web-based software: Verify 3D",** focuses on the web-based solution, Verify 3D, with a similar structure to explain its existing capabilities, integration process, and the enhancements introduced to support urbanism and accessibility checks.
- **Section 6, "Conclusions",** concludes the deliverable, summarising key findings and the impact of these tools on the digitalisation of building permit processes.

2.3 Relation with other project tasks

The development of the desktop-based and web-based tools for urbanism and accessibility in this deliverable is closely linked with several tasks within the CHEK project, as illustrated in Figure 1. The tools' development is informed by the to-be process map (D1.1) and user requirements (D4.1), ensuring that they align with the needs of stakeholders involved in the building permit process. The data requirements and specifications created in WP2, particularly T2.1

through T2.4, provide the foundation for managing Open BIM standards, regulations, and GIS/BIM data. These tasks help shape the validation processes used in the software tools by ensuring that data standards are consistently applied. Additionally, the data validity-support tools from D2.5 are critical for informing the compliance checks carried out by the software.

The integration of CYPE URBAN and Verify 3D into the DBP platform, developed in Task 4.3 and informed in deliverable D4.3, relies on the Open API in Task 4.4. This connection allows both tools to exchange data with the DBP platform efficiently, ensuring that validation results are communicated. As these tools focus specifically on urbanism and accessibility compliance, they complement the 3D city model visualisation functionalities being developed in Task 4.6, which provide detailed spatial analysis for regulatory validation.

The role of Task 4.7 in documentation and workshops supports the implementation of the software tools, ensuring that users can adopt them effectively. Meanwhile, Task 4.8 focuses on developing the business case, which is crucial for the market uptake and further deployment of the tools developed in D4.6. This ensures that the new functionalities reach their intended audience and deliver value within the broader context of the CHEK project.

Moreover, the efforts in WP5 focus on upskilling and reskilling relevant stakeholders, ensuring they can effectively use the developed tools within their workflows. WP6 facilitates the pilot testing of these tools, allowing them to be validated in real-world urbanism and accessibility scenarios. Finally, WP7 handles the dissemination and exploitation of the project's outcomes, ensuring that the tools and innovations reach a broader audience and support the digital transformation of building permit processes across the industry.

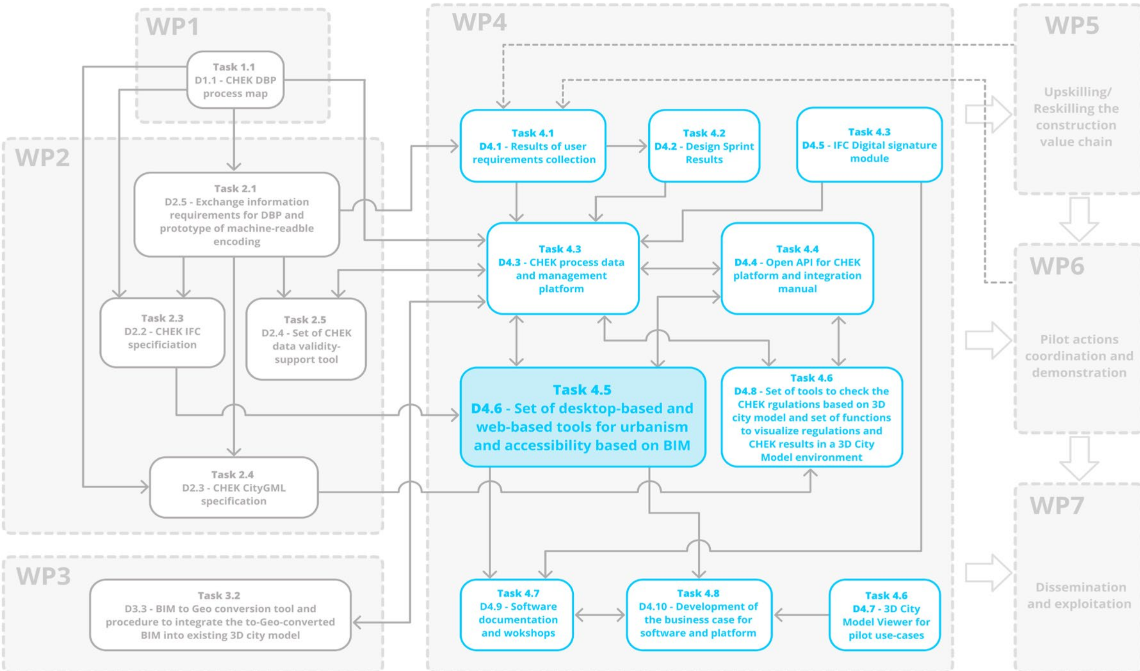


Figure 1: Relation with other tasks

3. Context

Describing the context of the CHEK project is crucial for understanding the development of the desktop-based and web-based tools presented in this deliverable. These tools are part of a broader initiative to modernise and digitalise the building permit process through the integration of Building Information Modelling (BIM) and Geographic Information System (GIS) data. This section outlines the main objectives of the CHEK project, summarises the role of the Digital Building Permit (DBP) platform as described in D4.3, and highlights how the Open API from D4.4 facilitates the integration of these new tools into the platform.

3.1 The CHEK project context

The CHEK project aims to develop a digital framework for modernising the building permit process, focusing on integrating Building Information modelling (BIM) and Geographic Information System (GIS) data into a unified workflow. This framework seeks to automate and optimise the approval of building permits, ensuring that municipalities and other stakeholders can access the tools needed for effective regulation and validation. Task 4.5 contributes directly to this vision by providing advanced tools for urbanism and accessibility, supporting municipalities in evaluating project compliance against a wide range of regulatory requirements.

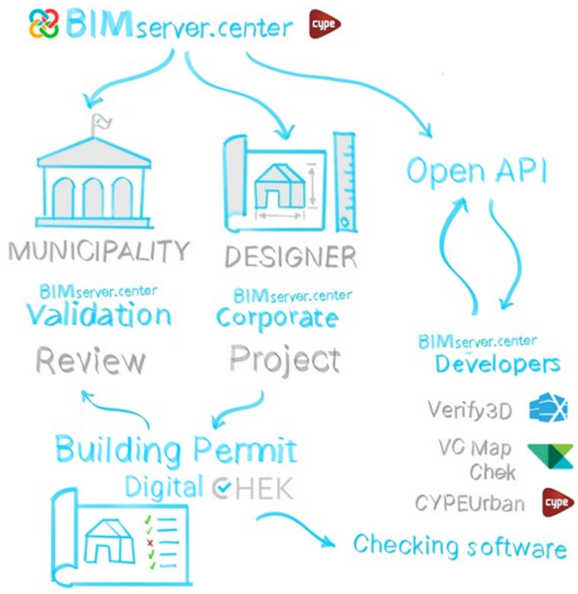


Figure 2: DBP CHEK framework

3.2 General DBP platform overview

The DBP platform, as outlined in D4.3, serves as the core digital environment where building permit processes are managed, from project submission to approval. It facilitates collaboration between designers, municipalities, and software developers, offering features like “Corporate” accounts for design teams, “Validation” accounts for municipalities, “Developers” accounts for software developers, and integration capabilities through the Open API. The platform’s design focuses on user-friendliness, allowing stakeholders to easily manage project data, review compliance checks, and track project status in real time. The enhancements developed in D4.6 further extend the platform's functionality, specifically targeting the needs of urban planning and accessibility validation.

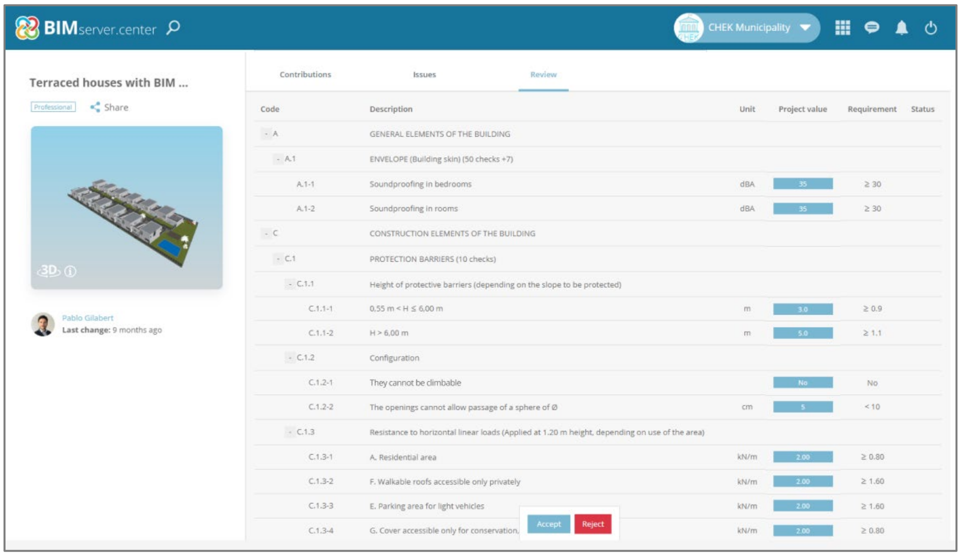


Figure 3: DBP platform project review

3.3 Open API integration

The Open API, detailed in D4.4, plays a crucial role in enabling the integration of external software tools with the DBP platform. By providing a standardised interface for communication between the platform and third-party applications, the API ensures that tools like CYPEURBAN, VCMap CHEK plugin and Verify3D can interact efficiently with the platform's data management systems (Figure 4). The API supports authentication, data transfer, and the management of contributions, allowing developers to create customised solutions that align with the platform's workflows, the API includes specific calls. This capability is essential for implementing the compliance checks and validation processes required by urbanism and accessibility regulations, ensuring the smooth operation of integrated tools within the DBP platform.

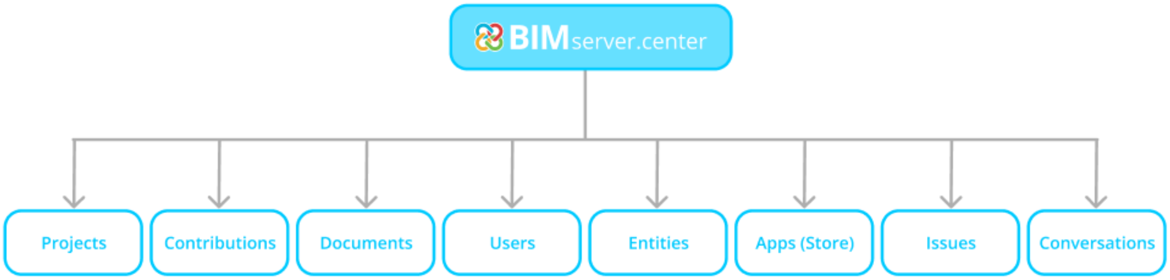


Figure 4: Main components of BIMserver.center platform and API

4. Desktop-based software

In the context of the CHEK project, desktop-based software plays a key role in supporting the digitalisation of building permit processes. These tools offer powerful, local processing capabilities that enable detailed analysis and validation of building projects against regulatory frameworks. Unlike web-based solutions, desktop applications are capable of handling large Building Information Modelling (BIM) datasets directly on local machines, providing greater flexibility and control over complex validation tasks. By using desktop-based software, designers can efficiently manage compliance checks related to urban planning and accessibility, ensuring that the digital building permit process aligns with existing regulations and standards. Within this framework, two critical desktop-based tools have been updated: CYPEURBAN, focusing on urban planning validation, and CYPE Accessibility, dedicated to assessing accessibility compliance. During the project development capabilities of both tools have been integrated in CYPE Architecture, the BIM modelling software tool from CYPE, a free tool for BIM modelling. This transition represents a significant evolution in the CYPEURBAN/ CYPE Accessibility development path, requiring technical reorientation and temporarily diverting resources from implementing checks. However, it lays the foundation for long-term exploitation and sustainability of the results beyond the CHEK project, allowing for a more flexible, maintainable, and scalable system.

4.1 Overview of existing features of desktop checking software.

CYPEURBAN and CYPE Accessibility are desktop-based applications included as part of the CHEK project to assist designer and municipalities in validating building projects according to urbanism and accessibility regulations. This software provides tools for analysing BIM data and integrating it with urban planning and accessibility rules, offering a robust solution for ensuring that projects comply with zoning laws, land use policies, and other local regulations before they can be approved.

4.1.1 CYPEURBAN.

CYPEURBAN offers a range of features designed to support urban planning processes. These include the ability to import IFC models, which contain detailed information about building projects, and apply to them various zoning and land-use rules to assess compliance. The software allows users to apply various urban and zoning regulations to assess compliance. With the ability to navigate 3D models, visualise spatial relationships, and generate detailed compliance reports, CYPEURBAN helps urban planners and designers evaluate how proposed projects align with local regulations. Its intuitive interface simplifies the management of complex data and enables precise analysis.

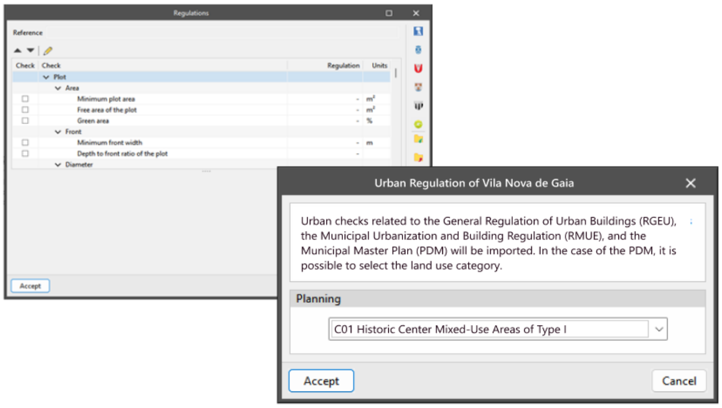


Figure 5: CYPEURBAN new regulation creation/loading

CYPEURBAN allows users to load or create their own sets of urban planning regulations, with several municipalities' rules already preloaded for quick access (Figure 5). Once the regulations are in place, users can classify building surfaces according to computability (e.g., fully, partially, or non-computable) and automate the process of associating spaces from IFC models with the appropriate regulatory categories using the "Import Space Assistant." This streamlines the compliance check process and ensures that all building elements are evaluated according to the correct zoning and land-use rules

After setting the relevant regulations, users can manage how different types of surfaces are classified and calculated within the project. The software supports defining computability percentages based on specific zoning rules, ensuring precise and accurate evaluations. With these tools, users can handle both preloaded and custom regulations efficiently, ensuring that every aspect of the project adheres to the required standards.

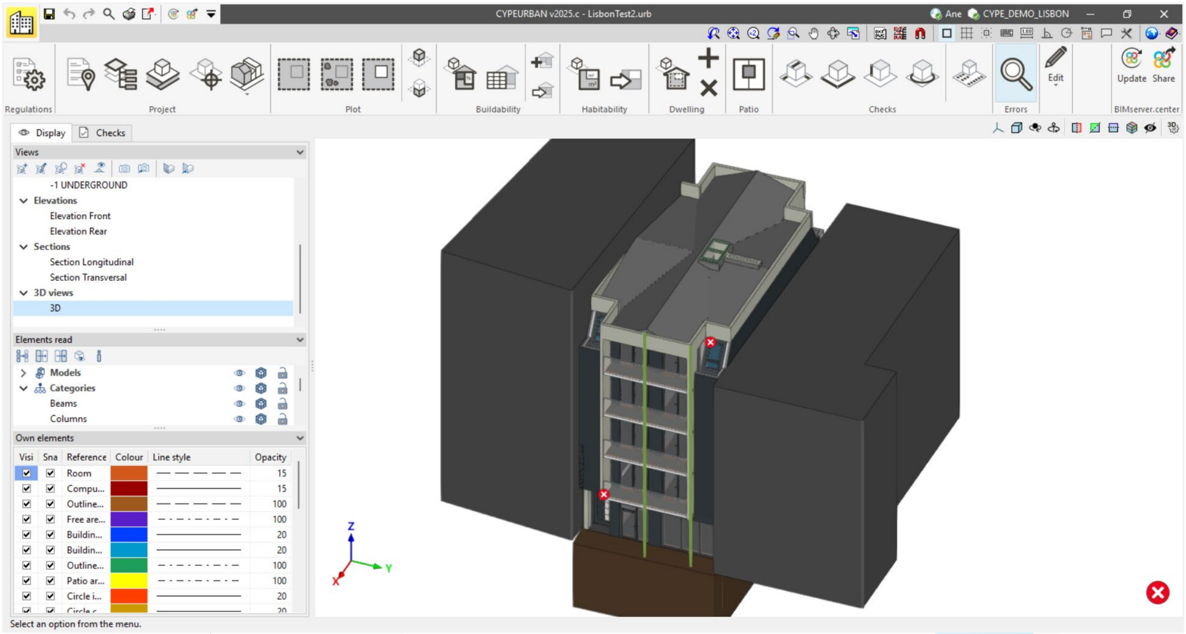


Figure 6: CYPEURBAN Visualisation tab with "Lisbon DEMO"

The Visualisation tab, as shown in Figure 6, provides users with full control over the display of 3D models and project elements. Users can create and manage views such as floor plans, sections, and elevations, and isolate specific components or adjust transparency to focus on key details. Additionally, visibility options allow users to show or hide selected elements and assign colours to different parts of the model, making it easier to highlight important areas during compliance reviews. These features ensure that all critical elements of the project are clearly visible and properly evaluated during the validation process.

Through the Checks tab, users are provided with a centralised list of all mandatory checks that must be performed on the project (Figure 7). It allows users to navigate through various regulations applicable to their model and check whether each aspect complies with local planning regulations. The platform clearly displays the compliance status, showing whether each check is compliant, non-compliant, or requires additional data. This enables users to identify areas that need attention quickly, with each check linked directly to the relevant part of the model. By double-clicking on a specific check, users can view more details, including the regulatory text and specific requirements, helping them understand the compliance status and make necessary adjustments.

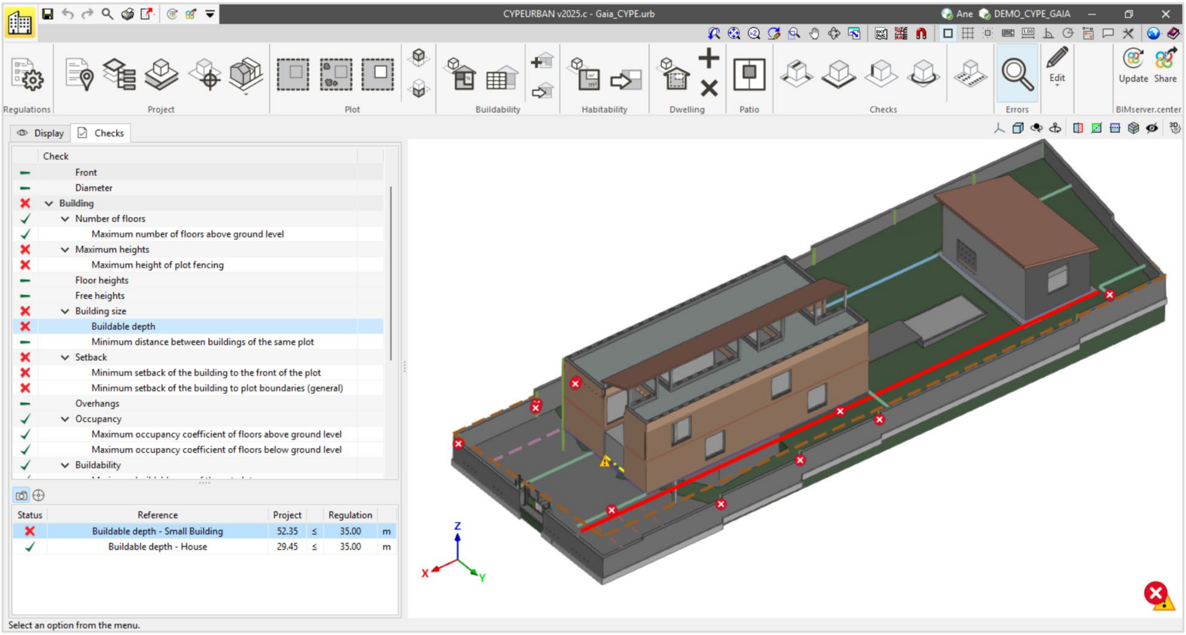


Figure 7: CYPEURBAN Checks tab "Gaiurb DEMO"

CYPEURBAN also enables users to create custom checks. This function allows users to input specific project data, such as plot size, building heights, setbacks, and other urban constraints. The platform guides users through the process, enabling them to create checks by measuring relevant data directly from the BIM model and applying the appropriate regulations. This feature is essential when working with custom or non-standard regulations that may not already be included in the system. Users can easily define occupancy limits, plot coverage, and height restrictions, and the platform will automatically validate the BIM model against these parameters, ensuring flexibility and accuracy in the compliance process.

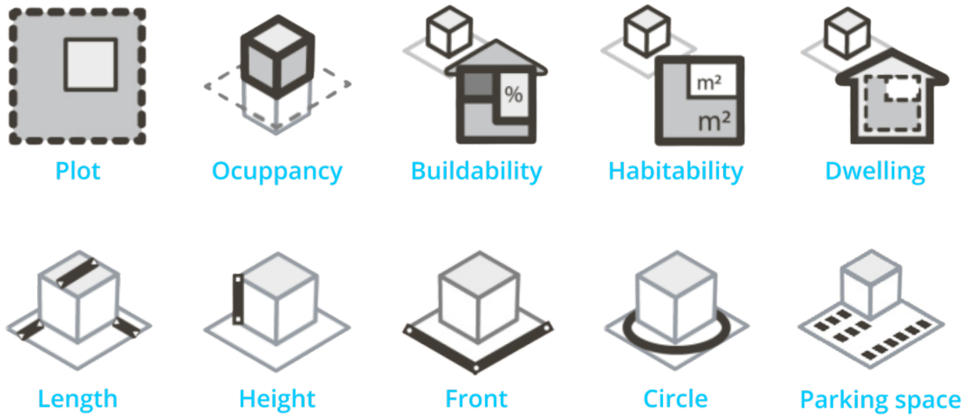


Figure 8: CYPEURBAN custom checks

The Edit section allows users to modify the data and elements related to compliance checks (Figure 9). It provide tools to adjust parameters, such as plot boundaries or building dimensions, and make necessary changes without the need to rework the entire project. Users can move, delete, or copy elements, and the platform updates the results in real-time to reflect these modifications. This feature is particularly useful for making adjustments to the project without disrupting the workflow, ensuring that compliance is maintained as the design evolves.

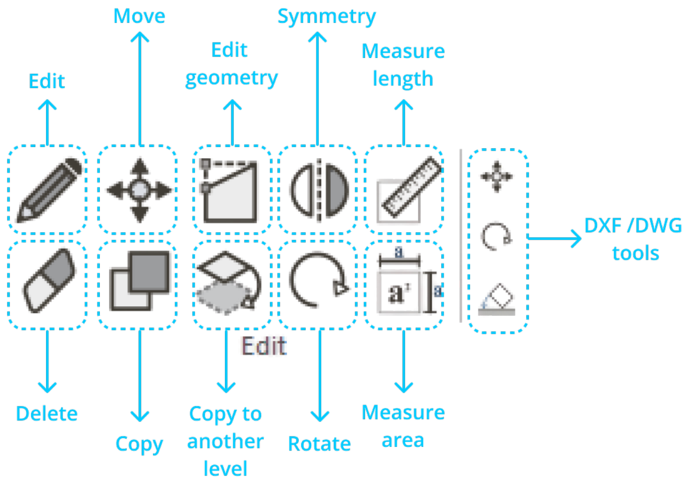
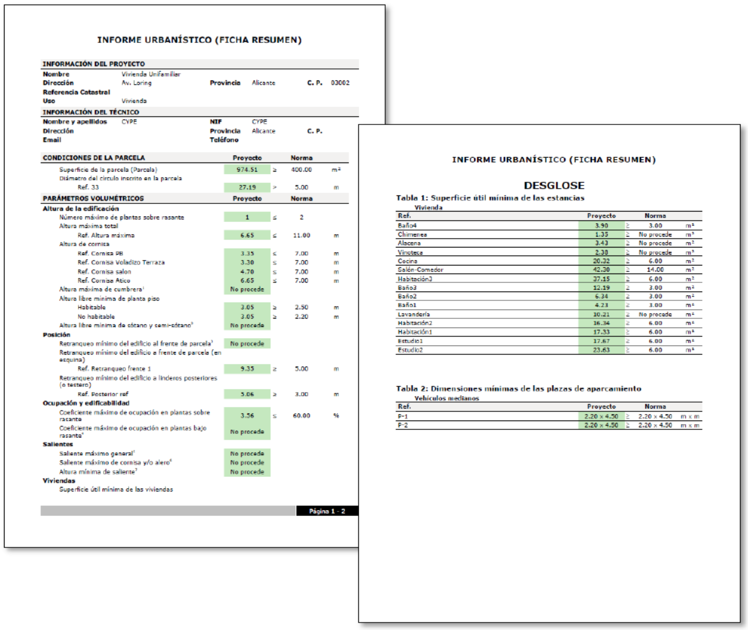


Figure 9: CYPEURBAN custom checks

Documentation is another strong aspect of CYPEURBAN. The platform enables users to generate detailed reports that document the compliance status of the entire project. These reports include the relevant regulations, the checks performed, and whether the project complies with the applicable planning rules. The reports are customisable and can be exported for submission to authorities or internal use (Figure 10). Additionally, users can generate BIM models that contain the compliance data, ensuring all necessary documentation is included in the project submission. This feature streamlines the documentation process, making it easier to prepare comprehensive and accurate reports for regulatory approval.



INFORME URBANÍSTICO (FICHA RESUMEN)

INFORMACIÓN DEL PROYECTO					
Nombre	Vivienda Unifamiliar				
Dirección	Av. Loring	Provincia	Alicante	C. P.	03002
Referencia Catastral					
Uso	Vivienda				

INFORMACIÓN DEL TÉCNICO					
Nombre y apellidos	CYPE	NIF	CYPE		
Dirección		Provincia	Alicante	C. P.	
Email		Teléfono			

CONDICIONES DE LA PARCELA	Proyecto		Norma	
Superficie de la parcela (Parcela)	974.51	≥	400.00	m²
Diámetro del circulo inscrito en la parcela				
Ref. 33	27.19	>	5.00	m

PARÁMETROS VOLUMÉTRICOS	Proyecto		Norma	
Altura de la edificación				
Número máximo de plantas sobre rasante	1	≤	2	
Altura máxima total				
Ref. Altura máxima	6.65	≤	11.00	m
Altura de cornisa				
Ref. Cornisa PB	3.35	≤	7.00	m
Ref. Cornisa Voladizo Terraza	3.30	≤	7.00	m
Ref. Cornisa salon	4.70	≤	7.00	m
Ref. Cornisa Atico	6.65	≤	7.00	m
Altura máxima de cumbrera[1]	No procede			
Altura libre mínima de planta piso				
Habitable	3.05	≥	2.50	m
No habitable	3.05	≥	2.20	m
Altura libre mínima de sótano y semi-sótano[2]	No procede			
Posición				
Retranqueo mínimo del edificio al frente de parcela[3]	No procede			
Retranqueo mínimo del edificio a frente de parcela (en esquina)				
Ref. Retranqueo frente 1	9.35	≥	5.00	m
Retranqueo mínimo del edificio a linderos posteriores (o testero)				
Ref. Posterior ref	5.06	≥	3.00	m
Ocupación y edificabilidad				
Coeficiente máximo de ocupación en plantas sobre rasante	3.56	≤	60.00	%
Coeficiente máximo de ocupación en plantas bajo rasante[4]	No procede			
Salientes				
Saliente máximo general[5]	No procede			
Saliente máximo de cornisa y/o alero[6]	No procede			
Altura mínima de saliente[7]	No procede			
Viviendas				
Superficie útil mínima de las viviendas				

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INFORME URBANÍSTICO (FICHA RESUMEN)

DESGLOSE

Tabla 1: Superficie útil mínima de las estancias

Vivienda

Ref.	Proyecto		Norma	
Baño4	3.90	≥	3.00	m²
Chimenea	1.35	≥	No procede	m²
Alacena	3.43	≥	No procede	m²
Vinoteca	2.38	≥	No procede	m²
Cocina	20.32	≥	6.00	m²
Salón-Comedor	42.30	≥	14.00	m²
Habitación3	37.15	≥	6.00	m²
Baño3	12.19	≥	3.00	m²
Baño2	6.34	≥	3.00	m²
Baño1	4.23	≥	3.00	m²
Lavandería	10.21	≥	No procede	m²
Habitación2	16.34	≥	6.00	m²
Habitación1	17.33	≥	6.00	m²
Estudio1	17.67	≥	6.00	m²
Estudio2	23.63	≥	6.00	m²

Tabla 2: Dimensiones mínimas de las plazas de aparcamiento

Vehículos medianos

Ref.	Proyecto		Norma	
P-1	2.20 x 4.50	≥	2.20 x 4.50	m x m
P-2	2.20 x 4.50	≥	2.20 x 4.50	m x m

Figure 10: CYPEURBAN compliance check report

The Digital Building Permit (DBP) platform, integrated with BIMserver.center, operates within an Open BIM environment that allows seamless interoperability between various BIM tools and systems. This integration ensures that data, from design to validation, is centralised and accessible to all stakeholders. BIMserver.center acts as a collaborative hub where BIM models, compliance checks, and other project-related data are stored, shared, and updated in real-time. Through this workflow, CYPEURBAN plays a crucial role by allowing project designers to manage compliance checks for urban planning regulations within a structured and collaborative framework.

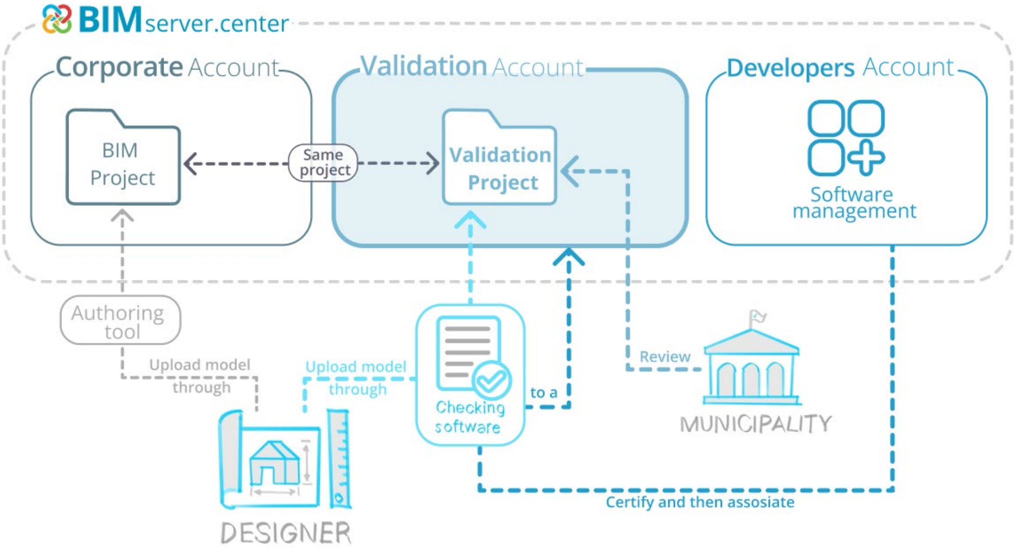

Figure 11: DBP Platform integration workflow

The general workflow of connecting to the DBP platform is illustrated in Figure 11. Developer Accounts must first certify CYPEURBAN as Checking Software. Once certified, it then is associated with the Validation Account, allowing municipalities to review and validate the project's compliance with local regulations through the DBP platform. Designers, using an authoring tool, create the BIM model, which is uploaded to BIMserver.center via a Corporate Account. Once the model is on the platform, the same project is linked to a Validation Account, typically associated with municipalities or regulatory authorities.

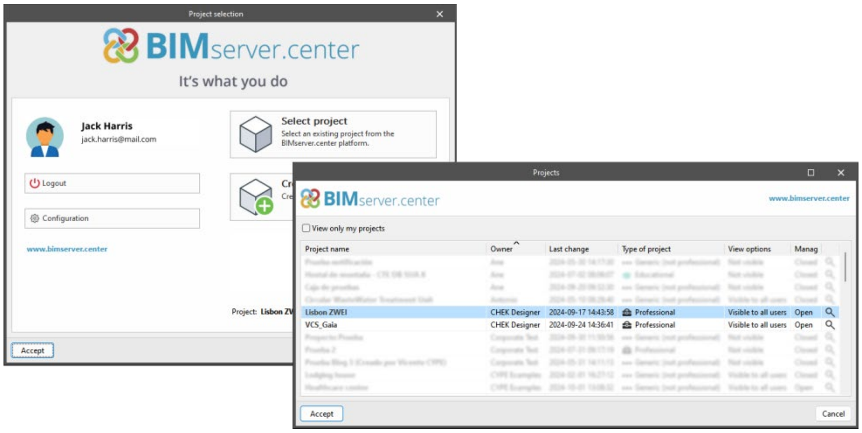

Figure 12: BIMserver.center project selection

To link an existing project from BIMserver.center into a CYPEURBAN project, it must have first been created by a Corporate Account in the platform. Then, in CYPEURBAN, users must log in into their BIMserver.center accounts, and then click the "Select Project" button, where all the account's listed projects will appear. From this list, the desired project should be selected; making sure it is the same as the one in the Corporate Account (Figure 12). This will associate the local CYPEURBAN project with the platform's online project.

Then, the project's existing IFC models may be loaded into CYPEURBAN if needed (Figure 13). Should updates occur; the user will be notified and given the option to reload the latest version of the models, keeping all collaborators aligned with the most current project information. This menu can be accessed at any time by selecting the "Update" button under the "BIMserver.center" panel, on the top right of the ribbon.

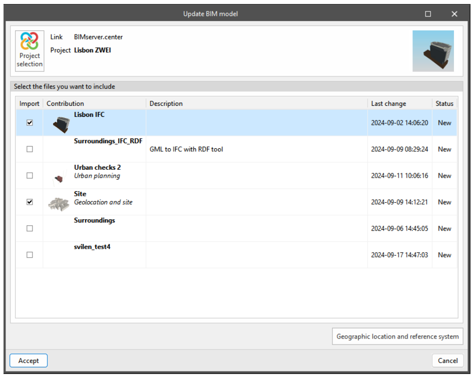

Figure 13: BIMserver.center model update

After loading the models, the software initiates an importation phase in which the elements of the BIM model are mapped to the corresponding elements defined in the applicable regulations. This process was specifically designed to ease the adaptation of models to municipal requirements. Typically BIM models are developed to support the internal project management needs of the promoter, rather than being tailored to the regulatory criteria set by municipalities. Within the CHEK project, the same issue was addressed by the CHEK IFC exporters developed within T2.5 (D2.4), intended to facilitate the export of the CHEK IDS-compliant files from authoring software. Whether such an automatic procedure might not be sufficient, or to choose a different method, the tool provided by CYPE can still bridge the gap by facilitating the alignment of project data with local regulatory frameworks, through a manually controlled procedure, ensuring smoother and more efficient compliance validation.

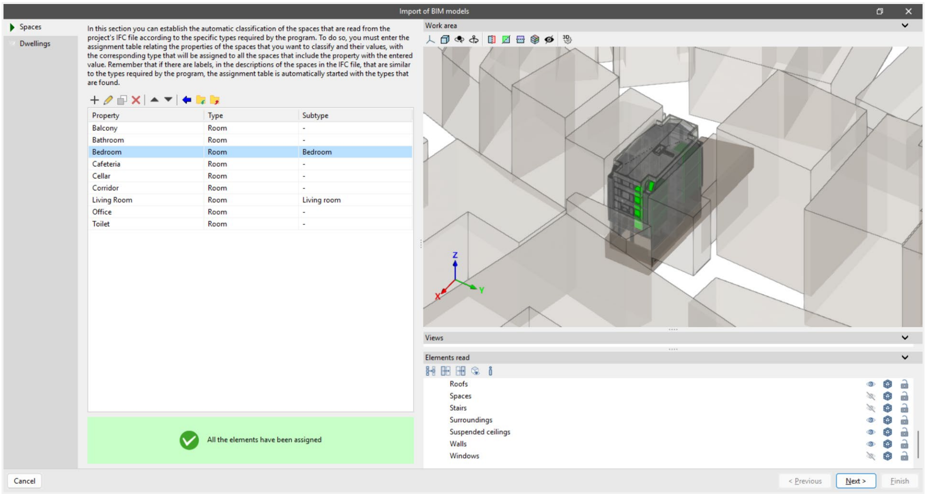

Figure 14: Importing IFC models in CYPEURBAN. Mapping of “space” entities.

After the desired BIM models are updated from BIMserver.center, users can begin applying urban planning regulations and performing compliance checks. Once the compliance checks have been performed, the results can be shared and exported back to the DBP platform (BIMserver.center) through the “Share” button under BIMserver.center panel in the top right (Figure 14).

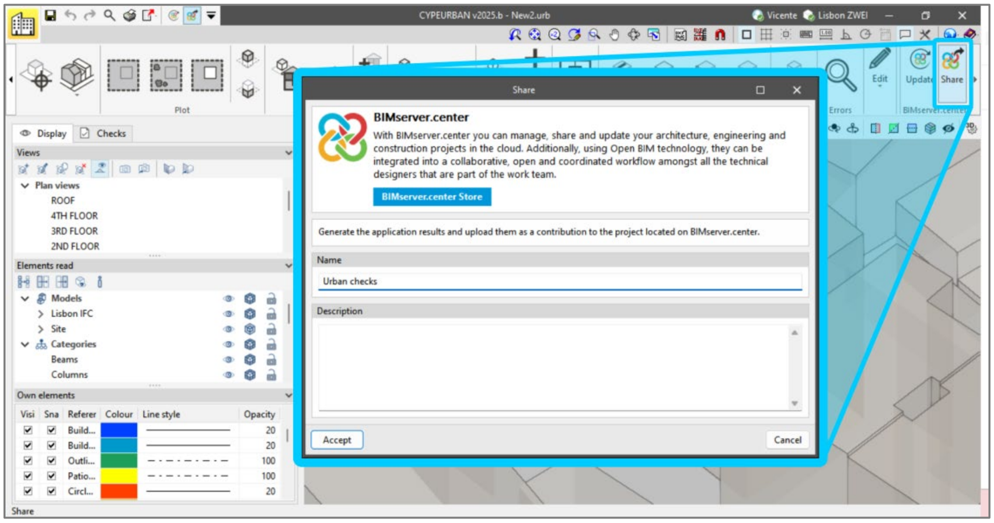

Figure 15: BIMserver.center contribution upload from CYPEURBAN

This will create a contribution in the DBP platform, where designers can access the information through their “Corporate” accounts for further development, and municipalities review the regulation data though their “Validation” accounts, as seen above in Figure 11. This process ensures that all stakeholders have access to the necessary documentation and compliance results, optimising the building permit approval process. The share function can be initiated directly within CYPEURBAN, and the results are uploaded to the same project on BIMserver.center.

4.1.2 CYPE Accessibility.

CYPE Accessibility is a specialised desktop application designed to assist with the evaluation and validation of accessibility requirements in architectural projects. As part of the CHEK project, this tool has been integrated into the broader digital building permit framework to ensure that accessibility compliance becomes an integral part of the early design and review stages.

The software enables users to check whether a building model complies with accessibility regulations, particularly those related to spatial circulation, accessible routes, and the usability of common spaces for individuals with reduced mobility. CYPE Accessibility processes architectural IFC models and identifies elements such as entrances, doors, ramps, lifts, sanitary spaces, and circulation paths, comparing them against national or regional accessibility standards.

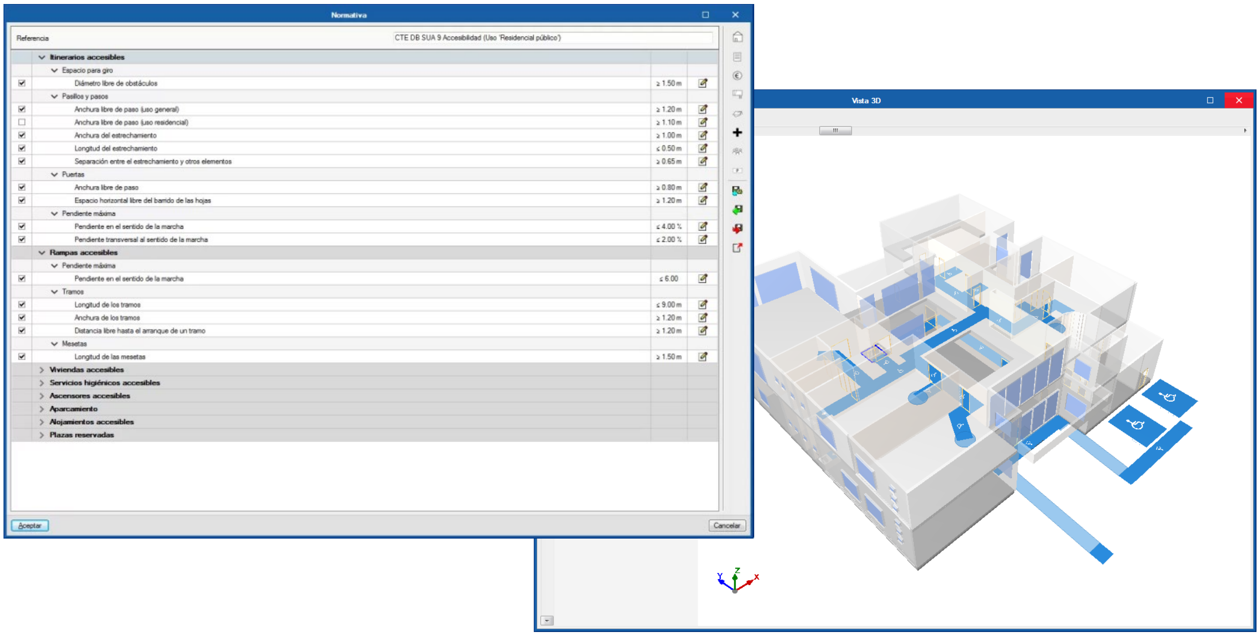

Figure 16: Interface CYPE Accessibility

The interface allows users to navigate the 3D model, specific warnings or non-conformities are visually indicated, enabling designers to understand and resolve issues during the design phase. The tool also includes editable regulation templates, enabling adaptation to specific legal frameworks or user-defined rules, which is particularly relevant for implementation in diverse municipal contexts within the CHEK pilot environments. In addition to compliance checking, CYPE Accessibility supports the documentation of verification results. Users can generate comprehensive reports. These reports can be exported and submitted as part of the digital permit process.

Within the CHEK project, CYPE Accessibility has been connected to the DBP platform through BIMserver.center, enabling seamless sharing of results with other stakeholders. Once the accessibility checks are complete, designers can upload the results directly to the platform, allowing validation authorities to review and approve them as part of the broader compliance workflow.

4.2 New functionalities developed for CHEK project.

As part of the CHEK project, functional improvement have been developed for the desktop-based tools CYPEURBAN and CYPE Accessibility. These developments focus primarily on adapting the tools to perform specific regulatory checks as defined by the partner municipalities, including the incorporation of GIS-based data, creation of new rule templates, and integration in the CYPE Architecture modelling environment. These improvements aim to facilitate the compliance verification for urban planning and accessibility by the use of enriched BIM data and contextual information from the surroundings.

4.2.1 CYPEURBAN.

The evolution of CYPEURBAN under the CHEK project has centered on expanding its analytical capabilities to account for contextual information extracted from Geographic Information Systems (GIS), thereby supporting more comprehensive urban regulation checks. Since most GIS information is not natively supported in IFC format, a necessary transformation process is needed before importing the information in CYPEURBAN. Once imported, CYPEURBAN is capable of reading the properties from the surrounding environment encoded in the IFC, which allows for new contextual checks to be performed.

To support these capabilities, several new features have been developed within CYPEURBAN, including:

- Surroundings information table: Displays detailed data from adjacent buildings imported via IFC.
- Import tool for surrounding buildings: Allows designers to bring in contextual data relevant to the building plot.
- Manual data enrichment: Users can manually assign or modify information associated with surrounding buildings to ensure accurate analysis.

These functionalities enable the execution of a new class of checks that depend on contextual information, such as: Maximum number of floors based on adjacent buildings, total maximum height depending on surrounding buildings, maximum façade height in relation to the street profile or neighboring buildings. Moreover, CYPEURBAN has been extended to support predefined regulatory templates developed in collaboration with the municipalities of Vila Nova de Gaia and Lisbon.

- Gaia regulation package (12 checks): Includes rules such as minimum plot area, maximum number of floors, fencing height limits, buildable depth, minimum distances between buildings, various setbacks, occupancy coefficients, buildable area limitations, room area standards, and parking requirements based on computable floor area.
- Lisbon regulation package (14 checks): Introduces complex checks including relative height restrictions based on surrounding buildings, minimum free height per floor type, overhang limits, setbacks, and minimum net floor areas.

These predefined libraries allow for out-of-the-box application of local regulations, facilitating fast validation and aligning CYPEURBAN with the specific needs of the CHEK pilot municipalities.

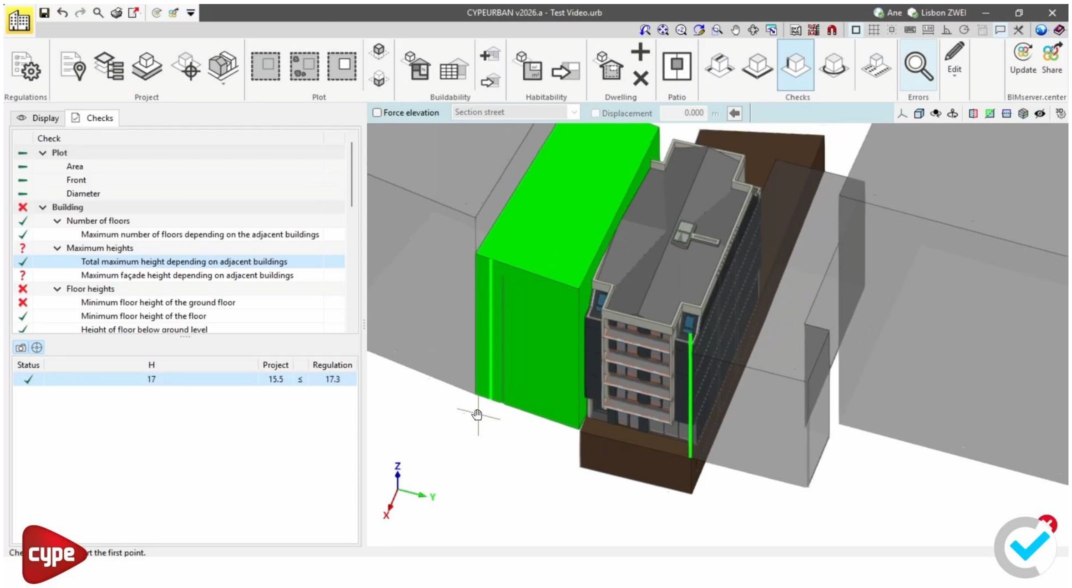

Figure 17: Interface CYPEURBAN with “Lisbon DEMO” and check of the maximum height depending on the surrounding buildings.

4.2.2 CYPE Accessibility.

Developments in Open BIM Accessibility within the scope of CHEK have focused on its seamless integration into CYPE Architecture. This integration not only brings accessibility checks into the early design stage but also allows for direct modelling of accessible components, thereby embedding compliance into the design workflow.

New features developed for the project include the ability to place and parameterize common accessible elements directly within the model, such as: Stair lifts and platform lifts, accessible bathroom fixtures, including shower seats and support bars. These elements can now be incorporated into the BIM model and subsequently evaluated during compliance checks, ensuring that accessibility is embedded into both the design and the regulatory validation stages.

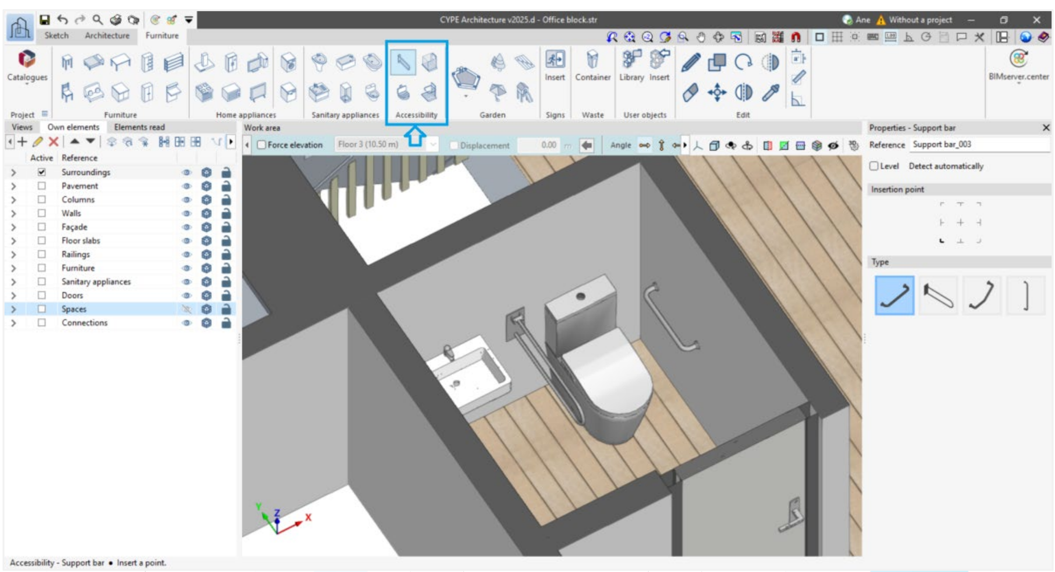

Figure 18: Accessibility elements in CYPE Architecture.

4.2.3 Integration of the checking desktop tools in CYPE Architecture.

One of the most significant evolutions carried out within the CHEK project has been the integration of the compliance checking functionalities of CYPEURBAN and CYPE Accessibility directly into CYPE Architecture, CYPE's free BIM modeler. This integration was not only a technical improvement but a strategic response to a fundamental limitation of the previous standalone tools: lack of scalability and limited adaptability to local regulatory changes.

Originally, updating or modifying compliance checks required direct intervention from CYPE's development team, posing a bottleneck for widespread adoption and limiting the flexibility of the tools across different regions. In contrast, the new architecture is designed around a decentralized, modular, and scalable approach, enabling municipalities to create, modify, and deploy their own regulatory checks independently of CYPE's internal development cycles.

This shift is made possible through the Open BIM Systems Database, an existing CYPE's technology initially designed for managing product manufacturer data, now repurposed and extended to support urban and accessibility regulations. While the adaptation of this system was not originally planned as part of the CHEK project (and has been developed outside the CHEK developments), CYPE identified the absence of a structured and scalable regulation management system as a critical gap (which was only partially achieved in the Task 2.1 "Interpretation and formalization of regulations and encoding into a prototyped machine-readable format) by UMinho but without a sufficient TRL to be deployed as a database, and not ready to be deployed in ready-to-market tools such as CYPE Architecture), and proactively adapted its existing infrastructure to support this functionality within CHEK's scope.

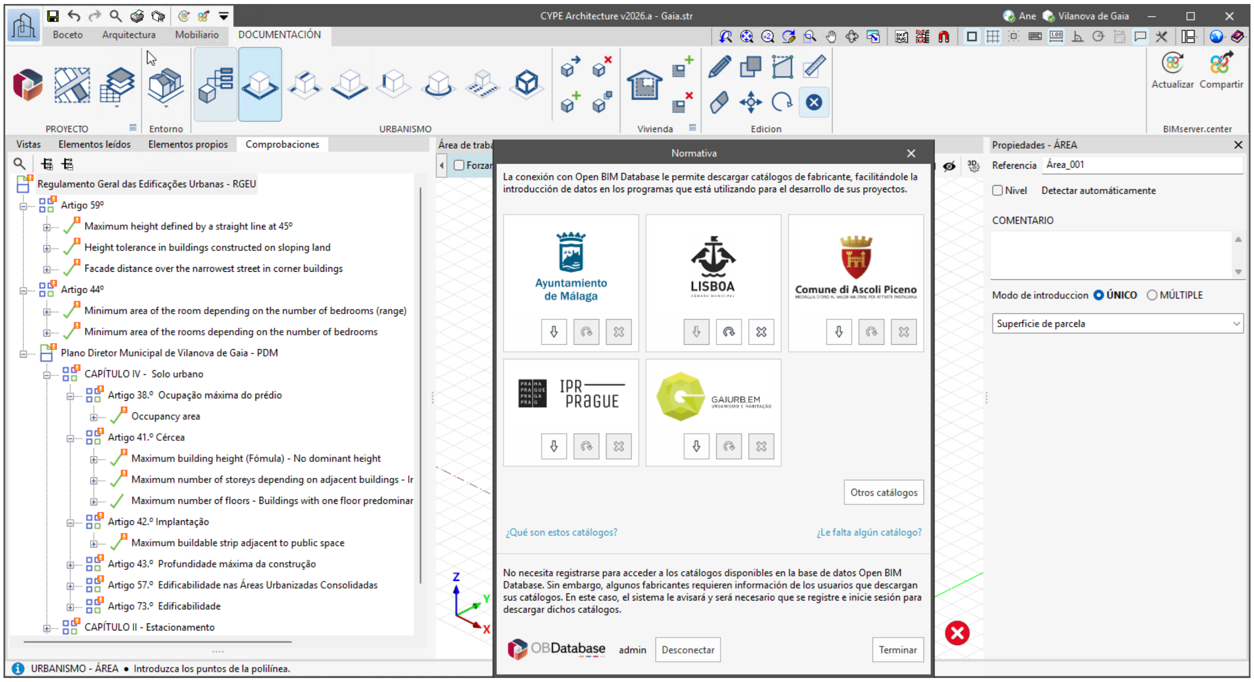

Figure 19: Interface CYPE Architecture access to OBDB Database to download the regulation of municipalities.

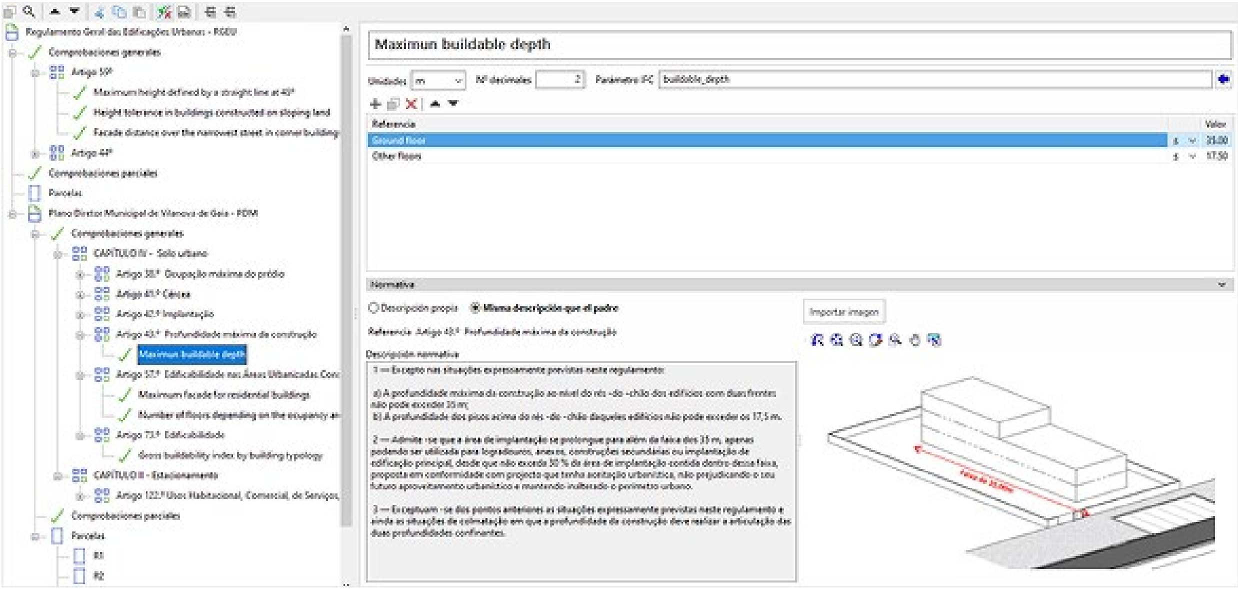

Figure 20: Definition of a check for maximum buildable depth of "Gaia DEMO" visualization of the OBDB database in CYPE Architecture.

While the integration required a temporary reallocation of development resources—resulting in a slower rollout of new regulation checks—it ultimately represents a paradigm shift in how digital compliance validation is delivered. By empowering end users and institutions to take control of their own regulatory logic, the system fosters collaborative governance, localization of rules, and greater sustainability of the results.

The advantages of this new integration approach are substantial:

- Scalability: Municipalities can manage their own regulation libraries and deploy updates at any time, allowing the system to grow organically across cities and regions without additional workload on CYPE's side.
- Autonomy: Local authorities or certified consultants can create and maintain their own validation rules through a user-friendly interface, removing dependency on CYPE for each new rule or change.
- Real-time validation during design: With checking logic embedded into the BIM modelling tool itself, users can verify compliance dynamically as they develop the model, simplifying workflows and minimizing design rework. (The tool is also capable of loading models in IFC for third party tools such as Revit, ArchiCAD…)
- Future-proofing: This approach lays a robust foundation for long-term exploitation beyond the lifetime of the CHEK project, enabling municipalities to adapt to changing regulations and new urban planning challenges without being constrained by software version cycles.

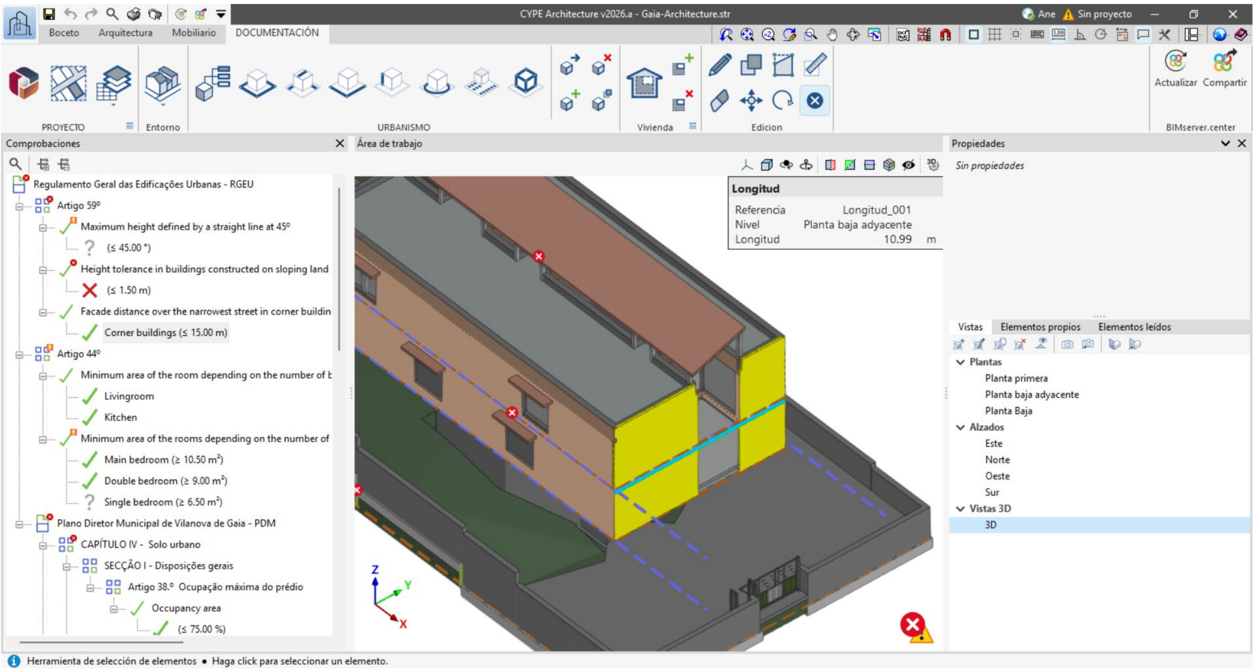

Figure 21: Check of “minimum façade distance” in CYPE Architecture and “Gaia DEMO”.

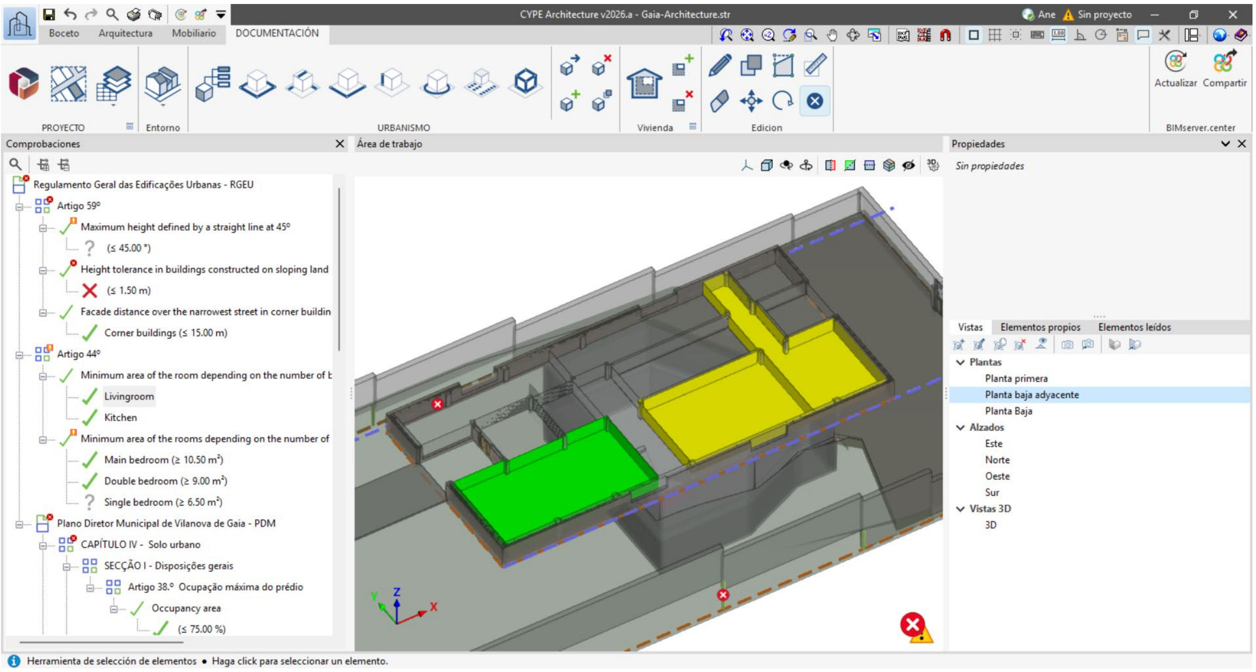

Figure 22: Check of “minimum area of the living room depending on the number of bedrooms” in CYPE Architecture and “Gaia DEMO”.

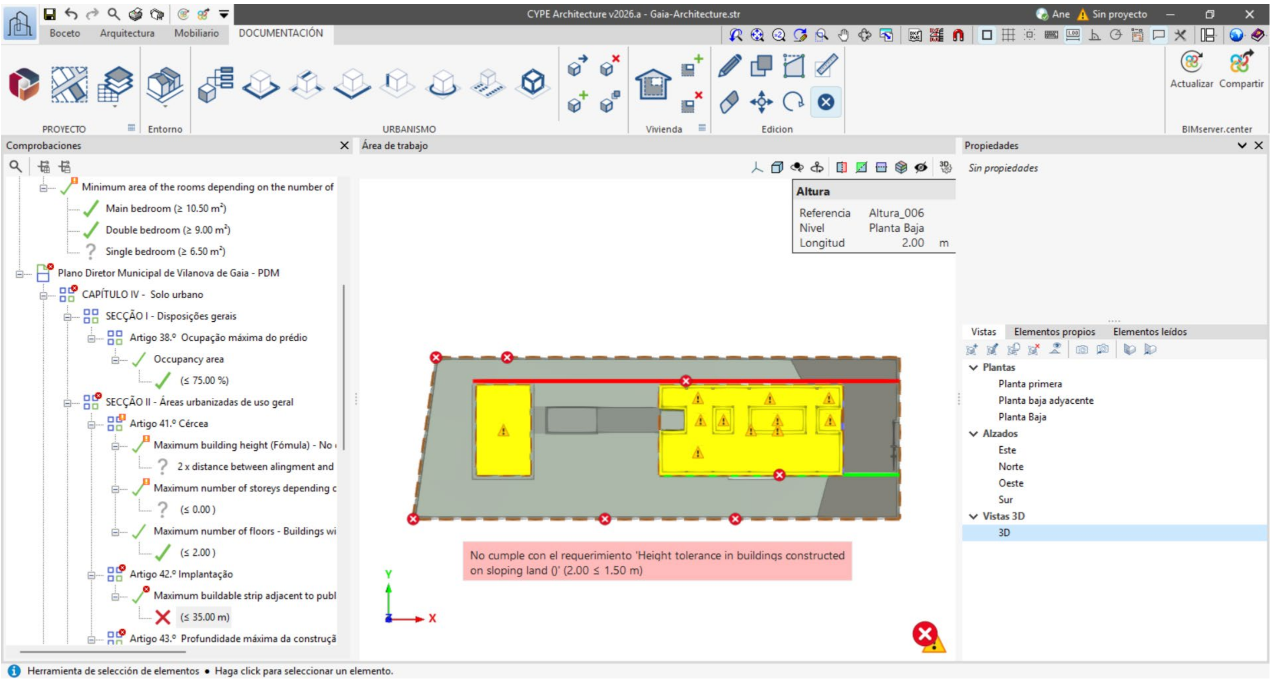

Figure 23: Check of “maximum buildable depth” in CYPE Architecture and “Gaia DEMO”.

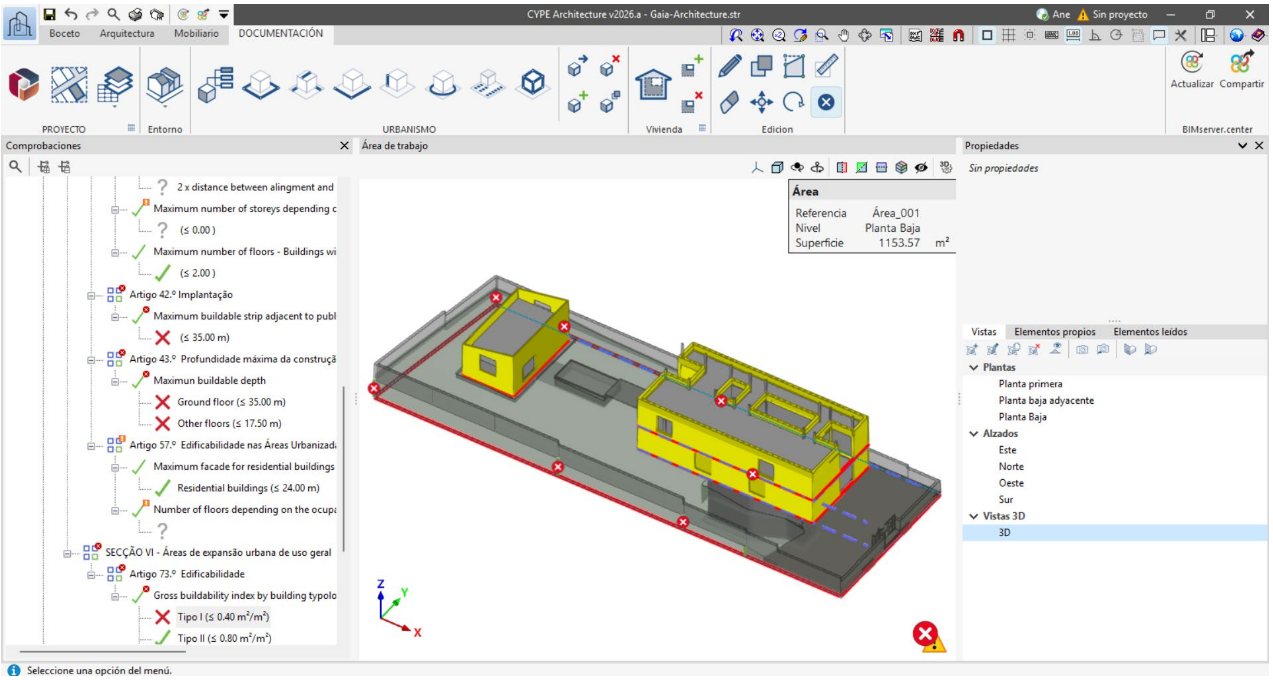

Figure 24: Check of “gross buildability index by building type” in CYPE Architecture and “Gaia DEMO”.

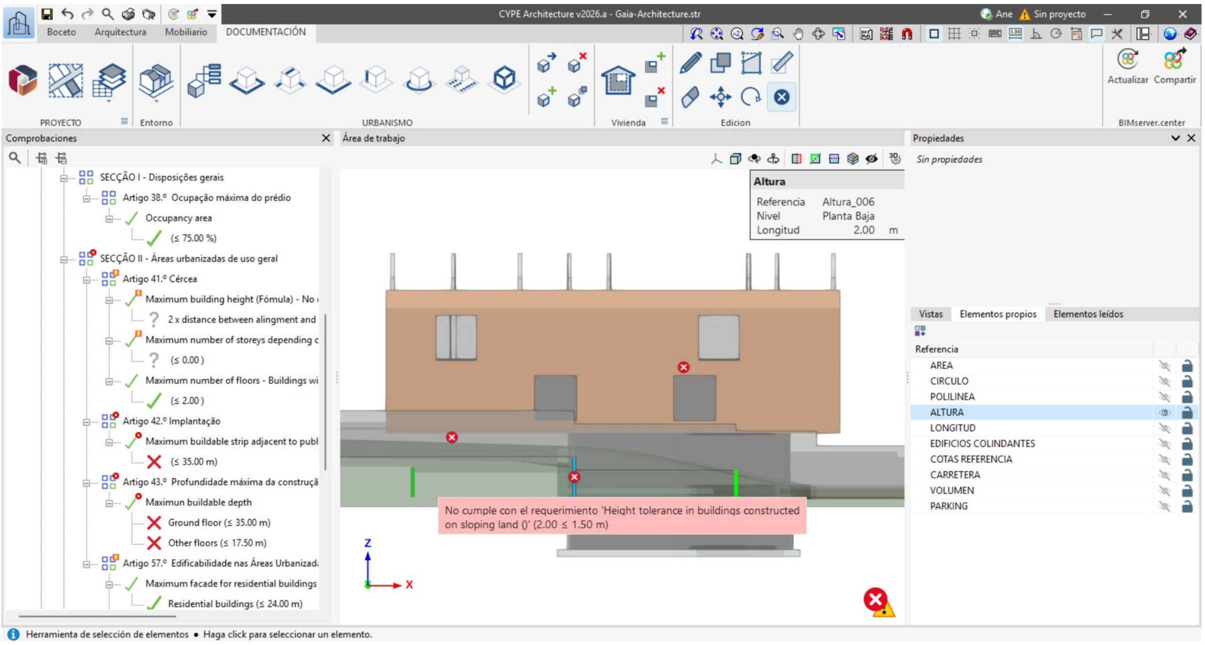

Figure 25: Check of "Height tolerance in buildings constructed on sloping land" in CYPE Architecture and "Gaia DEMO".

5. Web-based software: Verifi3D

5.1 Overview of Verifi3D

5.1.1 Verifi3D, Solibri CheckPoint and Solibri Office

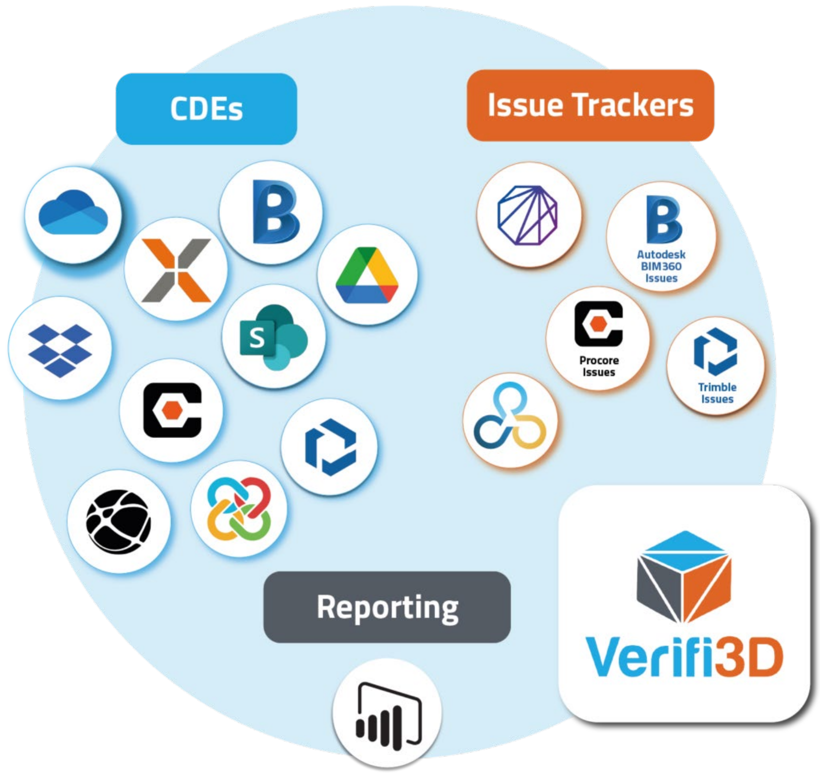

Figure 26: Verifi3D offers many options to connect to both open and proprietary systems

Verifi3D is a web application for BIM model checking. As any web application, it consists of two parts: the backend, which is running on a server in the cloud, and the front-end, which is running on the local machine of the computer. In this way, it can combine the best of two worlds. Because the display and checking of models takes place in code that runs in the web browser on the user's local machine, it is just a powerful as locally installed software. It has access to the same memory, the same processor, the same model data as desktop software. Yet, unlike desktop software, it is not limited by the resources on the users' desktop, but plugs into the cloud, which offers highly connected and scalable computational resources and options for collaboration. Verifi3D does not need to be locally installed, or updated, or otherwise maintained by the users their organisation's IT support. With their login credentials, users have secure, immediate and up-to-date access to all application features, as well as access to projects, federated models, checking rule sets and result issues that other users could share with them. The newest versions of models are obtained directly from integrated Common Data Environments (platform) that serve as single source of truth for the entire project.

In October 2024, Xinaps, the company behind Verifi3D, was acquired by Solibri, the company behind the industry-standard model checking application for the desktop, Solibri Office. As a result, Verifi3D's legacy continues in the form of a new product, Solibri CheckPoint, which is built cloud-only workflows as well as interoperation with Solibri Office itself.

5.2 Connection to the DBP platform.

For the CHEK project, BIMserver.center, was added as integration to the choice of platforms available in Verifi3D. In this way, users have the choice of checking work-in-progress models from their local machine, from the platform that is used according to the project's BIM Execution Plan, or models submitted to the DBP platform itself.

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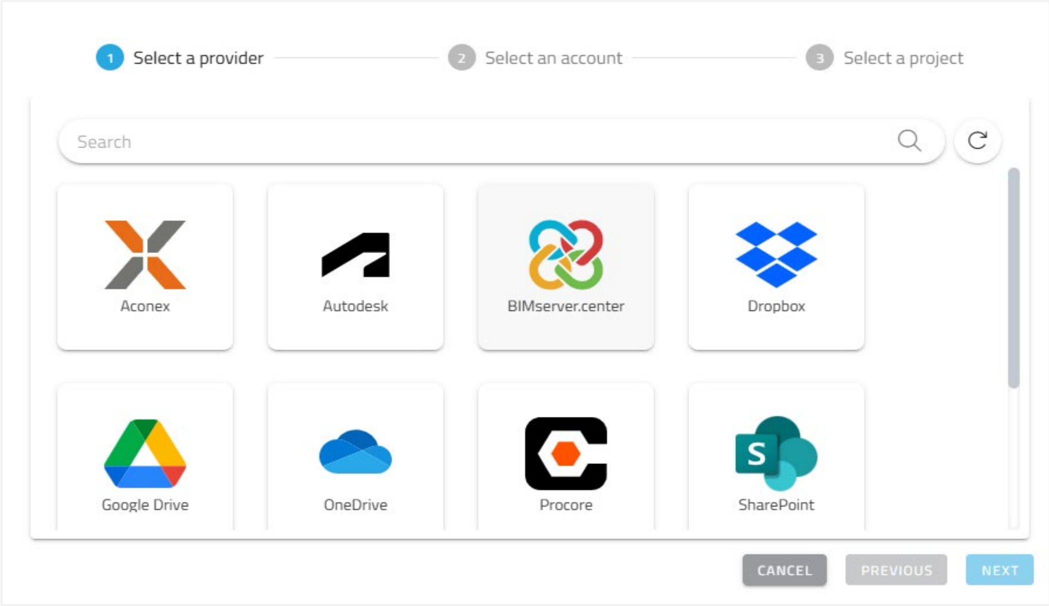


Figure 27: BIMserver.center as one of Verifi3D's platform integrations

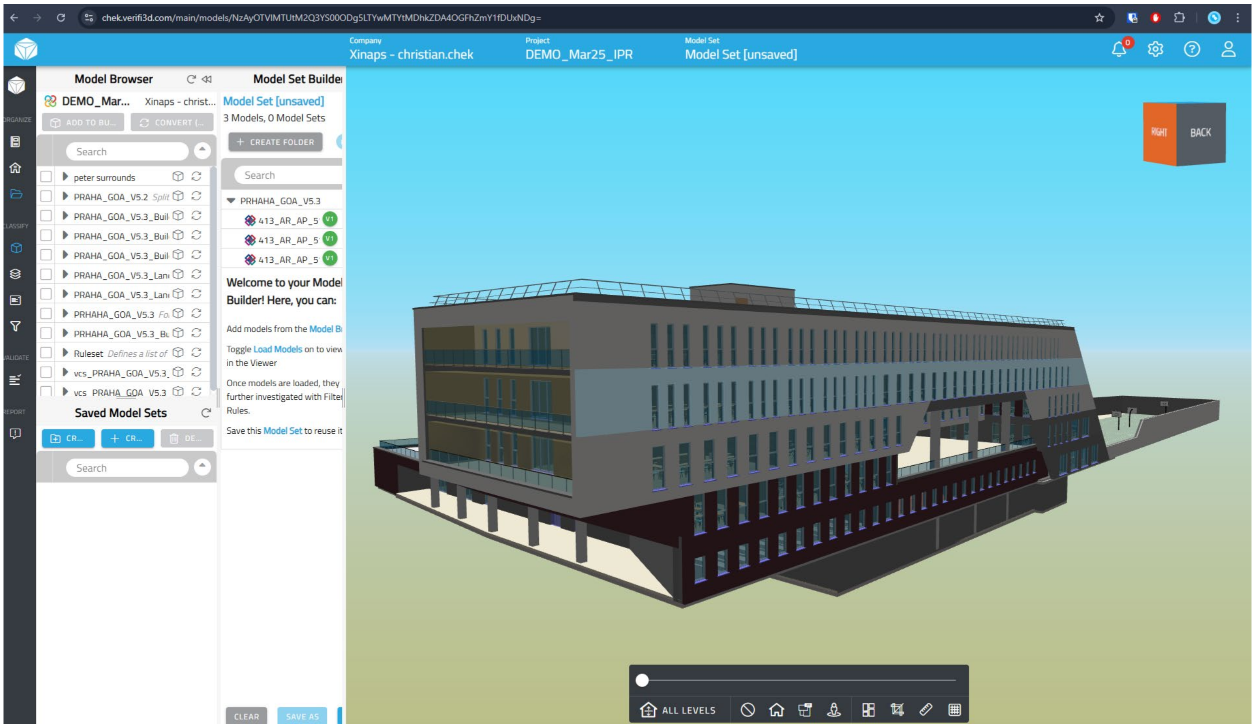


Figure 28: Models contributed to the DBP platform are directly available in Verifi3D

5.3 New Rule Types developed for CHEK project.

5.3.1 Filters and Rules in Verifi3D

Next to a high-performance 3D viewer, Verifi3D offers a Data Viewer that can display both BIM data and check results in customizable tables. Verifi3D's Data Viewer supports customization of columns, filtering, grouping and aggregation, all of which can be saved and shared as Data Views. 3D Viewer and Data Viewer are connected and can be used together with visualization and measuring tools for manual checking workflows, e.g. for identifying the necessary features for determining building height and measuring the respective distances. Fully automated checking is also possible, with Verifi3D's choice of Rule algorithms for checking well-structured BIM models, for example for information requirements, geometric clashes, or spatial relations between building elements. Users can set up rules by selecting an algorithm and set parameters, including filters that select elements. For example, Verifi3D has an algorithm that can detect whether objects are present or absent within a volumetric space relative to a building element. In this way, it is possible to detect all external doors that do not have an emergency exit sign above them. For this check, the algorithm needs to be able to identify all doors that are external, and then calculate a volume of space in front and on top of the door, and to see whether it contains any element identifiable as emergency exit sign. Filters in Verifi3D rely on the information available in the BIM models themselves, which contains the elements, their attributes and relations. For automatic checking of building code it is thus necessary for the BIM models' ontology to reflect legal concepts.

For the CHEK project, a series of checking algorithms called "Rule Types" were added to Verifi3D.

5.3.2 Area Ratio Check – Land Index KPP MAX & Building Index KPPp MAX

The "Area Ratio Check" calculates the ratio between the project area and the gross floor area, and determines whether it is below the allowable maximum. Rule Sets have been created for allowable ratio KPP MAX (land index) and maximum permissible ratio KPPp MAX (building index) according to the Prague Building Regulations (PBR).

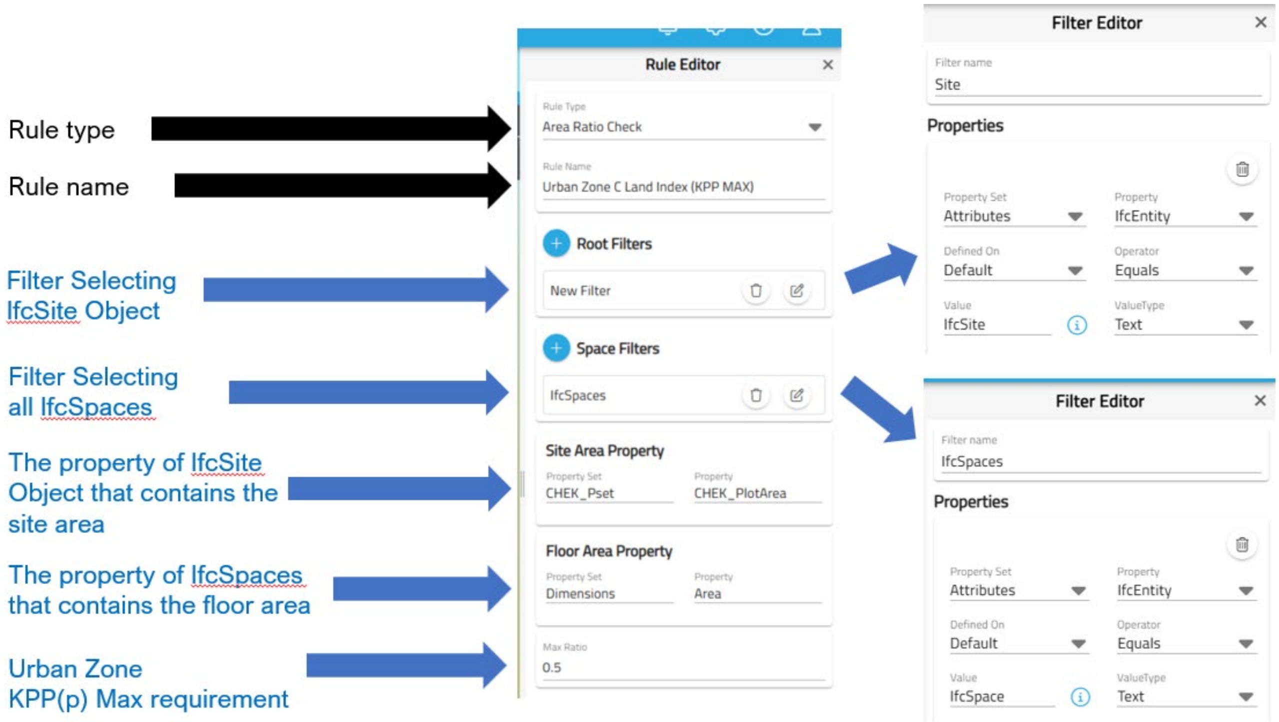


Figure 29: Parameter and Filter settings for KPP MAX checking according to PBR

5.3.3 Inner Clearance Check - Ceiling Height

The Inner Clearance Check algorithms is an advanced geometric check that determines for each element of a filter-selected set of building elements the bottom and top surfaces, which in a room are the floor and ceiling. The surfaces are determined as triangulations, and overlapping parts of triangles from bottom and top surface are matched. For each matching overlap the slope and parts above and below the minimum clearance height are calculated. In this way, it is possible to determine precisely whether the top surface is above the required clearance height and if not, which proportion of it still meets the requirements.

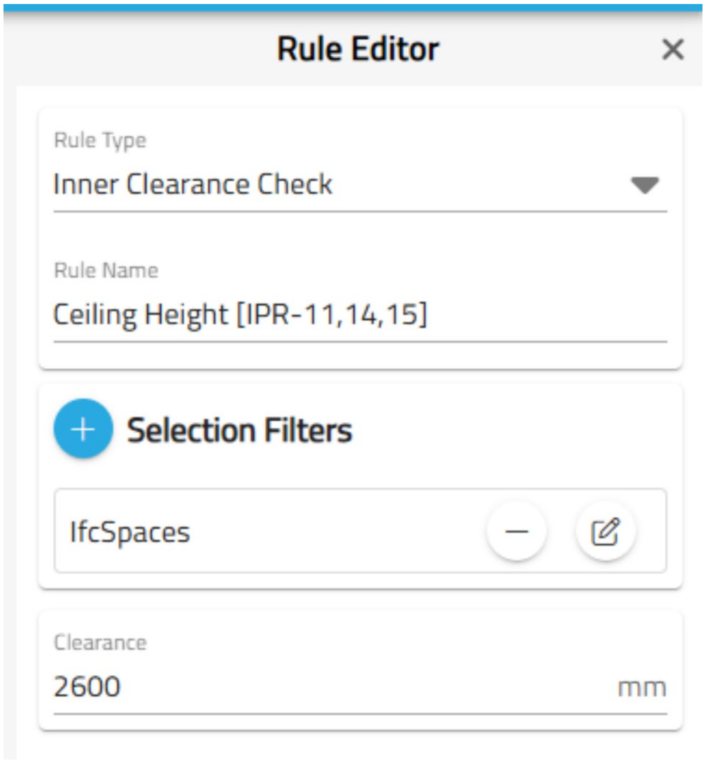


Figure 30: Inner Clearance Check, parametrized for Ceiling Height checking according to PBR

5.3.4 Window clearance

The Prague Building Regulation's requirements for the allowable distance of a window to an existing neighbouring building include a complex calculation. It starts with a point in the middle of the window, either at its bottom or at 1m above the room's floor. A cone is formed around the vertical axis at this point, offset at a degree of 45 degrees from the vertical, and with dead angles of 25 degrees from the façade surface. The requirement is met when no neighbouring building is within this cone in an uninterrupted angle of 45 degrees.

The "Windows Clearance" rule type allows for fully automated checking following this exact calculation.

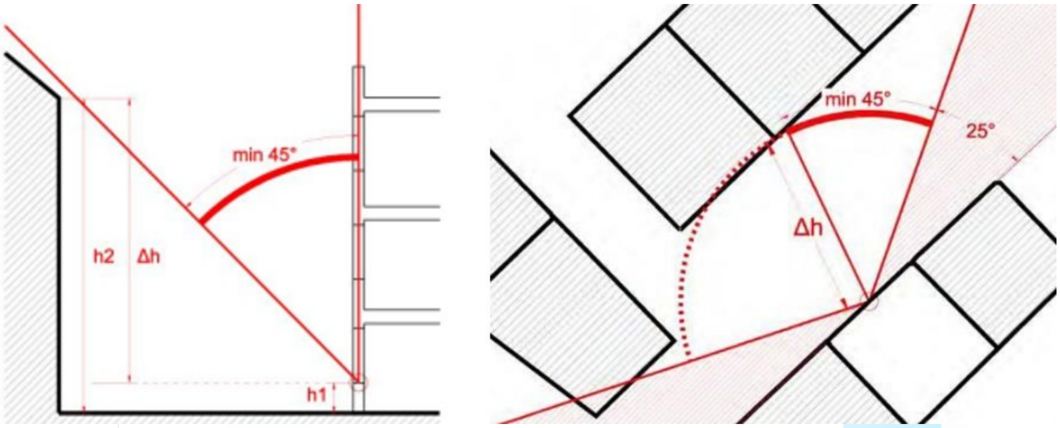


Figure 31: Diagrams for PBR window clearance calculation

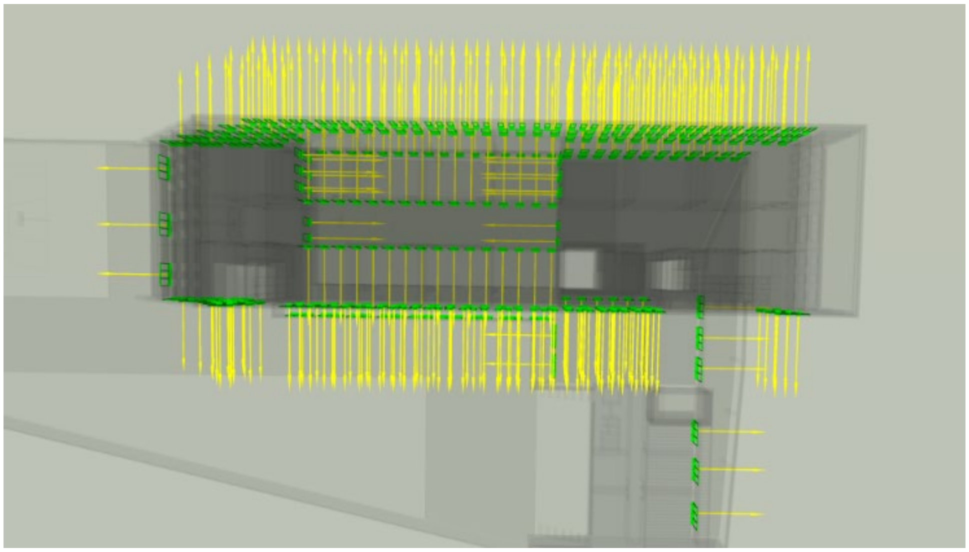


Figure 32: Visualization of windows and their direction in Verifi3D

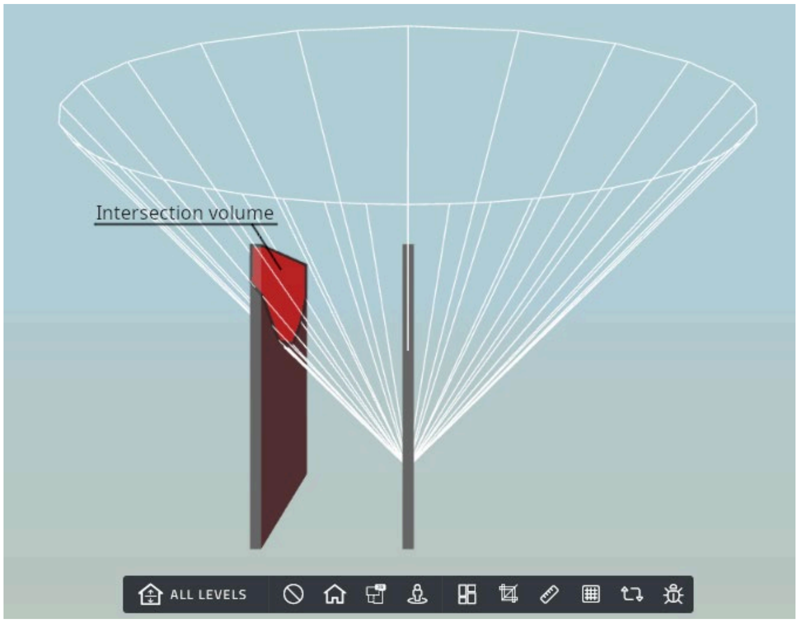


Figure 33: Three-dimensional diagram of the clearance cone

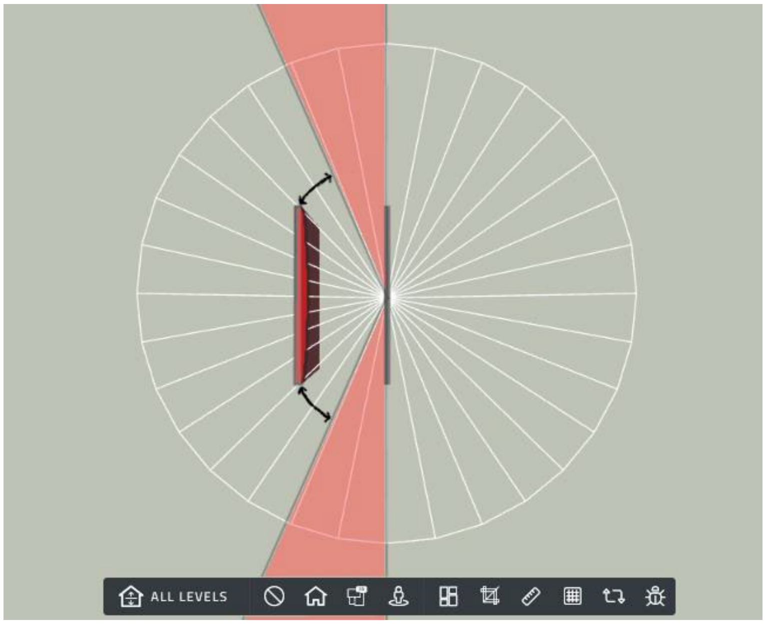


Figure 34: Three-dimensional diagram of dead angles

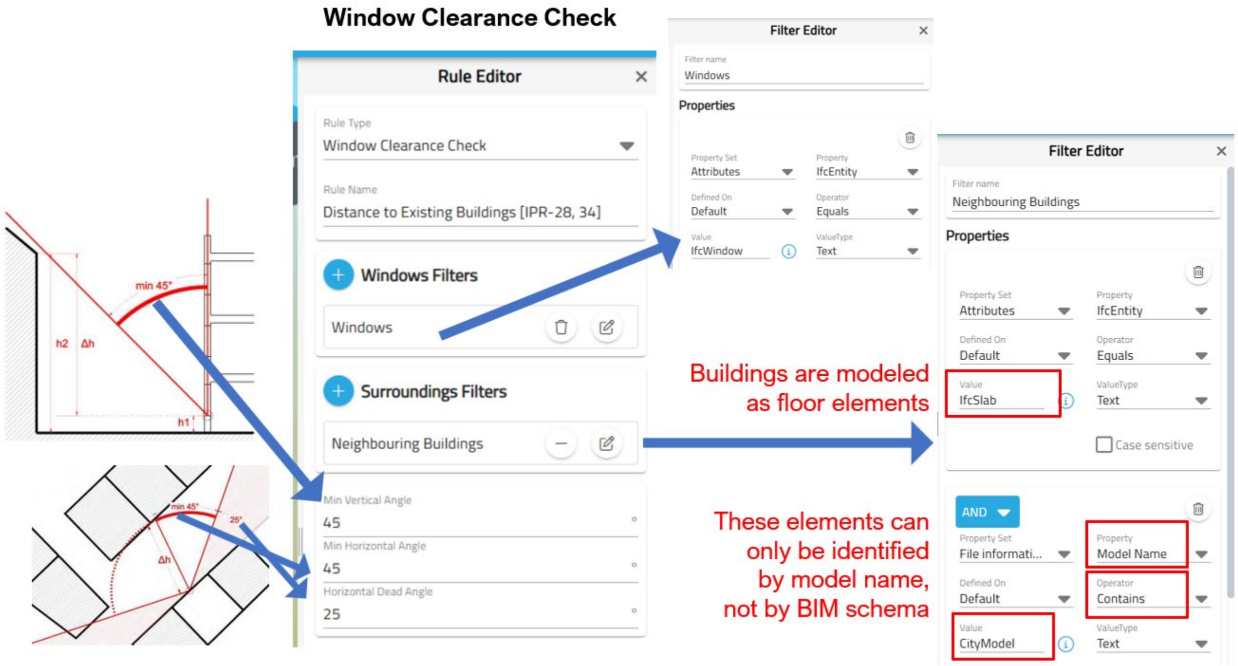


Figure 35: Window clearance check parameters according to PBR requirements

5.3.5 Required Amounts Check - Classroom Occupancy

The “Required Amounts Check” establishes that the ratio between two properties of an object is above a minimum requirement. For the Prague municipality’s Rule Set, it was parametrized to check that the occupancy of classrooms does not exceed 1.65m² per pupil.

IPR-21
Czech Republic Decree No.410 Art. 4-2

In the premises of education
and training
establishments,
excluding outdoor schools and education and training establishments,
there must be at least 1.65 m per pupil in classrooms,
at least 2 m per pupil in vocational rooms, laboratories and computer rooms, language rooms and written and electronic communication rooms. In classrooms Primary school work activities must have at least 4 m per pupil. In school implementing an educational programme for pupils with special educational needs, the area per pupil in theoretical classrooms shall be at least 2.3 m2.

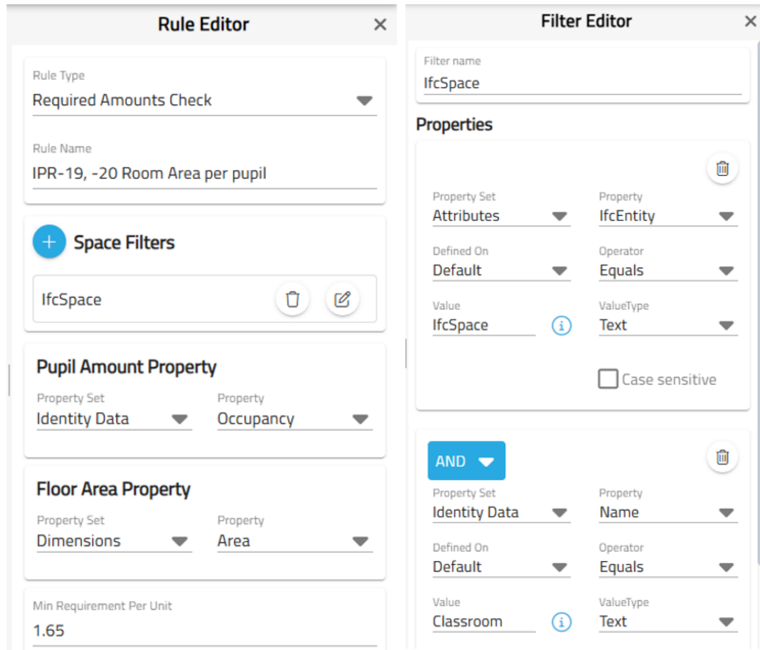


Figure 36: Required Amount Check, parametrized for Classroom occupancy according to PBR

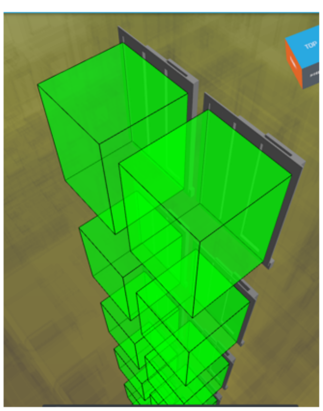
5.3.6 Lift Entry Clearance

Verifi3D's existing "Free Space Check" could be used for checking the accessibility of elevator doors.

Czech Republic Decree

IPR-39-1
Decree No.398/2009 Annex 1, item 3.1.1

The clear area in front of the entry points to the lifts must be at least 1500 mm x 1500 mm.



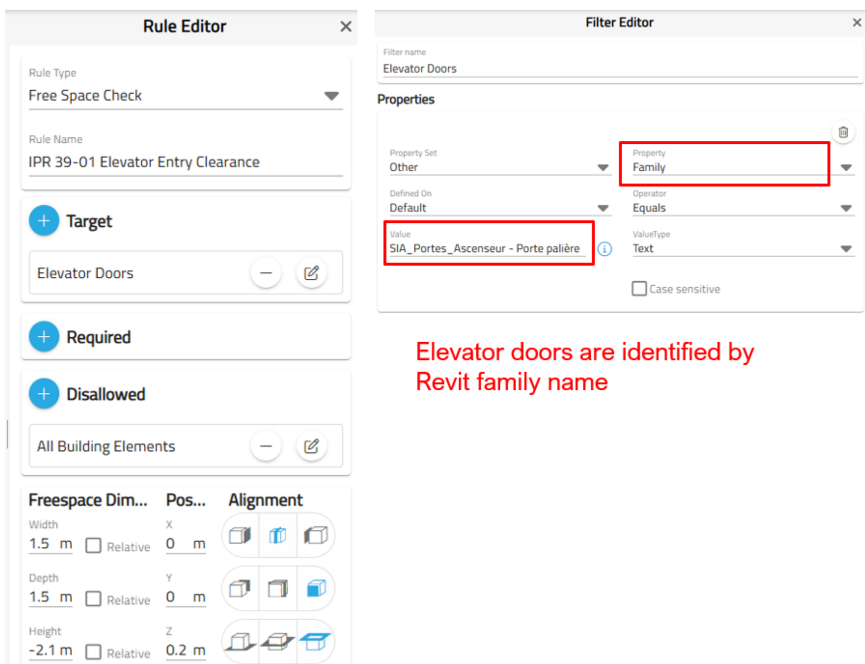


Figure 37: Free Space Check, parameterized according to PBR's accessibility requirements for elevator doors

6. Conclusions

This deliverable, focused on the development of checking software based on IFC, presents significant advancements in the digitalisation of the building permit process, aligning with the broader goals of the CHEK project. The desktop-based and web-based tools introduced in this deliverable, CYPEURBAN, CYPE Accessibility, and Verify 3D, were specifically developed to support urbanism and accessibility validation, ensuring that municipalities, designers, and other stakeholders can work within a well-organized and efficient framework for digital project validation and approval.

One of the key achievements is the successful integration of CYPEURBAN, a desktop-based tool that enhances urban planning compliance. This software allows users to import and validate IFC models against local zoning and land-use regulations, offering municipalities and designers the ability to automate and streamline their compliance processes. The functionalities developed for the CHEK project contribute to improving workflow efficiency, ensuring projects align with local regulations, and accelerating project approvals.

The integration of CYPE Accessibility into the DBP platform has been a crucial advancement in ensuring that accessibility regulations are embedded into the building permit process from the outset. This tool enables both municipalities and designers to evaluate project designs against established accessibility standards, ensuring that the built environment is inclusive and accessible to all individuals, including those with disabilities. The CYPE Accessibility tool simplifies the process of performing compliance checks by allowing users to assess key accessibility elements, such as entrances, pathways, and accessible facilities, directly within the 3D BIM model. It also provides real-time feedback and validation, helping to identify and resolve potential issues early in the design phase.

For Verifi3D, the integration of BIMserver.center amongst its list of platform integrations allows for seamless choice between (Pre-)checking workflows that involve the DBP platform or other platforms that already mandatory due to the construction projects' BIM execution plan.

This deliverable presents significant advancements in the digitalisation of the building permit process through the development and integration of desktop-based and web-based tools aligned with the goals of the CHEK project. Specifically, the tools CYPEURBAN**,** CYPE Accessibility, (merge in CYPE Architecture) and Verify3D have been designed to support regulatory validation in the fields of urbanism and accessibility, providing municipalities, designers, and stakeholders with a unified, efficient, and transparent framework for project evaluation and approval.

One of the key outcomes is the improvement of CYPEURBAN, a desktop-based tool that allows users to import and validate IFC models against local zoning and land-use regulations. Enhanced with new functionalities developed within the CHEK project—including contextual checks using GIS data, predefined regulation libraries for municipalities like Vila Nova de Gaia and Lisbon, and interaction with BIMserver.center—CYPEURBAN significantly improves workflow efficiency and facilitates automated compliance verification: CYPEURBAN – CYPE Software. CYPE Accessibility contributes to embedding accessibility considerations directly into the design and permitting process. The tool enables the evaluation of accessibility elements—such as circulation routes, ramps, lifts, and bathrooms—by validating IFC models against national and regional standards. CYPE Accessibility – CYPE Software

Both tools have been successfully embedded **into** CYPE Architecture, CYPE's free BIM modelling environment, which now supports real-time regulatory checks within the design workflow. This integration not only streamlines compliance management but also decentralizes the creation and maintenance of regulations, giving municipalities the autonomy to manage their own rule sets: [CYPE Architecture – CYPE Software]

Verifi3D's has been successfully integrated with new generic Rule Types that can be used for a variety of checks, including building regulations. For the municipality of Prague, a Rule Set is available that allows for fully automated checking, partially replacing complex 2D calculations with three-dimensional, BIM-based and fully automated checks.

By connecting these tools to the Digital Building Permit (DBP) platform via BIMserver.center, the CHEK project demonstrates how automation, open standards, and integrated workflows can radically improve the building permit process. The use of IFC-based models ensures interoperability and data consistency, while the DBP platform provides a collaborative digital environment for exchanging compliance results between designers and municipal authorities.

7. References

7.1 List of Figures

7.2 List of used abbreviations

API	-	Application Programming Interface
BIM	-	Building Information Modelling
D	-	Deliverable
DBP	-	Digital Building Permit
EU	-	European Union
GIS	-	Geographic Information System
T	-	Task
WP	-	Work Package