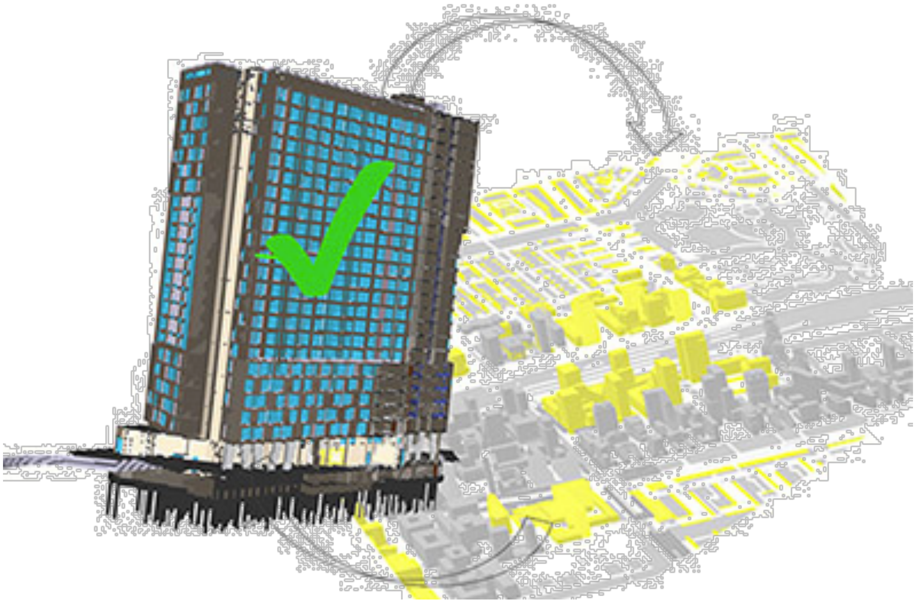
Investigating the Automation of the Building Permission Issuing process through 3D GeoBIM information



Deliverable 1

Report about background and initial analysis to support the development of a tool automating the process of regulations checks in building permission issuing.

Version 2

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1. Introduction

This document is the first outcome of the project “Investigating the Automation of the Building Permission Issuing process through 3D GeoBIM information”, begun on December 2019.

Some context to the project is given in the initial sections, where the concept of “GeoBIM” (integration of geoinformation with Building Information Models) is defined, together with the related challenges. Part of this is the description of the open standard data models which will be considered for the integration, namely, the Industry Foundation Classes (by buildingSMART) for Building Information Models (BIM) and CityGML for 3D city models. Additionally, CityJSON is introduced as an alternative implementation of CityGML, which will be probably considered in the later implementations, since it was recently released but tools are being developed using it and it could be an easier way to use the 3D city information effectively.

After this general part, the scope of the project is presented, as follow-up of a previous collaboration within the EuroSDR GeoBIM project: the use of GeoBIM information for the building permission issuing use case was initially explored and a workflow was proposed for this.

In the second part of the document, more details are given about the on-going work for this project.

Since it is a challenging topic, we began the development of a methodology starting from a specific case study, described in section 8.

For this case study, two regulations were considered, one dealing with building dimensions and the other one regarding parking places.

These two regulations were analysed, with the support by expert Municipality officers, within two workshops specifically organised.

The result of this analysis was a first attempt of formalization for such regulations, and a consequent mapping of the information needed to check them to the CityGML and IFC data models (Sections 10-13).

In the following part of the work, this formalization will be used to implement a tool making the checks automatically.

2. A premise on GeoBIM

Many applications dealing with urban analyses and management can be supported effectively by 3D information systems.

Such 3D information systems are mainly:

- 3D city models, stemming from the geospatial domain, which are used to represent city objects and succeed maps and other cartographic products in order to support city analysis and management, city planning, navigation, and so on.
- Building information models (BIM), from the architectural engineering and construction domain, which assist the building (and infrastructure, and any other construction) design and construction, and which also have features useful to project management and asset management.

Some examples of use cases effectively supported by 3D city models are energy estimations at city level, air flows studies and microclimate simulations, pollution study, shadow analysis, bomb detonation simulation, noise modelling. BIM supports 3D building design, quantities and cost estimations, energy modeling, installations design, and so on. Thorough overviews can be found in Biljecki et al. (2015), McGlinn et al. (2016), and Wu et al. (2018).

Both domains have strong potential to capture valuable data about the built environment. However, the data in both domains have different characteristics, such as the kind of geometry which is used (mainly solid parametric objects in BIM and boundary representation of surfaces in 3D city models), the semantics used to structure their entities (e.g. specific materials for BIM and uses for 3D city models), and the need to georeference the models (essential in 3D city models and seldom carried out for BIM) (Noardo et al., 2019b).

The same characteristics are reflected in the respective open standards, which are used to archive their information in interoperable and open formats to represent and exchange, respectively, 3D city models and BIM models: CityGML by the Open Geospatial Consortium (OGC, 2012) (Section 3) and the Industry Foundation Classes (IFC) by buildingSMART (Section 5) are well-known standards used in most cases.

The topic 'GeoBIM' means multiple concepts, which have to be all addressed to reach an actual integration. First of all, the integration of the data (as produced) must be addressed, intended as the achievement of harmonizable and explicit characteristics, so that they can actually fit together once that more technical integration are performed. Secondly, the data must have an interoperable format, towards which the definition and use of open standard is a first step. However, it is still necessary to work for the standardized data to be suitably supported by software and correctly coded and exchanged. A third challenge is the definition of suitable procedures able to make completely consistent conversions between the two kinds of data. A study funded by the International Society for Photogrammetry and Remote Sensing (ISPRS) and the European association for Spatial Data Research (EuroSDR), the GeoBIM benchmark 2019 (https://3d.bk.tudelft.nl/projects/geobim-benchmark/) addressed those last two issues. Finally, it is also necessary to integrate and harmonize the involved procedures implied in BIM and GIS-related tools and methods, for them to be used in seamless workflows (Noardo, 2019).

The study of the building permission issuing use case was chosen as a starting point for tackling all these aspects coherently in order to reach the integration effectively.

3. CityGML

CityGML (by Open Geospatial Consortium, 2012) is the most prominent standard to store and exchange 3D city models with semantics in the GIS domain. It presents a structured way to describe the geometry and semantics of city objects. CityGML as a data format is implemented as an application schema for the Geography Markup Language (GML) (CityGML uses version 3.1.1 of GML) (OGC, 2004).

CityGML 2.0 (current version) contains classes structured into 12 modules, each of them extending the core module, containing the most general classes in the data model, with city object-specific classifications (e.g. Building, Bridge, WaterBody, CityFurniture, LandUse, Relief, Transportation, Tunnel, Vegetation) (Figure 1). These classes differ in the way objects are structured into smaller parts and the attributes that are expected for each. Probably the most developed and used module in data is the Building module (Figure 2). CityGML supports the possibility to further extend the schema through a standardized Application Domain Extension (ADE) system. Some existing official ADEs, which could be useful for future developments of this project, are, for example, the Noise ADE, the Energy ADE, the Utility network ADE.

CityGML geometries are essentially the same for all classes: objects are represented as boundary surfaces embedded in 3D and consist of triangular and polygonal faces.

For more information about CityGML visit citygmlwiki.org.

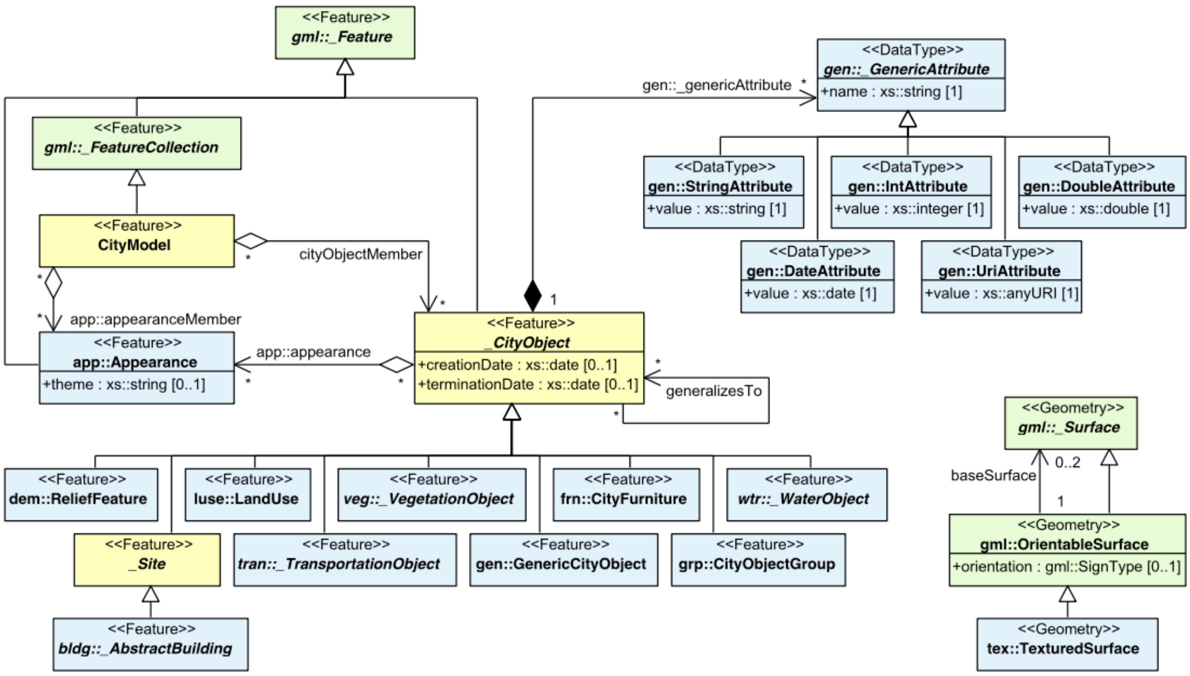

Figure 1. CityGML's top level class hierarchy. Prefixes are used to indicate XML namespaces associated with model elements. Element names without a prefix are defined within the CityGML Core module.

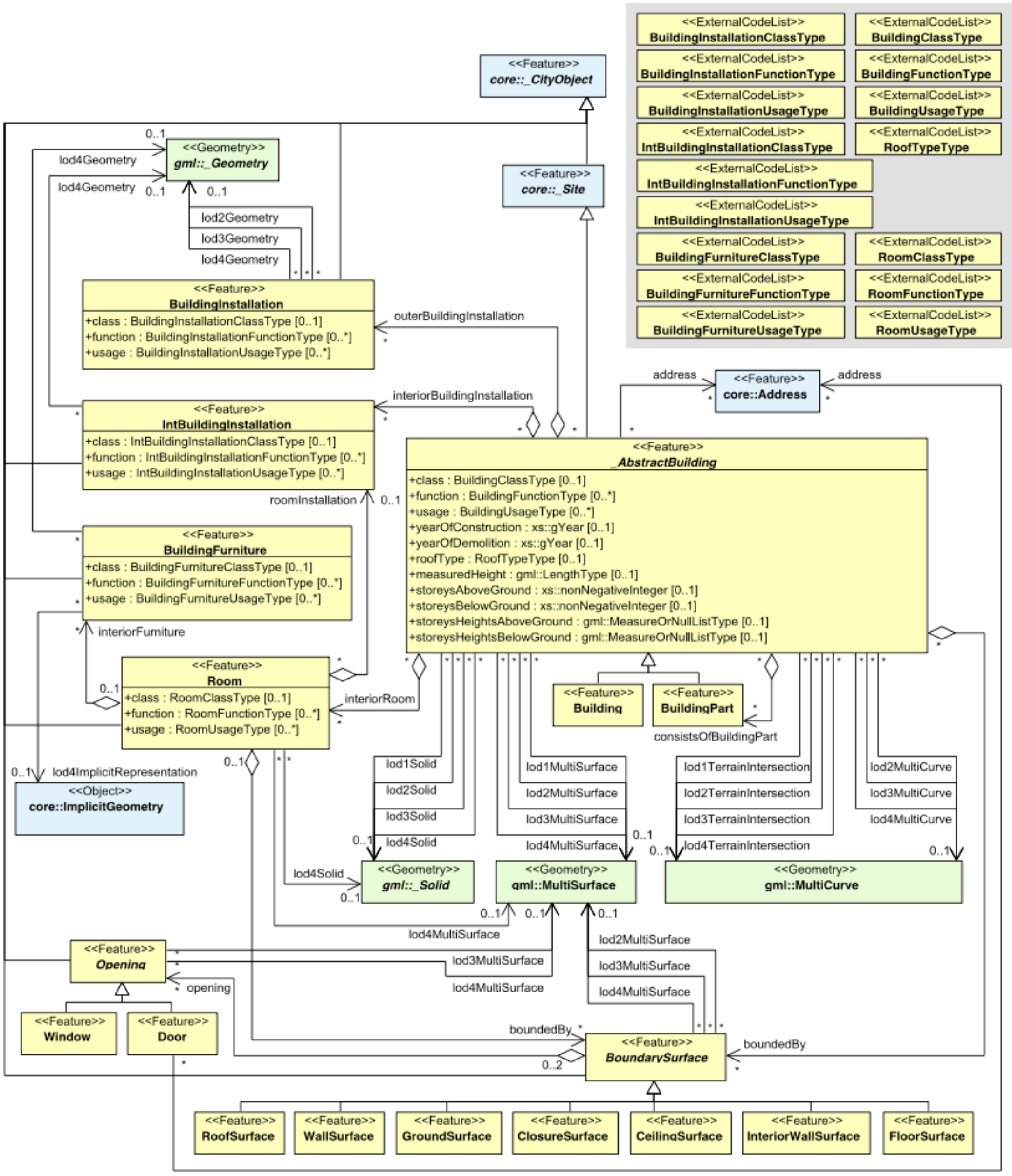

Figure 2. UML diagram of CityGML's building model. Prefixes are used to indicate XML namespaces associated with model elements. Element names without a prefix are defined within the CityGML Building module.

4. CityJSON

CityJSON (version 1.0.0) was recently presented by Ledoux et al. (2019) as an alternative, JSON, encoding for the CityGML 2.0.0 data model.

JSON is, like GML, a text-based data exchange format that can be read both by humans and machines. JSON was chosen as an alternative encoding to GML for several reasons:

- it's an easier and widely used format to exchange data via web;
- it is predominantly favoured by developers;
- it is based on two data structures that are available in virtually every programming language and it is therefore possible to structure a file in the way that a developer would build and index in memory the objects (developers then do not need to use external libraries, all features and geometries are already indexed, and ready to use).

CityJSON follows the philosophy of another (non-standardised) encoding of CityGML: 3DCityDB (Yao et al., 2018). That is, to be stored efficiently and allow practitioners to access features and their geometries easily, the deep hierarchies of the CityGML data model are removed and replaced by a simpler representation. Furthermore, there is one and only one way to represent the semantics and the geometries of a given feature, and some more additional restrictions are applied.

At the moment CityJSON is not an official standard, but there is already a wide consensus around it, by users which are choosing it as alternative to CityGML and a few tools already developed to effectively work with it.

Anyway, the conceptual model which is in that way implemented is still the CityGML v.2.0 one. Therefore, in this document a specific CityJSON model is not considered. However, for the reasons previously explained, it's likely it will be used in the implementation of this project too, at least as an alternative to plain CityGML.

More information at https://www.cityjson.org

5. Industry Foundation Classes

The buildingSMART Industry Foundation Classes (IFC)[1] standard (ISO16739:2013) is an open standard data model for Building Information Modelling (BIM) to be shared and exchanged through soft- ware applications, domains and use cases, within the Architecture Engineering and Construction (AEC) and Facility Management (FM) fields. It includes classes for describing both physical and abstract concepts (e.g. cost, schedule, etc.) concerning AEC-FM for buildings, mainly (recent versions are extending it for including infrastructures and other kinds of constructions[2]). It has also been adapted as the ISO 16739 international standard (ISO, 2013).

It can be seen as an inclusive model covering the description and representation of all the possible information and concepts related to buildings' components and processes for AEC- FM, for all related use cases.

The terms which can be used in IFC, are defined within the International Framework for Dictionaries (IFD), also called Data Dictionary in the recent resources by buildingSMART[3]. It is based on the standard ISO 12006-3. Such definitions are also reported in the 'description' field' in the IFC specification[4].

The third part of the standards is the Information Delivery Manual (IDM), which is supposed to define the workflow and the information exchange specifications and requirements in the processes involved in the construction life cycle. From each IDM, a Model View Definition (MVD) can be defined for identifying the portion of the IFC model which is needed for the procedure described in the IDM to be fulfilled. This can define a use-case oriented part of the wide IFC model, to be implemented in software.

MVDs can be as broad as nearly the entire schema (e.g. for archiving a project) or as specific as a couple object types and associated data (e.g. for pricing a curtain wall system). The documentation of an MVD allows the exchange to be repeated, providing consistency and predictability across a variety of projects and software platforms[5]. The mechanism is somehow the opposite of CityGML ADEs.

The concepts represented in the IFC (version 4.1, which is the most recent official one) are organized in four conceptual layers, as represented in (Figure 3).

The **core layer** contains the classes which are central and most general in the data model. In particular, the Kernel contains the root classes for the definition of objects, relationships and properties and their relationships (e.g. IfcRoot, superclass of all the other entities; IfcRelationship, superclass of all relationships; IfcObject, which is the parent entity of IfcGroup, IfcActor, IfcResource, IfcControl, IfcProcess, IfcProject and IfcProduct, being specified in the further extensions of the model). In the core layer there are also the three main extensions representing the foreseen possible representations by IFC:

1. The Control Extension schema declares basic classes for control objects (IfcControl, IfcPerformanceHistory) and assignment of these (IfcRelAssignsToControl) to any object derived from IfcObjectDefinition;
2. The IfcProcessExtension schema represents information regarding the processes and the planning and scheduling of work and the procedures and resources required to carry out work;
3. The IfcProductExtension, which is probably the most interesting one for our aims, further specialises the concepts of a (physical) product (IfcProduct and IfcTypeProduct), i.e. a component likely to have a shape and a placement within the project context.

[1] https://technical.buildingsmart.org/standards/ifc/
[2] https://technical.buildingsmart.org/standards/ifc/ifc-schema-specifications/.
[3] http://bsdd.buildingsmart.org
[4] e.g. https://standards.buildingsmart.org/IFC/RELEASE/IFC4_1/FINAL/HTML/schema/ifcmaterialresource/pset/pset_materialwood.htm
[5] https://technical.buildingsmart.org/standards/mvd/

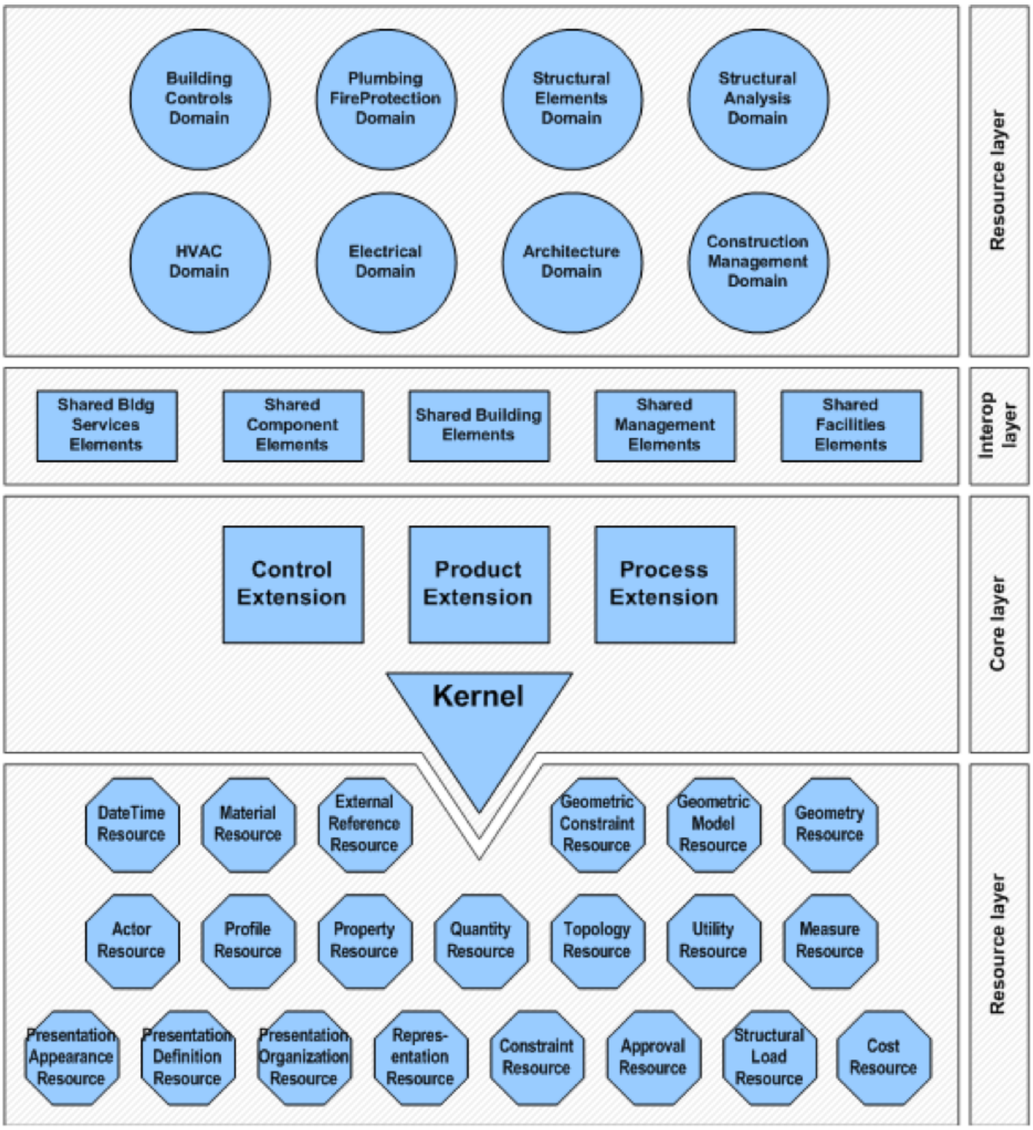

Figure 1 — Data schema architecture with conceptual layers

Figure 3. The four layers in which the Industry Foundation Classes are organised. Source: IFC4.1 specification

The **product extension** specifies IfcProduct with, for example, the following classes: IfcElement; IfcSpatialElement, superclass of IfcSpatialStructureElement (superclass of IfcSite, IfcBuilding, IfcBuildingStorey, IfcSpace, which are related each other through an aggregation relationship); IfcPositioningElement; ifcPort; IfcProxy; IfcSystem (to represent an 'organized combination of related parts within an AEC product, composed for a common purpose or function or to provide a service'); IfcZone (subclass of IfcSystems grouping spaces, partial spaces or other zones).

The **interoperability layer** includes classes specializing the classes defined in the IfcProductExtension schema, increasing the level of detail of the represented information. The included entities can be of interest of multiple domains.

Some even more specific information can be represented through the **domain specific** part of the schema, which can specify either classes represented in the interoperability layer or in the product extension directly (IfcArchitectureDomain, IfcBuildingControlsDomain, IfcConstructionMgmtDomain, IfcElectricalDomain, IfcHvacDomain, IfcPlumbingFireProtectionDomain, IfcStructuralAnalysisDomain, IfcStructuralElementsDomain).

The **resource layer** defines entities to further describe the objects defined in the other levels. Unlike entities in other layers, resource definition data structures cannot exist independently, but they can only exist if referenced (directly or indirectly) by one or more entities deriving from IfcRoot.

Properly **georeferencing** an IFC file makes it possible to link the (local) coordinates inside an IFC model with their corresponding real-world coordinates, and thus to place the model of a single building or construction within the virtual environment. However, it is important to say that most IFC models are not georeferenced properly (or at all), which is a major issue in practice.

In order to georeference an IFC file, it is possible to use the IFC entity IfcSite, which defines an area where construction works are undertaken, and option- ally allows for storage of the real-world location of a project using the *RefLat- itude*, *RefLongitude* and *RefElevation* attributes. The latitude and longitude are defined as angles with degrees, minutes, seconds, and optionally millionths of seconds with respect to the world geodetic system WGS84 (EPSG:4326). Posi- tive values represent locations north of the equator, west of the geodetic zero meridian (nominally the Greenwich prime meridian) in IFC2x3, or east of the zero meridian IFC4. Negative values represent locations south of the equator, east of the zero meridian in IFC2x3, or west of the zero meridian in IFC4. All the components of these angles (ie degrees, minutes, seconds and millionth-seconds of arc) should have the same sign. According to the IFC standard, the geographic reference given might be the exact location of the origin of the local placement of the IfcSite or it might be an approximate position for informa- tional purposes only. The elevation is defined according to the datum elevation relative to sea level.

The IFC entity IfcGeometricRepresentationContext is used to define the co- ordinate space of an IFC model in 3D and optionally the 2D plan of such a model. This entity can be used to offset the project coordinate system from the global point of origin using the *WorldCoordinateSystem* attribute, it defines the *Precision* under which two given points are still assumed to be identical, and it defines the direction of the *TrueNorth* relative to the underlying coordinate system. The latter attribute defaults to the positive direction of the y-axis of the *WorldCoordinateSystem*.

The **geometries** in them can use several different representation paradigms which can be combined freely. In practice, most IFC objects are built using sweep volumes, explicit faceted surface models and CSG (El-Mekawy, Östman, 2010).

Its geometric aspects are mostly defined or derived from a different standard, the ISO 10303 (ISO, 2014), which also specifies the STEP Physical File (SPF) encoding that is most commonly used in IFC files (.ifc).

6. A note on standards versions

For the project, it is possible to consider more than one version of the involved standards CityGML and IFC. Those standards, as similar others, are the result of an evolution of their definition through the time.

First version of CityGML (v.1.0) was in 2008. Version 2.0, the current one, became official in 2012. Version 3.0 is announced but not yet released.

The IFC data structure has a longer history (starting from 1997), but we can just consider the version 2x3, which was released in 2005, with some technical improvement in the 2007. It is one of the versions official at present. The other official version is the 4.1, from 2018. A version 4.2 is candidate standard at the moment.

In the project the information is mapped to the two official models: CityGML v.2 and IFC 4.1 (with notice of eventual discrepancies to the 2x3 version).

However, it is necessary to consider also the available data employing those schemas. In fact, the information in the data that will be actually produced and used as input for the tool is to be considered as the priority for the tool to work properly.

From an initial review of sample models as produced in practice we could find that the most used version of CityGML is the 2.0, while for representing the BIMs, IFC 2x3 is used. It is therefore important to refer to these ones in the implementation, at least in an initial phase.

7. This project background and previous work

7.1. Rotterdam Digital city

Rotterdam "Digital city" pilot represents the effort of the Rotterdam Municipality to transpose procedures to a digital integrated environment, able to help the optimization of resources and improve the efficiency of management, through integrated information, city monitoring and automatic processes.

A part of this is the automation of the building permission process, within which this project was conceived

7.2. International digital efforts

Similar attempts are being developed in many other Countries, in Europe (Noardo et al., 2019c) and in the World (e.g. Singapore). To push even further this interest, the European Directive 2014/24/EU was published, strongly encouraging the use of BIM for public projects. The result of this is that in many countries from 2018 a process began towards the mandatory adoption of BIM at least for public buildings, generally to be fulfilled by 2022.

7.3. The EuroSDR project

The counterpart constituting the background of this project was the EuroSDR GeoBIM project[6], within which the TUDelft 3D geoinformation group began the investigation of the building permission use case, with Rotterdam as a case study.

The aim of the EuroSDR GeoBIM project was the development of a coherent approach to the integration of geoinformation with Building Information Models (BIM) (GeoBIM) with consensus between multiple stakeholders from both the geoinformation and the BIM sides, working at an international level. This project was sponsored by EuroSDR (European Spatial Data Research), the research association of European National Mapping and Cadastral Agencies (NMCAs) and the involved partners: NMCAs from 12 European countries and five academic institutions (full list of participants in the website).

After a preliminary investigation of the state of implementation of GeoBIM integration in the participating Countries, the project focused on the development of specific solutions utilizing GeoBIM information by means of two use cases (identified during the first phase as key opportunities): issuing building permits (premise to this project with the Rotterdam Municipality) and assets and facilities management.

7.4. GeoBIM for building permission issuing use case

In the case of the building permit process, there are several advantages given by a GeoBIM approach compared to the current situation, which, in most countries today, is based on 2D cross-section drawings (of the building) and a 2–2.5D situation plan (showing where the building is situated on a municipal map). For example, several building regulations could benefit from a GeoBIM approach for enabling automation. In a Swedish case study (Olsson *et al*. 2018), it was shown that it was possible to check e.g. the building heights (which in Swedish regulation includes roof forms, main viewing direction, etc.) using a GeoBIM approach. Also, visual building regulations such that a new building should maintain the character of a built-up area would benefit of a GeoBIM approach (Noardo et al., 2019a).

Furthermore, the objectivity and time-effectiveness in the interpretation of regulations, by both the designer and the Municipality offices in charge of issuing building permits, would increase, with clear advantages for both parties. The GeoBIM approach allows the effective use and reuse of the data. In the current situation:

1) building designers design the building in BIM;
2) they export the needed 2D data for building permission (with obvious loss of data from such a rich and powerful tool as BIM);

[6] https://3d.bk.tudelft.nl/projects/eurosdr-geobim/

3) locate some of the 2D drawings in the city map to show the context, without a defined methodology and with consequent possible errors and blunders in the location;

4) the Municipality office checks the regulations compliance through a partial view of the project: the 2D representations aided by a report submitted by the applicant about dimensions, technical details, and so on;

5) after the building is approved and built, the existing BIM is not used again (and potentially lost) and the city model needs to be updated through new surveying, modelling and checking phases.

Instead, by using GeoBIM, the rich information produced by design (1) and correctly georeferenced into the 3D city model through a tested methodology (3) can be effectively and objectively used in its completeness by the Municipality (4) and the same, checked, data can converge into the 3D city model to update it (5). One only building model would therefore be used in a complete workflow, together with the 3D city model, instead of many disconnected (or little connected) different data, which would be lost after the end of the process with the additional benefit of fewer inconsistencies.

Given the above opportunities, three core questions were identified in relation to the development of the permits/planning use case:

1. *What workflow should be followed for effectively using GeoBIM information for a Building Permission use case?* A more complex workflow than the one currently followed is needed, including conversions through different data formats (at least CityGML and IFC should be considered) and automatic tools.
2. *What are the regulations that can be (semi)automatically checked by a GeoBIM approach?* A set of constraints that are common across the participating countries, and can be used to highlight the potential of GeoBIM in planning, will be identified.
3. *What are the related requirements for, and availability of, data for this automation?*This question will address the technical integration aspects: what data are needed to exploit the potential of GeoBIM in a real-world case study? This will identify also the gaps between existing and required data (both BIM and geo).

In order to effectively address these research questions, we began the informal collaboration with the Rotterdam Municipality, as a case study, that brought to the initial outcomes described in sections 7.5 and 7.6 and to the definition of the framework for this project.

7.5. Initial outcome n.1: a workflow for the automatic building permission issuing use case using GeoBIM

Starting from the analysis of the workflows for building permission issuing in different Countries, including both the technical steps, describing the use of the data, and the procedural, bureaucratic steps to be followed, we defined a workflow, reviewed several times in different Municipalities (e.g. in Sweden, Amsterdam, besides Rotterdam, who participated actively in this) and by the EuroSDR project partners. A synthesis is shown in Figure 4, while Figure 5 represent the full workflow, which could be associated to the Sequence UML diagram describing also the involved stakeholders (Figure 6).

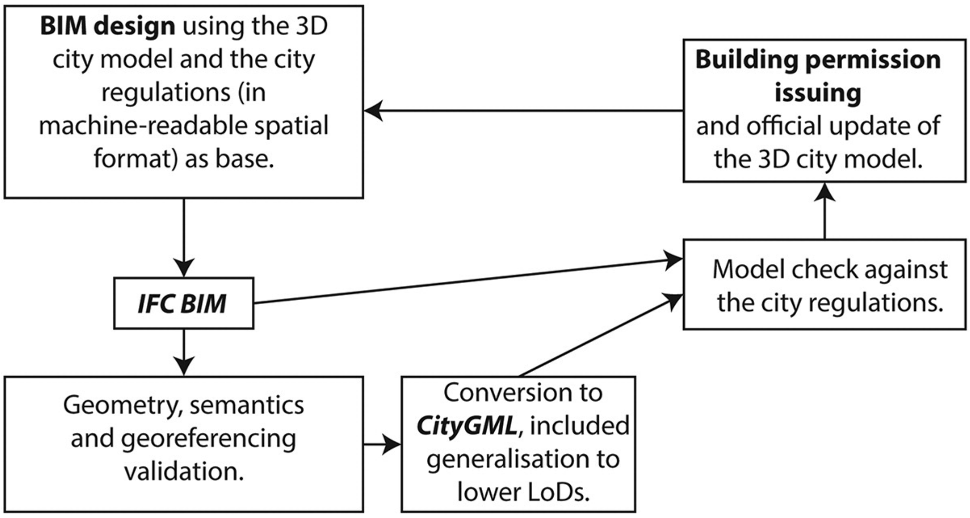

Figure 4. Synthetic representation of the technical workflow using GeoBIM information for planning permissions.

The following steps outline the proposed workflow (Noardo et al., 2019a):

1. read and use of 3D city model and the machine-readable regulations (e.g. cadastral parcels, existing built environment, context, vegetation, 3D high-level-of-detail existing building models as base for restoration or new intervention) to support and guide the design, analysing the existing environment, importing some data in the design software for immediate reference and preliminarily testing different design solutions in the building's context;
2. check of the validity of the designed BIM geometry, semantics and georeferencing (exported in IFC);
3. conversion of the BIM to an open standard (CityGML), generalisation to the lower levels of detail and integration of the information with further necessary attributes;
4. analysis of the integrated information for checking the selected city regulations (in the detailed development plan);
5. building permit issuing. The BIM will be finally stored in a connected repository linked to the new entity in the 3D city model, available for subsequent use;
6. if the new building project does not comply with regulations, or the design is changed, the BIM should be modified and the whole process needs to be repeated.

It is important to note that within this broad workflow, further refinements can be added to account for the need to check a vast range of requirements both in terms of planning constraints but also those defined by other fields of expertise involved (e.g. building physics experts, fire safety experts). This work will be partially developed as the scope of this current project.

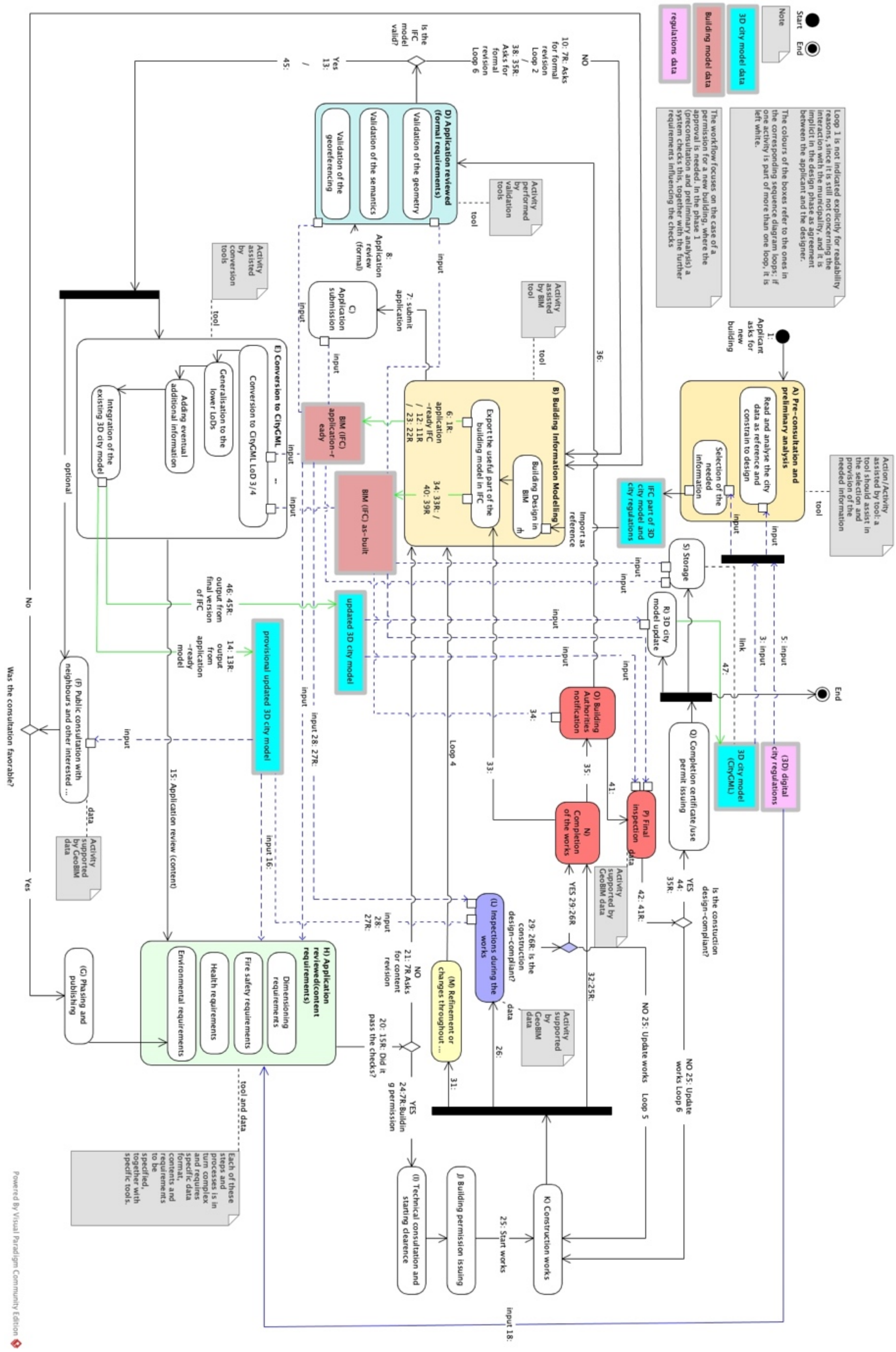

Figure 5. Complete activity model for the building permission workflow

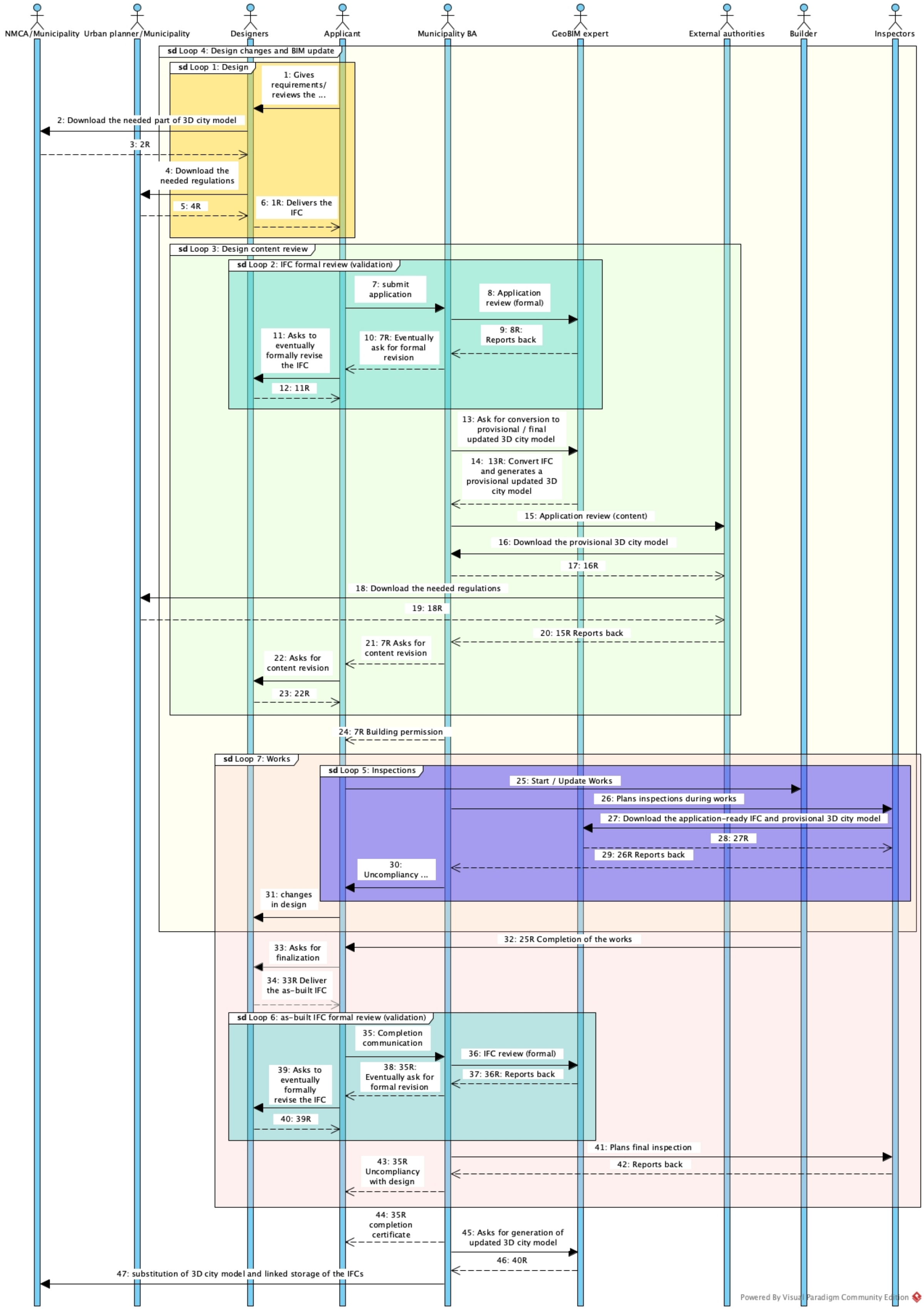

Figure 6. Complete sequence model for the building permission workflow.

7.6. Checking which regulations have the most advantage by GeoBIM

A second outcome from the collaboration between Rotterdam and TUDelft groups was a list of regulations that can be more effectively checked than in the current processes through a GeoBIM integrated approach (Table 1):

- Building dimensions and zoning;
- Parking places;
- Impact of the building on the environment and vice versa (shadows, noise, energy, traffic, pollution…);
- Advanced structural study (considering the water flows and the ground movements);
- Advanced safety route study (considering both interior and exterior routes and spaces).

Therefore, we started a specific project to formalize a selection of these and build a prototype that will show the possible automation. This report describes the first step of this project.

Table 1. Common checks in planning that will benefit from an integrated GeoBIM approach (from Noardo et al., 2019a).

Needed check	**3D Spatial aspects**	**Semantics aspects**	**GeoBIM-related advantages**
Zoning and dimensions:	Maximum height and distances from the other buildings, considering also overhanging objects (like balconies); volume; densification level (total building footprint area divided by real estate area)	Not all the building elements follow the same rules in their dimensioning requirements (e.g. heights of the ventilation pipes in restaurants in Amsterdam should rise 2 m higher than the surrounding buildings).	Heights limits in some cases are related to the surrounding buildings (e.g. again, the case of restaurants' chimneys in Amsterdam, but also cases in which the maximum height in buildings follow geometric rules also considering the view angle from the surrounding areas). A 3D GeoBIM approach would be able to consider overhanging objects (like balconies or other elements) which may not be visible in a 2D section of the building taken where no overhanging objects are visible; The automatic calculation of surface area and volume of the building would be more accurate than a manual one.
Parking availability and plans connected to the new buildings	parking spaces underground and in covered areas (which may be on different/multiple floors) should be considered	Different functions have different parking needs; different kinds of parking spaces are required in some cases (e.g. cars, bikes…).	In an integrated GeoBIM environment it is possible to consider the parking spaces in covered areas and specific buildings or building spaces both existing or designed, as well as those in the neighbourhood. This makes the calculation of the required number of new parking spaces according to the accurate automatic measurements of the new building (volume, surface area and so on) and the identification of these in the building and its surroundings
Impact of the building **on its environment and of the environment**	*The influence of the building in terms of shadows cast (determined from the 3D model)*;	The functions of specific spaces is important as a potential source of pollution	The integration of the designed building (including 3D shape, materials, specific functions and so on) with the 3D city context enables enhanced (with a richer information and a higher level of detail) analysis of the

on the building in higher detail: *shadows* analysis, and connected possibility to exploit (new or existing) *solar* energy systems; *noise* analysis; *air quality.*	for noise analysis the distribution of building spaces and elements is important (e.g. noise barriers and 3D distance from noise sources); for air quality the position of ventilation devices and open areas, and possible pollution barriers, are important.	(noise, air pollution) or area where such pollution should be minimised. Moreover, the kind of materials and surfaces (e.g. glass) can be relevant.	resulting city and the impact the proposed building will have. Shadows cast by the building on surrounding buildings (hence impacting their lighting and heating needs) and vice versa (permitting the prediction of the lighting and heating needs of the new building) can be determined at an early stage of design.

8. The case study

In consultation with Rotterdam, we selected the Terraced towers / Peak towers buildings as case study for this project. These buildings are planned in the Maritiem district[7] in Rotterdam (Figure 7-Figure 9).

The Maritiem District is an area in the centre of the city, on the river. The existing zoning plan, was drawn up in 2015 in the spirit of the coming environmental law[8], and it was already object of a previous experiment regarding a pilot for 3D, foreseeing the implementation of the environmental law, by the city of Rotterdam (https://arcg.is/1Cu0Te).

Figure 10 and Figure 12 show the area in the Ruimtelijkeplannen webGIS, mapping the zoning regulations for the Netherlands, with reference to the two considered regulations: building dimensions and parking regulation (see Section 9).

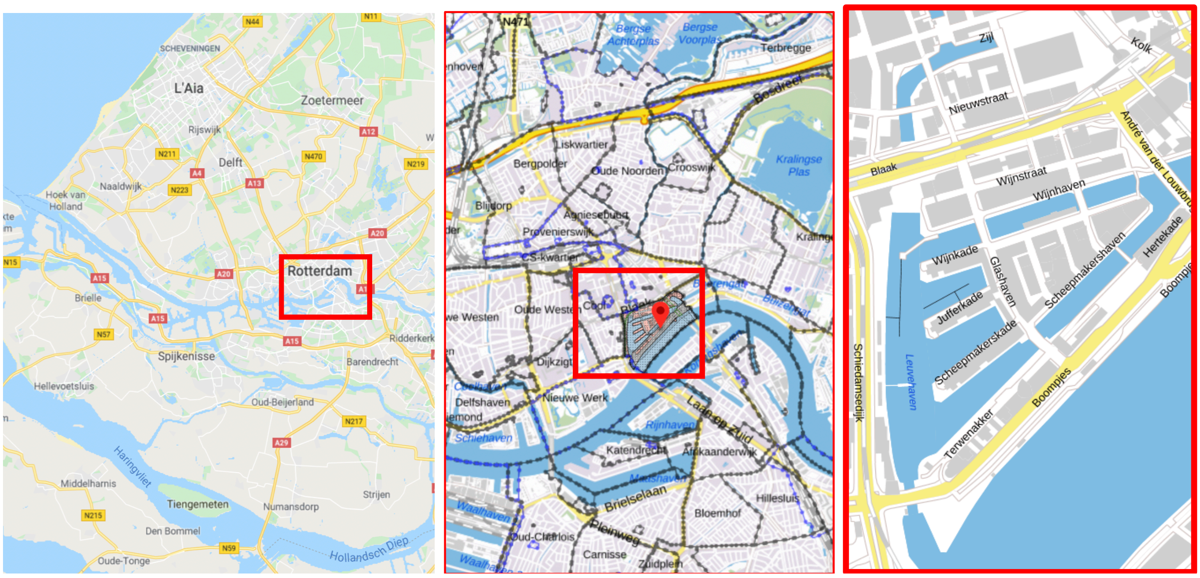

Figure 7. Map of the Maritiem district in Rotterdam.

Figure 8. Planned development of the Maritiem district, with the planned new buildings.

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[7] https://www.rotterdam.nl/wonen-leven/leuvepaviljoen/#gen_id_547-0.

[8] With the Environment Act the government wants to simplify and merge rules for spatial development. So that it will be easier, for example, to start construction projects. The Environment Act is expected to enter into force in 2021. (https://www.rijksoverheid.nl/onderwerpen/omgevingswet)

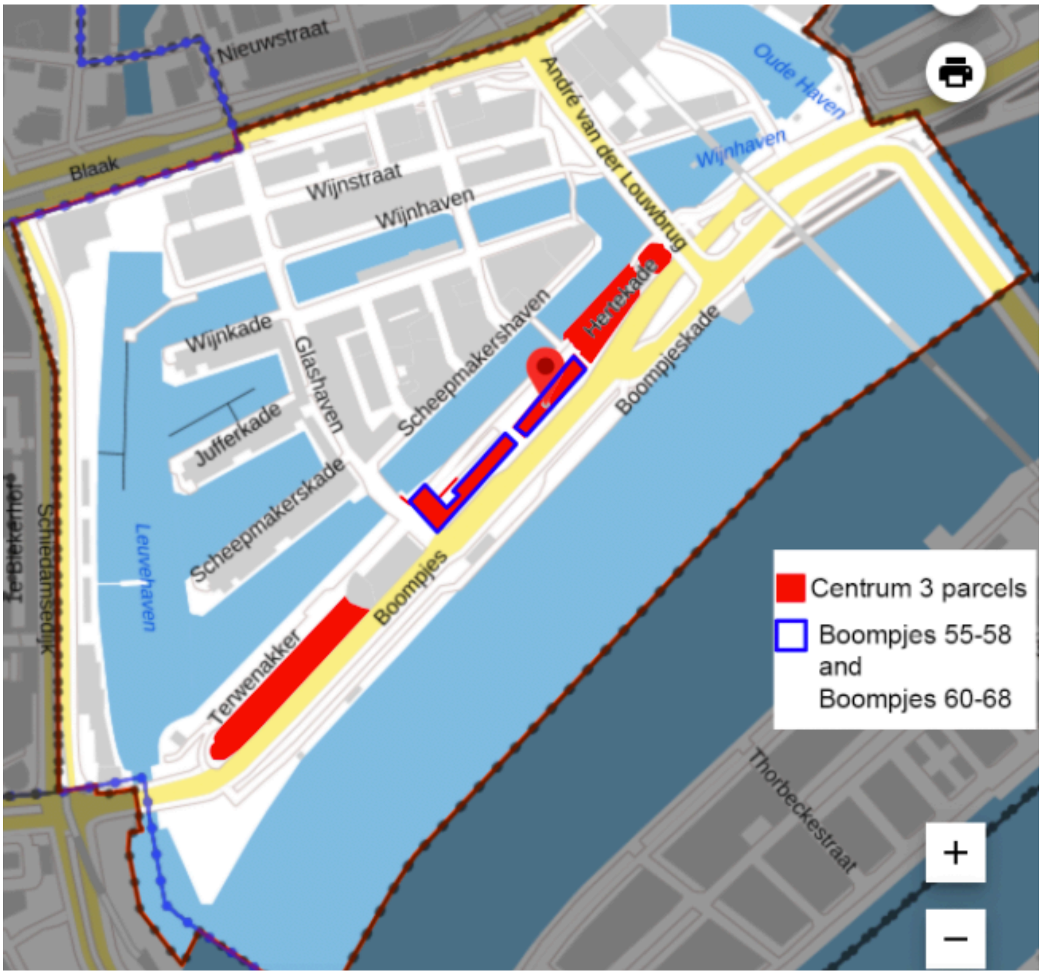


Figure 9. Map of the maritiem district, where the case study is located. In particular in is in the "Centrum 3" area, in red in the image, and at the addresses Boompjes 55-58 and 60-60, stroken in blue.

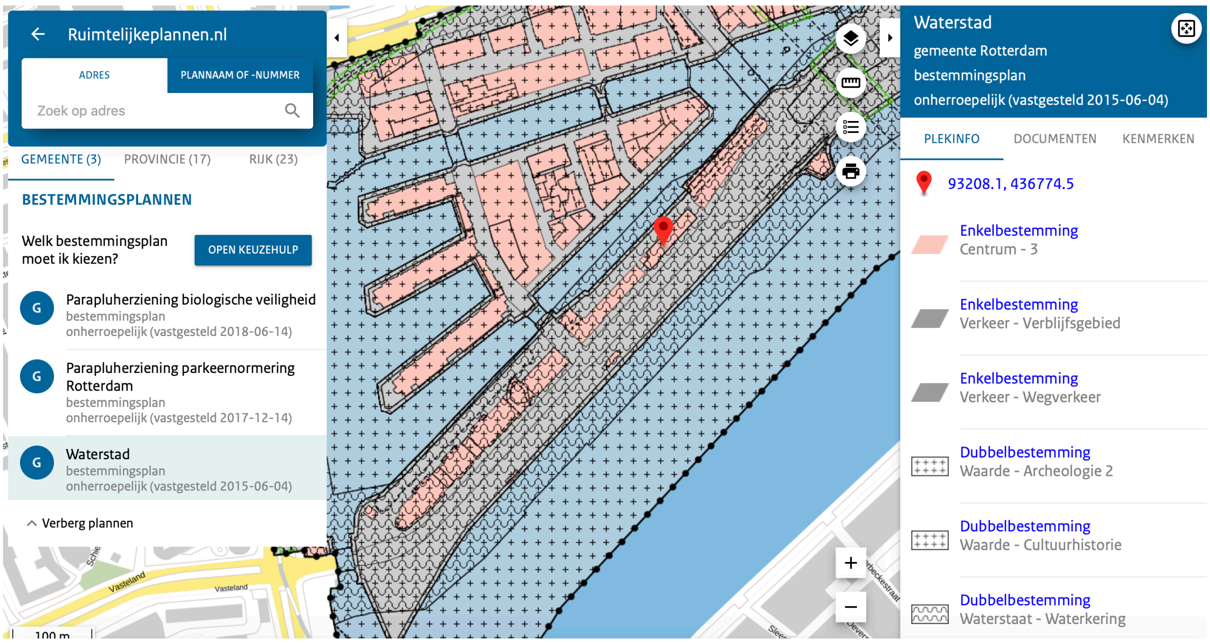


Figure 10. The case study site in the Ruimtelijkeplannen webgis, from which it is possible to access the data about urban regulations for each site in the Netherlands. On the right side, the Waterstad zoning legend is shown.

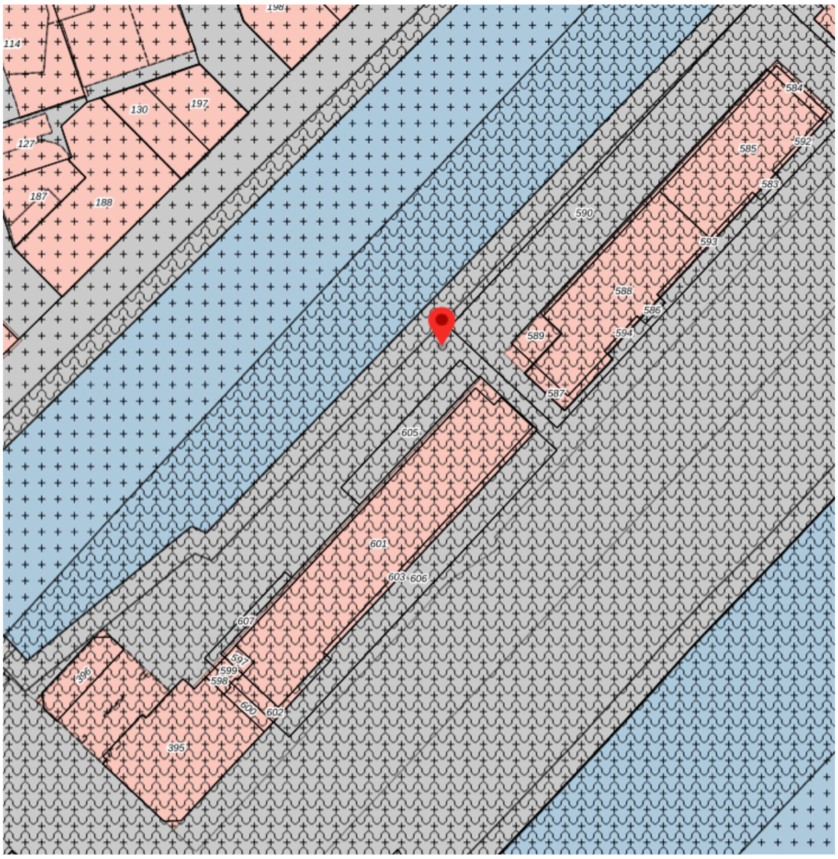


Figure 11. The two zoning 'Centrum-3' with the respective parcels.

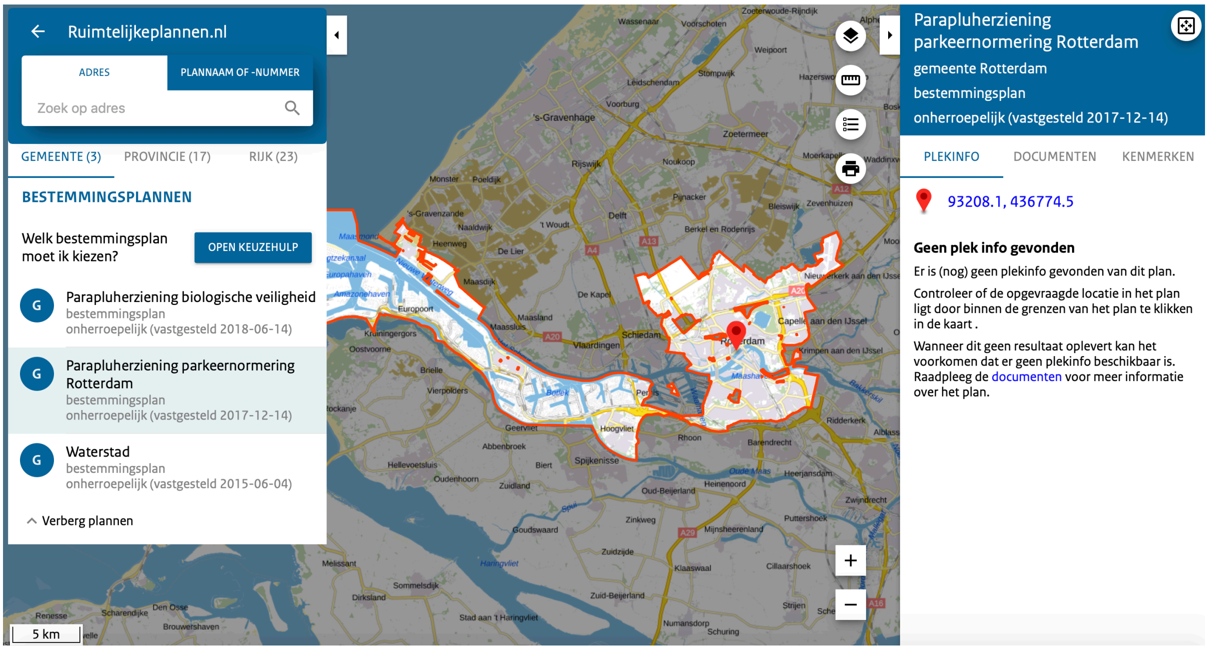


Figure 12. The area to which the case study site belongs, with respect to the parking regulation, viewed in the Ruimtelijkeplannen webgis.

9. The chosen regulations and the workshops with Rotterdam Municipality experts.

For this project it was decided to select two regulations needing little interaction from widely differentiated expertise fields, at least in an initial moment: building dimensions regulations and parking places calculations. Being these apparently simpler that other ones, we assessed the implementation task, in consultation with Municipality experts, as more feasible. Starting with this, it will be possible to tackle initial common problems and hopefully extend the work further in future.

An initial analysis showed that the (human) interpretation of these considered regulations is not straightforward. This is important in order to automate the regulation checking and to correctly apply them. To clarify the ambiguous aspects, the Municipality of Rotterdam (H. Tezerdi and R. Manbodh) organized two workshops with internal experts in building permission issuing.

The first workshop took place on the 16th October 2019, with the experts in the building main regulation (bouwbesluit). During this one, the details of the regulations were explained and agreed upon in order to support their translation in a more formal format, in preparation to the implementation of the automatic tool for checking regulations (Figure 13).

The second workshop was organized on the 5th November 2019 in order to involve the experts in related disciplines, which are part of the secondary checks for the building permission process (fire prevention, structural safety, etc.). Those aspects can all have a role in the definition of different criteria for dimensions. Therefore, they will be probably involved in the following part of this project, besides being considered for extending this work with further regulations (see pictures and results of the workshop in Figure 14 and Annex 6).

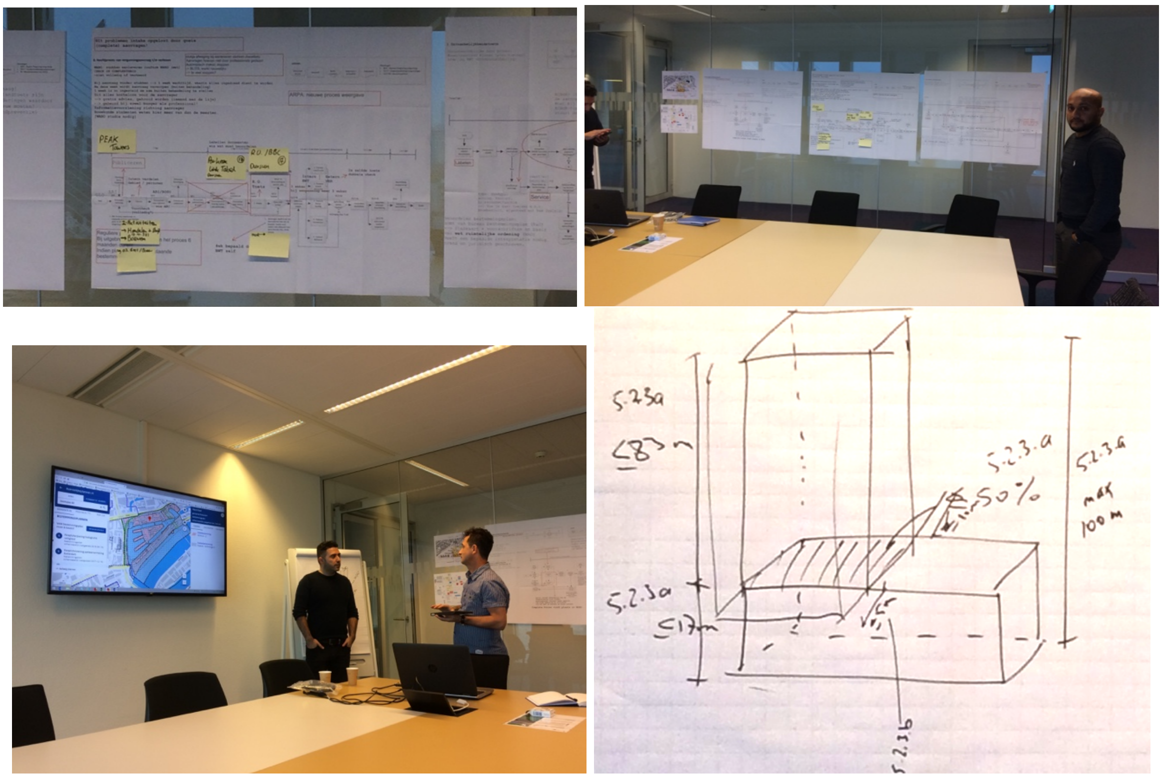


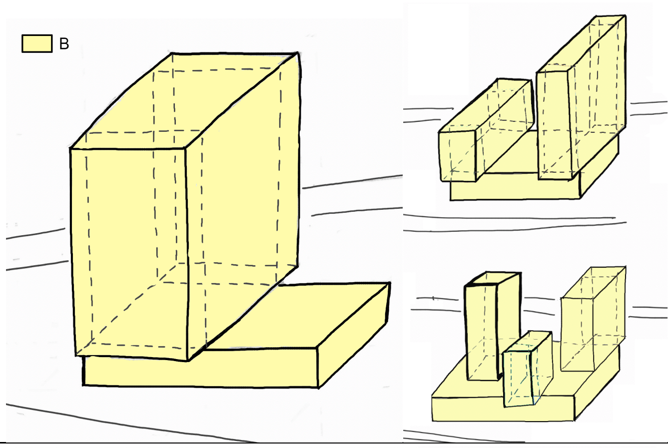
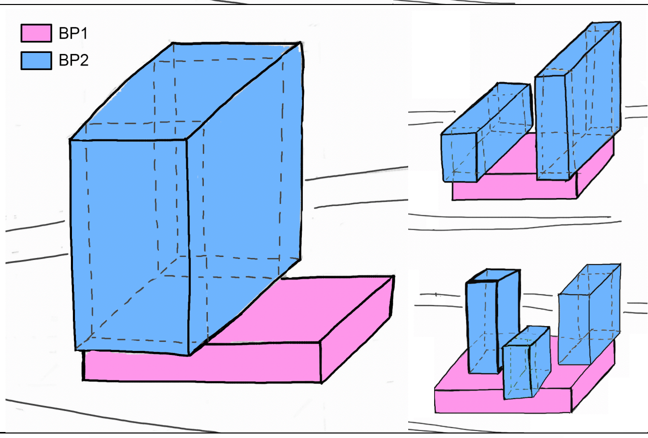
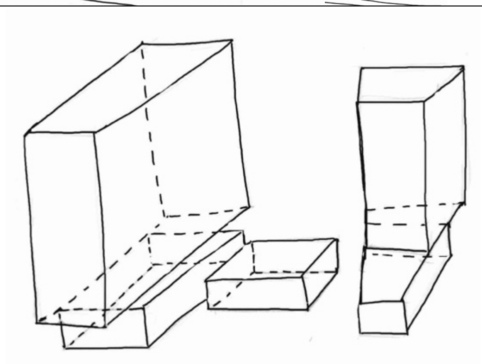
Figure 13. I Workshop 16/10/2019 – Building dimensions and parking spaces design in the city regulations

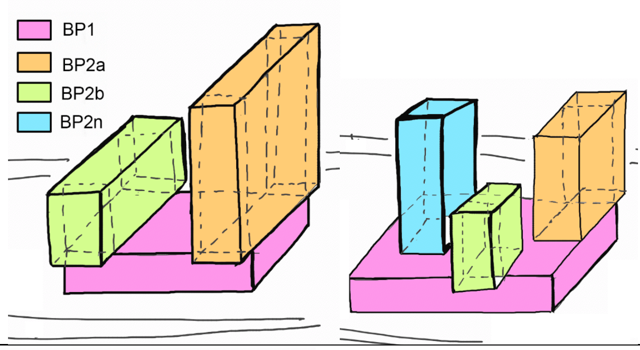
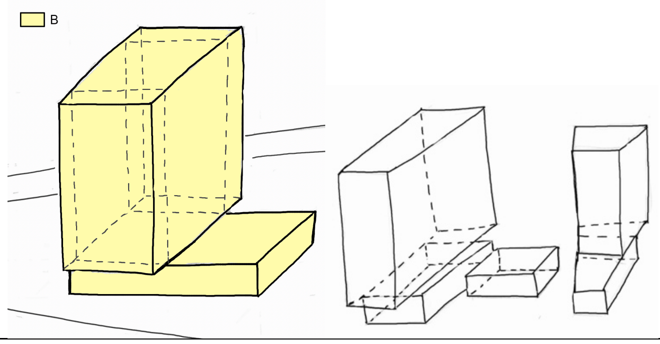
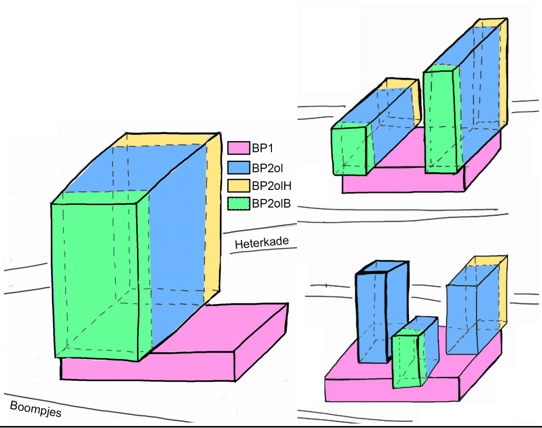
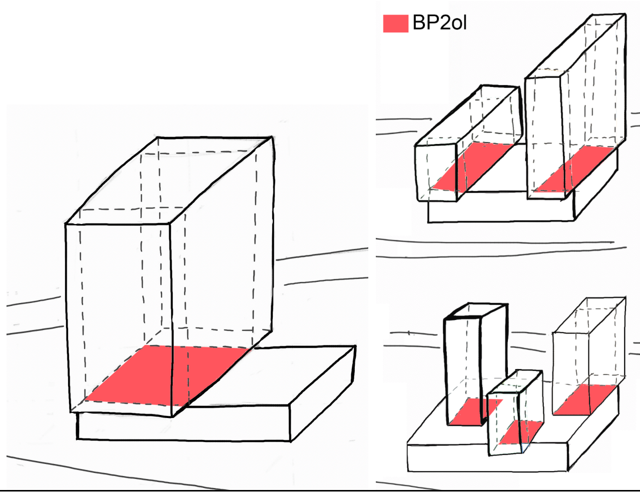
Figure 14. II Workshop 05/11/2019 – External experts involved in building permission issuing (Fire safety, structural safety, City aesthetics, Building physics)

10. Formalization and conceptualization of the needed information for regulation I

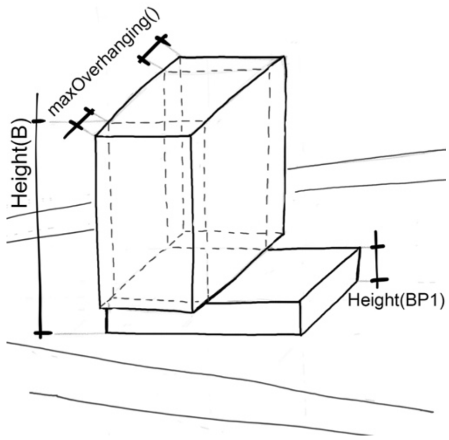
The regulation considered here is the Waterstadt - *Artikel 5 Centrum* – 3, specifically, the section 5.2 Building rules - 5.2.3 Building standards. See Annex 1 for the original text of the law and Annex 2 for an English translation.

> **Regulation text:** *"The maximum building height is 100 meters, on the understanding that it can be realized with a substructure of a maximum of 17 meters high and a construction of a maximum of 50% of the surface of the substructure. At the location of Boompjes 60-68 and Boompjes 55-58, an overhang of 5 meters on the Boompjes side and 10 meters on the Hertekade side is permitted".*

Definitions	
B := Building	
BP1 := Building Part 1 **BP2** := Building Part 2 $B := BP1 \cup BP2$ $BP2xy \cap BP1xy$ AND $\min(BP2z) \geq \max(BP1z)$	
BP1a, **BP1b**,…, **BP1n**: = possibly disconnected parts of BP1 **BP1 :=** $BP1a \cup BP1b \cup BP1n$	

BP2a, **BP2b**,…, **BP2n**: = possibly disconnected parts of BP2 `BP2 := BP2a ∪ BP2b ∪ BP2n`	
Footprint(BP1) := footprint[9], of the Building part 1	
BP2ol := part of BP2 with a footprint overlapping the BP1 one. **BP2ohB** := part of BP2 with outline overhanging, on the side towards “Boompjes” street. **BP2ohH** := part of BP2 with outline overhanging, on the side towards “Heterkade” street. `BP2:= BP2ol ∪ BP2ohB ∪ BP2ohH`	
footprint.A() = Area of the footprint, intended as maximum total extension on the xy plan **footprint.A(BP2ol)** = Area of the footprint, intended as maximum total extension on the xy plan, of BP2 overlapping with BP1	

[9] ‘footprint’ is the part touching and intersecting the ground (or, eventually, the building part below); ‘outline’ of the building is the maximum extension on xy plane of the maximum envelope of the building, including overhanging parts and 3D extension.

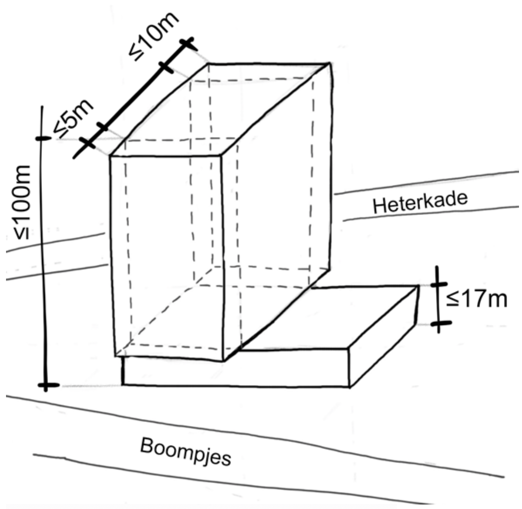
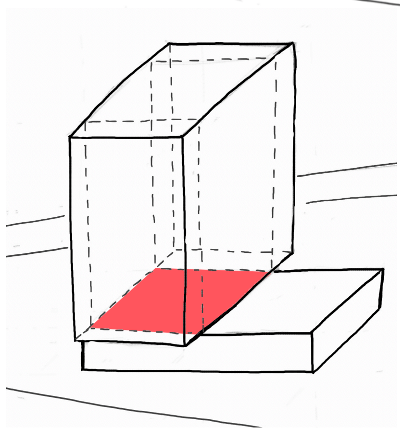
Height(B) = height of the building
 	
Measurement from (excerpt from the 'bestemmingsplan' Waterstad, section definitions):
 	
1.45 Level (street)
 	
• a. For a structure, the main entrance of which is adjacent to the road: the height of the road at the top of the road;
 	
• b. for a building whose main access is not adjacent to the road: the height of the site at the location of that main access, after completion of the construction of that site.
 	
If a structure is built on more than one road, the level of the highest road is the norm.
 	
Height(BP1) = height of the building part 1
 	
`Height(B) := max(Bz) – min (Bz)`
 	
`Height(BP1) := max(BP1z) – min (BP1z)`
 	
maxOverhanging() = maximum outline overhanging of the top part BP2 with respect to BP1 footprint.
	

Parcel(address) = attribute identifying the parcel	

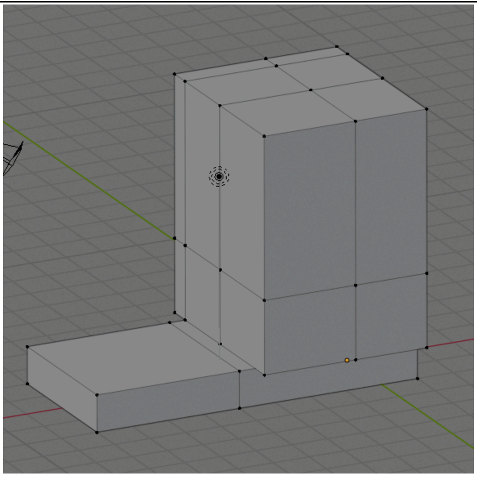
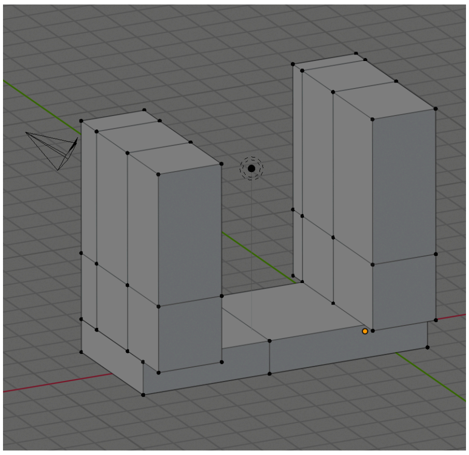
Used operators

:=	defined by
=	Equal
∪	Union
∩:	Intersection
⊆	subset or equal to

Rules (must be true)	

`footprint(BP1) ⊆ parcel`[10]
 	
`Height(B) ≤ 100m`
 	
`2.6 m`[11] `≤ Height(BP1) ≤ 17 m`
 	
`footprint.A(BP2ol) ≤ 0.5*footprint.A(BP1)`
 	
`IF`
`Parcel ⊆ "Boompjes 60-68"`[12]
`Or`
`Parcel ⊆ "Boompjes 55-58"`
`THEN`
`BP2olxy ⊆ BP1xy`
`AND`
`maxOverhanging(BP2ohB)≤ 5m`
`AND`
`maxOverhanging(BP2ohH)≤ 10m`
 	
`ELSE`
`BP2xy ⊆ BP1xy`
	
	

[10] The footprint of the base of the building (BP1) must fit into the parcel; no further rules such as alignments or minimum/maximum coverage.
[11] This number doesn't come from this regulation but it is the minimum ceiling height defined by bouwbesluit.
[12] The rules apply to parcels, namely polygons in the map. The names 'Boompjes 60-68' and 'Boompjes 55-58' actually identify the zoning polygon within which the parcels are subject to this regulation.

In the case the owner of multiple parcels builds only one build building, the rules apply per building (figure a). A configuration like in Figure b is not necessary.	 (a)  (b)

11. Mapping information from CityGML model and IFC models to check regulation I

Object provided by applicant in the BIM model
Object provided by Municipality in the 3D city model
Object derived from an existed object through segmentation/ extrusion/ collapse/ addition/ subtraction…
Attribute provided by applicant in the BIM model
Attribute provided by Municipality in the 3D city model
Attribute calculated from the BIM or from the objects generated from it.
Attribute calculated from the 3D city model
Calculation considering the integrated BIM and 3D city model

The models IFC 4.1 and CityGML v.2.0 was considered for this initial hypothesis of mapping.

<table>
<tr><th></th><th>Information mapped to the IFC or CityGML data models</th><th>Present in data</th></tr>
<tr><td rowspan="3">To define BP1 and BP2:
B := BP1 ∪ BP2
BP2xy∩BP1xy
AND
BP2z min ≥ BP1z max
BP1 := BP1a ∪ BP1b ∪ BP1n
BP2 := BP2a ∪ BP2b ∪ BP2n
BP2 := BP2ol ∪ BP2ohB ∪ BP2ohH
Rules (must be true)
footprint(BP1) ⊆ parcel
Height(B) ≤ 100m
2.6 m ≤ Height(BP1) ≤ 17 m
footprint.A(BP2ol) ≤ 0.5 * footprint.A(BP1)
IF
Parcel ⊆ “Boompjes 60-68”
OR
Parcel ⊆ “Boompjes 55-58”
THEN
BP2olxy ⊆ BP1xy
AND
maxOverhanging(BP2ohB) ≤ 5m
maxOverhanging(BP2ohH) ≤ 10m
ELSE
BP2xy ⊆ BP1xy</td><td>B = IfcBuilding</td><td>Yes</td></tr>
<tr><td>Parcel (address) = the entity ‘parcel’ or equivalent is not present in the CityGML v.2.0 data model. It should be therefore introduced in order to be reference for the calculations. An attribute identifying it must be added to such entity.

We can consider the possibility to use the parcels in the Ruimtelijkplannen WebGIS.</td><td>We will try to find suitable data and possibly propose a way to store this in the same 3D city model.</td></tr>
<tr><td>In order to calculate the overhanging of the building towards the two streets, the CityGML v.2.0 “Road” entity of the Transportation module is needed.

No attribute “name” or other identifier is foreseen by the model, but it should be added, as a generic Attribute</td><td>As soon as we will have the 3D city model of Rotterdam including streets, we will check if the attribute is there, even if not appearing in the CityGML schema.</td></tr>
</table>

12. Formalization and conceptualization of the needed information for regulation II

The parking regulation considered here is the “Beleidsregeling Parkeernormen auto en fiets gemeente Rotterdam 2018”[13]. In particular, the part considering the count of parkings and parking surface is analysed in this initial phase, based on the excel sheet by ……., officer in the Municipality of Rotterdam (see Annex 4 as example).

Definitions and rules from regulation	Definitions
BUH40 = Count BU (function.“home”) AND (A(BU) < 40 m^2) **BUH40-65** = Count BU (function.“home”) AND (40 < A(BU) < 65 m^2) **BUH65-85** = Count BU (function.“home”) AND (65 < A(BU) < 85 m^2) **BUH85-120** = Count BU (function.“home”) AND (85 < A(BU) < 120 m^2) **BUH120** = Count BU (function.“home”) AND (120 m^2< A(BU)) **Rules (must be true)** IF parcel ∩ ParkingZone(name/id=“A”) AND BU(function) = “home” THEN **MinNPP**= (BUH40*0.1) + (BUH40-65*0.4) + (BUH65-85*0,6) + (BUH85-120*1) + (BUH120*1.2) ELSE IF parcel ∩ ParkingZone B AND BU(function) = “home” THEN **MinNPP**= (BUH40*0.1) + (BUH40-65*0.5) + (BUH65-85*0,8) + (BUH85-120*1) + (BUH120*1.2) ELSE IF parcel ∩ ParkingZone(name/id=”C”) AND BU(function) = “home” THEN **MinNPP**= (BUH40*0.1) + (BUH40-65*0.6) + (BUH65-85*1.4) + (BUH85-120*1.6) + (BUH120*1.8) ELSE IF	**BU** = Building unit, single dwelling or ‘ownership/cadaster unit’? **BUH**= building unit with function “home” **BU(function)** = attribute ‘function’ related to each building unit. **A (BU)** = attribute ‘area’ related to each building unit **ParkingZone(name/id)** = attribute describing the name of the Parking zone to which the area (parcel) belongs to. **MinNPP** = Minimum number parking places. **MinMQPP** = Minimum square meters parking places

[13] http://decentrale.regelgeving.overheid.nl/cvdr/xhtmloutput/Historie/Rotterdam/486392/486392_1.html) NL.IMRO.0599.BP1097PapluParkern-va01.

parcel ∩ ParkingZone(name/id="A") AND BU(function) = "office" THEN **MinMQPP** = BU(A)*0,0076 NOTE: this last part has to be repeated for all the functions labelled as "work" and "shop", considering the values reported in the Annex 3. And the same for parcel in ParkingZone B and C. For further functions, other units of measurements will need to be considered.	
NewParkings ≥ sum(MinNPP) + sum((MinMQPP/1parkingArea)) NewParkingArea ≥ sum(MinMQPP) + sum((MinNPP*1parkingArea))	
Exceptions and more complex regulations to be developed in next phases (e.g. based on walking distances from specific facilities)	

A similar formalization has to be repeated for the calculation and check of the bike parking places.

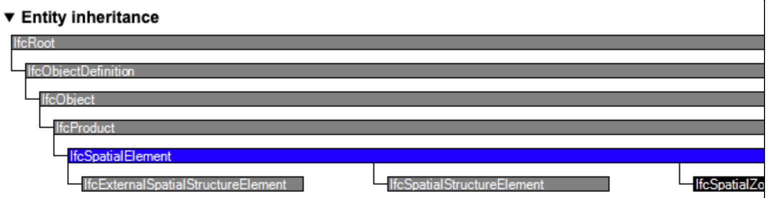
13. Mapping information from CityGML model and IFC models to check regulation II

Object provided by applicant in the BIM model
Object provided by Municipality in the 3D city model
Object derived from an existed object through segmentation/extrusion/collapse/addition/subtraction…
Attribute provided by applicant in the BIM model
Attribute provided by Municipality in the 3D city model
Attribute calculated from the BIM or from the objects generated from it.
Attribute calculated from the 3D city model
Calculation considering the integrated BIM and 3D city model

The models IFC 4.1 and CityGML v.2.0 was considered for this initial hypothesis of mapping.

	Possible mapping of the information to the IFC or CityGML data models	

BU	IFC 4.1 IfcSpatialElement
	
	A spatial element is the generalization of all spatial elements that might be used to define a spatial structure or to define spatial zones.
	
	• A hierarchical spatial structure element as IfcSpatialStructureElement:
	  ○ a spatial structure is a hiearchical decomposition of the project. That spatial structure is often used to provide a project structure to organize a building project.
	  ○ A spatial project structure might define as many levels of decomposition as necessary for the building project. Elements within the spatial project structure are site, building, storey, and space.
	
	• A spatial zone as IfcSpatialZone:
	  ○ a spatial zone is a non-hierarchical and potentially overlapping decomposition of the project under some functional consideration.
	  ○ a spatial zone might be used to represent a thermal zone, a lighting zone, a usable area zone.
	  ○ a spatial zone might be used to represent a horizontal spatial structure as used in civil works.
	  ○ a spatial zone might have its independent placement and shape representation.
		In Boompjes_gebow there are parking spaces as IfcBuildingElementProxy

		
BU (function)	No codelists about functions are present in IFC. Some attributes foreseeing the description of the buiding or building units functions could be found as follows: - MarketCategory (IfcLabel) Category of use e.g. residential, commercial, recreation etc. In Pset_BuildingUse to IfcBuilding - Market SubCategory (IfcLabel) Subset of category of use e.g. multi-family, 2 bedroom, low rise. In Pset_BuildingUse to IfcBuilding However, none of them are associated to IfcSpatialElement (nor to IfcSpatialStructureElement or to IfcSpatialZone), which is the most suitable IFC entity to represent the building units. The codelists defined in the CityGML v.2.0 standard for the attributes “function” and “usage” of the AbstractBuilding entity (in Annex 5)	
A (BU)	Although the preferable solution will be the calculation on the flight of the surface area for each defined building unit (for example as group of spaces included in the IfcSpatialElement), some attributes are present in the IFC model to describe the area of a building/building storey / space. We could consider them in the case we will choose a different solution for obtaining such information. ***NetPlannedArea (IfcAreaMeasure)*** Total planned net area for the building Used for programming the building. In Pset_BuildingCommon related to IfcBuilding ***GrossPlannedArea (IfcAreaMeasure)*** Total planned area for the building storey. Used for programming the building storey. In Pset_BuildingStoreyCommon related to IfcBuildingStorey	

	NetPlannedArea (IfcAreaMeasure) Total planned net area for the building Used for programming the building. In Pset_BuildingStoreyCommon related to IfcBuildingStorey ***GrossPlannedArea (IfcAreaMeasure)*** Total planned gross area for the space. Used for programming the space. In Pset_SpaceCommon related to IfcSpace ***NetPlannedArea (IfcAreaMeasure)*** Total planned net area for the space. Used for programming the space. In Pset_SpaceCommon related to IfcSpace	
NewParkings ≥ sum(MinNPP) + sum((MinMQPP/1parkingArea)) NewParkingArea ≥ sum(MinMQPP) + sum((MinNPP*1parkingArea))	This is still very undefined, but some attributes that could result useful in the count of parking places or parking surface. ***ParkingUse(IfcLabel)*** Identifies the type of transportation for which the parking space is designed. Values are not predefined but might include car, compact car, motorcycle, bicycle, truck, bus etc. In Pset_SpaceParking related to IfcSpace ***ParkingUnits(IfcCountMeasure)*** Indicates the number of transporation units of the type specified by the property ParkingUse that may be accommodated within the space. Generally, this value should default to 1 unit. However, where the parking space is for motorcycles or bicycles, provision may be made for more than one unit in the space. In Pset_SpaceParking related to IfcSpace ***IsAisle(IfcBoolean)*** Indicates that this parking zone is for accessing the parking units, i.e. an aisle (TRUE) and not a parking unit itself (FALSE) In Pset_SpaceParking related to IfcSpace ***IsOneWay(IfcBoolean)***	

	Indicates whether the parking aisle is designed for oneway traffic (TRUE) or twoway traffic (FALSE). Should only be provided if the property IsAisle is set to TRUE. In Pset_SpaceParking related to IfcSpace A specific entity for bike parking places has to be specified.	
Exceptions and more complex regulations to be developed in next phases (e.g. based on walking distances from specific facilities)		

14. Conclusions

In this document, we defined the premises for the development of a tool able to assist the Municipality in the building permission issuing process, considering two initial regulations: one regarding the building dimensions and general shape prescribed in a specific area of Rotterdam, chosen as case study, and the other one regarding the calculation of parking places.

In the next steps those definitions and this document will be double checked again with the Municipality offices having the task of building permission issuing, in order to completely remove the residual possible ambiguity and to further specify the information when needed. A new version of this document will be possibly written if relevant changes and integrations will be added.

A relevant part will regard the inspection of the available 3D information systems, namely, the 3D city model and the Building information models to be used for testing the checking tools.

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Annex 1. Dutch original text for regulation 1

Artikel 5 Centrum - 3[14]

5.1 Bestemmingsomschrijving

De voor 'Centrum - 3' aangewezen gronden zijn bestemd voor:

a. wonen, met inachtneming van het bepaalde in artikel 5.2.4;
b. kantoor, tot een maximum van 254.084 m^2 b.v.o. in Centrum - 1, Centrum - 2 en Centrum - 3 gezamenlijk;
c. hotel;
d. maatschappelijke voorzieningen;
e. bedrijven t/m categorie 2, uitsluitend op de begane grond;
f. detailhandel, uitsluitend op de begane grond, tot een maximum van 3.440m^2 b.v.o. in 'Centrum - 1', 'Centrum - 2', 'Centrum - 3' en 'Centrum - 4' gezamenlijk, met inachtneming van het bepaalde in artikel 5.3.2;
g. dienstverlening, uitsluitend op de begane grond;
h. horeca, uitsluitend op de begane grond;
i. cultuur en ontspanning, uitsluitend op de begane grond;
j. parkeergarages (boven- en/of ondergronds);
k. dakterrassen;
l. berg- en stallingsruimten, groen, water, tuin, parkeervoorzieningen, ontsluitingswegen en -paden;
m. openbare nutsvoorzieningen, niet groter dan 80 m^3;
n. 'Waarde - Archeologie 1', 'Waarde - Archeologie 2', 'Waarde - Cultuurhistorie','Waterstaat - Waterkering', 'Waterstaat - Waterstaatkundige functie', voor zover de gronden mede als zodanig zijn bestemd.

5.2 Bouwregels

5.2.1 Algemeen

Op de voor 'Centrum - 3' bestemde gronden mag uitsluitend worden gebouwd ten behoeve van de aldaar genoemde functies.

5.2.2 Medebestemming

Voor zover de gronden mede zijn bestemd voor 'Waarde - Archeologie 1', 'Waarde - Archeologie 2', 'Waarde - Cultuurhistorie','Waterstaat - Waterkering', 'Waterstaat - Waterstaatkundige functie', is voor het bouwen het bepaalde terzake in genoemde bestemmingen mede van toepassing.

5.2.3 Bebouwingsnormen

a. **De maximum bouwhoogte is 100 meter, met dien verstande dat deze gerealiseerd mag worden met een onderbouw van maximaal 17 meter hoog en een opbouw van maximaal 50% van de oppervlakte van de onderbouw.**
b. **Ter plaatse van de Boompjes 60-68 en de Boompjes 55-58 is boven de 17 meter een overkraging toegestaan van 5 meter aan de Boompjeszijde en 10 meter aan de zijde van de Hertekade;**
c. Ter plaatse van de aanduiding "onderdoorgang", is een onderdoorgang verplicht.

[14] https://www.ruimtelijkeplannen.nl/documents/NL.IMRO.0599.BP1054Waterstad-va01/r_NL.IMRO.0599.BP1054Waterstad-va01.html#_5_Centrum-3

d. Bij een bouwhoogte van meer dan 70 meter kan ter voorkoming van gevaar of hinder voor het luchtverkeer een omgevingsvergunning alleen worden verleend na advies van de Luchtverkeersleiding Nederland.

5.2.4 Toevoegen woningen

a. In 'Centrum - 1', 'Centrum - 2', 'Centrum - 3' en 'Centrum - 4' mogen vanaf het moment van de terinzagelegging van het ontwerpbestemmingsplan met inachtneming van het bepaalde in de volgende subleden gezamenlijk maximaal 800 woningen worden toegevoegd.
b. Indien studenteneenheden worden toegevoegd, dan wordt het aantal toegevoegde woningen als volgt berekend: studenteneenheden x 0,1= aantal toegevoegde woningen.
c. Indien woningen worden toegevoegd door middel van transformatie van een kantoorpand, dan wordt het aantal toegevoegde woningen als volgt berekend:

getransformeerde woningen x 0,5 = aantal toegevoegde woningen.

d. Transformatie van kantoorruimte naar woning(en) is uitsluitend toegestaan indien per woning gemiddeld 100 m2 bvo aan kantoorruimte wordt omgezet.
e. De binnenwaarde van een woning die door transformatie van kantoorruimte is toegevoegd mag maximaal 38 dB bedragen.

5.3 Specifieke gebruiksregels

5.3.1 Algemeen

Woningen mogen mede worden gebruikt voor de uitoefening van een aan huis gebonden beroep of bedrijf, mits:

a. de woonfunctie in overwegende mate gehandhaafd blijft, waarbij het bruto vloeroppervlak van de woning voor ten hoogste 30% mag worden gebruikt voor een aan huis gebonden beroep of bedrijf;
b. ten aanzien van een aan huis gebonden bedrijf sprake is van een bedrijf tot en met categorie 1 als bedoeld in de bij deze regels horende lijst van bedrijfsactiviteiten;
c. de gevel en dakrand van de woning niet worden gebruikt ten behoeve van reclame-uitingen;
d. er geen bedrijfsmatige activiteiten plaatsvinden die betrekking hebben op het onderhouden en repareren van motorvoertuigen;
e. er geen detailhandel plaatsvindt, tenzij als ondergeschikt onderdeel van het aan huis gebonden beroep of bedrijf.

5.3.2 Detailhandel

Detailhandel is toegestaan, uitsluitend op de begane grond, in de straten Posthoornstraat, Glashaven, Rederijstraat, Wolfshoek, Wijnhaven (noordzijde).

Daarnaast is detailhandel toegestaan;

a. op de begane grond van de gebouwen Red Apple/ Ibis hotel, gelegen binnen het bouwblok Wijnhaven, Punt, Scheepmakershaven, Scheepmakerspassage en Wijnbrugstraat;
b. op de begane grond van de Waterstadstoren 3, gelegen aan de Bierstraat, Wijnhaven, Wijnbrugstraat.

5.3.3 Toegestane bedrijven

Uitsluitend bedrijven t/m categorie 2 van de lijst van bedrijfsactiviteiten behorende bij deze regels zijn toegestaan.

5.3.4 Luchtkwaliteit bij scholen en kinderopvang

Nieuwe vestigingen van scholen voor basisonderwijs en voortgezet onderwijs en van kinderopvang zijn, na de terinzagelegging van dit ontwerpbestemmingsplan, niet toegestaan binnen 50 meter vanaf de rand van de buitenste rijbaan van de volgende wegen:

Blaak, Boompjes, Burgemeester van Walsumweg, Nieuwe Leuvebrug, Schiedamsedijk en Verlengde Willemsbrug. en Verlengde Willemsbrug.

5.4 Afwijken van de gebruiksregels
5.4.1 Afwijken gebruiksfuncties op verdiepingen
Burgemeester en wethouders kunnen bij een omgevingsvergunning afwijken van het bepaalde in lid 5.1 ten behoeve van het toestaan van de functies bedrijven t/m categorie 2, dienstverlening, horeca, cultuur en ontspanning op de verdiepingen, indien deze functie op de verdieping het omringende woon- en leefmilieu niet in onevenredige mate aantast.
5.4.2 Afwijken toegestane bedrijven
Burgemeester en wethouders kunnen bij een omgevingsvergunning afwijken van het bepaalde in 5.3.1 en 5.3.3 terzake van de toegestane bedrijfsactiviteiten ten behoeve van andere bedrijfsactiviteiten dan die primair zijn toegelaten, welke - gehoord de milieudeskundige - daarmede naar aard en invloed op de omgeving gelijk te stellen zijn.

Annex 2. English translation of the text[15]

Article 5 Center - 3

5.1 Destination description

The grounds designated for 'Center - 3' are intended for:

living, subject to the provisions of Article 5.2.4;

office, up to a maximum of 254,084 m2, e.g. in Center - 1, Center - 2 and Center - 3 together;

hotel;

social services;

holdings up to and including category 2, only on the ground floor;

retail trade, exclusively on the ground floor, up to a maximum of 3,440m² b.v.o. in 'Center - 1', 'Center - 2', 'Center - 3' and 'Center - 4' together, subject to the provisions of Article 5.3.2;

services, exclusively on the ground floor;

catering, only on the ground floor;

culture and relaxation, exclusively on the ground floor;

parking garages (above and / or underground);

roof terraces;

storage and parking spaces, greenery, water, garden, parking facilities, access roads and paths;

public utilities, no larger than 80 m3;

'Value - Archeology 1', 'Value - Archeology 2', 'Value - Cultural history', 'Waterstaat - Water defenses', 'Waterstaat - Waterstaat function', insofar as the grounds are also intended as such.

5.2 Building rules

5.2.1 General

Building for the 'Center - 3' may only be carried out for the functions mentioned there.

5.2.2 Co-destination

Insofar as the grounds are also intended for 'Value - Archeology 1', 'Value - Archeology 2', 'Value - Cultural History', 'Waterstaat - Water defenses', 'Waterstaat - Waterstaat function', the provisions in the aforementioned destinations also apply.

5.2.3 Building standards

The maximum building height is 100 meters, on the understanding that it can be realized with a substructure of a maximum of 17 meters high and a construction of a maximum of 50% of the surface of the substructure.

At the location of Boompjes 60-68 and Boompjes 55-58, an overhang of 5 meters on the Boompjes side and 10 meters on the Hertekade side is permitted;

At the location of the indication "underpass", an underpass is mandatory.

With a construction height of more than 70 meters, an environmental permit can only be granted to prevent air traffic hazard or nuisance after advice from Air Traffic Control the Netherlands.

5.2.4 Adding properties

[15] Please that this is not a reasoned translation, but it's the plain result of a translation tool and it can therefore contain inaccuracies.

In 'Center - 1', 'Center - 2', 'Center - 3' and 'Center - 4', a maximum of 800 homes may be added together from the moment that the draft zoning plan is made available, taking into account the provisions of the following subsections.

If student units are added, the number of added houses is calculated as follows: student units x 0.1 = number of added houses.

If homes are added by transforming an office building, the number of added homes is calculated as follows:

transformed dwellings x 0.5 = number of added dwellings.

Transformation from office space to home (s) is only permitted if an average of 100 m2 GFA of office space is converted per home.

The interior value of a home that has been added by transforming office space may not exceed 38 dB.

5.3 Specific usage rules

5.3.1 General

Homes may also be used for the exercise of a home-based profession or business, provided that:

the residential function is largely retained, whereby the gross floor area of the home may be used for a maximum of 30% for a home-based profession or business;

with regard to a home-based business, there is a business up to and including category 1 as referred to in the list of business activities associated with these rules;

the facade and eaves of the house are not used for advertising purposes;

no commercial activities take place that relate to the maintenance and repair of motor vehicles;

no retail trade takes place, unless as a subordinate part of the home-based profession or business.

5.3.2 Retail

Retail trade is permitted, only on the ground floor, in the streets Posthoornstraat, Glashaven, Rederijstraat, Wolfshoek, Wijnhaven (north side).

In addition, retail is permitted;

on the ground floor of the Red Apple / Ibis hotel buildings, located within the Wijnhaven, Punt, Scheepmakershaven, Scheepmakerspassage and Wijnbrugstraat blocks;

on the ground floor of Waterstadstoren 3, located on Bierstraat, Wijnhaven, Wijnbrugstraat.

5.3.3 Authorized companies

Only companies up to and including category 2 of the list of business activities associated with these rules are permitted.

5.3.4 Air quality in schools and childcare

New locations of schools for primary and secondary education and of childcare are not allowed, after the inspection of this draft zoning plan, within 50 meters from the edge of the outer carriageway of the following roads:

Blaak, Boompjes, Burgemeester van Walsumweg, Nieuwe Leuvebrug, Schiedamsedijk en Verlengde Willemsbrug.

5.4 Deviation from the usage rules

5.4.1 Deviating user functions on floors

The mayor and aldermen may deviate from the provisions in paragraph 5.1 for the permit for companies up to and including category 2, services, catering, culture and entertainment on the floors, if this function on the floor surrounds the surrounding residential area. and does not adversely affect the environment.

5.4.2 Deviation from permitted companies

The Mayor and Aldermen may deviate from the provisions in 5.3.1 and 5.3.3 with regard to the permitted business activities for business activities other than those that are primarily permitted, which - having been heard by the environmental expert - similar to nature and influence on the environment. to be set.

Annex 3. List of functions on which the calculation of the parking depend

- “home”

Work

- “office”
- “workshop”
- “labor intensive/intensive company visits (industry, laboratory, workshop, etc.)”
- “extensive labor / visitors extensive listings (warehouse, store, transport, etc.)”

Shop

- “commercial services and offices with counter function”
- “Retail incl. Thrift store and pharmacy”
- “Grocery store”
- “Basket Supermarket (max. Size 500 sqm)”
- “scale retail”
- “home”
- “DIY, garden centers, thrift”
- “Showroom, furniture”

Sports and recreation

- “Gymnasium, indoor sports hall (incl.squash, tennis) (m²)”
- “Outdoor sports (incl.tennisbaan) (ha. Net area)”
- “Dance studio, gym (sqm)”
- “Marina (per berth)”

Culture

- “Museum (sqm)”
- “Library (sqm)”
- “Cinema, theater, theater (per seat)”
- “Social Cultural Center, area (m²)”
- “Religion building (visitors per site)”

Catering industry

- “Cafeteria / snack bar (catering I) (m²)”
- “Disco / party room (catering II) (m²)”
- “Cafe / bar (catering III) (m²)”
- “Restaurant (catering IV) (m²)”
- “Hotel 1 2 3 stars (catering V) (per 10 rooms: excl.congres- and meeting facilities)”
- “Hotel 4, 5 stars (catering V) (per 10 rooms: excl.congres- and meeting facilities)”

Education

- “Crèche, peutelspeelzaal, nursery (sqm)”
- “Primary education (30 local students, excl. Kiss & Ride strip)”
- “Pre-time education (VMBO, HAVO, VWO) (local of 30 students)”
- “Beroepsonderwijs and WO (Local of 30 students)”

Healthcare

- “Hospital (per bed)”
- “Nursing, rehabilitation home, hospice (per unit)”
- “1st line health (doctor, dentist, therapist) (per treatment)”

Annex 4. Extract from the excel sheet for parking calculations built by ……………, Municipality of Rotterdam.

4.1 Car Parking standards

USE AREA HOMES (sqm)	houses	A sector	sector B	sector C	
<40 m²	0	=B4*0,1	=B4*0,1	=B4*0,1	
40-65 sqm	4	=B5*0,4	=B5*0,5	=B5*0,6	
65-85 sqm	138	=B6*0,6	=B6*0,8	=B6*1,4	
85-120 sqm	105	=B7*1	=B7*1	=B7*1,6	
> 120 m²	15	=B8*1,2	=B8*1,2	=B8*1,8	
TOTAL NUMBER OF HOUSES / I	**=B4+B5+B6+B7+B8**	**=C4+C5+C6+C7+C8**	**=D4+D5+D6+D7+D8**	**=E4+E5+E6+E7+E8**	**=F4+F5+F6+F7+F8**

100 per sqm GFA, unless other

TO WORK	sqm	zone A	zone B	zone C	Bicycle
Office	0	=B13*0,0076	=B13*0,01	=B13*0,012	=B13*0,017
Bedrijfsverzamelgebouw / worksh	0	=B14*0,0072	=B14*0,008	=B14*0,008	=B14*0,017
Labor intensive / intensive compa	0	=B15*0,0067	=B15*0,012	=B15*0,02	=B15*0,01
Extensive labor / visitors extensiv	0	=B16*0,0019	=B16*0,003	=B16*0,006	=B16*0,0025

SHOP	sqm				
Commercial services and offices v	0	=B21*0,012	=B21*0,02	=B21*0,025	=B21*0,05
Retail incl. Thrift store and pharm	0	=B22*0,0038	=B22*0,025	=B22*0,025	=B22*0,027
Grocery store	0	=B23*0,0038	=B23*0,025	=B23*0,028	=B23*0,029
Basket Supermarket (max. Size 5	0	na	na	na	=B24*0,029
scale retail	0	na	=B25*0,045	=B25*0,055	=B25*0,004
DIY, garden centers, thrift	0	na	=B26*0,022	=B26*0,022	=B26*0,004
Showroom, furniture	0	=B27*0,0026	=B27*0,006	=B27*0,006	=B27*0,004

SPORTS & RECREATION	unit	zone A	zone B	zone C	zone C
Gymnasium, indoor sports hall (in	0	=B31*0,0008	=B31*0,017	=B31*0,02	=B31*0,025
Outdoor sports (incl.tennisbaan) (	0	=B32*0,65	=B32*13	=B32*13	=B32*61
Dance studio, gym (sqm)	0	=B33*0,001	=B33*0,02	=B33*0,03	=B33*0,05
Marina (per berth)	0	=B34*0,05	=B34*0,5	=B34*0,5	custom

Annex 5. Codelists from CityGML v.2.0 specification

Code list of the _*AbstractBuilding* attributes *function* and *usage*			
http://www.sig3d.org/codelists/standard/building/2.0/_AbstractBuilding_function.xml http://www.sig3d.org/codelists/standard/building/2.0/_AbstractBuilding_usage.xml			
1000	residential building	1840	rubbish bunker
1010	tenement	1850	building for rubbish incineration
1020	hostel	1860	building for rubbish disposal
1030	residential- and administration building	1870	building for agrarian and forestry
1040	residential- and office building	1880	barn
1050	residential- and business building	1890	stall
1060	residential- and plant building	1900	equestrian hall
1070	agrarian- and forestry building	1910	alpine cabin
1080	residential- and commercial building	1920	hunting lodge
1090	forester's lodge	1930	arboretum
1100	holiday house	1940	glass house
1110	summer house	1950	moveable glass house
1120	office building	1960	public building
1130	credit institution	1970	administration building
1140	insurance	1980	parliament
1150	business building	1990	guildhall
1160	department store	2000	post office
1170	shopping centre	2010	customs office
1180	kiosk	2020	court
1190	pharmacy	2030	embassy or consulate
1200	pavilion	2040	district administration
1210	hotel	2050	district government
1220	youth hostel	2060	tax office
1230	campsite building	2070	building for education and research
1240	restaurant	2080	comprehensive school
1250	cantine	2090	vocational school
1260	recreational site	2100	college or university
1270	function room	2110	research establishment
1280	cinema	2120	building for cultural purposes
1290	bowling alley	2130	castle
1300	casino	2140	theatre or opera
1310	industrial building	2150	concert building
1320	factory	2160	museum

1330	workshop	2170	broadcasting building
1340	petrol / gas station	2180	activity building
1350	washing plant	2190	library
1360	cold store	2200	fort
1370	depot	2210	religious building
1380	building for research purposes	2220	church
1390	quarry	2230	synagogue
1400	salt works	2240	chapel
1410	miscellaneous industrial building	2250	community center
1420	mill	2260	place of worship
1430	windmill	2270	mosque
1440	water mill	2280	temple
1450	bucket elevator	2290	convent
1460	weather station	2300	building for health care
1470	traffic assets office	2310	hospital
1480	street maintenance	2320	healing centre or care home
1490	waiting hall	2330	health centre or outpatients clinic
1500	signal control box	2340	building for social purposes
1510	engine shed	2350	youth centre
1520	signal box or stop signal	2360	seniors centre
1530	plant building for air traffic	2370	homeless shelter
1540	hangar	2380	kindergarten or nursery
1550	plant building for shipping	2390	asylum seekers home
1560	shipyard	2400	police station
1570	dock	2410	fire station
1580	plant building for canal lock	2420	barracks
1590	boathouse	2430	bunker
1600	plant building for cablecar	2440	penitentiary or prison
1610	multi-storey car park	2450	cemetery building
1620	parking level	2460	funeral parlor
1630	garage	2470	crematorium
1640	vehicle hall	2480	train station
1650	underground garage	2490	airport building
1660	building for supply	2500	building for underground station
1670	waterworks	2510	building for tramway
1680	pump station	2520	building for bus station
1690	water basin	2530	shipping terminal
1700	electric power station	2540	building for recuperation purposes
1710	transformer station	2550	building for sport purposes
1720	converter	2560	sports hall
1730	reactor	2570	building for sports field
1740	turbine house	2580	swimming baths
1750	boiler house	2590	indoor swimming pool
1760	building for telecommunications	2600	sanatorium
1770	gas works	2610	zoo building
1780	heat plant	2620	green house
1790	pumping station	2630	botanical show house
1800	building for disposal	2640	bothy
1810	building for effluent disposal	2650	tourist information centre
1820	building for filter plant	2700	others
1830	toilet		