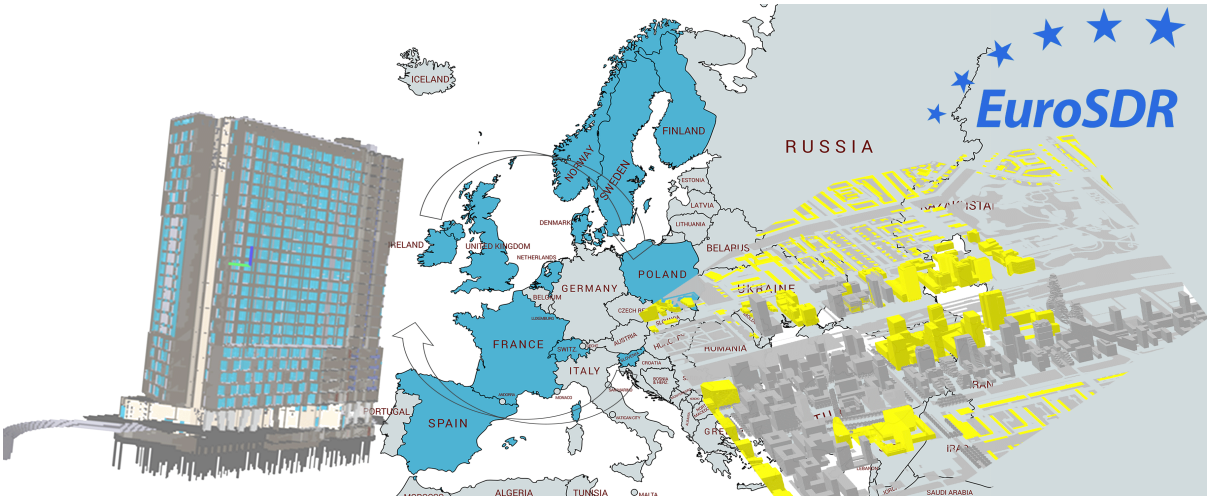
EuroSDR GeoBIM project



Integrated Workflow using GeoBIM information for building permit process

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The EuroSDR GeoBIM project

In both the Geographic Information (Geo) and Building Information Modelling (BIM) domains, it is widely acknowledged that the integration of data from both domains is beneficial and a crucial step in facing the multi-disciplinary challenges of our built environment.

From the data perspective, this integration raises the question of how to integrate very detailed design & construction data from the BIM domain with contextual geospatial data (both 2D and 3D) that models a very diverse range of aspects of the wider built environment and also underpins analytical analysis.

Developing a coherent approach to GeoBIM integration requires consensus between multiple stake-holders from both the Geo and the BIM side. Logically this is best addressed at the multi-country level, and is the topic of the new EuroSDR project on GeoBIM integration. The general aim of the project is to detail both the needs and the issues of GeoBIM integration, studied from use cases as well as from existing experiences in the participating countries.

The partners in this project (besides EuroSDR) are listed in the cover page, and are mainly European National Mapping and Cadastral Agancies (NMCAs) and research institutes. Apart from co-funders, these organisations are active partners in the project and they will carry out parts of the project.

The project was divided into two phases. In the first phase, (November 2017-May 2018) an inventory was made of the GeoBIM state-of-play in the participating countries by means of a questionnaire.

The second phase (2018-2020) defined a workflow and began addressing the many challenges involved for managing GeoBIM information within two specific use cases:

- Use case 1 - Workflow from global design to building permits issuing;
- Use case 2 - Life-cycle support in asset-management.

In this document, the workflow proposed for using GeoBIM information for the “Building permits issuing” use case is described, as resulting from the research performed within the EuroSDR GeoBIM project (see more details about the project and the full list of partners at https://3d.bk.tudelft.nl/projects/eurosdr-geobim/). Some studies were used as base for the development of this workflow (Ellul at al., 2018; Noardo et al., 2019; Noardo et al., 2019a)[1] together with the working sessions with the participation of all the partners during the project meetings (see the website for more detail). Moreover, it was reviewed later within Municipalities (e.g. Rotterdam, Den Haag, Amsterdam, some municipalities in Sweden).

Workflow using GeoBIM information for building permit process

The workflow is very complex, many stakeholders are involved and several sub-workflow should be considered.

Future work will deal with the definition of the specific requirements for the involved information and with the needed tools for each phase.

In order to focus on a more specific case, only the permissions for a new building are considered in this workflow. The work will be extended in future in order to include more permission cases (extension, change and so on).

[1] Please cite some of them when referring to this document.

The workflow is described in two UML models: one activity diagram[2] (Figure 1), specifying the steps in detail, and one sequence diagram[3] (Figure 2) pointing out the sequence of the activities and the involved stakeholders. Each part of the workflow (reading together the two models) is described in detail in the following text.

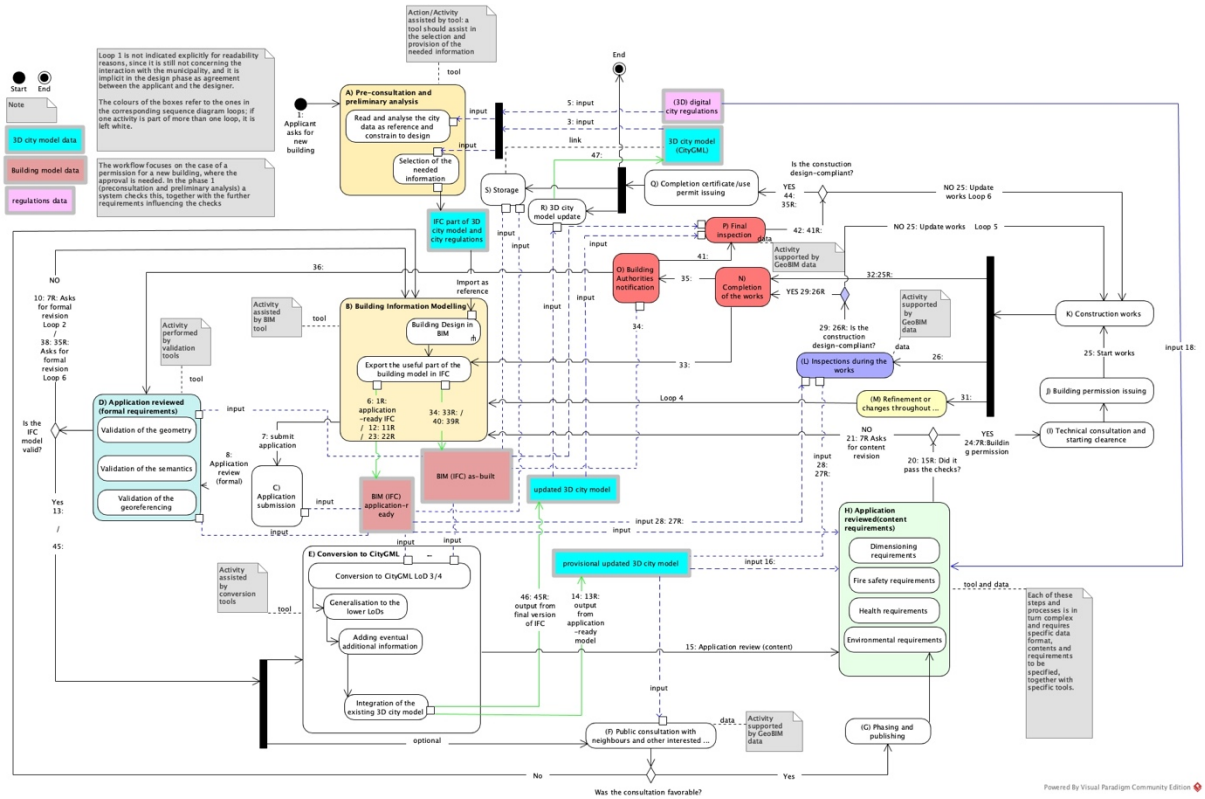


Figure 1 – Complete activity model for the building permission workflow

[2] https://www.visual-paradigm.com/guide/uml-unified-modeling-language/what-is-activity-diagram/
[3] https://www.visual-paradigm.com/guide/uml-unified-modeling-language/what-is-sequence-diagram/

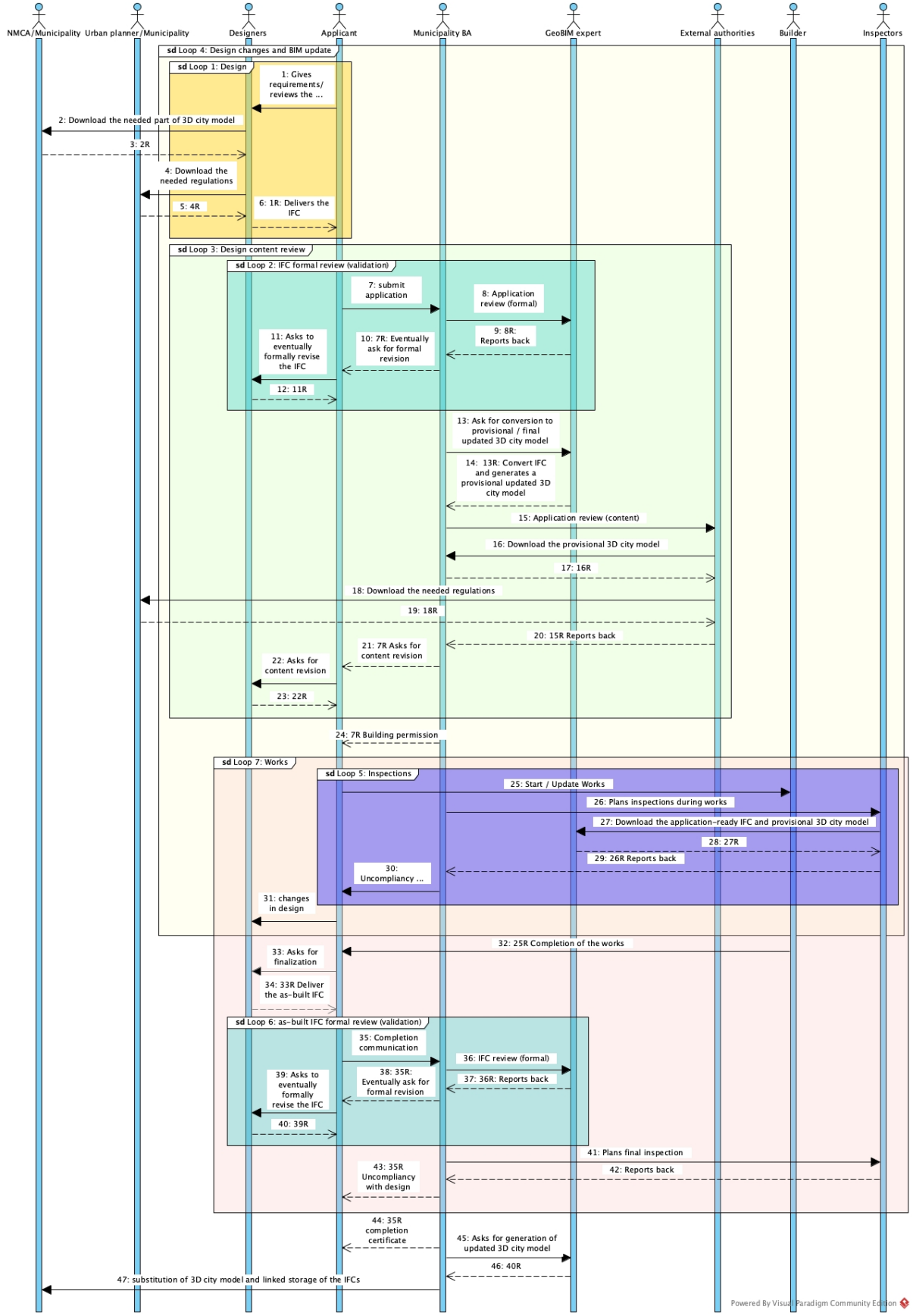
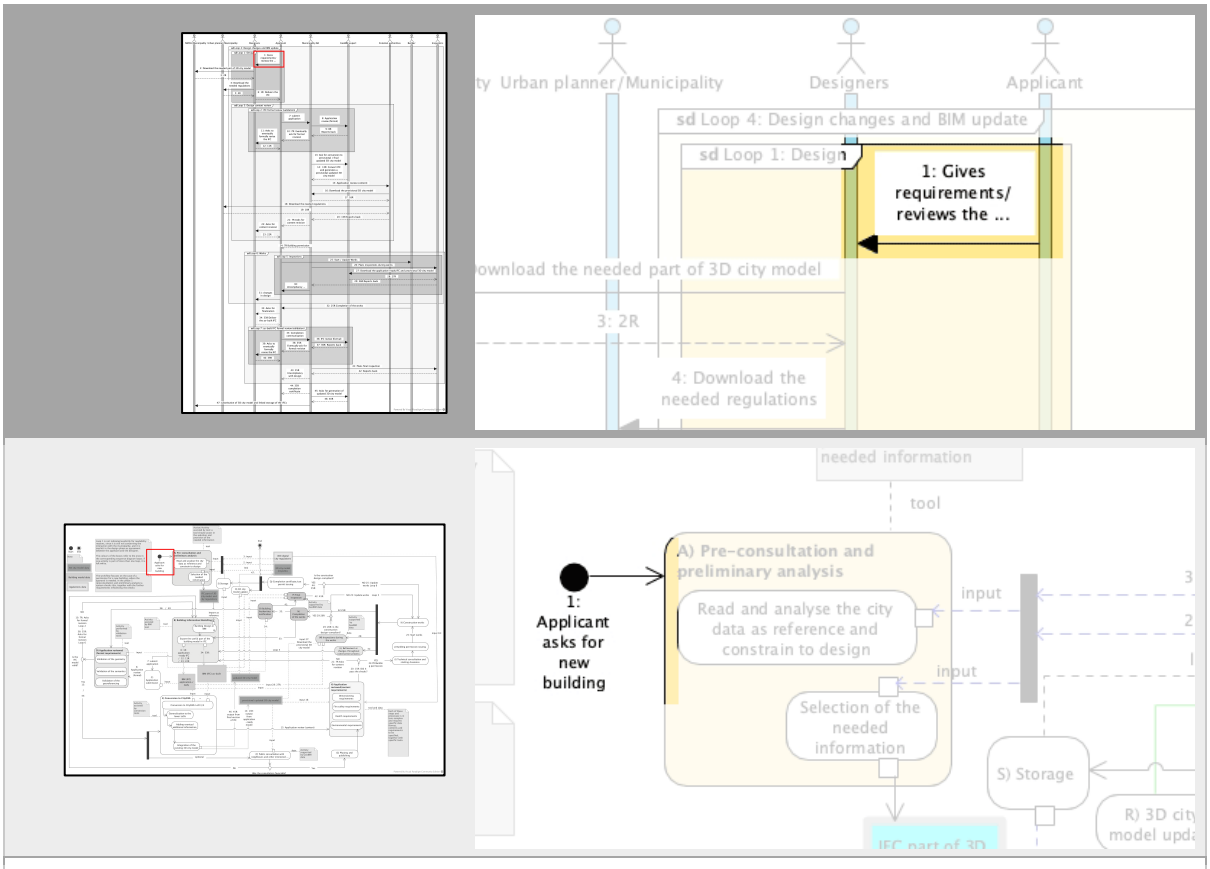


Figure 2 – Complete sequence model for the building permission workflow.

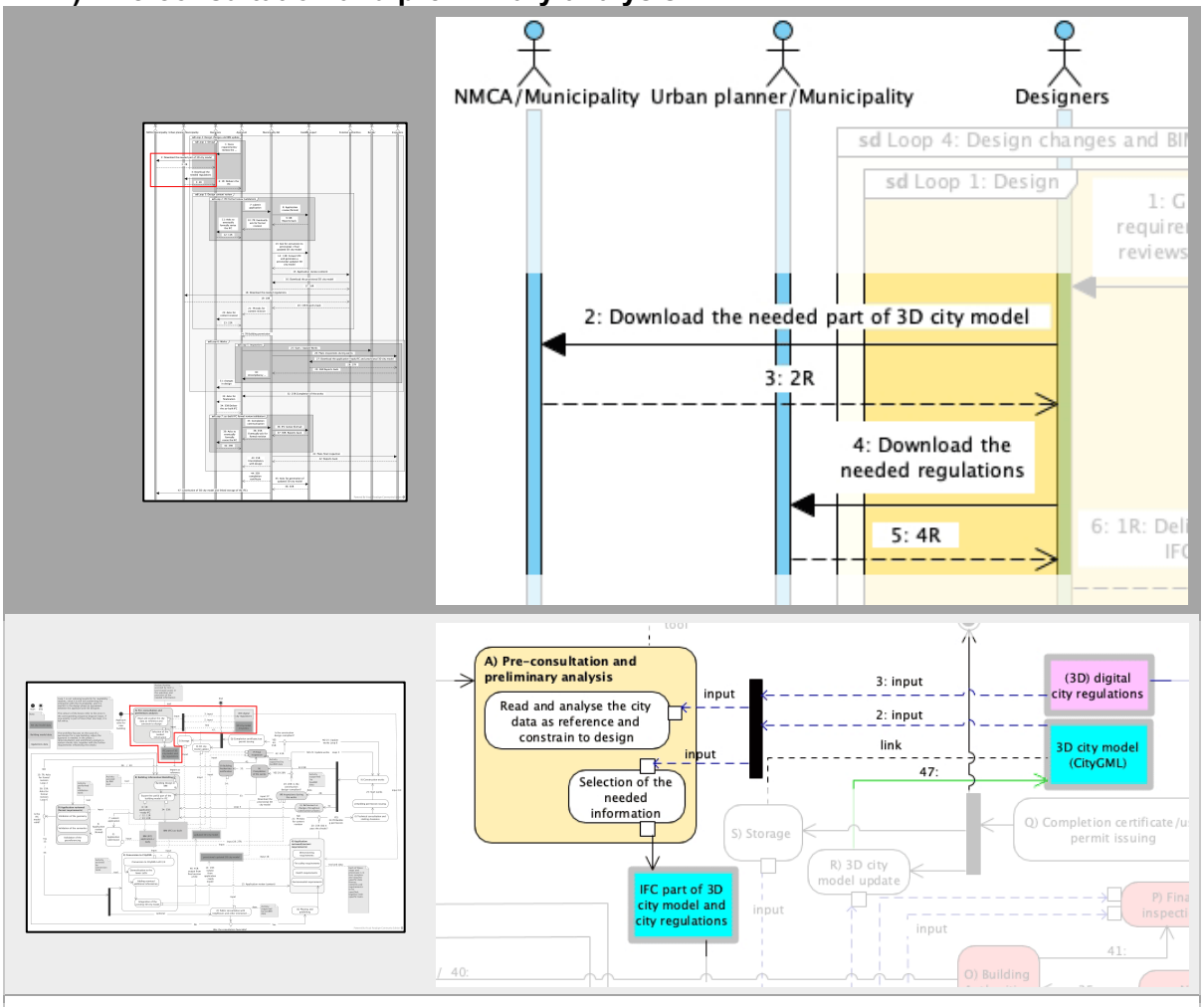
The start

1: Applicant asks for new building (Figure 3)



This is the beginning of the process, starting when the applicant contacts the designer for designing and constructing a new building. In this phase the applicant gives the designer its requirements about the desired formal and functional design of the new building.

A) Pre-consultation and preliminary analysis



This step of the workflow implies that the designer:
2: downloads the needed part of the 3D city model (and receives it back in 3: 2R:);
4: downloads the needed regulations (and receives them back in 5: 4R:).

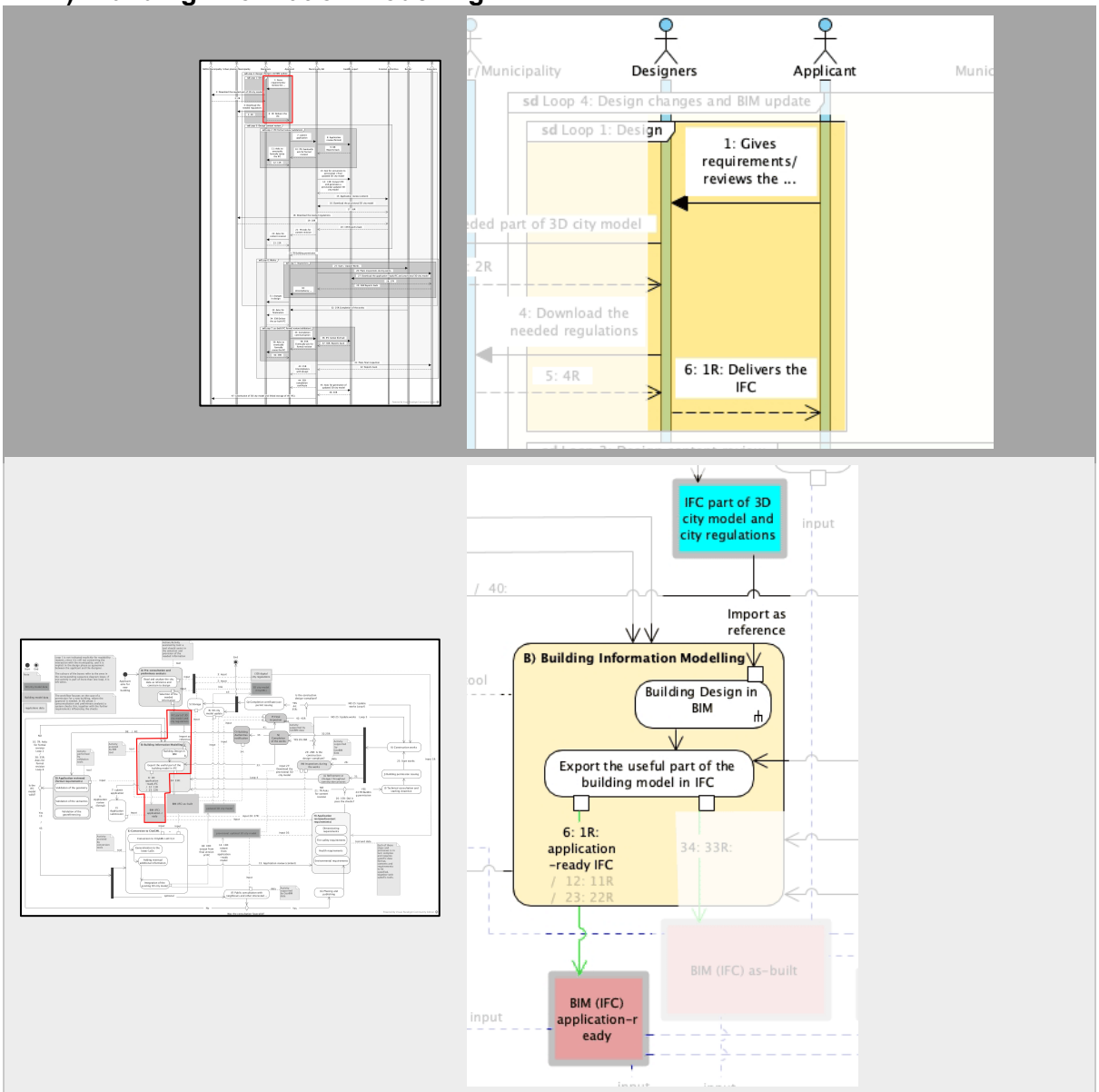
After he gets the data, the phase representing the 'Pre-consultation and preliminary analysis' (A) can be performed:

"Reads and analyses the city data as reference and constrain to the design", using tools external to the design software, to consider and understand a wide part of the city and enable the development of more general and aware design choices (e.g. considering noise, pollution, flooding risk, etc.). It is possible that this step is not essential, however, once the involved data (3D city model and regulations) are made available and accessible, it could help to increase the quality of the designed works without further effort.

"Select the needed information", refer to the specific information regarding the building site and the affected/affecting surrounding, which can be converted to IFC or a supported format to be directly imported in the (BIM) tool used for the design as a clear reference.

Preliminary condition of this step is that city regulations are stored digitally (probably a 3D format could help, but this will be assessed and investigated considering the specific regulations).
Similarly, a suitable 3D city model must be available.

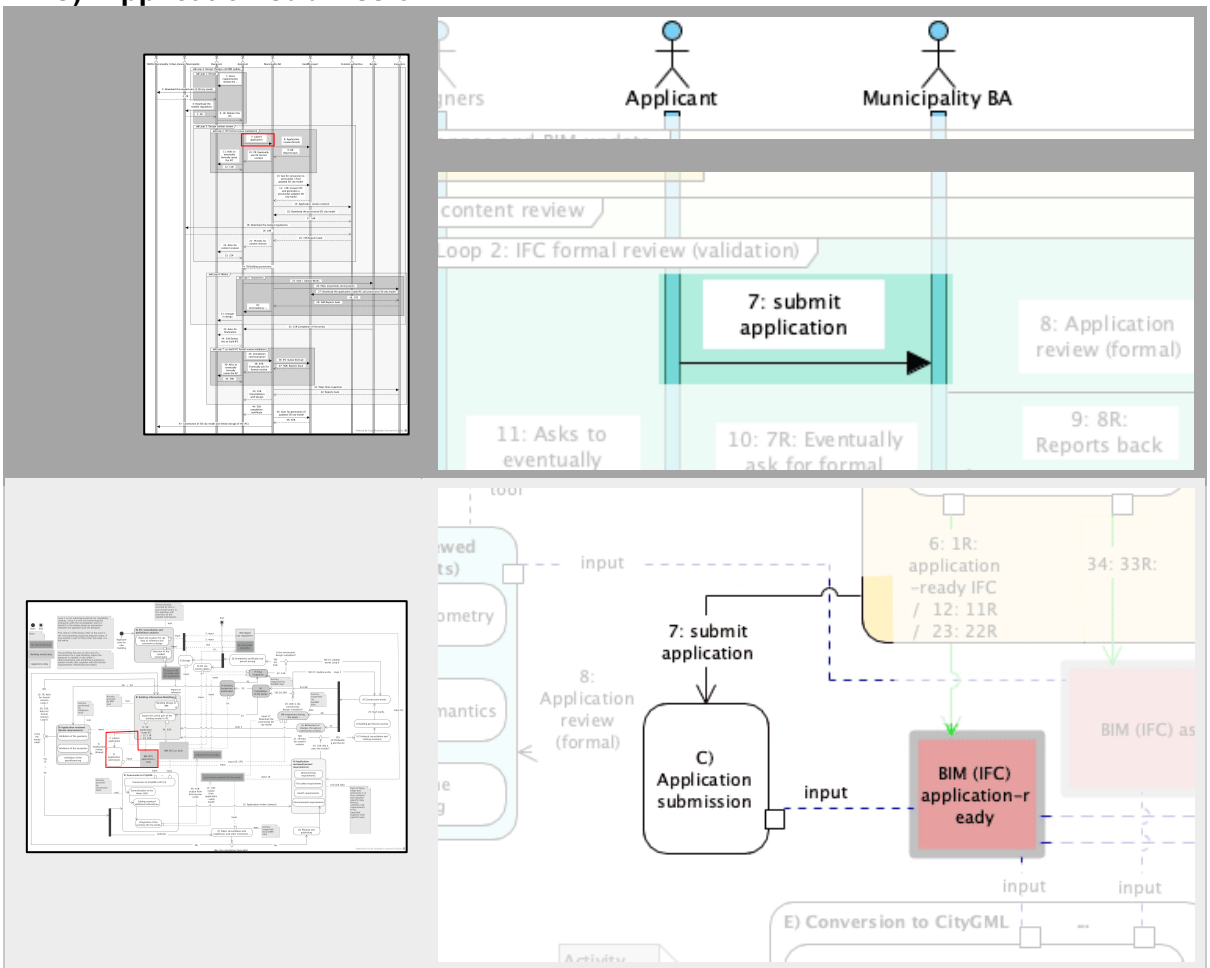
B) Building information modelling



In the proper design step, the designers[4] model the building as required by the applicant (1:). They are able to import the part of the 3d city model and of the city regulations which are supposed to be respected in the part of the city and for the kind of building/s that they are about to design, in order to be directly used as reference and constrain during the modelling.
After that, they can model their design within a BIM tool (*Building Design in BIM*), and deliver it to the applicant, who can accept it in the delivered version or ask for changes/ refinements/ different configurations/ more requirements. The designers would update the design and the BIM until it is completely approved by the applicant. This is represented in the *Loop 1: Design*.
When the applicant approves the design, the designers can "*export the useful part of the building model in IFC"* for the building permission checks (the *6: 1R: application-ready IFC*): a BIM usually includes very high amount and complex information, which is not all needed for the checks.

[4] It is plural, since it includes all the professionals involved in the design of the different parts of one building: architect, structural engineer, installations designers and so on.

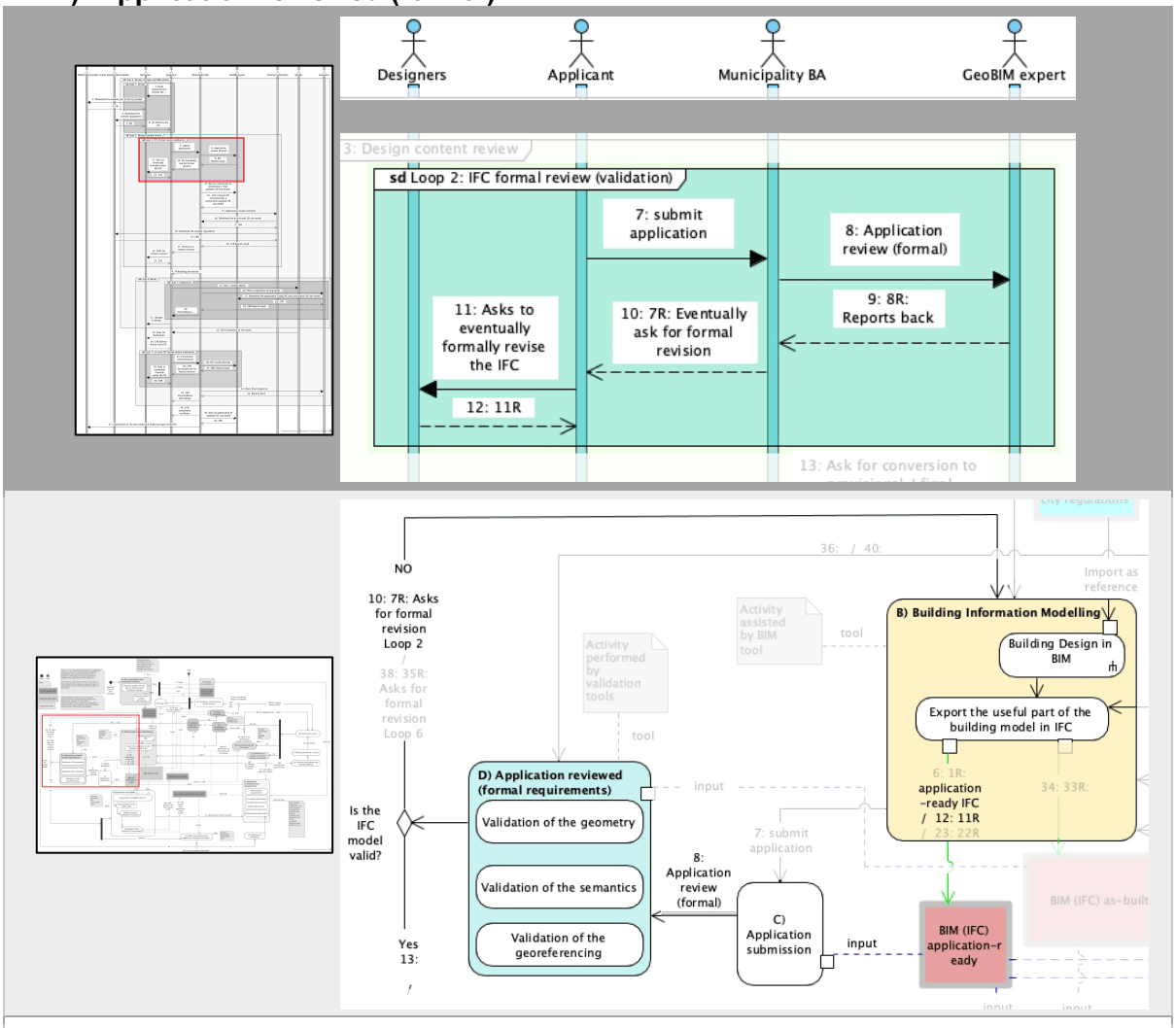
C) Application submission



In this step, the applicant submits the application for the Building permit (7:), delivering the application-ready IFC (following the established rules and guidelines enabling the automatic checks)[5] as provided by the designer.

[5] The development and test of the rules guiding this export is part of an on-going further part of this research and it is strictly connected to the regulations which will be automized.

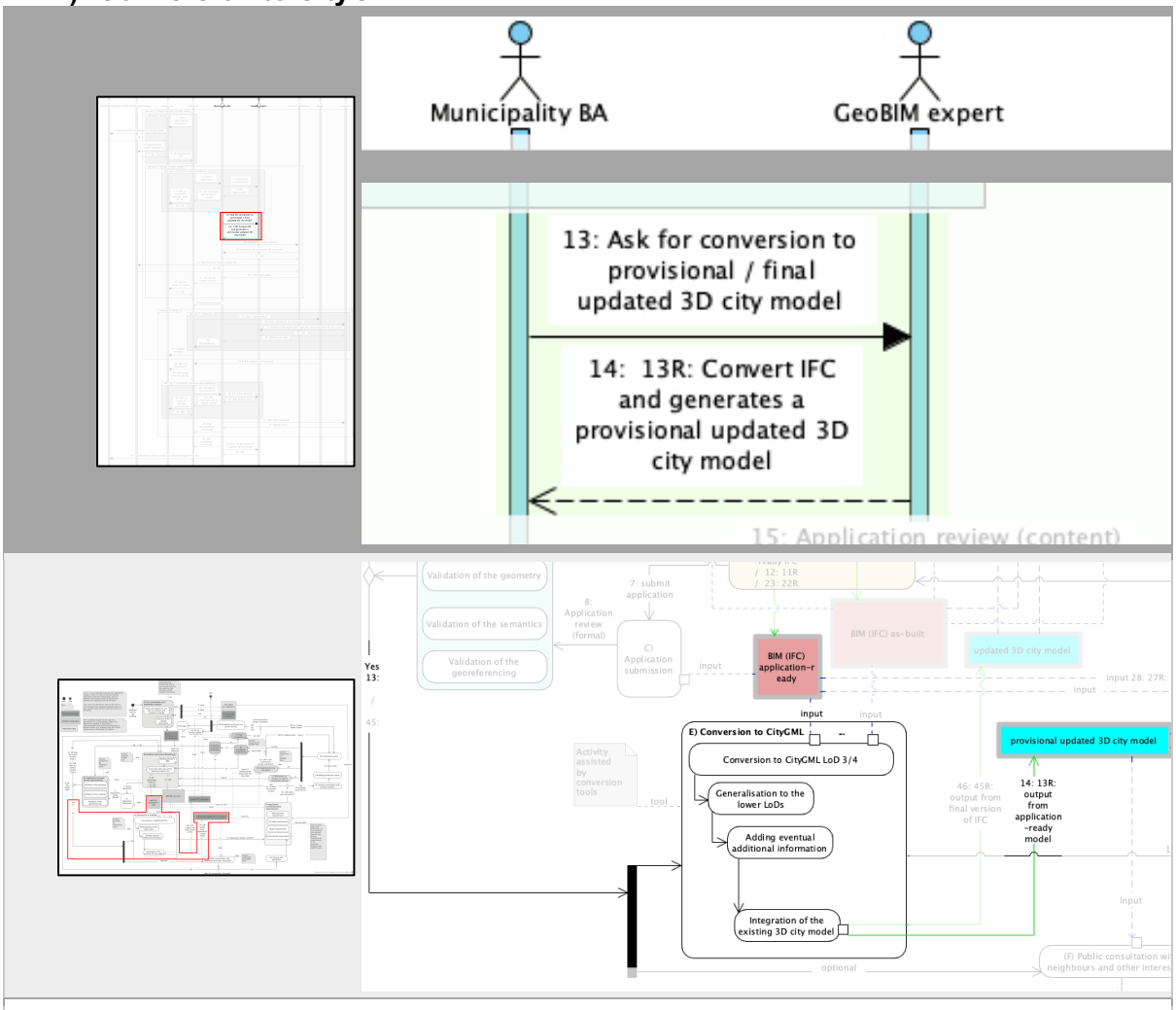
D) Application reviewed (formal)



In the formal application review (8:) the validity of the delivered IFC (geometric, semantic and georeferencing validity) is checked, using suitable validation tools[6].
If the model is not valid, the applicant (10: 7R:), and in turn the designer (11:), are asked to submit a new valid version of the IFC (12: 11R:) to be re-checked, until the result of validation is successful (13:) (Loop 2).

[6] The development and test of such tools is part of an on-going further part of this research.

E) Conversion to CityGML

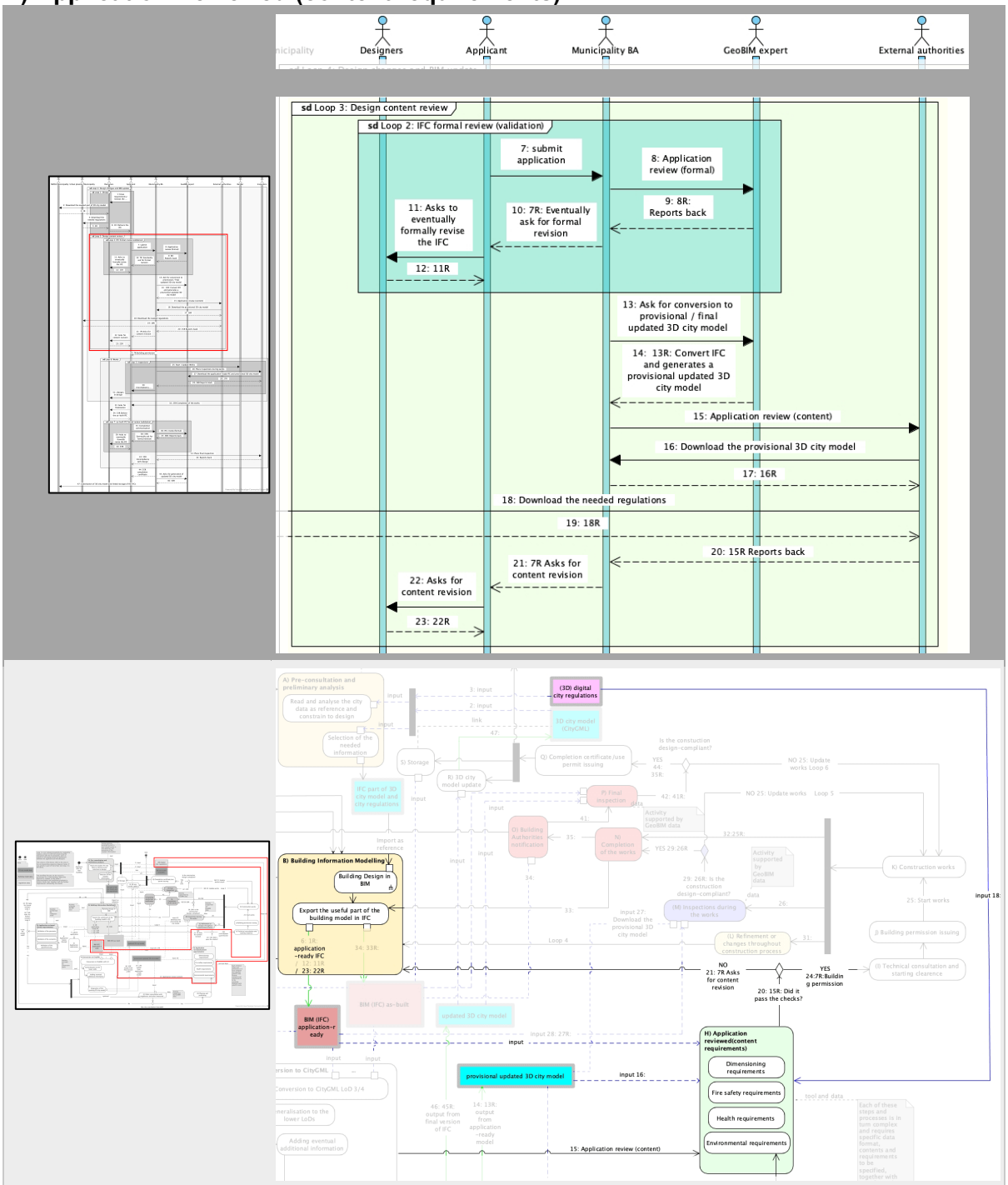


The valid application-ready IFC (submitted during the application) is here converted to CityGML to suitably integrate the 3D city model, in order to be used as input for the part of the checks needing a 3D city model.
A provisional updated 3D city model is generated (14: 13R:) to be used for checking the compliancy of the design in the regulations regarding the way the new building affects / is affected by the city.
The conversion to CityGML (E) includes several phases:

- the conversion of the IFC to a Level of detail (LoD) 3 or 4;
- the generalization of those to the lower LoDs, in order to generate the complete multi-LoD 3D city model;
- the addition of information eventually not included in the original model (e.g. in useful Application Domain Extensions);
- And finally, the integration of the new model in the existing 3D city model.

These steps are for the moment hypothetical, but they will be further investigated and tested within more specific procedures to understand the most effective solution for a successful and useful conversion.

H) Application Reviewed (content requirements)

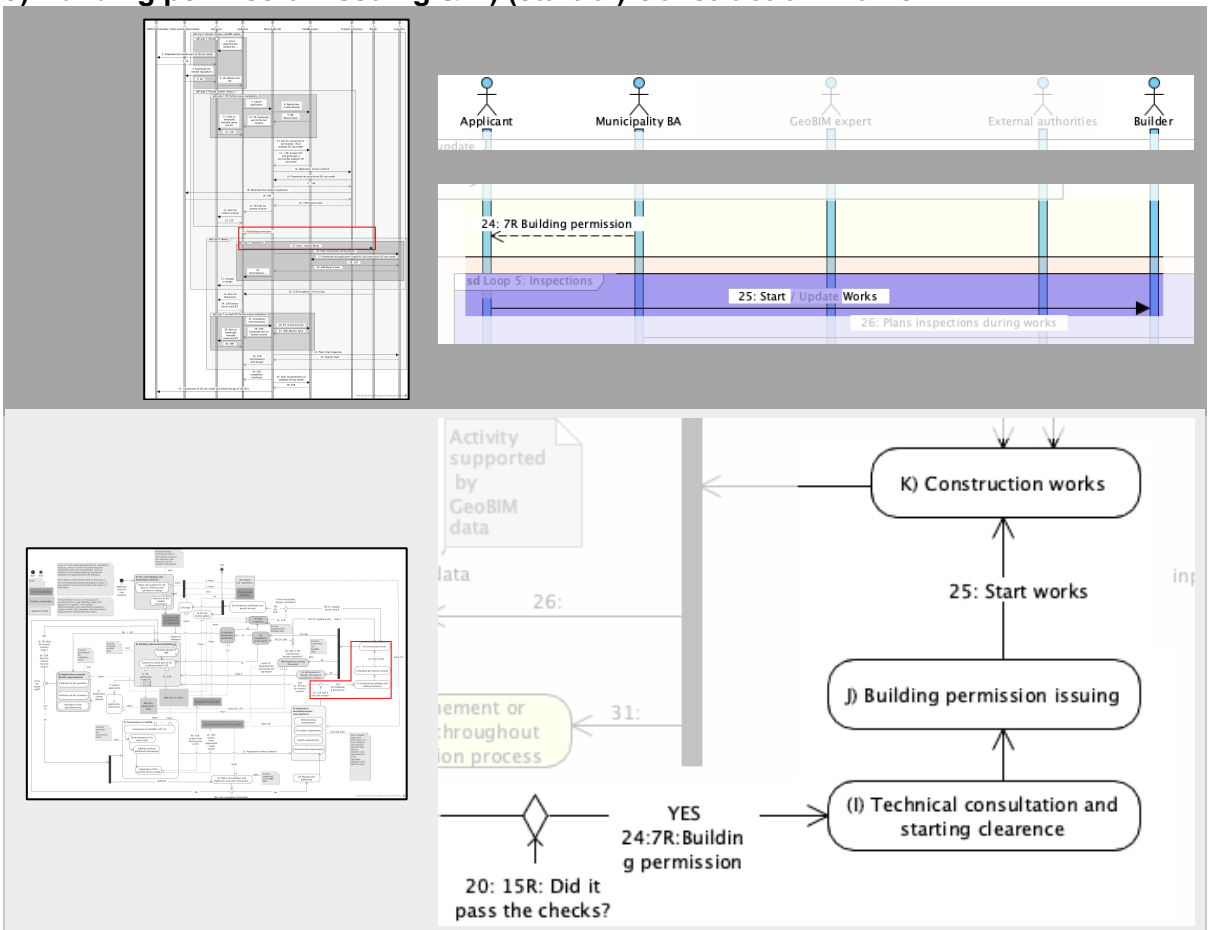


In the review of the application content, specific authorities (both internal and external to the Municipality: design auditors, structural reviewers, fire safety authorities, historical and artistic authority, when needed, health and safety authorities and so on) are asked to review and approve the design of the new building (15:).
In doing this, they need the delivered application-ready IFC, the provisional updated 3D city model (16:) and the city regulations and constraints provided in a suitable digital format (18:).
By using this information as input in suitable tools[7], it will be possible to automatize the checking of the compliancy to the regulations.

[7]The development and test of such tools is part of an on-going further part of this research, and they should be customized based on the specific regulations needs.

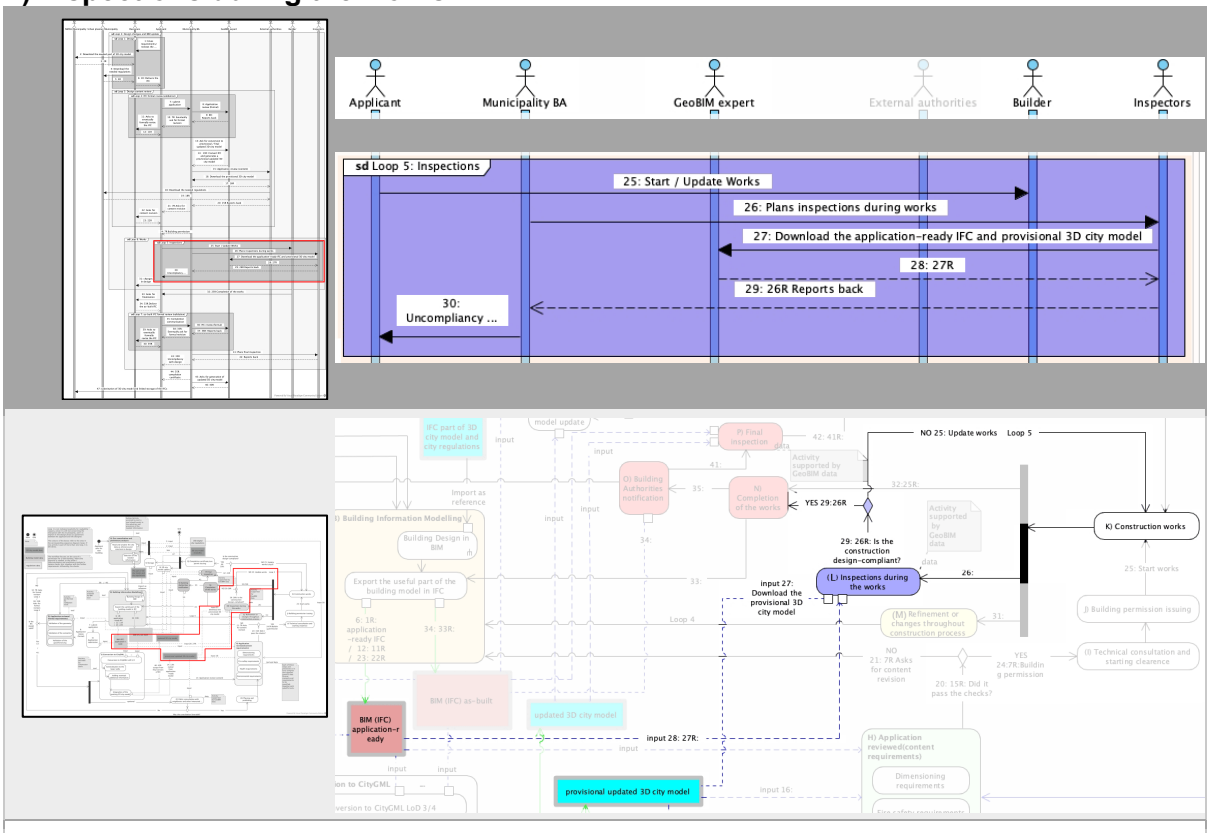
If the result of the checks is positive (24: 7R:), the workflow proceed to the building permission issuing phase. Otherwise (21: 7R), the process goes back to the modelling phase, and the applicant (and the designer, in turn) are asked to submit a new version of the design respecting the requirements and constraints given by the regulations.
The new version of the BIM is then submitted again and has to pass through all the steps again (validation D; conversion to 3D city model E, and content review H) (Loop 3).

J) Building permission issuing & K) (start of) Construction Works



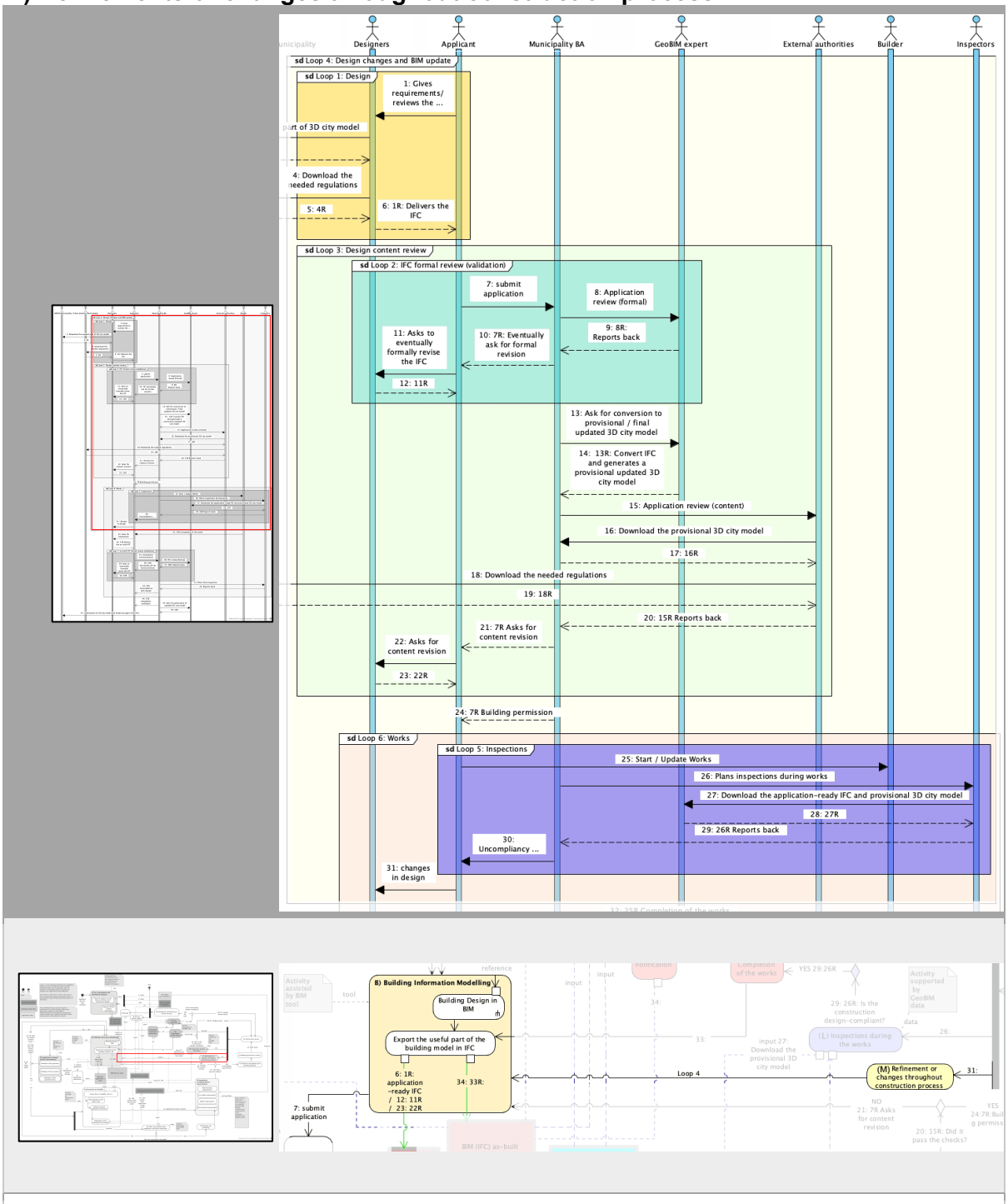
If all the checks are successful, the building permission is issued (J) and the Construction works (K) can start (25:).

L) Inspections during the works



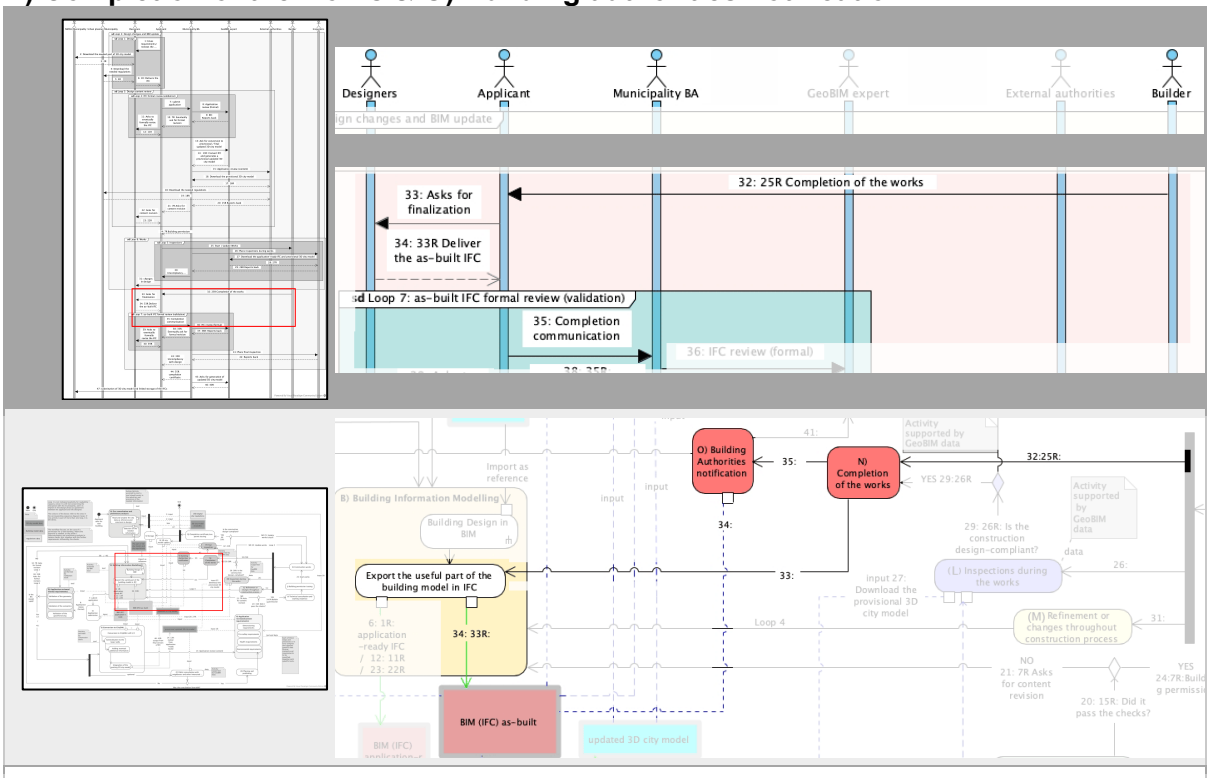
During the works, the Municipality can plan inspections (26:), for which the application-ready IFC (28: 27R:) and the provisional 3D city model (28: 27R:) are used as reference. If the works are not compliant with the design, the works must change the construction in order to make it compliant (25:) until the inspection result is positive (Loop 5).

M) Refinements or changes throughout construction process



It is the case in which the Applicant decides to ask for changes to the submitted design (31:) (even small changes, like the increase of height of the building and so on), also as a consequence to a not successful inspection, so that he could try this solution instead of demolishing the already realized works.
In this case the process goes back to the modelling phase (B) and all the steps must be performed again (submission of the IFC, formal review D, conversion to 3D city model E, content review H) (Loop 4).

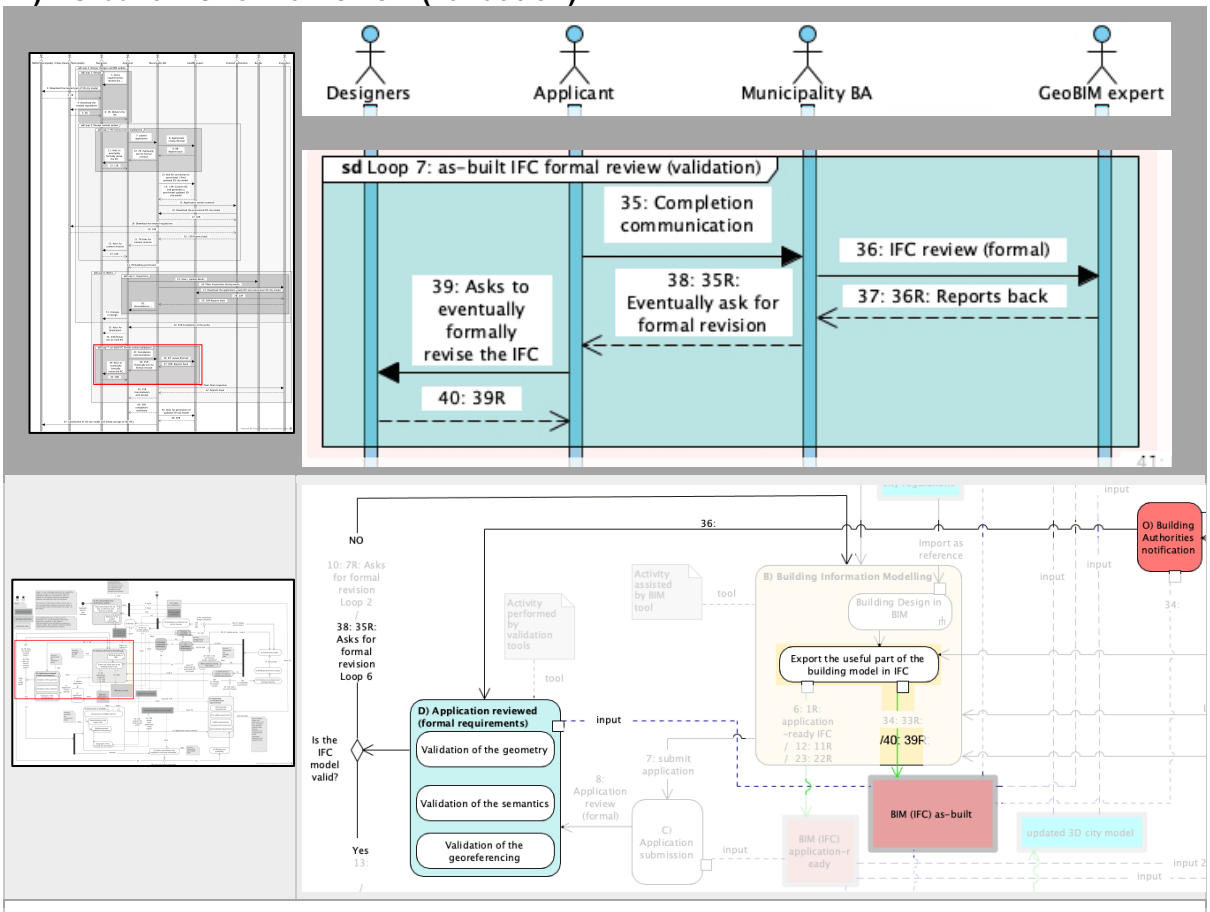
N) Completion of the works & O) Building authorities notification



When the works are completed, the as-built IFC[8] is exported (34: 33R:) and delivered as part of the documentation for the Building Authorities notification (O) when communicating the completion.

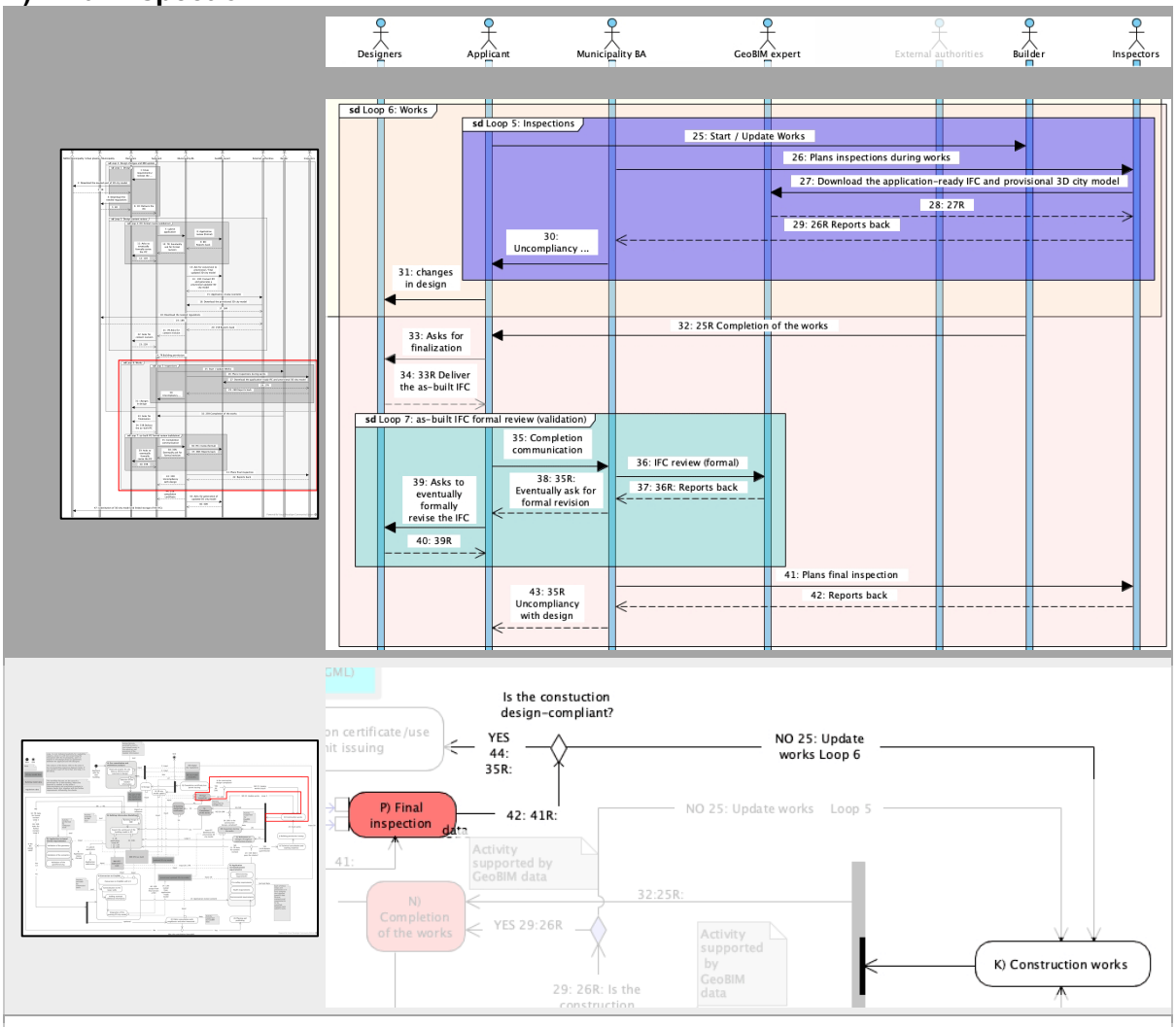
[8] This model is exported from the same BIM used for design, which was also the source of the IFC delivered for the previous phases. However, the export follows different rules, since the included information and Level of development of the included objects are different (more specific).

D') As-built IFC formal review (validation)



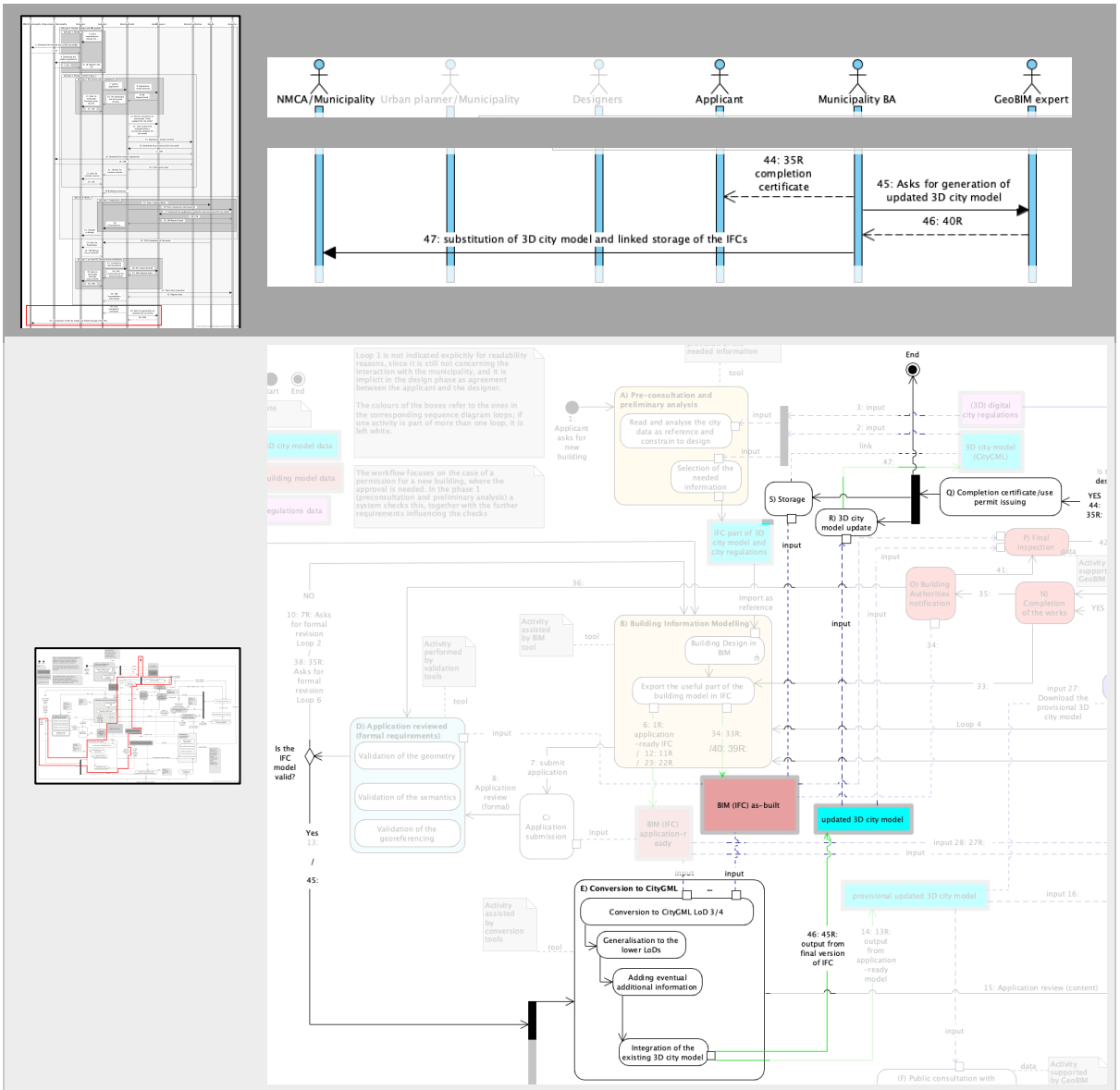
The as-built IFC has also to pass through a validation process (D) which must be successful, otherwise the IFC must be fixed accordingly (38: 35R:) (Loop 6).

P) Final inspection



With the full and up-to-date documentation, the final inspection can be performed (42: 41R:). If the construction is not design-compliant (25:), the works must be updated to fix it, and the process would begin again from that point (Loop 7).

Q) Completion certificate / use permit issuing & R) 3D city model update & S) Storage of BIMs



In the result of the final inspection is positive (44: 35R:), the completion certificate is issued by the municipality, which also stores the updated 3D city model deriving from the integration of the final version of the IFC (46:), replacing the previous one (47:). The IFC, both in the application-ready format and in the as-built format are stored by the municipality in connection to the 3D city model, in order to be reference for further developments (e.g. future works and building changes) or other use cases (e.g. asset management support).

References

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