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ORIGINAL ARTICLE

Proposal for conceptual model for city information modeling at a University

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Abstract:

The term City Information Modeling - CIM is a recent concept that encompasses, among other aspects, the integration between Building Information Modeling and Geographic Information Systems. CIM has been predominantly applied in cities; however, since the environment of a university campus possesses characteristics similar to a municipality, CIM can be a promising tool for managing these institutions. This paper proposes a data organization model for CIM, based on CityGML extensions. A methodology was proposed for the creation of extensions that can be applied to activities requiring spatial and building data. As an example, the activity of developing a technical project for fire and disaster prevention was used, in the environment of the Federal University of Paraná. To create the method, the available data and its format were studied, as well as its geometric and semantic correspondence with CityGML. The result was a conceptual model for the application domain extension (ADE) of CityGML for the development of firefighting projects, referred to in this work as ADE_FirePrev.

Keywords: 3D City models; Building Information Modeling; 3D Geographic Information Systems; CityGML; IFC.

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1. Introduction

Three-dimensional city models are tools that have enabled data analysis in various applications, such as energy generation potential, urban land registry, infrastructure planning, route optimization, noise propagation, energy demand estimation, emergency response, etc. (Biljecki et al. 2015). Semantic 3D city models are three-dimensional models that contain urban knowledge or semantic information, as opposed to a 3D model that contains only pure geometric information. (Billen et al. 2014).

Since semantic 3D representations of the city are models that contain information - predominantly of buildings and engineering structures - it is possible to establish a parallel with the concept of Building Information Modeling (BIM), as both are methods for modeling, creating and analyzing three-dimensional representations of physical objects in the environment. (Kolbe and Donaubauer 2021). BIM, defined by Eastman et al. (2011) as "a modeling technology and an associated set of processes for creating, communicating and analyzing building models", is mainly focused on modeling buildings and their construction components, supporting and monitoring the management of physical assets, such as buildings, networks and urban furniture, and processes, in the planning, construction and life cycle phases.

The synergy between the concepts of semantic 3D city models and BIM led to the creation of a new term: City Information Modeling (CIM), introduced by Khemlani, editor and founder of the online publication AECbytes, in 2005, in his article "Hurricanes and their Aftermath: How Can Technology Help?" (Gil 2020; de Amorim 2015). Since then, the term has been used in various research related to urban environment modeling technologies. Gil (2020: 512) introduces CIM as described below:

> "City Information Modelling is the practice of using interactive digital technologies in the process of urban planning, by all actors and stakeholders, to collaboratively deliver the vision of a Smart City: a sustainable, inclusive, healthy, prosperous and participative city. CIM consists of an ecosystem of interoperable (open source) tools from different knowledge domains, for data processing, urban analysis, design, modelling, simulation and visualization. (...)."

The information is organized in a model, in which its characteristics and relationships are described, which support different types of analysis, design, modeling, simulation, reporting, collaboration, and visualization. In semantic 3D city models, the ontological structure, including thematic classes, attributes, and their interrelations, is stored in the conceptual model. The objects are decomposed into parts by logical criteria, which follow given or observable structures in the real world. (Kolbe 2009). In Building Information Modeling, the models are composed of instances, or BIM objects, that store information about construction components, such as walls, beams, columns, parts and plumbing and electrical installations, equipment, furniture, etc. (Soares 2021). The heterogeneity of this data poses challenges in terms of potential conflicts and inconsistencies.

Considering that the City Information Modeling has been studied as an aid to city management, this paper hypothesizes that CIM could be applied to the management of the physical structure of a university campus, due to the similar aspects they share with cities. A university campus is characterised by a variety of features, including buildings, infrastructure networks, green areas, roads and urban furniture. It is a common occurrence that information pertaining to the organisational structure of universities is stored in a variety of repositories and formats, which often poses significant challenges when attempting to integrate this data.

The problem of this research was how to define a d organization model focusing on a specific application, using the Federal University of Paraná, Brazil, as a case study. The central supposition of this study is that an extension of CityGML, a standard format for 3D city models, has the potential to organise data for specific tasks in such a manner as to facilitate analyses and enhance building management. The objective of this study was to propose a methodology for creating a conceptual model of the application domain extension that can structure City

Information Modelling, with a particular focus on the university environment. CityGML, a format approved by the Open Geospatial Consortium (OGC) to standardize the entities, attributes, and basic relationships of a 3D city model (Kolbe et al. 2021), will be presented in section 2.

The application studied in this work was the activity of developing a technical project for fire and disaster prevention. To elaborate on a technical fire and disaster prevention project, information about the building and its surroundings is key to determining which safety measures should be used in the building. Despite CityGML be well-documented and has important applications implemented, in the context of a technical fire and disaster prevention project, this model lacks specific information regarding some elements of the building, such as alarms and piping. In order to address this deficiency, it is possible to integrate information from vector data, in shapefile format, and BIM models, in IFC format, into the conceptual model (Figure 1).

Vector data was supplied by the UFPR CampusMap Project (UCM), an initiative which makes mapping data available to the entire university community. The project has facilitated the management and planning of infrastructure, as well as the planning of contracts, in several sectors. With regard to BIM models, Brazilian legislation has been instrumental in promoting their adoption within the public sector. For universities, the integration of BIM into the management of their facilities constitutes a pivotal strategy for enhancing the maintenance of their infrastructure, extending the lifespan of their buildings, and optimising the utilisation of public resources.

The present paper proposes a conceptual model for the incorporation of the aforementioned data into CityGML, utilising an Application Domain Extension (ADE). An ADE is a mechanism used to incorporate specific application data into the conceptual model in a systematic and well-structured manner, preserving the core concepts. (Kolbe et al. 2021). Two important ADE’s already developed, GeoBIM (De Laat and van Berlo 2011) and IfcADE (Biljecki et al. 2021), use IFC data to enrich the CityGML model. In addition to IFC data, other types of information, coming from sensors, for example, can be incorporated into the model.

Source: The authors (2025).

Figure 1: Vector data and BIM model of university building.

In this work, version 3.0 of CityGML was used. However, due to the relatively recent publication of this version, not much literature has been published up to now regarding ADEs (Bachert et al 2024). Recent works include Petrova-Antonova et al. (2024), which proposes a conceptual model for a Vegetation ADE module; Bachert et al. (2024), which addresses the adaptation of the Energy ADE to CityGML 3.0, aiming for lossless data conversion while leveraging the new version's features; Saeidian et al. (2023), which proposes an ADE to support 3D underground land administration; and Eriksson et al. (2020), which presents a proposal for a national building standard in Sweden. The proposed ADEs contribute significantly to specific domains, demonstrating that CityGML 3.0 offers greater flexibility for advanced urban modeling.

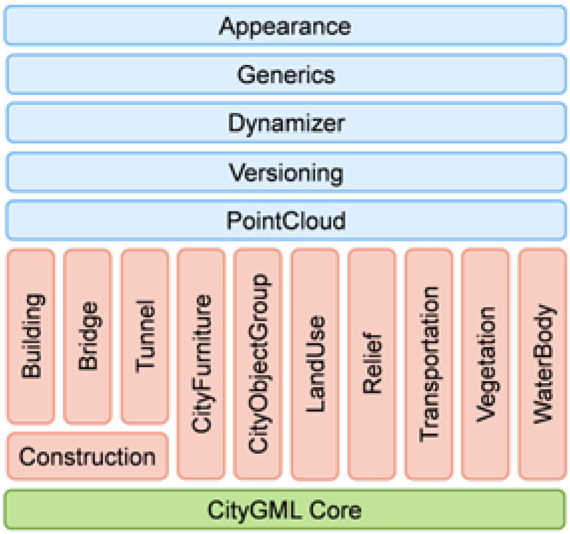
2. CityGML

CityGML is a standard based on Geography Markup Language (GML), created for a common definition of the entities, attributes, and basic relationships of a 3D city model, which promotes sustainable and economical maintenance of the modeling, allowing the reuse of the same data in different fields of application. (Kolbe et al. 2021). Version 3.0, published in 2021, has the most recent structure adopted by the format. (Kutzner et al. 2020).

The structure of CityGML 3.0 (Figure 2) consists of a central module (Core) and several extension modules. While the central module comprises the basic concepts and components of a virtual city, each extension module covers a specific thematic field such as buildings, bridges, tunnels, digital terrain model, water bodies, vegetation, transportation, urban furniture objects, etc., necessary to support the entire data model, but it can employ only a subset of modules according to its specific needs. (Kolbe e Donaubauer 2021). The vertical boxes show the different thematic modules, and the horizontal ones specify concepts applicable to all thematic modules.

The conceptual model of CityGML is documented using UML notation, through static structure diagrams. (Kolbe et al 2021). As mentioned by Biljecki et al (2021), “at the expense of keeping things simple, it might be considered limited and might not suit a large number of use cases and situations. For this reason, the CityGML data model is often extended using the ADE mechanism”.

ADEs can be constructed by introducing new classes or resources, adding new attributes to existing classes or resources, or extending lists of attribute codes. The modeling of ADEs allows for changes, such as creating classes for solar panels with their own geometry and attributes, including the number of units in a building (an attribute that does not exist in the standard model), and adding new types of construction that do not fit the CityGML code list, to create national standards. (Biljecki et al. 2021).



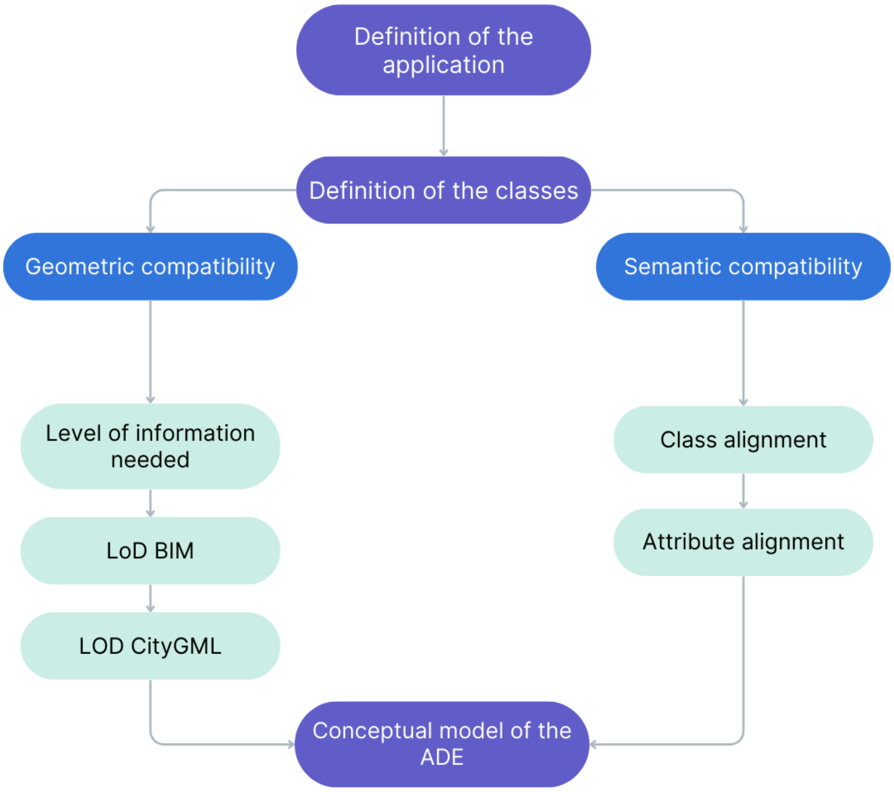
Source: Kolbe et al (2021).

Figure 2: CityGML 3.0 structure.

Just like the conceptual model of CityGML, an ADE must be defined in UML language, according to the specifications of ISO 19109:2015, which guides the rules for application models. The rules of ISO 19103:2015, which standardizes the use of UML for geographic information, must also be followed. (Kolbe et al. 2021). The classes of an ADE can have an unlimited number of attributes and associations, in addition to those inherited from the existing classes in CityGML. To ensure semantic interoperability, the predefined attribute types of CityGML or the standardized models of the ISO 19100 series of International Standards should be used whenever appropriate. If a predefined type is not available, ADEs can define their own data types or import data types from external conceptual models. (Kolbe et al. 2021).

3. Materials and methods

This chapter describes the procedures involved in proposing the conceptual model for the ADE. The development followed the steps outlined in Figure 3. The first step is the definition of the application, so that the ADE classes can be determined. In this case study, the classes will be defined based on the safety measures required for the building, in the technical fire and disaster prevention project, determined by the - Fire and Panic Safety Code – CSCIP of the state of Paraná, Brazil. Once the classes are determined, geometric compatibilization will be carried out based on the necessary level of information and semantic compatibilization, with the alignment of classes and attributes.



Fonte: The authors (2025).

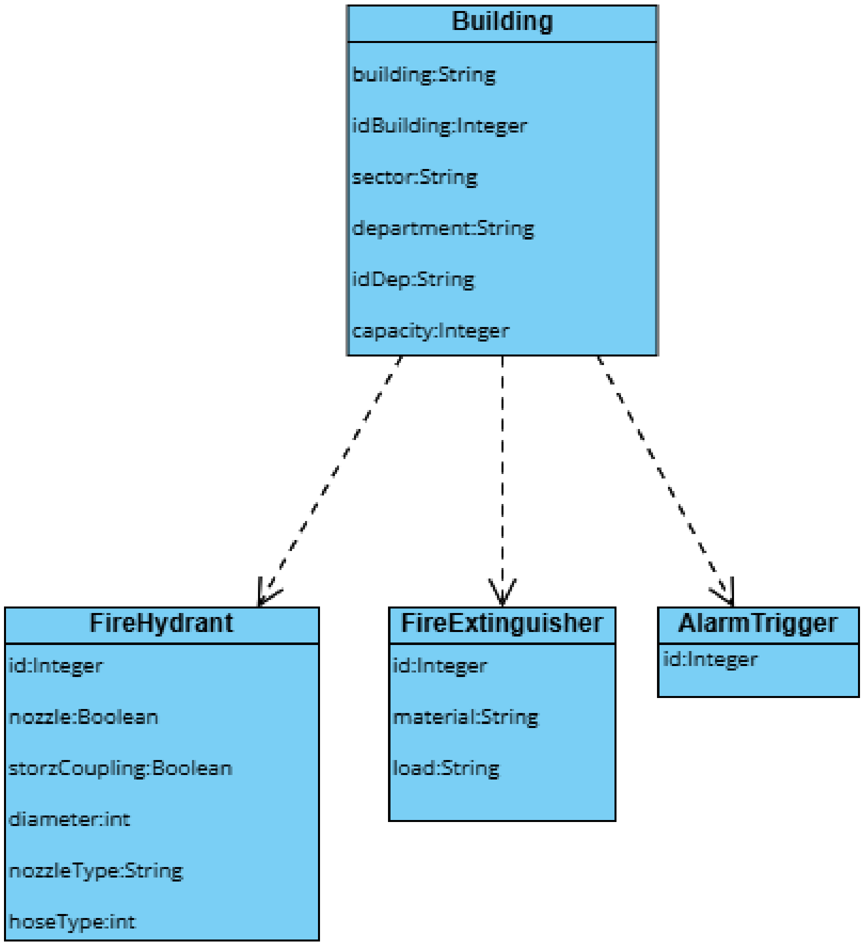
Figure 3: Methodology overview.

For the development of the ADE framework, the following documents were used:

- Fire and Panic Safety Code – CSCIP of the state of Paraná;
- Documentation of CityGML and IFC;
- Vector geospatial data;
- IFC models of the university buildings.

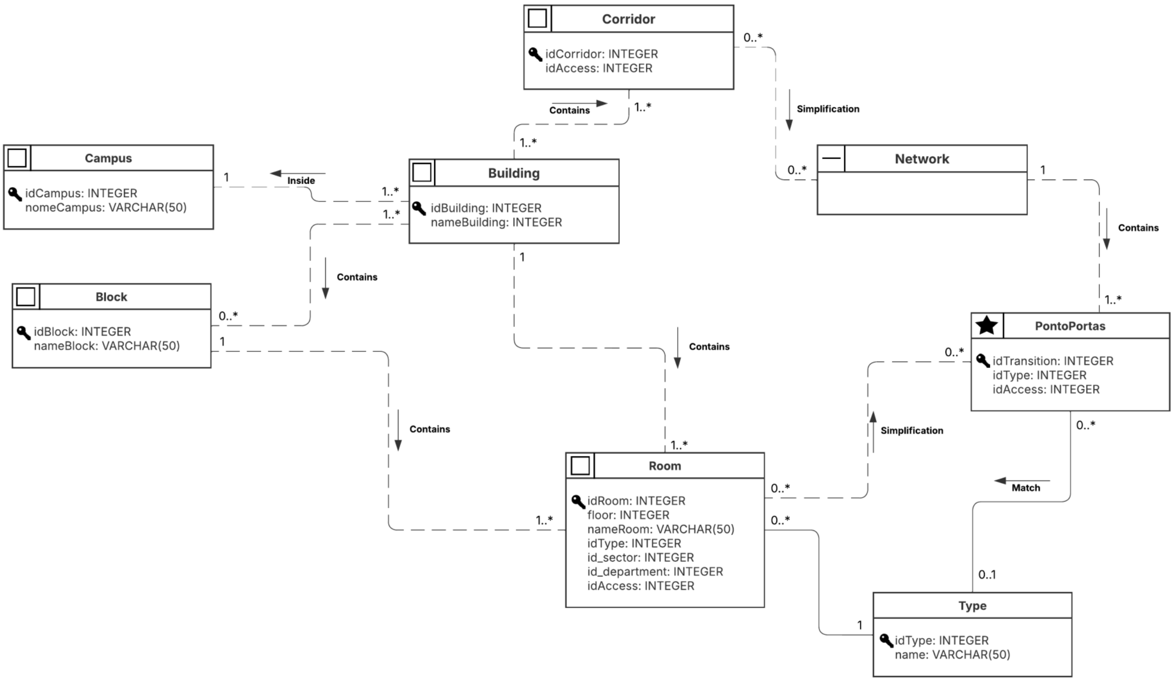
The vector data served as the basis for creating the CityGML model and is structured using a conceptual model based on the ET-EDGV – Technical Specification for Structuring Vector Geospatial Data. The ET-EDGV is the Brazilian standard that defines the structure of all object classes, attributes and the spatial and topological relationship that are dealt with when acquiring geospatial data. (CONCAR 2017). The UCM mapping was used to obtain data regarding internal elements that did not have a specific class in the IFC model, such as fire extinguishers, for example, and the surroundings of the buildings. Moreover, the UCM mapping could serve as a basis for the creation of the CityGML 3D model. The class diagram illustrating the mapping of UCM fire equipment is presented in Figure 4, while Figure 5 shows the class diagram of the UCM general mapping.

The methodology of this work is delineated across five sections. Section 3.1 discusses the definition of the application and presents in detail the development of a technical project for fire and disaster prevention. Section 3.2 presents the definition of the classes that represent real-world objects relevant to the activity. The geometric compatibility between the data models necessary for the project development is described in section 3.3, and the semantic compatibility is described in section 3.4. Section 3.5 presents the development of the conceptual model for the ADE.



Fonte: The authors (2025).

Figure 4: Class diagram of the mapping of UCM fire equipment.



Source: The Authors (2025).

Figure 5: Class diagram of the general mapping of UCM.

3.1 Definition of the application

The definition of the activity encompasses the identification of the type and quantity of information required for its development, executed by the relevant actors. In the context of incorporating information into CityGML model, this process of compatibilisation must be informed by the requisite level of information for the specific activity, evaluated from both geometric and semantic standpoints.

For the technical fire and disaster prevention project, whether for designed or existing buildings, information about the construction and its surroundings is required. When the building already exists and must be adapted to more recent standards, a common condition in older institutions, an even greater amount of data is required, as the existing safety measures in the building, such as extinguishers and safety lights. In Brazil, the technical fire and disaster prevention project is developed based on standards and codes published in each state. The Fire and Panic Safety Code of the Fire Department of Paraná (Paraná 2018) presents safety measures that must be adopted in buildings, based on the type of occupancy, height, and fire load. These are: vehicle access, separation between buildings, fire resistance of construction materials, compartmentalization, control of finishing materials, emergency exits, emergency elevator, smoke control, fire risk management, fire brigade, emergency lighting, emergency signage, extinguishers, automatic fire detection, fire alarm, structural safety, hydrants and hoses, automatic sprinklers, emergency plan.

For each safety measure that the standard provides, there are information requirements that are necessary for the preparation of the project. For example, in order to determine the size of the emergency exits, it is necessary to know the height of the room, the width of the stairs and doors, among other information related to the building elements and the surroundings. These elements were identified as objects and, based on them, the classes that represent them in CityGML, IFC, and the UCM conceptual model were defined (Table 1).

Table 1: Objects and classes.

Objects	CityGML	IFC	UCM
Window	*Window*	*IfcWindow*	-
Room	*BuildingRoom*	*IfcSpace*	*Room*
Building	*AbstractBuilding*	*IfcBuilding*	*Building*
Opening	*AbstractFillingElement*	*IfcOpeningElement*	-
Reservoir	*BuildingConstructiveElement*	*IfcTank*	-
Stairs	*BuildingInstallation*	*IfcStair*	-
Corridor	*BuildingPart*	*IfcSpace*	*Corridor*
Door	*Door*	*IfcDoor*	-
Railing	-	*IfcRailing*	-
Main door	*Door*	*IfcDoor*	-
Floor	*FloorSurface*	*IfcCovering*	-
Wall	*InteriorWallSurface*	*IfcWall*	-
Ceiling Surface	*CeilingSurface*	*IfcCovering*	-
Roof Surface	*RoofSurface*	*IfcCovering*	-
Road	*Road*	-	*RoadSegment*
Slab	*BuildingConstructiveElement*	*IfcSlab*	-
Beam	*BuildingConstructiveElement*	*IfcBeam*	-
Wall Surface	*WallSurface*	*IfcWall*	-
Elevator	*BuildingInstallation*	*IfcTransportElement*	-
Building Floor	*BuildingUnit*	*IfcBuildingStorey*	-
Air inlet /Air outlet	-	*IfcFlowTerminal/IfcDuctSegment*	-
Emergency light fixture	-	*IfcLightFixture*	-
Emergency signage	-	*IfcSign*	-
Fire extinguisher	-	-	*FireExtinguisher*
Alarm trigger	-	*IfcAlarm*	*Alarmtrigger*
Alarm indicator	-	*IfcAlarm*	-
Smoke detector	-	-	-
Hydrant	-	*IfcFireSupressionTerminal*	*FireHydrant*
Antifire piping	-	*IfcPipeSegment*	-
Fire pump	-	*IfcPump*	-
Booster valve	-	*IfcValve*	-
Automatic sprinklers valve	-	*IfcValve*	-

Source: The authors (2025)

The correspondence between the data models was carried out geometrically and semantically, as described in the following items.

3.2 Geometric Compatibilization

For the geometric compatibilization between IFC and CityGML, the concepts of Level Of Development (LoD) from the BIM Forum were used for IFC, and Level of Detail (LOD) from CityGML. For the IFC objects, a LoD of 350 was used, as it is necessary that "their quantity, size, shape, location, orientation, and interfaces with adjacent or dependent Model Elements can be measured" (BIM Forum, 2023, p. 15). From the IFC LoD, the correspondence with the CityGML LoD was carried out. In the case of doors, for example, the LOD involves an internal LOD3 and an external LOD3. Version 3.0 of CityGML differentiates the LODs inside and outside the building. External openings are added in LOD3, and the same logic was followed for the interior part.

For the UCM classes, the geometric compatibility was conducted as proposed by Santos (2021) based on the provisions in the Brazilian standard Technical Specification for the Acquisition of Vector Geospatial Data (ET – ADGV) and the CityGML 2.0 documentation, which was used here as an analogy, given that the specification of the LODs is more complete in this version. Since the vector data was used to create the CityGML model, this correspondence was created with the aim of having an idea, for each class worked on, in which LOD the features could fit and whether they would exist in the representation, according to the prerequisites for each LOD of CityGML 3.0. (Santos 2021).

For the *Building* and *RoadSegment* classes, the scales and their relationship with the CityGML LODs were analyzed and represented in Table 2. The classes *Room* and *Corridor* do not exist in ET-EDGV; however, they have already been included in the IFC analysis. Table 2 presents the scales planned for the acquisition of the class, with the value referring to the thousandth of the denominator of the scale, that is, *RoadNetworkSegment*, for example, can be represented from the scale 1:1,000 to the scale 1:100,000. A, L, and P represent possible options for graphic primitives for acquiring the object, according to its dimension. In the case of an area representation (A), for the *RoadSegment*, for example, it must be larger than 12.5mm². In the case of representation by line (L), the length must be greater than 10mm. For this class, point representation (P) is not possible. (CONCAR, 2017).

Table 2: Objects acquisition according to scale.

Class	Scales	Height	Width	P
		s>=(mm²)	D>=(mm)	
RoadSegment	1-100	12,5	10	-
Building	1-100	1	-	X

Source: Adapted from CONCAR (2017)

Table 3 presents the minimum elements representable in CityGML. It was adapted from Santos (2021) with the exclusion of LOD 4, as in version 2.0, it was used for interior representations and constructive elements. The minimum representation dimensions of A and L, in Table 2, were calculated for each scale. They were also compared to the minimums considered for CityGML 2.0, to verify their representation in that model.

Table 3: Elements which are representable in CityGML.

	Area (m²)	Line (m)
LOD 1	36	6
LOD 2	16	4
LOD 3	4	2

Source: Adapted from Santos (2021)

4. Results and discussion

32 real-world objects were identified. (Table 1). Of the 32 listed objects, 19 had CityGML classes that represented them. The IFC classes, in turn, encompassed 29 of the 32 objects. The UCM classes, only 7 objects. This result was expected, given that many of the objects are elements of the building and IFC is the format richest in information about the interior of the building.

4.1 Geometric Compatibilization

Table 4 presents the minimum LODs of the CityGML model for each object, considering the BIM LoD defined in 350 for all, due to the need for reliable measurements of the elements. When windows need to be represented, for example, the minimum external LOD of CityGML is 3, as openings are required. Internally, details are not necessary, so a LOD 0 could be accepted. However, if the rooms have fundamental representation in the CityGML model, the external LOD can be 1, as there is no need for details; internally, divisions are required, so LOD 3 is the minimum recommended. It is important to note that the configuration of this table will vary according to the distinct characteristics inherent in each application type, even in this type of project, because different measures of the Safety Code necessitate different elements of the model, so the LOD can change.

Regarding the UCM classes *RoadSegment* and *Building*, which are derived from ET-EDGV, Tables 5 and 6 present the minimum dimensions for area and width representation for each scale. It is also presented in which CityGML LODs each scale can be represented and whether this occurs through line, area, both, or neither. For the 1:1,000 scale, for example, the minimum dimension to be mapped for an object of the *RoadSegment* class would be an area of 12.5m² and a length of 10m. An object with these dimensions would be represented in CityGML only in LOD3. The buildings, in turn, begin to be mapped in CityGML starting from the 1:10,000 scale, in LOD3.

Table 4: Detail levels.

Object	External CityGML LOD	Internal CityGML LOD
Window	3	0
Room, Slab, Beam, Corridor, Railing, Floor, Lining, Elevator, Floor of the building, Air inlet/outlet, Emergency light fixture, Extinguisher, Alarm trigger, Alarm indicator, Smoke detector, Hydrant, Fire piping, Fire pump, Booster valve and Sprinklers valve	1	3
Building	2	0
Opening	3	3
Reservoir	2	3
Stairway	3	3
Door	3	3
Gate	3	-
Wall	3	3
Roof	3	0
Road	-	-
Façade	1	0

Source: The authors (2025)

Table 5: Minimum dimensions for area and width representation for the class *RoadSegment.*

Scales	1000	10000	25000	50000	100000
Minimum area (m²)	12.5	125	312.5	625	1250
Minimum dimension (m)	10	100	250	500	1000
LOD1	no	yes	yes	yes	yes
LOD2	no	yes	yes	yes	yes
LOD3	yes	yes	yes	yes	yes

Source: The authors (2024)

Table 6: Minimum dimensions for area and width representation for the class *Building.*

Scales	1000	10000	25000	50000	100000
Minimum area (m²)	1	10	25	50	100
Minimum dimension (m)	-	-	-	-	-
LOD1	no	no	no	yes	yes
LOD2	no	no	yes	yes	yes
LOD3	no	yes	yes	yes	yes

Source: The authors (2025)

The classes *Room* and *Corridor* do not belong to ET-EDGV, but since they are classes that belong to IFC and have already had their analysis conducted in this section, they were not addressed again.

The classes *Extinguisher, Hydrant* and *AlarmTrigger* are not derived from ET-EDGV and do not have a corresponding class in CityGML.

4.2 Semantic Compatibilization

For a total of 86 attributes analyzed, referring to the classes in Table 1, 21 had a total correspondence, 27 had a partial correspondence, and 38 had no correspondence. These are:

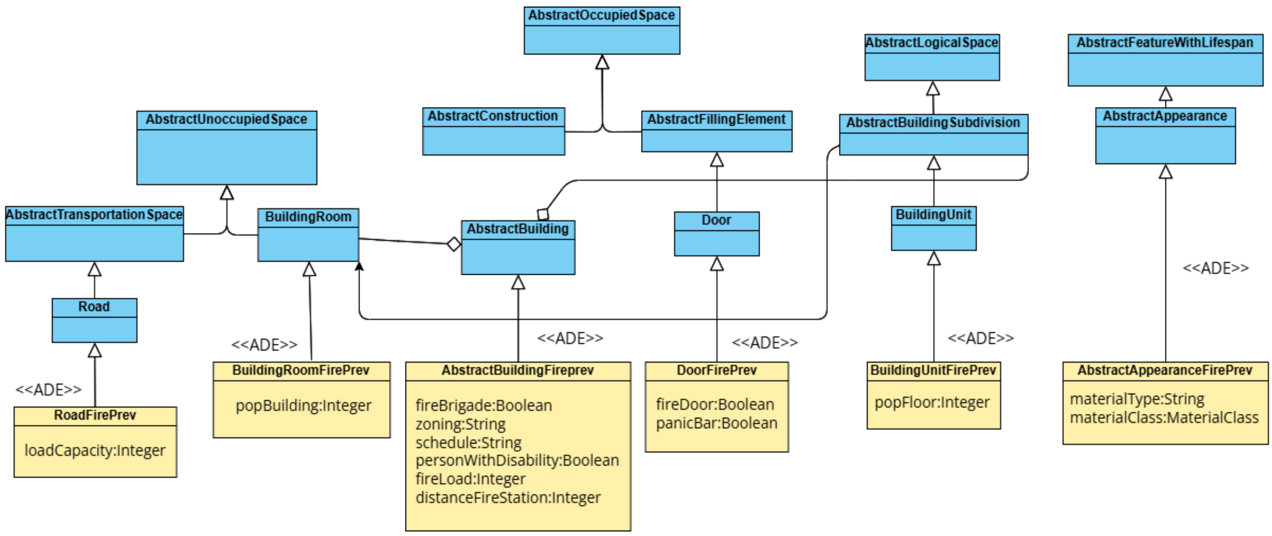
Total correspondence: location of windows; height and area of rooms; height, location, address, type, and occupancy of the building; location and area of openings; location and volume of the reservoir; width and height of stairs; width of the corridor; height, direction of opening, and operation of doors; width and height of the gate.

Partial correspondence: population of the rooms; material and height of the stairs, length of the landings, length of the enclosed stairwell lobby, height of the enclosed stairwell lobby; material of the doors, presence of fire door and panic bar; material of the floors, walls, ceiling, roof, slabs, beams, façade and elevator; width, load capacity, and clear height of the road; floor population.

No correspondence: distance to the fire department; height of the railing; distance from the floor to the duct in enclosed staircases, area of the duct section, proportion of duct dimensions, vertical distance between the duct's entrance and exit, horizontal distance on the floor plan from the air outlet to the entrance door of the anteroom, horizontal distance on the floor plan from the air inlet to the entrance door of the enclosed staircase; location, illumination level, and type of emergency lighting fixture; location and type of emergency signage; height of alarm indicators; location of smoke detectors; location and type of fire extinguishers; location and height of alarm triggers; location, dimensions, height, material, and type of fire hydrants, diameter and length of the hose, number of valves, minimum flow rate and pressure, distance from the hydrants to doors and stairs; location, diameter, material, condition (apparent or concealed), and color of the fire piping; flow rate and power of the pump; location of the hydrant valve and the sprinklers' valve.

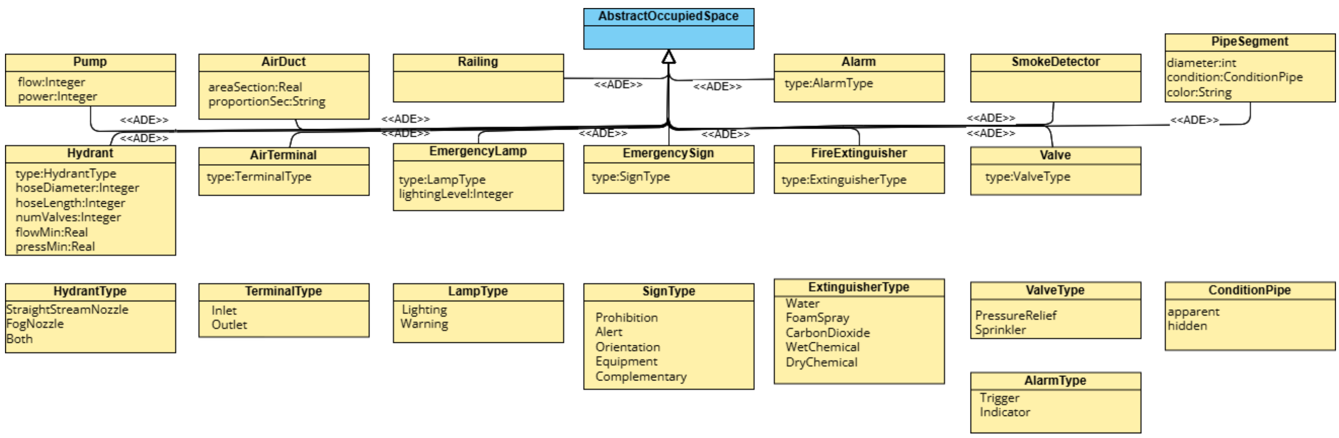
The conceptual schema was divided into two parts, A and B, and is represented in Figures 6 and 7. In part A, there are the existing classes that had attributes added. These are: *AbstractAppearanceFirePrev, BuildingRoomFirePrev, AbstractBuildingFirePrev, DoorFirePrev, RoadFirePrev*, and *BuildingUnitFirePrev*. In part B, 12 classes were created: *Railing; AirDuct; AirTerminal; EmergencyLamp; EmergencySign; FireExtinguisher; Alarm; SmokeDetector; Hydrant; PipeSegment; Pump* and *Valve*. The classes are classified in colors: the blue classes are CityGML pre-existing classes, yellow classes are the new classes.

The attributes related to the staircase are geometric and can be measured in the elements, therefore, it was decided to stick with the *BuildingInstallation* class, without the need to add attributes.



Source: The authors (2025).

Figure 6: Part A of ADE_FirePrev.



Source: The authors (2025).

Figure 7: Part B of ADE_FirePrev.

5. Final Considerations

The correspondence of real-world objects (related to buildings and surroundings) to IFC was much greater than that of CityGML, which can be explained by the fact that the latter contains more generic classes regarding the interior of the building. Thus, activities that involve internal elements of the building will be better represented in CityGML with the addition of information from IFC.

Although the UCM had fewer classes corresponding to CityGML, it serves as a basis for creating the CityGML model, in addition to filling some gaps, such as fire extinguishers, which do not have a specific class in IFC, and the road segments.

The choice to use CityGML as the basis for the conceptual data model was correct, as the addition of attributes to this format occurs in a logical and efficient manner. The model can be extended to a wide range of activities by users, and with version 3.0, there were changes that made the addition of new attributes even simpler. There are some classes, such as fire extinguishers, that also do not exist in IFC. However, the ADE mechanism makes it easier to create a class for this element in CityGML than in IFC, as in the latter new classes must be created according to the official standard.

This research focused on the development of the conceptual model. The coding and implementation will be carried out in later stages. The proposed data model, when implemented, will allow access to object attributes along with their visualization, which will expedite the process. Moreover, measurements that currently need to be verified on-site can be obtained by interested parties by accessing the model.

Despite the benefits of the proposed method, there are several points that need to be emphasized when it comes to limitations in obtaining IFC data, mainly, as reported by (Biljecki et al., 2021). The IFC datasets, in practice, are not always rich in semantics. Therefore, it is possible that there is a lack of information or incorrect classification, which hinders its utilization.

The study also presents some other limitations, such as the use of CityGML, which is still not supported by many software programs. Moreover, what the work proposes, that each ADE defined for different activities has classes and attributes determined according to different information requirements, results in the construction of different extensions for each activity, which can be somewhat laborious.

Even though the focus was on a university, the proposed method can also be used without detriment in cities and condominiums. The elements of the buildings and the surroundings are very similar, and although cities have a higher degree of complexity, specific ADEs can still be created for many activities involved.

As future recommendations, the following suggestions are made:

- The coding and implementation of the application;

- The construction of other ADEs for other activities developed at the university.

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AUTHORS CONTRIBUTION

Author 1: Conceptualization, Methodology, Validation, Formal analysis, Investigation, Resources, Data curation, Writing Original Draft, Visualization; Author 2: Conceptualization, Resources, Writing – Review and Editing, Supervision, Project Administration, Funding acquisition.

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