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WAARDERINGSKAMER

Semantically Rich 3D Building And Cadastral Models For Valuation

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Introduction

- Valuation of the properties can be defined as all efforts to calculate the market value
- Valuation of real estate/ properties is in many countries/ cities the basis for fair taxation
- Semantically rich 3D building models (e.g. BIM) and 3D Cadastral models are becoming more widely used day by day for different purposes.

Aim & Summary

- In this context , this study investigates
 - Relationship between physical real world objects and legal (virtual) objects
 - Valuation approaches in various countries around the globe
 - Improved valuation possibilities for the future

Building Models (Physical Objects)

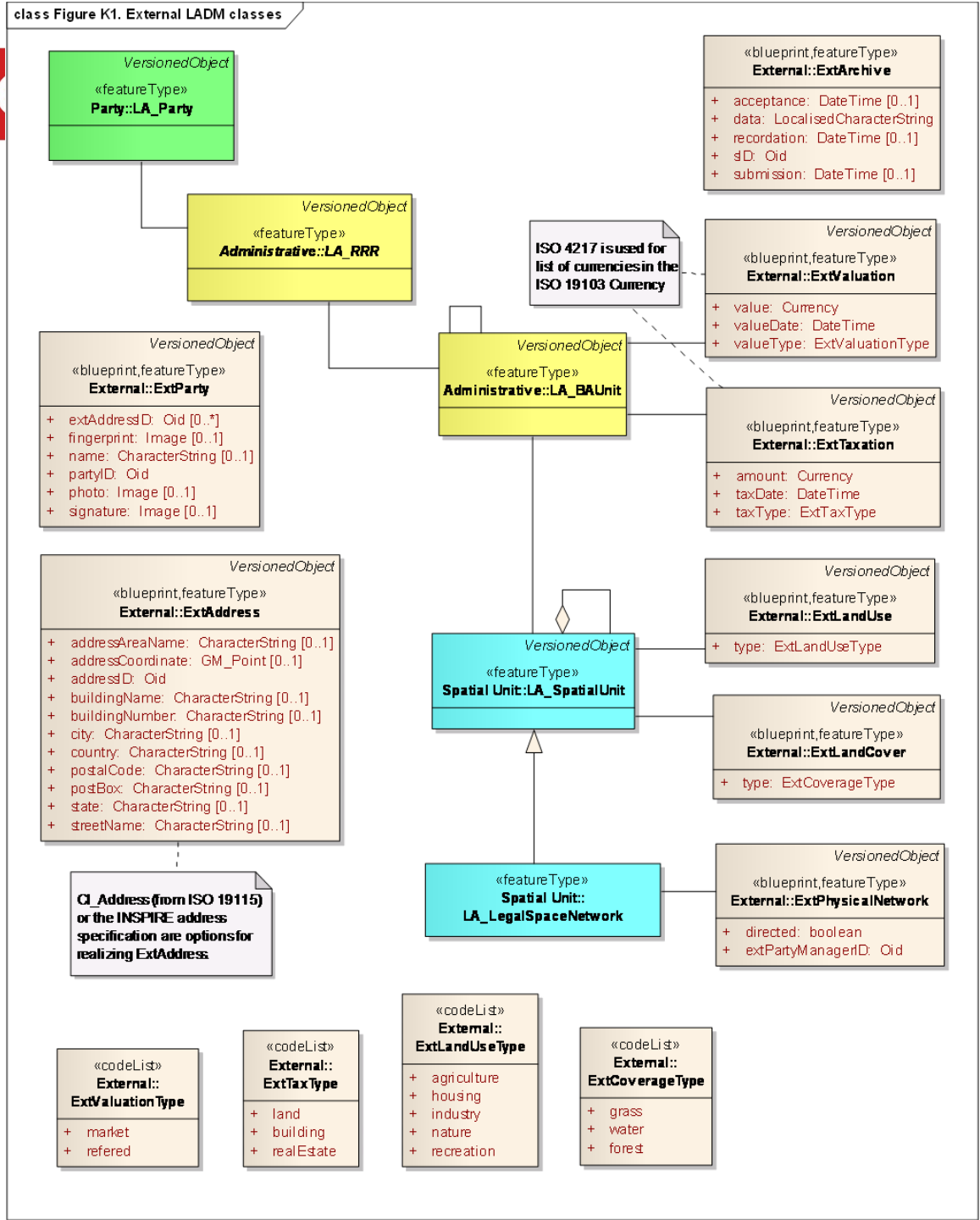
- Types of representation
 - 3D CAD
 - (Geometry-only / Solid- or Non-Solid representations / No GeoReference / Single but Most Detailed LOD \rightarrow LOD ∞)
 - GeoInformation Models (2,5D)
 - (Geometry – Linked Semantics / Feature Model of GIS / LOD 0-3 usually / GeoReferenced)
 - BIM (3D)
 - (Geometry + Semantic Data Definition in an Object Data Model - ISO 10303 based exchange format / Single but Most Detailed LOD \rightarrow LOD ∞ / Rarely GeoReferenced)
 - CityGML (3D)
 - (Geometry + Semantic Data Definition in an Object Data Model - XML based exchange format / LOD 0-4 / GeoReferenced)

Land Administration (Legal/Virtual Objects)

- Land administrations systems (land registry, cadastre) have different origins in different countries.
 - The information was sometimes collected for taxation purposes and in other cases for legal security
 - In many countries the land administration systems more and more served both applications; e.g. in the area of spatial development or spatial planning
 - Multi-purpose cadastre
- Based on the initiative of the FIG, ISO has developed the standard Land Administration Domain Model (LADM), ISO 19152:2012
 - Describes the relation between people and land
- The objects (parcels) are called legal or virtual objects, because they do not need to be visible in the real world.
 - Parcels can be in 3D→and mostly correspond to legal spaces (i.e. Tunnel, building part)

Relationship Between Physical And Virtual Objects

- (3D) Cadastre is about the legal spaces. That is, spaces described by geometry (and topology) where certain rights, restrictions or responsibilities (RRRs) are attached to.
- Only when the RRRs are different then also a separate geometry is needed
- Most likely only a part of the indoor building modeling information may be relevant in 3D Cadastre context (and perhaps that geometry is even implicit; e.g. a 3D boundary defined by the 'middle of the wall').
- The geometries of the real world (physical) objects and the geometries of the legal objects should be consistent
- When one has the responsibility to pay certain amount of tax based on the function/ type of a room/ space in a building, then this would fall under the definition of a legal space.



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Valuation In Various Countries

Turkey

- Determining the Market Value
 - Comparison with a reference sales price
 - Income approach; e.g. such as rent
 - Cost approach (Value of the land lot + Value of the building)
- Determining the Taxation Value
 - Comparison – when there are similarities
 - Income approach; e.g. such as rent
 - Asset cost= Gross Floor Area x Unit Cost (Unit Cost= Cost of 1 m².)

United Kingdom

- Valuation for Taxation
- In UK taxation scheme a property is defined as “A separate unit of living accommodation, occupied by the same person(s) and within the same area of land, comprises a ‘dwelling’, together with any garden, yard, garage or other outbuildings attached to it.
- In tax calculations each property is allocated to one of the eight bands, A to H, (‘A’ being the lowest) according to its national value on 1 April 1991
-a house decreases in value because...
-a home gains a higher value because...

USA

$$\bullet \text{ Assessed Tax} = (\text{Assessed Value} \pm \text{Correction}) * \text{Tax Rate}$$

Annotations:

- Always on target (points to Assessed Tax)
- Low side (points to +/- Correction)
- = sales price, 1st year (points to Assessed Value)
- Before cut-off (points to +/- Correction)
- After cut-off (points to Tax Rate)

- Assessed value
 - Fair market value
 - Preferential treatment: farms, non-profits, large employers, ...
 - Actual / optimal use
 - Type, use, size, location, improvements, desirability, RRR, original/replacement cost, income
- Local variation
- Benefit of 3D models/cadastres
 - Documentation, communication
 - Streamlining of assessment, correction
 - Forecasting, policy planning (effects of assessment changes)
- Guaranteed by property, owner, next owner

Germany

Einheitswert * Grundsteuer-messzahl

- Jahresgrundsteuer^{Assessed Tax} = (Grundsteuer-messwert^{Assessed Value}) * Hebesatz^{Tax Rate}

Always on target

Value Proxy!

- Assessed value
 - Value proxy
 - Preferential treatment: ...
 - Actual / optimal use
 - Type, use, size, location, *improvements, desirability, RRR, original/replacement cost, income*
- Local variation: Tax rate
- Benefit of 3D models/cadastres
 - Documentation, communication
 - Streamlining of assessment, *correction*
 - Forecasting, policy planning (effects of increasing density, RRR, ...)
- Guaranteed by property, owner, next owner

Netherlands

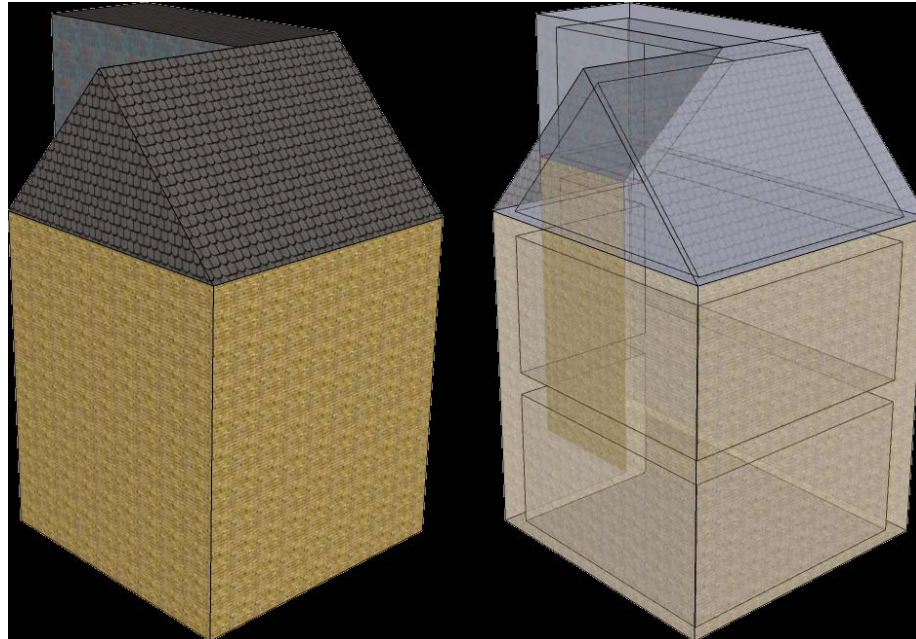
- Valuation
 - Residential:
 - Comparable sales
 - 0.1% – 0.2% tax rate
 - Non-residential:
 - Income/cost approach (& depreciation)
 - Higher rate
 - Paid by owner & by user, once each
- Mass appraisal
 - Administrative data, street view, ...
 - Determine comparable objects
 - Valuation by municipality
- Web-based viewer
 - Demonstrate reliable assessment
 - Transparent government

Analysis Of Findings

- Current valuation practice are primarily using administrative data for the valuation models.
- Models that use 2D or 3D geometries directly for valuations are not yet implemented in practice.
- However 2D and 3D models are becoming more important for ...
 - updating the information within the valuation models
 - presenting valuation results with the underlying data to for instance the owners of properties.

Possibilities For Future

- Opportunity provided by a uniform data base / model for automated analysis for valuation (and valuation for taxation)
- Many factors are in focus for valuation for taxation.
 - There already are many exemptions, separate assessments of land and improvements, assessment ratios and tax rates that differ by locale, type, and use, all of which expressly deviate from property tax being proportional to value. Sometimes income generating ability of either property or owner are taken into account, sometimes not
- Novel BIM and City GML representations of needs to be taken into account
 - City GML LOD 2 is extended with information about floors and thickness of walls and slabs (Boeters 2013)
 - The goal was to compute the internal net area (i.e. the area that can effectively be used), which is used amongst others also for taxation.



CityGML LOD2 and CityGML LOD+

This research has clearly shown that 3D representations can support mass computation of net area and consequently facilitate taxations of properties. The representations should not necessarily be very detailed, which allows for uniform automatic approaches.

Conclusion

- Despite analyzed countries primarily using administrative data for the valuation models, it has been argued in this paper that models using 2D or 3D geometries directly for valuations would have some significant benefits
- For fair annual valuations, it is clear that the used models and data need to be up-to-date
- Owners of property, but in general "the crowd" will play a greater role in keeping information up to date and this can also help updating functional 3D data systems.

- Who should be allowed to update authoritative 3D building models and cadastres,
- Based on which processes, and yielding which level of accuracy or reliability?
- Who should pay for it?
- Would volunteered data sets be included?

It might also be possible to assign levels of confidence, for each update. Any automated assessment analysis on top of such data may be able to derive an overall level of confidence for the resulting assessment. Prior to changing the formula to derive property taxes, officials could first query, what level of confidence is currently assigned to the existing data the new formula would be based on.