LADM Part 4 Valuation information

Extending NSDI with LADM Valuation Information Model and Expert Opinions to Calculate Score Values of 3D Real Estate

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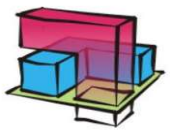
Introduction

The real estate valuation process involves an impartial assessment of the various elements that influence the potential value of a property, which include not only rights, restrictions, responsibilities (RRRs), condition of real estate, spatial planning status and constraints but also environmental, geographical, locational and socio-cultural information.

If a country has an effective **National Spatial Data Infrastructure (NSDI)** with 3D support, it can be used to link different data themes, such as buildings, cadastre, land use, addresses, etc., that are required in valuation processes.

The main objective of this study is to **extend the NSDI of Türkiye with ISO/DIS 19152-4 Valuation information** and va**lue affecting factors to cover all the characteristics required** in the **real estate management applications** (e.g., investment companies' software) and **3D real estate valuation**, and to **implement the model for calculating the parametric value scores of 3D buildings and condominium units**.

Using 3D Geographic Information Systems (GIS) allows for in-depth analysis in evaluating property characteristics and values through advanced geographic analysis such as visibility.

3D  Land Administration

Methodology

Purpose

To extend the NSDI of Türkiye with ISO/DIS 19152-4 Valuation information and value affecting factors to cover all the characteristics required in the smart city applications and 3D real estate valuation, and to implement the model for calculating the parametric value scores of 3D buildings and condominium units

Step-1

Examining the Land Administration Domain Model (LADM) Part 4: Valuation information and NSDI (TUCBS) data themes

Step-2

Designing LADM-Part 4 and NSDI compatible real estate valuation data models

Step-3

Determining the study area, obtaining 2D/3D datasets and defining 2D/3D factors afecting the real estate value through literature reviews and expert opinions

Step-4

Conducting questionnaires with appraisers and academicians working in the public and private sectors and calculating the factor weights with Multi-Criteria Decision Analysis (MCDA) methods

Step-5

Performing GIS analysis and Producing GIS-based parametric value scores for 3D buildings and condominium units

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Designing Real Estate Valuation Information Model

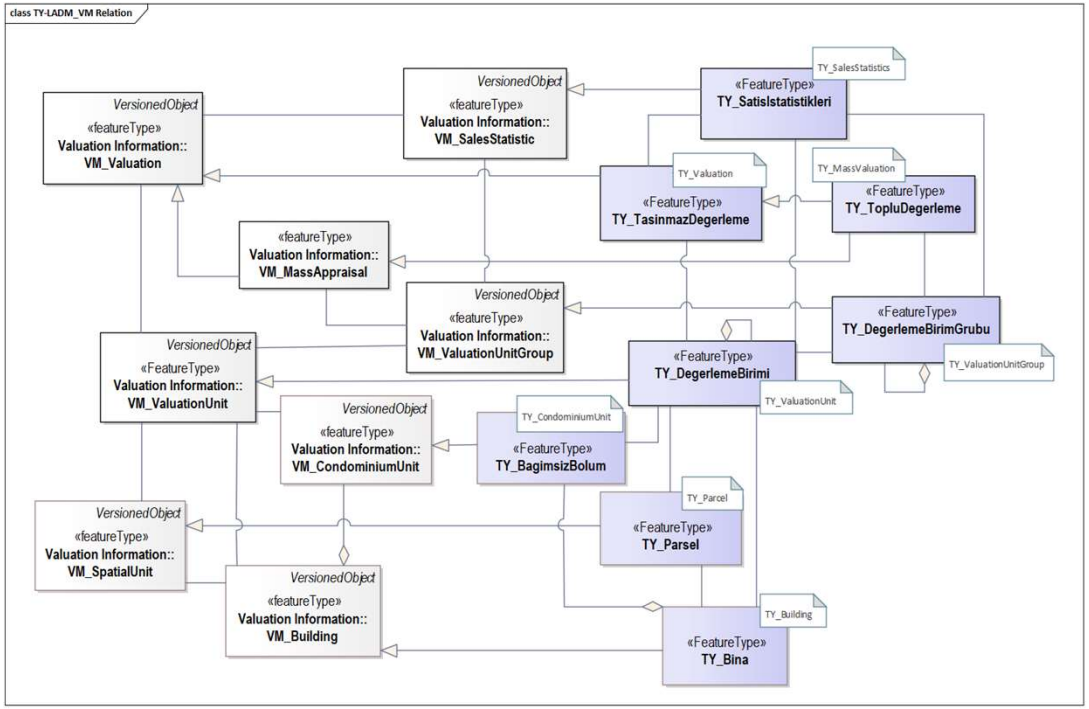
In this study, a comprehensive conceptual data model has been developed, which is specifically designed for open data management in the field of **Real Estate Management**.

An initial analysis of requirements was conducted, followed by an assessment of the resultant data components for compatibility with **Turkish national Geographic Data Infrastructure** (TUCBS).

The proposed model enables the inclusion of land and real property data in the TUCBS, which also encompasses other land-related data themes such as **buildings**, **land use**, **topography**, **addresses**, and **administrative units**. The model has been developed as a sub-scheme of the LADM_VM standard for real estate management.

Designing Real Estate Valuation Information Model

Overview of the Application Schema in Comparison with LADM_VM

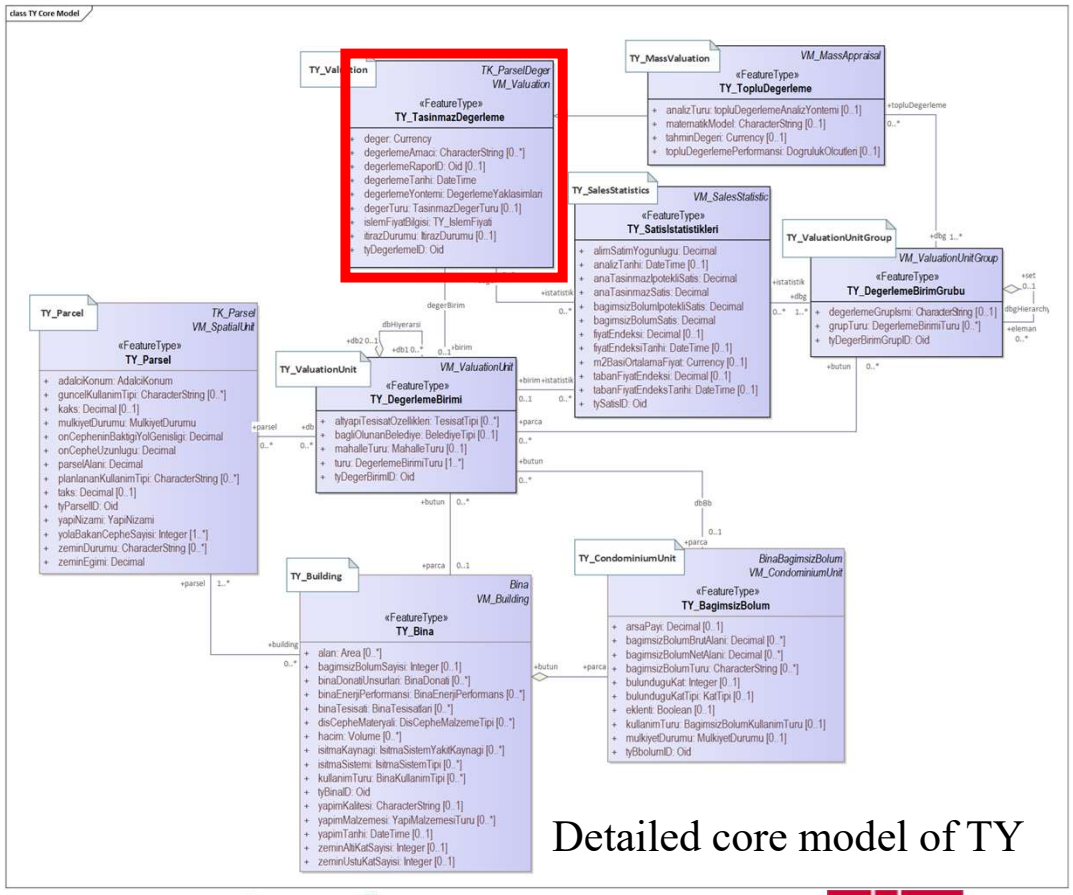


The relation between TY and LADM_VM Models

Since the designed TY model was built on the LADM_VM, it maintained its relationship with the LADM Core Model.

ISO 19152-4 LADM_VM standard is extended to develop the TY data model

Designing Real Estate Valuation Information Model



Detailed core model of TY

The TY data model is associated with the data themes include *Address, Land Use, Public Administration Zones and Protection Zones* of TUCBS, and extends the data themes Building and Cadastre

TY_Valuation class serves as the fundamental class in the TY data model, similar to the VM_Valuation in the LADM_VM model, for representing valuation information.

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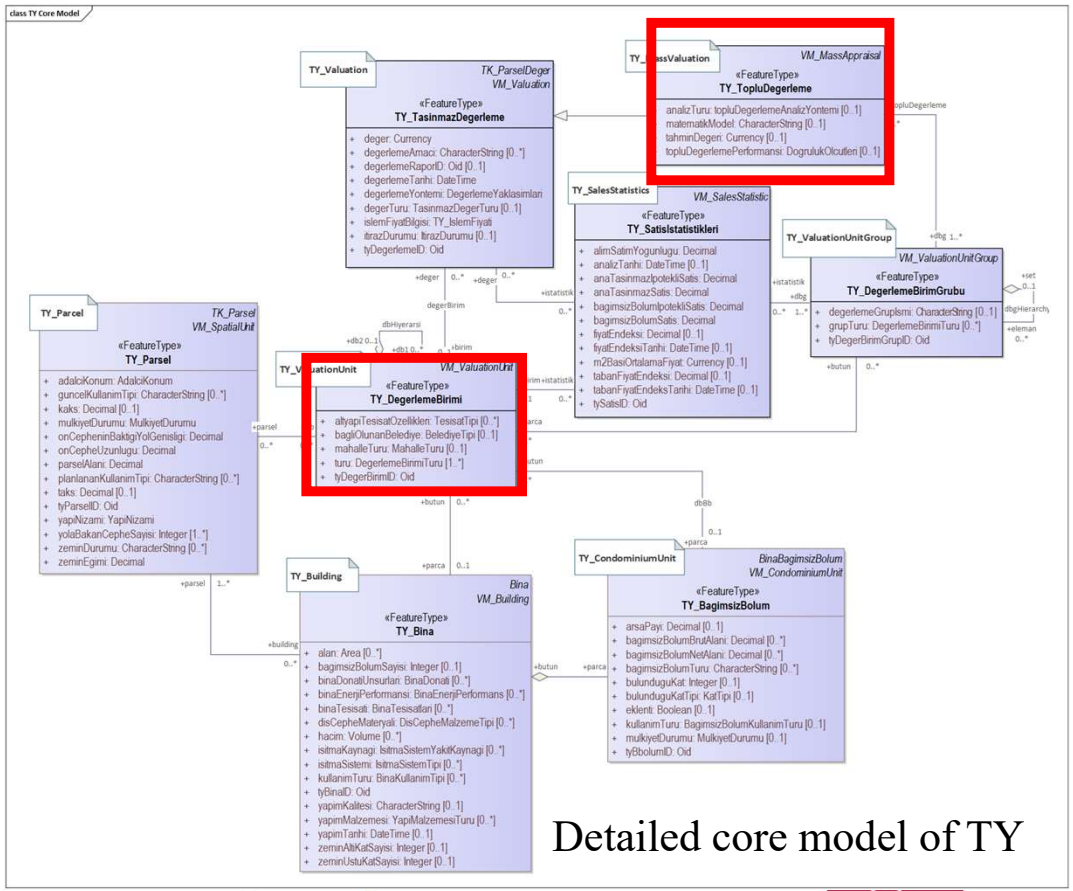
Designing Real Estate Valuation Information Model



Detailed core model of TY

TY_MassValuation contains the attributes mathematical model, statistical analysis method, performance indicators and predicted value (predictValue).

TY_ValuationUnit class refers to the basic transaction/record units that are subject to valuation. The value unit can be parcel, building or condominium unit.

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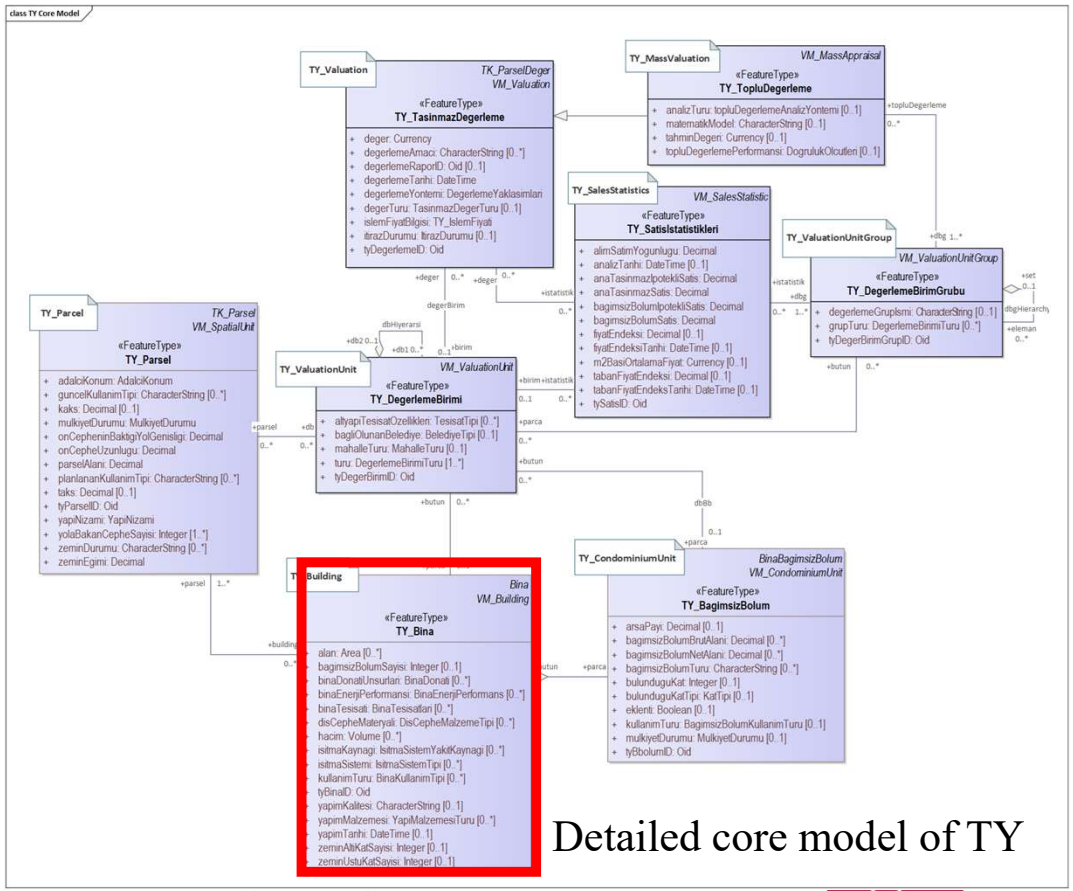
Designing Real Estate Valuation Information Model

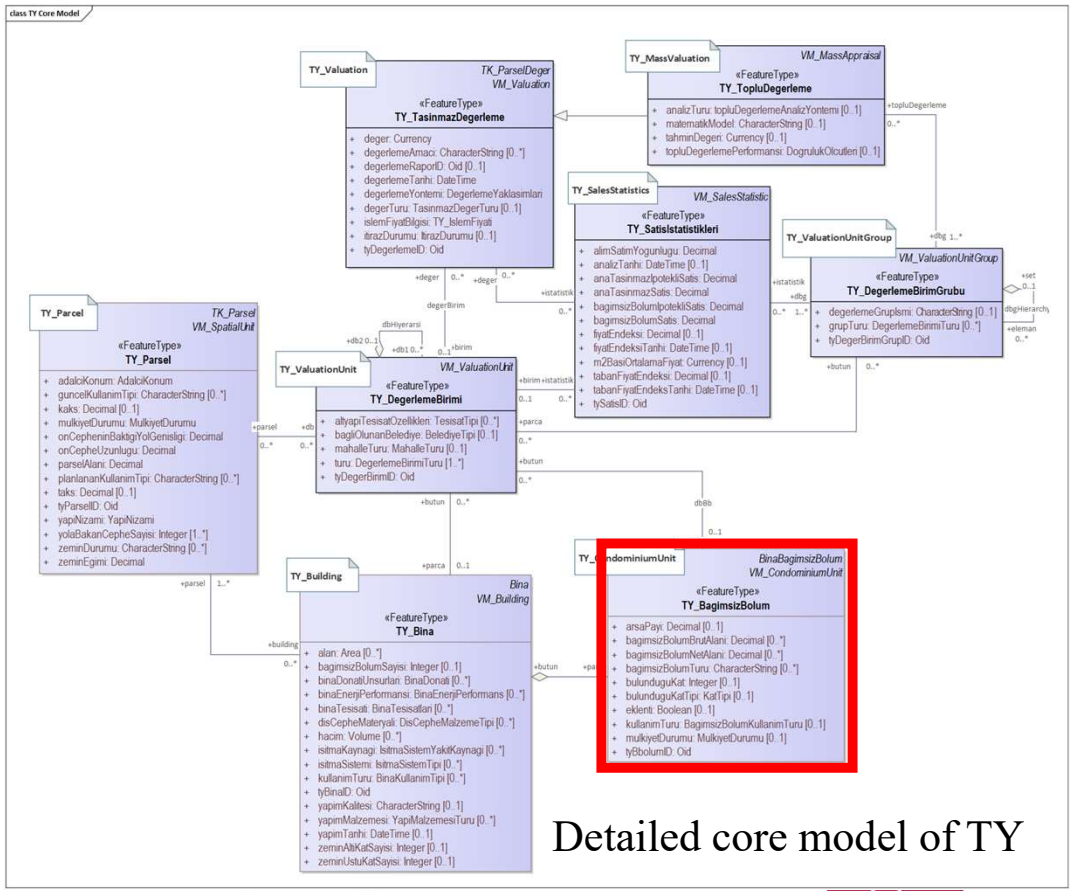


Detailed core model of TY

TY_Building represents the buildings subject to appraisal.

TY_Building is defined as a subclass of TUCBS Building

Designing Real Estate Valuation Information Model

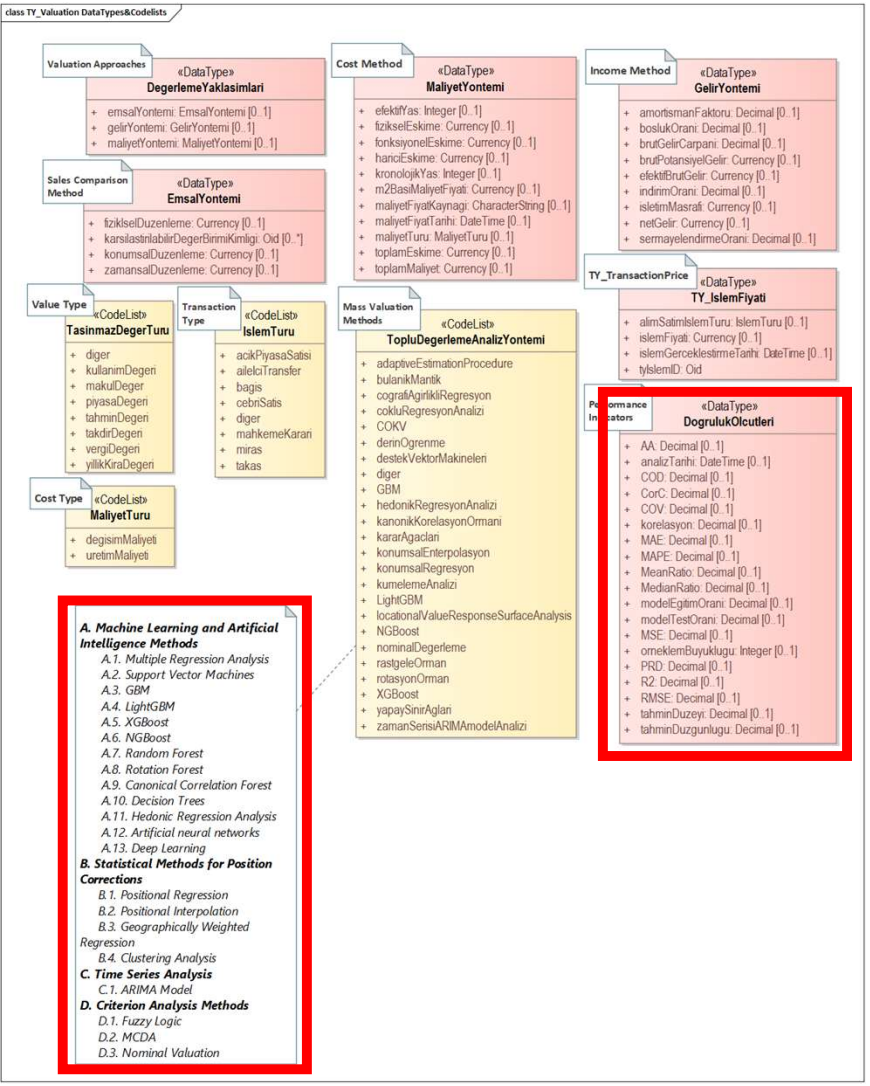


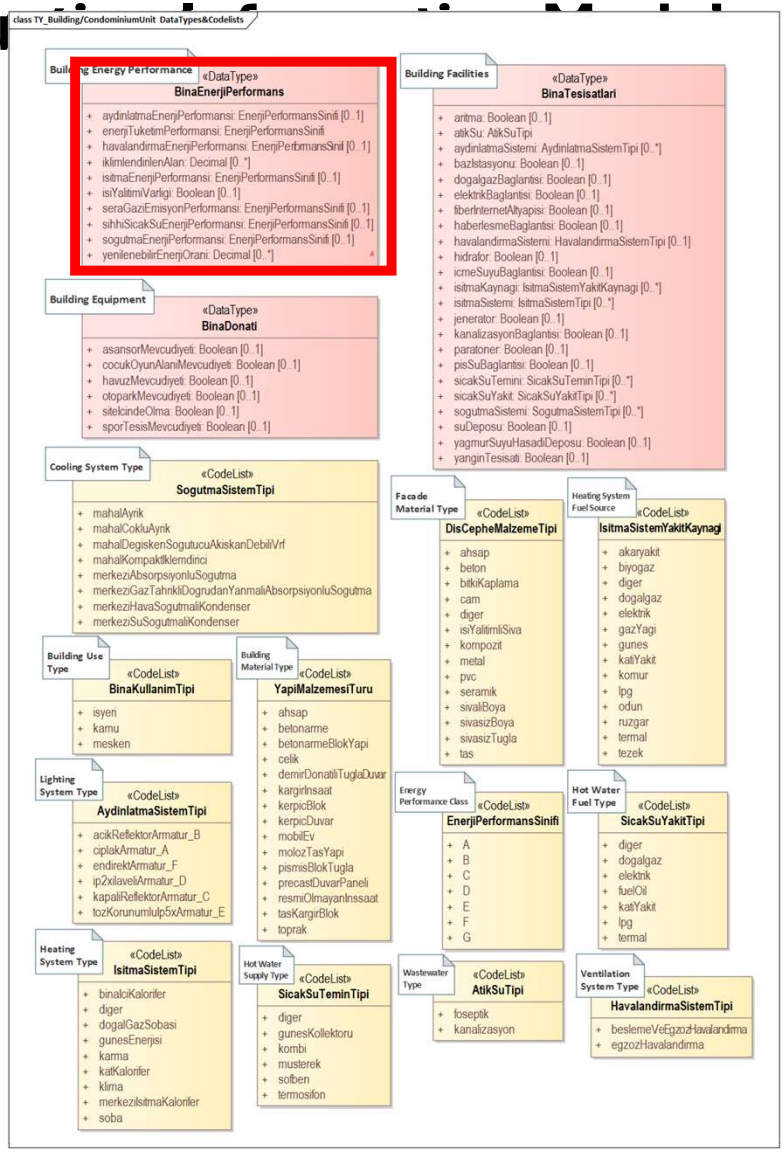
Detailed core model of TY

TY_CondominiumUnit is an individual unit that is subject to the valuation process and is categorised as a type of valuation unit.

This class defines as a subclass of TUCBS Building - Condominium Unit

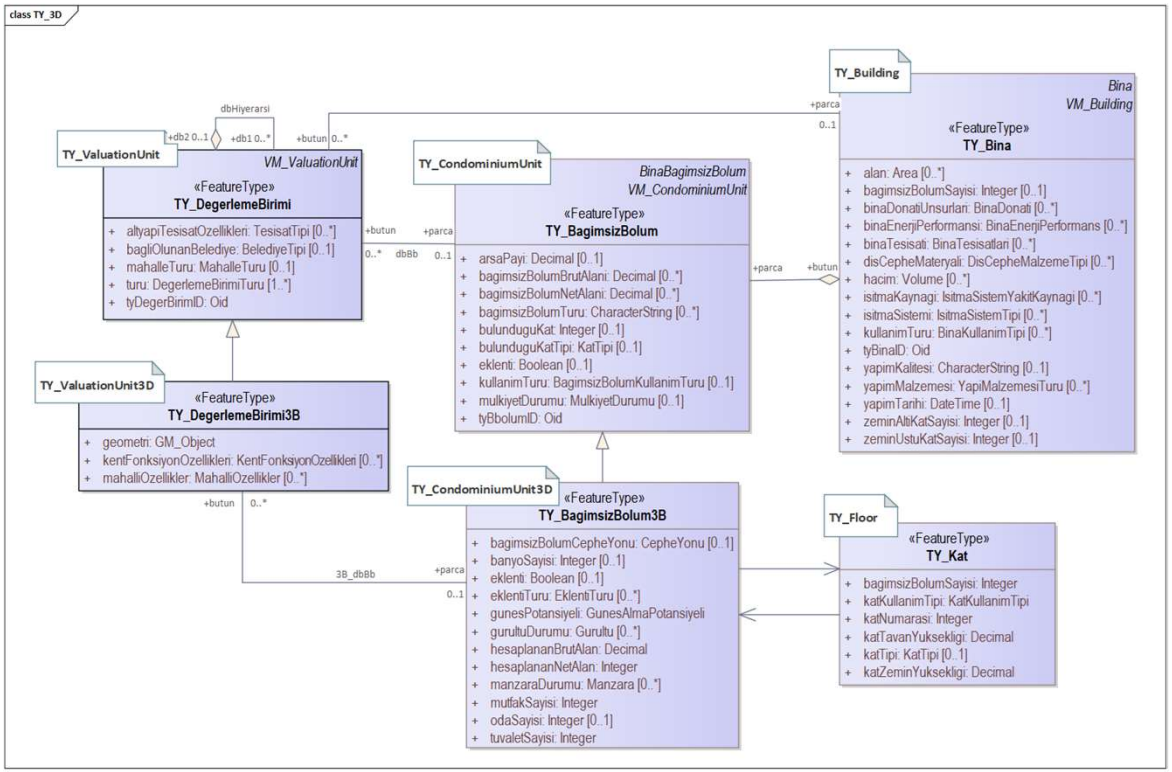
Designing Real Estate Valu





Data type classes and code lists associated with TY_Valuation

Designing Real Estate Valuation Information Model



3D profile of TY data model

This profile also incorporates features derived from geographical analyses using 2D and 3D datasets, and aligned with the TUCBS and INSPIRE Building data themes, CityGML, and buildingSMART - ISO 16739-1: Industry Foundation Classes (IFC) standards.

External factors, such as the **view**, **proximity to points of interest** (POI), **noise**, and **insolation potential** and so on also included.

Case Study

Methodology

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Case Study

Defining 2D/3D Factors Affecting the Real Estate Value and Factor Weights

- 2D/3D factors affecting real estate value are defined in **five thematic categories**, taking into account international standards, literature reviews and existing 3D data model content.
- To create **parametric value scores for real estate valuation**, it is necessary to calculate the **weight coefficients representing the importance level of the factors affecting the real estate value**. Multi-Criteria Decision Analysis (MCDA) method, specifically **Best Worst Method (BWM), is utilized to determine the weights of the criteria**.
- The questionnaires were conducted directly with appraisers working in the public and private sectors and academicians. **Each of the questionnaires was analyzed using BWM**. The weights for the calculated each thematic categories and sub-categories.

Case Study

Defining 2D/3D Factors Affecting the Real Estate Value and Factor Weights

Factor Group	Factors
Socio-demographic characteristics (0.214)	***Population (0.058)*** *(population density, women living in the neighbourhood (%), men living in the neighbourhood (%), children (0-14 age) living in the neighbourhood (%), young (15-24 age) living in the neighbourhood (%), adults (25-65 age) living in the neighbourhood (%), old (65+ age) (%) living in the neighbourhood),* ***Education Level (0.059)*** *(illiterate people (%), uneducated people who can read (%), primary school graduates (%), secondary school graduates (%), high school graduates (%), university graduates (%)),* ***Income Level (0.063)*** *(Number of people with group A+, A, B, C, D, size of income, income per capita),* ***Spending (0.034)*** *(food expenditures, healthcare expenditures, transportation expenditures, education expenditures, sheltering etc.)*

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Case Study

Defining 2D/3D Factors Affecting the Real Estate Value and Factor Weights

Factor Group	Factors
Planning characteristics (0.163)	***Zoning Characteristics (0.065)*** *(building coverage ratio, floor area ratio,* *parcel area, building order form (detached building, attached building),* *permitted parcel usage type),* ***Parcel Physical Characteristics (0.046)*** *(number of facades facing the road, facade front length, front facade road width, location of parcel in building block, land slope, ground conditions),* ***Property Status (0.052)*** *(condominium, condominium easement, timeshare)*

Case Study

Defining 2D/3D Factors Affecting the Real Estate Value and Factor Weights

Factor Group	Factors
Urban Functions (0.216)	***Education Facilities (0.041)*** *(kindergarten, primary and secondary school, high school, university),* ***Healthcare Facilities (0.041)*** *(local healthcare facility, hospital, pharmacy, emergency health service station),* ***Transportation (0.063) (****Rail System Stations, Airport, Sea Transport Stations, Road Transport Station, Proximity to Roads),* ***Points of Interest (0.027)*** *(bazar centre, shopping mall, district bazaar, market, cultural facility, coast, green area, sport facility, restaurant),* ***Public Services (0.020)*** *(administrative facility, courthouse, post office, bank, fire station, security unit),* ***Industrial Facilities (0.008)****, (petrol station, industrial facility, treatment facility),* ***Religious Facilities (0.016)*** *(worship, cemetery)*

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Case Study

Defining 2D/3D Factors Affecting the Real Estate Value and Factor Weights

Factor Group	Factors
Building Characteristics (0.209)	***Building Physical Characteristics (0.127)*** *(age of building, number of total building floors, heating system, existence of heat insulation),* ***Building Installations (0.082)*** *(within housing estate, existence of car parking, existence of pool, existence of elevator, existence of children playground)*
Condominium Unit Characteristics (0.196)	***Condominium Unit Physical Characteristics (0.110)*** *(landscape, direction, floor level),* ***Condominium Unit Interior Characteristics (0.086)*** *(floor area, number of rooms, room type, number of balcony, number of bathroom)*

Case Study

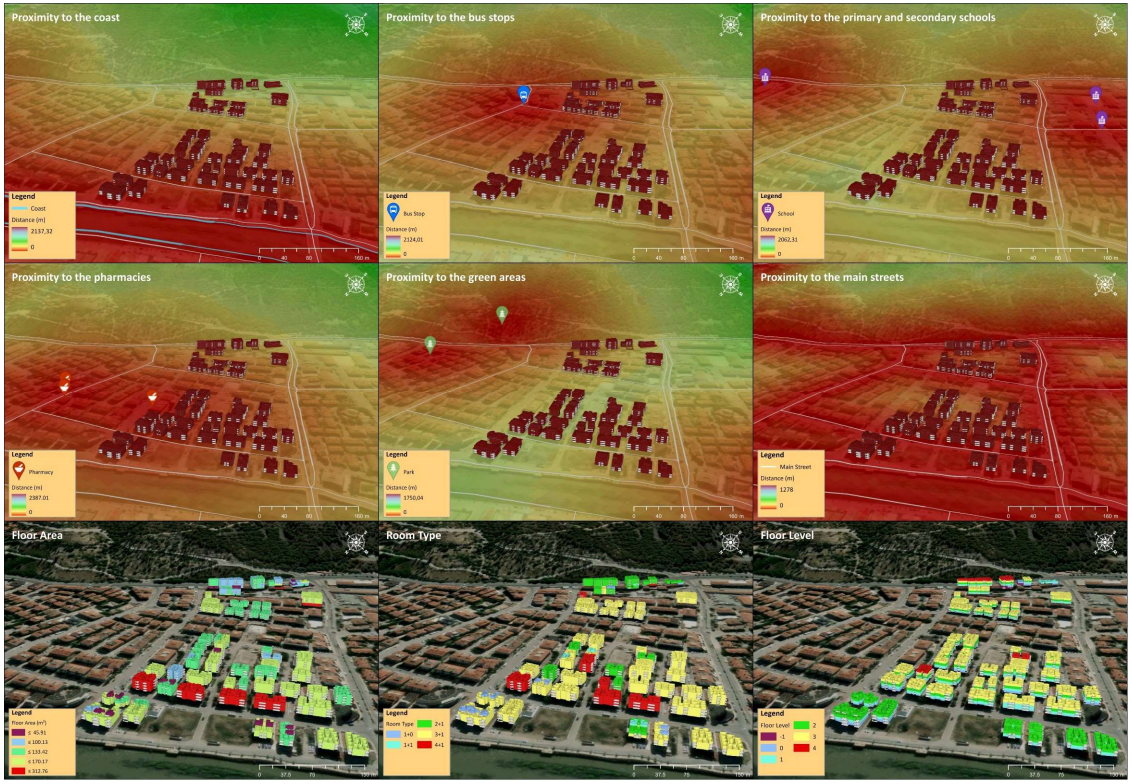
Study Area and Datasets

Within the scope of the "**3D City Models and Cadastre Project**" initiated by the General Directorate of Land Registry and Cadastre (GDLRC) of the Republic of Türkiye in 2020 (GDLRC, 2024), **3D building models** were produced in Amasya-Merkez district, the pilot project area.

Besides, data obtained from **Turkish Statistical Institute**, **Amasya Municipality** (zoning plans), the **Disaster and Emergency Management Presidency**, and **Open Street Map (OSM)** is utilized to produce nominal value scores for each residential unit in the study area.

Case Study

Producing Parametric Value Scores



Examples of geographical analyses for producing parametric value scores

The calculation of the parametric value scores was carried out in a hierarchical structure and a process was followed from the neighbourhood level to the condominium unit level.

Geographic data representing the 2D/3D factors defined were analysed in the GIS environment to produce parametric value scores in real estate valuation.

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Case Study

Producing Parametric Value Scores

Calculating parametric value scores for factor

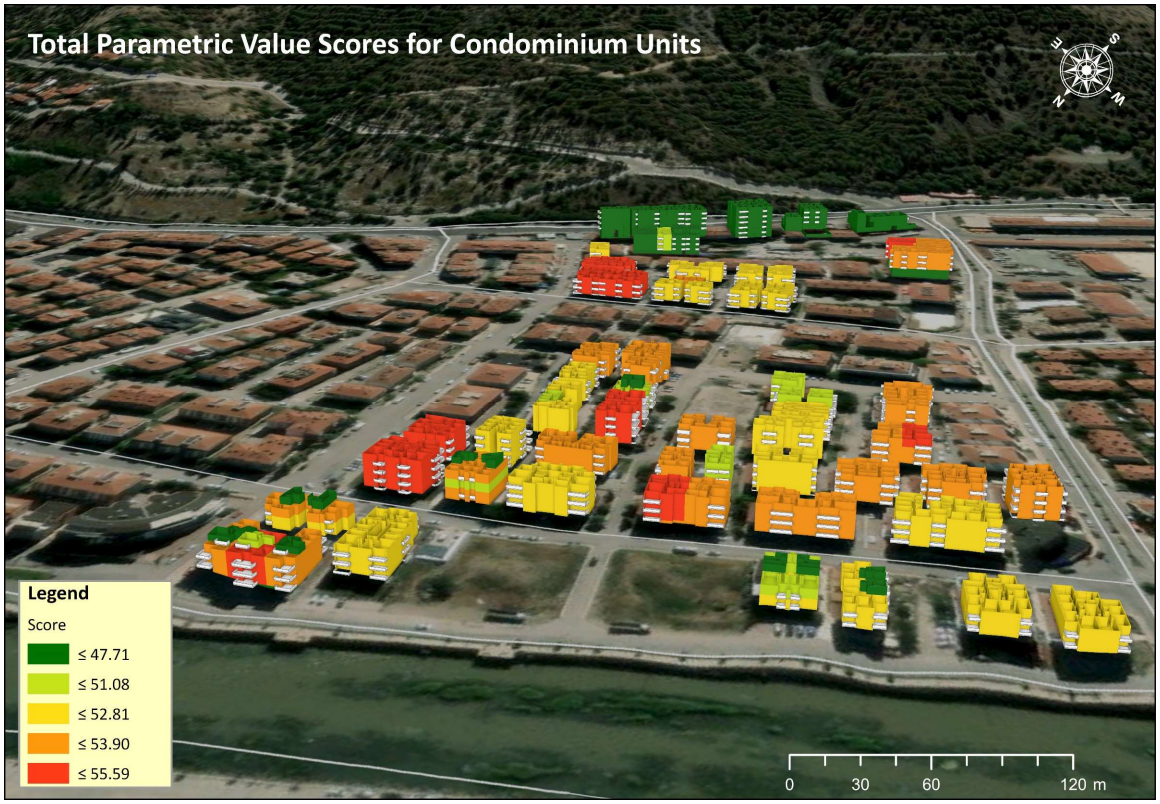
Parametric value scores were calculated for the five factor groups with the

$$S = \sum_{i=1}^{n} W_i F_i$$

Where S is the parametric value score; n is the number of factors included in the analysis. W_i is the weight coefficient of factor i which was calculated with the BWM, and F_i is the normalized analysis results for factor i.

Case Study

Producing Parametric Value Scores



The value of the parametric value score S ranges between 0 and 100, with a value close to 0 representing a low value real estate and 100 representing a high value real estate for the valuation.

Finally, the scores calculated for the five groups were combined and parametric value scores were calculated at the condominium unit level.

https://www.youtube.com/watch?v=ElQLgAs16Dg

Conclusion

- In extending the NSDI, it is reasonable to consider the use of international standards and local factors that may alter the value of the property. As the ISO 19152 Land Administration Domain Model (LADM) is the only standard that considers links between cadastral, building, land use and property valuation registers, it makes sense to use the LADM when extending an NSDI.

- As a future work, it is planned to test the developed model with real data in another case study area. Furthermore, the relationships between indices generated in smart city applications (e.g., quality of life) and real estate values need to be investigated, which is specified as future work.

Thank you!

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