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LADM based taxation model in Montenegro: Using BIM in taxation process

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Key words: taxation, LADM, BIM

SUMMARY

Real properties plays an integral role in the economy of every country. Considering this, property valuation and taxation processes are of great importance. Revenues from property taxes can be allocated to other areas thus improving the quality of life for all citizens. Since the valuation and taxation are related to properties themselves, the good cooperation between real estate cadastre and tax administration is necessary. Real estate cadastre submits current data on real properties and rights to them to the tax administration. These data and additional data on properties and their locations are then used to form a tax for citizens to pay.

In the paper, an analysis of the legal regulations and laws, as well as the way of functioning of the current information system for the tax administration in Montenegro is performed in order to develop LADM based tax administration model. Developed model is an extension of previously developed LADM country profile for Montenegro. Based on the new model, an information system for tax administration is developed and all relevant procedures prescribed by the 'Law on property tax' (2019) and 'Regulation on detailed criteria and methodology for determination of real property market values' (2011), are implemented. The most important procedures are how to define the value of the property or how to calculate appropriate taxes. The basic criteria for determining the value of real properties are average market price per m^2 of real property, purpose of the real property, size of real property, the place where the real property is located, quality of real property and other elements that may have an impact on the market value of real property. Every municipality defines the coefficients that correct the main formula for tax calculation.

The new buildings have a BIM model created in a design phase which is a part of the documentation for issuing a building permit. Such BIM model can be used for at least two other purposes in addition to basic use. The first one is to serve as an input for 3D cadastre. Another reason is the use of BIM to calculate taxes. Data such as the area of the building and the quality of the building (building construction, building facade, windows, number of rooms, installations, number of bathrooms, etc.) can be directly loaded into database from the appropriate BIM model. Such solution can be resolved by expanding the regulative and the law to allow the use of this data. In the paper, the authors presented the mapping of entities from the BIM model to the appropriate code lists of the building quality and other attributes defined by the national regulation which are used to calculate tax. In this way, the tax calculation process would be accelerated and automated because the data from the project documentation would not be entered manually but would be taken over from BIM.

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1. INTRODUCTION

Real properties play an integral role in the economy of every country. Considering the factors like size and location of the property, year of construction, quality of the property, purpose of the property, valuation and taxation processes are of great importance. Revenues from property taxes can be allocated to health care, environmental protection, energy efficiency, agriculture, water management, reforestation, paving, construction of kindergartens and preschools, education, sport and recreation and thus improving the quality of life for all citizens. Since the valuation and taxation are related to properties themselves, the good cooperation between real estate cadastre and tax administration is necessary. Real estate cadastre submits current data on real properties and rights to them to the tax administration. These data and additional data on properties and their locations are then used to form a tax for citizens to pay.

In this paper, an analysis of the legal regulations and laws, as well as the way of functioning of the tax administration procedure in Montenegro is performed in order to develop LADM based tax administration model. Based on the previously developed LADM country profile for Montenegro (Radulović et al., 2015), the LADM Valuation Information Model for Montenegro is developed and presented.

In the paper, the authors also presented the potential mapping of entities from the BIM model to the appropriate code lists of the building quality and other attributes defined by the national regulation which are used to calculate tax. In this way, the tax calculation process would be accelerated and automated because the data from the project documentation would not be entered manually, but would be taken over from BIM. Since the amount of data for the building quality is quite large, it is often not entered in practice (in order to speed up the procedure or if the data does not exist in documentation), but a predefined building quality coefficient is entered for each building. The source of such data is usually not the result of standardized procedures and is often left to the discretion of the citizen to report quality elements without the need for proof. Often these data are of questionable quality. This leads to a miscalculated tax, i.e. the same tax is paid for buildings of the same size that are luxuriously or moderately decorated. Automating this process by using BIM, which is mostly made for new buildings, would solve this problem, because the quality coefficient of the building would be determined according to the correct parameters, the municipality would receive more money than usual, and owners of moderate real properties would be satisfied not to pay

the same amount as the owners of exclusive properties. This would make the tax collection system more equitable.
An initial design of LADM based valuation and taxation data model was introduced by Çağdaş et al., (2016). Kara et al., (2021) describe the development of a prototype for the implementation of the LADM Valuation Information Model and assesses its operability through a case study for Turkey. Property valuation system using the LADM valuation information model in Croatia is presented by Tomić et al. (2021). Impacts of property taxation on residential real estate development was analysed by England et al. (2013).

Kara et al. (2020) analyze how three-dimensional (3D) information can be used in order to better estimate and explain values of property units. Property valuation domain does not widely use 3D models and 3D datasets to derive external characteristics of property unit except for visibility analysis. Therefore, the authors presented how 3D datasets and spatial analyses could be used to support property valuation activities and to investigate to what extent it is possible and meaningful to include derived 3D characteristics of property units in valuation registries. The research is based on 3D GIS solutions. Çağdaş (2013) proposed an Application Domain Extension (ADE) to CityGML for immovable property taxation. Use of 3D cadastral data for real estate mass valuation in the urban areas was proposed by Tomić et al. (2012). A BIM and machine learning integration framework for automated property valuation was proposed by Su and Li (2021). They propose an automatic information exchange between AEC projects and property valuation and develop IFC extension for property valuation and an IFC-based information extraction algorithm.

The paper is structured as follows. First Section contains introduction in which the motivation for this research and related work are described. Second Section describes the property taxation in Montenegro based on the actual laws and common practice. Third Section presents the new data model for property valuation and taxation in Montenegro based on LADM. Fourth Section presents possibilities to use BIM data as input for faster determination of building quality in process of property valuation and taxation. Conclusions and future work are given afterward.

2. PROPERTY TAXATION IN MONTENEGRO

Tax administration procedure in Montenegro is prescribed by the ‘Law on property tax’ (2019). The law defines how the real estate tax is calculated. The basis of real estate tax is the market value of the real property. The market value represents the value of that real property on the 1st of January of the year for which the tax is determined. The law provides basic criteria for its determination. The basic criteria for determining the market value of real property are:

- average market price per m^2,
- purpose of the real property,
- size of the real property,
- the place where the real property is located,
- quality of the real property and
- other elements that may have an impact on the market value of the real property.

Detailed criteria and methodology for determining the market value of real property are prescribed by the Government of Montenegro within the 'Regulation' (2011). Mass valuation of real property is still not conducted but is planned in the future changes of the law.
Every municipality defines the coefficients that correct the main formula for tax calculation. As pilot municipality, the Municipality of Bar is chosen. The Municipality of Bar is a coastal municipality in Montenegro, accompanied by rapid urbanization and construction of both residential and tourist buildings. The basis for the real property tax is being determined by multiplying the real property area by the average market price per m2 of real property in the Municipality of Bar and correcting it by coefficients of location, quality and purpose and property age. Price is determined on the municipality level for each type of building (residential, business, auxiliary, etc.), part of building (flat, business, garage, etc.) or purpose of the land (building and construction land, agricultural land, forest, etc.).

Next several formulas will present the procedure of determining tax value for one building and one building owner. Similar procedure is used to calculate the tax value for land or part of the building. Value of the building is determined as a product of building area and price of one m2 of the building with a certain purpose:

$$buildValue = price * area$$

The building area is a value that is obtained from the real estate cadastre together with other information like property purpose and right holders. This information is obtained on the 1st of January and according to this information a tax value is calculated. The price depends on a type of the building, and it is defined by the Municipality of Bar. The building value is then corrected with the age of the building (multiplied with the maximum age coefficient) and location of the building. The area of the Municipality of Bar is divided into seven zones and a special coefficient has been determined for each zone:

$$zoneVal = \left(buildValue - buildValue * \left(\frac{coefOld * (year - constYear)}{100} \right) \right) * coefZone$$

According to the quality criteria of the construction object, the market value is corrected by the quality coefficient of the building, by dividing the total number of points for all quality elements that building has, by the number of points for the highest quality of the building in the Municipality of Bar, which is 550 points.

Elements for determining the quality of the building are:

- type of building construction (barracks, prefabricated buildings, buildings made of prefabricated and mixed materials, classic construction),
- building exterior (classic facade, demit facade, artificial stone, natural stone and marble),
- building equipment (PVC joinery, wooden joinery, aluminum blinds, shutters),
- sanitary equipment (completely or partially arranged bathroom),
- water supply system (plumbing installation connected to the water supply network or to the well),
- sewerage system (sewage connected to the sewer network or to the septic tank),

- electrical and telephone installation,
- heating system (central, other),
- additional elements that increase value of the building like pools or exit to the asphalt road.

Quality of the building is calculated as follows:

$$qualVal = \left(\frac{\sum_{n=1}^{n}(qualBuild_n)}{coefQualTotal}\right)$$

The value of the tax is determined for each right holder individually, so it is necessary to obtain information on the right share from the real estate cadastre in order to adjust the amount that one party has to pay with that value. Tax rate is proportional value and amounts to 0.25% to 1.00% of the market value of the real property and this value depends on the type of the building. In the following formula, a tax value is calculated as a product of tax rate with building value corrected with location and quality, as well as with right share displayed as fraction (shareNum is numerator and shareDen is denominator in right share):

$$rateVal = \frac{\left(\frac{shareNum}{shareDen} * qualVal * zoneVal * taxRate\right)}{100}$$

Additionally, tax value is decreased if the right holder lives in that building. This is achieved with coefficient of inhabitance:

$$inhabVal = rateVal - rateVal * \frac{coefInhab}{100}$$

Tax value is corrected based on number of members in the household and for this, a special coefficient is defined for each number of members:

$$taxVal = inhabVal - inhabVal * \frac{coefMemb}{100}$$

Tax value is calculated for every year based on updated data from municipality, tax administration and real estate cadastre.

3. LADM BASED DATA MODEL FOR PROPERTY TAXATION IN MONTENEGRO

The data model is the basis of every information system, so it is necessary to harmonize the data model used for taxation with the land administration model. The Land Administration Domain Model - LADM defined by ISO 19152 is an international standard for the land administration domain. LADM focuses on the legal, geometric and administrative aspects of land management, but does not deal with real property valuation and taxation. However, LADM provides external classes that connect land administration systems to other related land administration databases. In this way, the model provides a good and flexible basis for property valuation and taxation. Since, many countries already developed their LADM country profiles and newly proposed LADM Valuation Information Model is on the agenda of the development of the second edition of LADM (Kara et al., 2021), it is natural to think about developing a country profile for valuation and taxation.

Figure 1 shows LADM based model for property taxation in Montenegro and its connections to LADM basic classes. Montenegrin LADM country profile is previously developed and presented by Radulović et. al (2015). In Figure 2 the basic classes of this model are displayed. Full list of classes are presented in Govedarica et. al (2021). Class MNE_RealestateFolio represent the real estate document that is used in Montenegro to connect together data about rights (MNE_Ownership) on one or several parcels (MNE_Parcel) in a way that the total sum of shares that each party (MNE_Owner) has is equal one. Additionally, the real estate document contains data on buildings (MNE_Building) and special parts of buildings (MNE_PartOfBuilding) that are located on parcels recorded within the same real estate document together with rights on them. Finally, the real estate document contains the data about existing restrictions (MNE_Restriction) on all properties recorded within the real estate document.

Classes that represent property taxation in Montenegro are displayed on Figure 3. MNE_ValuationUnit is a unit of valuation and taxation. In Montenegro, this unit can be parcel (MNE_VM_Parcel), building (MNE_VM_Building) and part of building (MNE_VM_PartOfBuilding). These classes are introduced in order to add additional attributes that represent location and quality information which are not recorded in basic LADM profile classes. In the model, connections between classes from LADM profile and valuation model are represented with associations between two appropriate classes, but in practice, information about spatial unit attributes are obtained via web services owned by geodetic authority. That way, all necessary information from both geodetic authority and tax administration can be used in valuation and taxation process. Two attributes that are important for valuation and taxation are location and quality of property. By its location, every property is categorized into one of seven zones and a coefficeint is added to each zone (MNE_ZoneElements). Zone is determined by property address. Second important attribute is a list of quality elements for each property. Quality elements and corresponding coefficients are defined within MNE_QualityElementsParcel code list for parcels and MNE_QualityElementBuilding code list for buildings and part of buildings. Important parameters that are obtained from real estate cadastre are area of the property, purpose/way of use of the property, year of construction for buildings, right holders and rights.

In the process of valuation and tax calculation, a predefined set of coefficeints is used. Most of the coefficients are defined within the valuation model (MNE_VM_ValuationModel) for a fiscal year. These coefficients are defined on the municipality and country level. Values displayed on the diagram are defined for the municipality of Bar. For different municipalities, coefficients can differ. Within this code list, a coefficients for each type/purpose of the property are defined, tax rate and price per m2. Also, a correction on the tax if possible if tax payer lives in property or if there are greater number of household members. For such situations, a set of coefficients are introduced and classes MNE_VM_Ownership and MNE_VM_TaxPayer with additional attributes in regard to classes MNE_Ownership and MNE_Owner.

Based on the formulas presented in previous section, a tax value is calculated for each property and a tax is assigned to a tax payers according to their share in right.

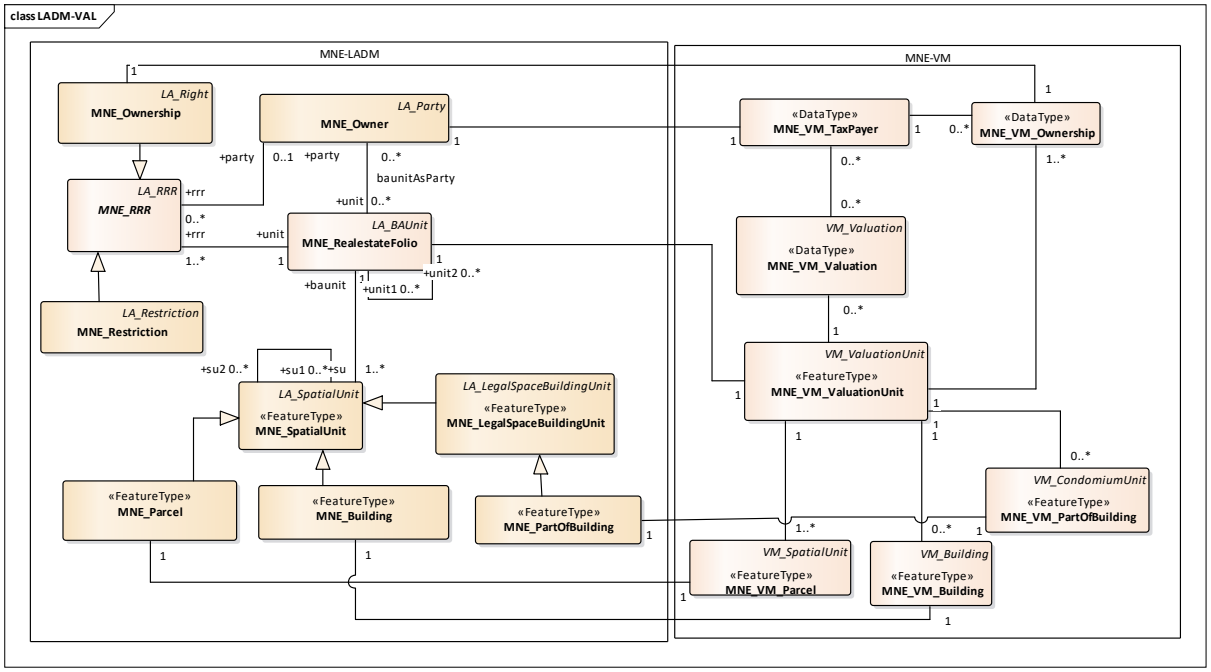

Figure 1. LADM based model for property taxation in Montenegro

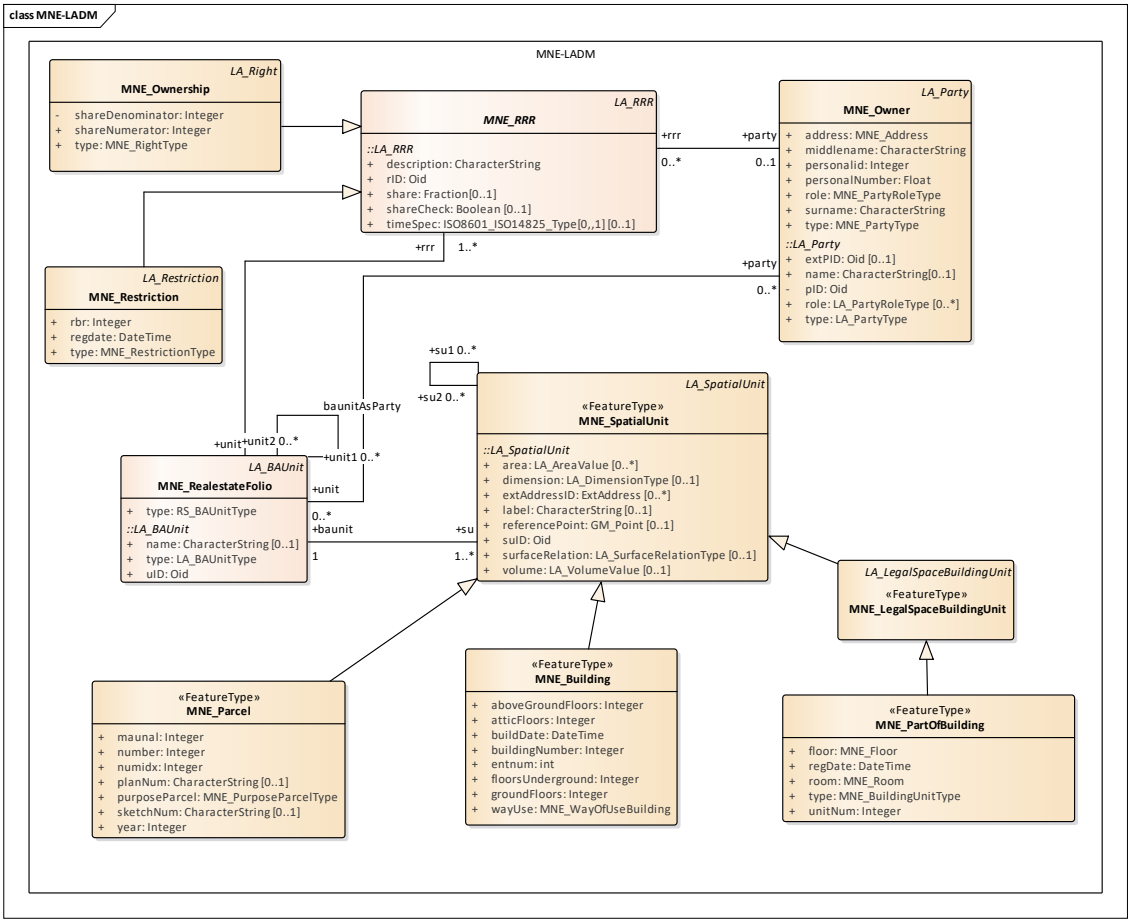

Figure 2. Montenegrin LADM country profile classes

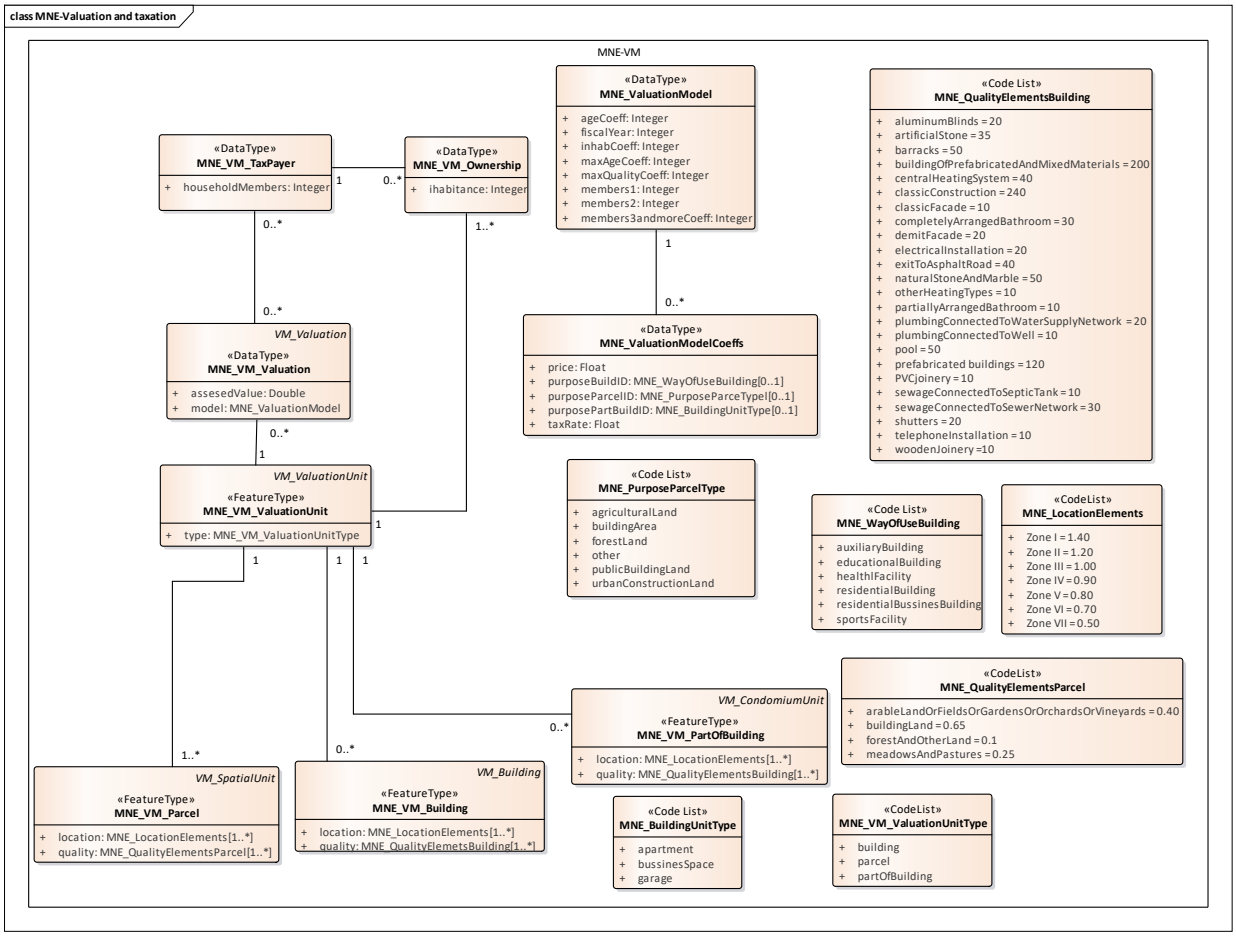

Figure 3. Valuation and taxation model for Montenegro

4. USING BIM FOR BUILDING QUALITY ASSESMENT

As pilot Municipality in this research, the Municipality of Bar is chosen. The Municipality of Bar is a coastal municipality in Montenegro, accompanied by rapid urbanization and construction of both residential and tourist buildings. The new buildings have a BIM model created in a design phase which is a part of the documentation for issuing a building permit. Such BIM model can be used for at least two other purposes in addition to basic use. The first one is to serve as an input for 3D cadastre. It can be linked to the cadastral database via unique property identification number (UPIN) as described by Sladić et al. (2020). The second one is the use of BIM to extract information relevant for calculation of taxes, such as quality of the building, building age, etc. In Montenegro, the tax is calculated based on several factors. Data such as the area of the building and the quality of the building (building construction, building facade, windows, number of rooms, installations, number of bathrooms, etc.) can be directly loaded into database from the appropriate BIM model. Such solution can be resolved by expanding the regulative and the law to allow the use of this data.

Figure 2 shows IFC entities and relations that could be used to extract information about the quality of the property. The central entity is ifcBuilding, a subtype of ifcProduct, which is defined by the property set (named PsetBuildingCommon) such as a year of construction, year

of last refurbishment, net planned area, or a construction method. Single value property (ifcPropertySingleValue) of an ifcBuilding named ConstructionMethod is of type ifcLabel and can be used to enter free text about construction method of the building according to the building construction code list. Building construction can also be extracted from the enumeration IfcConstructionMaterialResourceTypeEnum. However, this enumeration does not contain all the values from the code list, so it is necessary to expand it with user defined types. IfcConstructionMaterialResourceTypeEnum can also be used to extract information about building exterior (facade), but it is also necessary to expand it with user defined types. The Figure 2 also shows entities related to windows and window style (ifcWindow, ifcWindowStyle) such as PVC windows, which are also used to calculate the quality. Sanitary equipment can be determined using IfcSpaceType in the form of free text or using IfcSanitaryTerminalTypeEnum enumeration with the chosen values (bath, shower, sink, toiletpan, washhandbasin, wcseat, etc.).

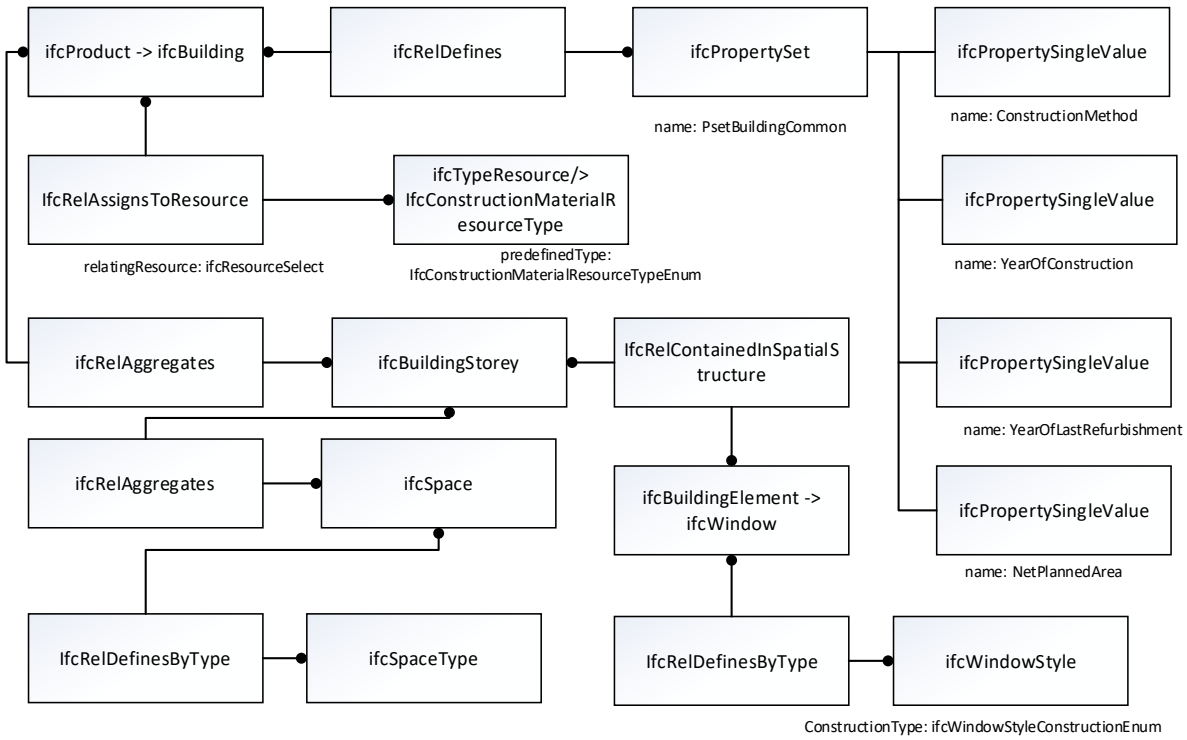

Figure 4. IFC entities related to property quality assessment

Table 1 shows the mapping of the IFC elements to the quality parameters defined in the quality code list. In addition to the entities showed on Figure 4 the mapping also contains parameters such as water supply, sewage, electrical installation, heating and elements that increase the value of an object. In some cases, the quality parameter can be extracted if the appropriate IFC entity exists, such as cable segments or electrical distribution board in the case of electrical installations. If enumerations are used, they usually should be expanded with user defined types, since they do not contain all the necessary values. Other option is to use free text in the name or label attributes.

Table 1. The mapping of the IFC elements to the quality parameters

Quality parameter	Quality description	IFC mapping
1. Building construction	1.1. Buildings made of unfired brick or barracks 50 points; 1.2. Prefabricated buildings (wooden, sheet metal, iron) 120 points; 1.3. Buildings made of prefabricated elements and mixed materials 200 points; 1.4. Classic construction (hard material) 240 points;	ifcBuilding - Pset_BuildingCommon - ConstructionMethod (ifcLabel) IfcConstructionMaterialResourceTypeEnum (AGGREGATES – Construction aggregate including sand, gravel, and crushed stone. CONCRETE – Cast-in-place concrete. DRYWALL – Wall board, including gypsum board. FUEL – Fuel for running equipment. GYPSUM – Any gypsum material. MASONRY – Masonry including brick, stone, concrete block, glass block, and tile. METAL – Any metallic material. PLASTIC - Any plastic material. WOOD – Any wood material. NOTDEFINED – Undefined resource. USERDEFINED – User-defined type
2. Building treatment (exterior)	2.1. Classic facade 10 points; 2.2. Demit facade and brick-clad facade 20 points; 2.3. Artificial stone 35 points; 2.4. Facade lined with natural stone or marble 50 points;	IfcConstructionMaterialResourceTypeEnum (AGGREGATES – Construction aggregate including sand, gravel, and crushed stone USERDEFINED – User-defined type)
3. Equipment of construction facilities	3.1. Window 3.1.1 PVC 10 points; 3.1.2 Wooden joinery 10 points; 3.1.3 Aluminum blinds 20 points; 3.1.4 Shutters - shutters 20 points;	ifcWindow, ifcWindowStyle, IfcWindowStyleConstructionEnum (ALUMINIUM, HIGH_GRADE_STEEL, STEEL,WOOD, ALUMINIUM_WOOD, PLASTIC, OTHER_CONSTRUCTION, NOTDEFINED)
4. Sanitary equipment	4.1. Completely decorated bathroom (bath - shower, toilet, sink) 30 points; 4.2. Partially decorated bathroom, 10 points per apartment;	IfcSpaceType/LongName , IfcSanitaryTerminalTypeEnum (BATH, SHOWER, SINK, TOILETPAN, WASHHANDBASIN, WCSEAT)
5. Water supply	5.1. Plumbing connected to the water supply network, 20 points per apartment; 5.2. Plumbing connected to the well - hydrophore 10 points;	IfcPipeSegment/ IfcPipeSegmentType / IfcPipeSegmentTypeEnum
6. Sewage	6.1. Sewerage connected to the sewerage network, per apartment 30 points; 6.2. Sewage connected to the septic tank, per apartment 10 points;	IfcWasteTerminalTypeEnum (FLOORWASTE – Pipe fitting, set into the floor, that collects waste water and discharges it to a separate trap, USERDEFINED - User-defined type.)
7. Electrical Installation	7.1. Electrical installation 20 points; 7.2. Telephone installation 10	IfcCableSegment / IfcCableSegmentType /IfcCableSegmentTypeEnum,

	points;	IfcElectricDistributionBoard / IfcElectricDistributionBoardType /IfcElectricDistributionBoardTypeEnum
8. Heating	8.1. Central heating 40 points; 8.2. Other heating (solid fuel, liquid and electric) 10 points;	IfcSpaceHeater / IfcSpaceHeaterType, IfcSpaceHeaterTypeEnum (CONVECTOR / RADIATOR / USERDEFINED)
9. Elements that increase the value of an object	9.1. Swimming pool 50 points; 9.2. Exit to the asphalt road 40 points	IfcConstructionEquipmentResourceTypeEnum (PAVING - Roads or walkways such as asphalt or concrete)

5. CONCLUSION

In this paper we developed LADM based conceptual model for property valuation and taxation in Montenegro. Basic classes form LADM country profile for Montenegro are presented and described in the paper. Based on this conceptual model, a database and a web-based software solution were developed in Municipality of Bar. Furthermore, we introduced the idea of using BIM to extract quality parameters of building that are used for valuation and taxation to provide automation, which are otherwise entered manually and are very often incorrect in practice. The proposed model covers all three types of properties in Montenegro, land (parcels), buildings and part of buildings like apartments, business offices, etc. BIM models that are already created for new buildings are introduced as a mean for automation of collection information about quality, while for the old buildings the data is already entered manually or will be entered manually as before.

Since the amount of data of building quality for the purpose of valuation and taxation is quite large in Montenegro and that the valuation model could operate with less and more generic data related to the building quality, there are two reasons for this kind of valuation. The first reason is that such procedure is defined by the law. Another reason is that there are large differences in the price of buildings at the same location. Without appropriate quality information the similar amount of tax would be assigned to moderate real properties and exclusive properties. The income of taxes is important for local self-governments, especially since Bar is a touristic place and there are a lot of luxury real properties for which a larger tax should be paid. Furthermore, there are a lot of luxury real properties that are built in recent years and are planned to be built, so using BIM for automation will decrease considerably time for entering quality information and increase accuracy of recorded data, since in past it was not unusual not to record the quality data but to enter some predefined value.

The property tax for real properties is determined and gathered on the local level by local Government, while other revenues from properties during transactions are gathered on the national level. Because of that, it is very important that property taxes are righteous, not to overload those who own low quality buildings, and also for luxury buildings a tax to be calculated as prescribed by the law. This income is very important for the municipality because these resources can be allocated to health care, environmental protection, energy efficiency, agriculture, water management, reforestation, paving, construction of

kindergartens and preschools, education, sport, and recreation and thus improving the quality of life for all citizens.
Future work will include development of IFC extension for property valuation. Since Montenegro has numerous summer resorts on its coast, the collection of tourist taxes can bring significant funds to the municipality. Future work will involve expanding the developed model to include tourist tax and procedure to calculate it.

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BIOGRAPHICAL NOTES

Aleksandra Radulović (Ph.D) is an Associate Professor at Faculty of Technicial Sciences, University of Novi Sad, Serbia. She has published several papers in ISI journals and conferences. She has also participated in several research projects including GIS (geoportal) for the Ministry of Environmental Protection and Ecology of Serbia, Information system of the real estate cadastre for Republic Geodetic Authority of Republika Srpska, Information system of the real estate cadastre in Montenegro, Information system for user requests submission in the cadastral system in Republic of Serbia, Information system for valuation in Bar, Montenegro and GIS for the city of Novi Pazar. Her domains of interest are Geographic Information Systems, Spatial Data Infrastructures, Service Oriented Architecture, Cadastral Systems, etc.

Dubravka Sladić (Ph.D) is an Associate Professor at Faculty of Technicial Sciences, University of Novi Sad, Serbia. She has published several papers in ISI journals and more than 20 papers in international and national journals and conferences. She has also participated in several research projects and projects including design and implementation of cadastral information systems in Republic of Srpska in Bosnia and Hertzegovina, Montenegro and Serbia and Information system for valuation in Bar, Montenegro. Her domains of interest are Geographic Information Systems, Spatial Data Infrastructures, Service Oriented Architecture, Cadastral Systems, etc.

Miro Govedarica (Ph.D) is a Full Professor at Faculty of Technicial Sciences, University of Novi Sad, Serbia. His practical and theoretical results belong to area of geoinformatics. He was a project leader in several research projects including GIS (geoportal) for the Ministry of Environmental Protection and Ecology of Serbia, Information system of the real estate cadastre for Republic Geodetic Authority of Republika Srpska, Information system of the real estate cadastre in Montenegro and Information system for user requests submission in the cadastral system in Republic of Serbia, Information system for valuation in Bar, Montenegro, GIS for the city of Novi Pazar and GPS permanent stations network in Serbia. He published a number of papers in journals and scientific conferences proceedings related to geoinformatics. Domain of interest include object-oriented software engineering, databases, geospatial databases, development of service-oriented geoinformation systems, photogrammetry, laser scanning, remote sensing, global navigation satellite systems, geoservices, geospatial data infrastructure and geobig data.

Dušan Raičević is the Mayor of the Municipality of Bar. His specialty is management in economy. During his career, he was the secretary in the Secretariat for Economy and Finance of Bar and in 2018, he was elected on mayor position. His work is focused on the development and progress of the municipality of Bar, which includes following the trends in the development of information technology, appropriate standards and cooperation with the academy as a relevant institution for such metter.

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