A Knowledge Organization System for the Development of an ISO 19152:2012 LADM Valuation Module

Volkan ÇAĞDAŞ, Abdullah KARA and Ümit İŞIKDAĞ, Turkey; Peter van OOSTEROM and Christiaan LEMMEN, The Netherlands; Erik STUBKJÆR, Denmark

Key words: Knowledge Organization Systems; Simple Knowledge Organization System (SKOS); ISO 19152:2012 Land Administration Domain Model (LADM); LADM Valuation Module

SUMMARY

The challenge to develop interactive information services for new domains is supported by Knowledge Organization Systems and Services (KOS), which model the underlying semantic structure of a domain through classification systems, thesauri, gazetteers, or ontologies. The ISO 19152:2012 Land Administration Domain Model (LADM) is an international standard regarding the management of information about ownership, value and use of land. The current version of LADM addresses legal and administrative aspects; the standard revision starts in 2017, according to ISO’s periodic maintenance procedure. A group of researchers have initiated the development of a valuation component of LADM in terms of a draft extension module. It concerns the fiscal parties involved in the valuation practices and fiscal real property units that are the objects of valuation (see Çağdaş et al., 2016). The present paper aims at supporting this initiative by providing a domain vocabulary and thesaurus. The presented Valuation Thesaurus is developed according to the ANSI/NISO Z.39.19-2005 ‘Guidelines for the Construction, Format, and Management of Monolingual Controlled Vocabularies’ and includes terms derived from international valuation standards, such as European Valuation Standards (TEGoVA, 2012), International Valuation Standard (IVSC, 2013), Standard on Mass Appraisal of Real Property (IAAO, 2013a), Standard on Automated Valuation Models (2003), Standard on Ratio Studies (IAAO, 2013b). It is encoded through the Simple Knowledge Organization Systems (SKOS) specifications developed by World Wide Web Consortium (W3C) for standardized representation of structured vocabularies. The Valuation Thesaurus reveals the core semantic of the immovable property valuation domain, and therefore supports the identification of candidate classes, class attributes and relationships for the further elaboration of the mentioned LADM Valuation Module.
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1. INTRODUCTION

The ISO 19152:2012 Land Administration Domain Model (LADM) is an international standard regarding the management of information about the relationships (formal, informal and customary) between people and land. The current edition of LADM addresses geometry, surveying/mapping and legal/administrative aspects; the standard revision starts in 2017, according to ISO’s periodic maintenance procedure. A recently initiated collaborative research aims at developing a LADM based international information model for one of the current ‘LADM external’ classes\(^1\) (included in external databases), namely in terms of a Valuation Module.

The purpose of the mentioned research is to define the semantics of valuation information, and to extend the scope of LADM with a fiscal perspective to provide an information model that could be used to construct information systems for immovable property valuation.

The present paper aims at supporting this initiative by providing a knowledge organization system (KOS) for immovable property valuation, and represents it through a Simple Knowledge Organization System (SKOS), according the specifications developed by the World Wide Web Consortium (W3C). The main purpose is to reveal the semantic structure of a domain with the developed KOS which may assist the identification of candidate classes, class attributes and relationships for the further elaboration of LADM Valuation Module. The developed KOS includes terms derived from international valuation standards, such as European Valuation Standards (TEGoVA, 2012), International Valuation Standard (IVSC, 2013), Standard on Mass Appraisal of Real Property (IAAO, 2013a), Standard on Automated Valuation Models (2003), Standard on Ratio Studies (IAAO, 2013b).

The remaining part of the paper is organized as follows: Section 2 outlines types of KOSs and section 3 renders the adopted methodology for the development and representation of KOSs. Section 4 describes the developed Immovable Property Valuation Thesaurus, and the last section suggest further research and concludes the present paper.

2. KNOWLEDGE ORGANIZATION SYSTEMS

\(^1\) LADM external databases may concern party data, address data, taxation data, land use data, land cover data, valuation data, physical utility network data, and archive data.
A knowledge organization system is a general term which refers to tools that present the organized interpretation of knowledge structures (Zeng, 2004, p. 377). It covers all types of schemes for organizing information and promoting knowledge management, such as (i) term lists, (ii) classifications and categories, and (iii) relationship lists (Hodge, 2000, p.4).

The first group of KOS, term lists comprises of glossaries, dictionaries and gazetteers. Glossaries and dictionaries are lists of terms with definitions. Dictionaries are more general in scope than are glossaries, and they may also provide information about the origin of a word, variants (by spelling and morphology), and multiple meanings across disciplines. (Miguel, 2009, p. 17). A gazetteer refers a list of place names (Hodge, 2000, p. 5). The second group of KOS, classifications and categories includes subject headings and taxonomies (Hodge, 2000, p. 6). These models are more complex than the first group of KOS, because of their hierarchical structure. A subject heading is a uniform group of words used to describe the subject of library materials, while a taxonomy is a controlled vocabulary consisting of preferred terms, all of which are connected in a hierarchy or polyhierarchy (ANSI/NISO Z39.19-2005, p. 18). The last group of KOS, relationship lists comprises of thesauri and ontologies (Hodge, 2000). A thesaurus was defined by ISO-2788 as a set of terms, formally organized so that the a priori relationships between these are made explicit. Relationships commonly expressed in a thesaurus include hierarchy (broader-narrower), equivalence (synonymy), and association or relatedness (Hodge, 2000, p. 6 ; see Clark and Zeng, 2012, for an update). The last type KOS, an ontology is an explicit formal specification of a shared conceptualization. It is used in information systems and in knowledge representation systems to denote a knowledge model, which represents a domain of interest (Gruber, 1993).

Among these KOSs, taxonomies, thesauri and ontologies are most commonly used schemas for modeling of knowledge domains (cf. Schwarz, 2005; van der Meer, 2008). A taxonomy is a rough modelling scheme because it only connects terms to each other with a hierarchical relationship, whereas a thesaurus is more specific, because it also offers equivalence and associative relationships. An ontology, however, is most precise because it defines the meaning of concepts by modelling properties that constrain the possible interpretations of a concept (Schwarz, 2005, p. 19). However the great size of the required models increases too much the complexity and cost of the ontology development process. Thesauri, on the other hand, provide a weaker semantics but they are simpler to create and bigger models are affordable (Miguel 2009, p. 13). They are also seen the core building block of ontologies (Ma et al. 2011, p. 1603). This research, therefore aims at constructing a thesaurus for the domain of immovable property valuation, and thereby further ontology building.

In the current version of the ISO LADM standard, there are sample values for the various code lists with types of rights, restrictions and responsibilities (LA RightType, LA RestrictionType, LA ResponsibilityType). Despite their importance, the code lists are in the informative part of the standard (and not in the normative part) and the values for the various types are just indicated by a single name (label) without definitions. An initial attempt to use semantic technologies, ranging from hierarchically structured code list to the RDF vocabulary
SKOS (see section 3.3), for structuring and maintaining LADM code lists was proposed ontologies (Paasch et al. 2015). The paper proposed the following rule: if ‘things’ are structurally different, i.e. different attributes/properties and/or different relationships, then adding a new class would be most appropriate, otherwise it is better to consider adding well-structured code list values (based on semantic technology). Adding refined meaning to the LADM code lists, covering both formal and informal registration of rights, restrictions and responsibilities, is a next step in the direction of international harmonization of the administrative/legal interests in land administration.

3. THESAURUS CONSTRUCTION

This paper follows the principles proposed by ANSI/NISO Z.39.19-2005 ‘Guidelines for the Construction, Format, and Management of Monolingual Controlled Vocabularies’, and organizes the thesaurus construction processes into the following stages: (i) Term selection, (ii) Identification of semantic relationships, and (iii) Specification of these relationships. The general content of these stages is summarized in the following sub-sections which will constitute the base for the methodology employed in Section 4.

3.1 Term selection

The first step of the thesaurus construction is the selection of a set of candidate terms. According to ANSI/NISO Z39.19-2005, the candidate terms could be selected by the committee method, the empirical method, or a combination of these methods (p. 91). In the committee method, domain experts draw up a list of key candidate terms and indicate the relationships among them, whereas in the empirical method extracts terms from documents, either manually by humans, or automatically by use of computers. Candidate terms could be derived from ‘prearranged standardized sources’ and ‘open-ended non-standardized sources’ (Soergel, 1974). Prearranged sources are already existing descriptor lists, classification schemes, thesauri, dictionaries, etc. On the other hand, open-ended sources consist of written sources and unwritten sources. The most traditional written sources are documents within a subject literature, where terms are selected from titles, abstracts, paragraphs, or the full-text (Schneider, 2004, p. 25-27).

3.2 Identifying semantic relationships

ANSI/NISO Z39.19-2005 defines three types of relationships used in controlled vocabularies: (i) Hierarchy, (ii) Equivalency, and (iii) Association (p. 42). A thesaurus includes all these relationships. This hierarchical relationship is represented using the notation BT (broader term) and NT (narrower term). There are three types of hierarchical relationship: the generic relationships, the instance relationships and the whole-part relationships. The generic relationship identifies the link between a class and its members or species, while instance relationship describes the link between a general category of things or events. Whole-Part relationship covers situations in which the meaning of one concept is
inherently included in another one so that the terms can be organized into logical hierarchies, with the whole treated as a broader term (ANSI/NISO Z39.19-2005, 2005, p. 48-49).

In addition to hierarchical relationship, a thesaurus also includes equivalence and association relationships. The equivalence relationship is the reciprocal relation between preferred term (PT) and non-preferred terms (NPT) where two or more terms are regarded as referring to the same concept. It covers synonyms, lexical variants, near-synonyms, generic posting, and cross reference to elements of compound terms (ANSI/NISO, Z39.19-2005, p. 43). The other type of relationships included by a thesaurus is the association relationship. An association relationship covers associations between terms that are neither equivalent nor hierarchical, yet the terms are semantically or conceptually associated. The most common associative relationship used in thesauri is symmetrical and is generally indicated by the abbreviation RT (related term) (ANSI/NISO Z39.19-2005, 2005, p. 51).

3.3 Specification: Simple Knowledge Organization System (SKOS)

The Simple Knowledge Organization System is a common data model for expressing the basic structure and content of concept schemes such as thesauri, classification schemes, subject heading lists, taxonomies, and other similar types of controlled vocabulary. Since the SKOS data model is an application of the Resource Description Framework (RDF), it enables machine-readable representation of a KOS, and allows sharing and linking KOSs via the Web (Isaac and Summers, 2009; Miles and Bechhofer, 2009). Because of its simplicity and advantages relative to other KOS representation formats (cf. Pastor-Sanchez et al., 2009), nowadays the SKOS data model has been increasingly used in the encoding of existing KOSs e.g. GEMET (General Multilingual Environmental Thesaurus), AGROVOC (Multilingual Agricultural Thesaurus), and the Cadastre and Land Administration Thesaurus (CaLAThe).

The general content of the SKOS data model is summarized below based on W3C Specifications of SKOS (Simple Knowledge Organization System Reference, 2009; SKOS Simple Knowledge Organization System Primer, 2009).
The components and relationships between the components of the SKOS data model are summarized in SKOS Reference as follows: "Using SKOS, concepts can be identified using URIs, labeled with lexical strings in one or more natural languages, assigned notations (lexical codes), documented with various types of note, linked to other concepts and organized into informal hierarchies and association networks, aggregated into concept schemes, grouped into labeled and/or ordered collections, and mapped to concepts in other schemes."

SKOS represents the elements of a KOS as concepts, provides them with various kinds of labels and documentation notes, and allows linking them together by three types of semantic relations. A SKOS concept, skos:Concept is the basic element of the SKOS data model, and it represent units of thought, ideas, meanings, or (categories of) objects and events. A SKOS concept scheme, skos:ConceptScheme is an aggregation of one or more SKOS concepts. These SKOS concept schemes and SKOS concepts are identified by URIs, enabling anyone to refer to them unambiguously from any context, and making them a part of the World Wide Web.

SKOS concepts can be labelled with any number of lexical strings in any natural language. SKOS provides three properties to attach labels to concepts, namely preferred term (skos:prefLabel), alternative term (skos:altLabel), and hidden label (skos:hiddenLabel). The first property is used for assigning a preferred lexical label to a concept, while the second one is used for alternatives of preferred label, e.g. synonyms. The last one is used in order to make concepts accessible by for instance misspelled variants of other lexical labels.

SKOS concepts can be linked to other SKOS concepts via semantic relation properties. There are two types of semantic relation properties: hierarchical and associative. A hierarchical link between two concepts indicates that one is in some way more general ("broader") than the other ("narrower"). An associative link between two concepts indicates
that the two are inherently "related", but that one is not in any way more general than the other. The properties skos:broader and skos:narrower are inverse relations, and used to assert a direct hierarchical link between two SKOS concepts. While, the property skos:related is used to assert an associative link between two SKOS concepts.

There are seven documentation notes in SKOS for providing information relating to SKOS concepts. For instance, the skos:scopeNote supplies some information about the intended meaning of a concept. The skos:definition is used for giving a complete explanation of the meaning of a concept. The skos:example supplies an example of the use of a concept, and skos:historyNote describes changes to the meaning or the form of a concept.

SKOS concepts can be mapped to other SKOS concepts in different concept schemes. The properties skos:broadMatch and skos:narrowMatch are used to state a hierarchical mapping link between two concepts, while skos:relatedMatch is used to state an associative mapping link between two concepts. The skos:closeMatch is preferred to link two concepts that are sufficiently similar, while skos:exactMatch is used if two concepts are exactly matching.

4. A THESAURUS for the DOMAIN of IMMOVABLE PROPERTY VALUATION

In the research for this paper we adopted the committee method, more specifically ‘prearranged standardized sources’, as introduced in Section 3.1. In recent years, a number of standards have been developed by valuation organizations, namely

- Standard on Mass Appraisal of Real Property (IAAO, 2013a)
- Standard on Ratio Studies (IAAO, 2013b)
- European Valuation Standards (TEGoVA, 2016)
- International Valuation Standard (IVSC, 2016)

In the first stage, the candidate terms for the immovable property valuation domain were derived by the empirical method mentioned in Section 3.1. The employed empirical method involves a manual term extraction process. In this process, total 522 terms which represents main valuation concepts and terms that represent factors affecting property values were derived from the glossaries and the main text of the international valuation standards. The manually extracted terms were analyzed and edited from a linguistic perspective, including elimination of repeated terms, control of the grammatical forms, spelling variants, singular and plural forms, abbreviations and acronyms, punctuation and capitalization (cf. Schneider, 2004, p. 28). Moreover, a number of terms which are mainly related to financing, land surveying, and statistics were eliminated from the vocabulary. During the next stage, the semantic relationships between the remaining 139 terms (i.e. hierarchical, equivalency and association relationships) were specified according to the principles explained in Section 3.2. Finally, the developed thesaurus was encoded through the SKOS formalism outlined in Section 3.3.
4.1 Description of the Immovable Property Taxation Thesaurus

This section presents a narrative description of the valuation domain with the terms of developed Immovable Property Valuation Thesaurus (IPVT).

*Immovable property valuation* or *Real estate appraisal* is performed by *Valuer* or *Appraiser* employed within a public or private organization to estimate *Value* of immovable properties for several public and private purposes, such as property taxation, expropriation, land use planning, real estate financing, investment analysis, insurance and further property transactions (see, Figure 2).

![Diagram of Valuer concept]

*Figure 2. The Valuer concept*

The term of *Value* refers to the relationship between an object desired and a potential owner (IAAO, 2013a; 2013b), and can be decomposed into several value types according to different legislations and requirements, such as *Acquisition value*, *Alternative use value*, *Appraised value*, *Assessed value*, *Base year value*, *Fair value*, *Hope value*, *Insurable value*, *Investment value*, *Market value*, *Mortgage lending value*, *Synergetic value*, *Net present value*, *Reconstruction value*, *Residual value*, *Reversionary value*, *Special value*, *Use value*, and *Plottage value* (see, Figure 3).
As illustrated in Figure 4, the object of valuation is the *Immovable property* or *Real estate* which consists of one or more *Parcel(s)* and the *Construction(s)* built on the *Parcel(s)*. These objects have characteristics that should be considered the in *Immovable property valuation*, such as *Parcel area*, *Land use* and *Topography* for the *Parcel*; and *Chronological age*, *Size* and *Construction quality* for the *Construction*. Moreover, selection of the *Valuation approach* to be employed requires classification of the *Immovable property* according to its use, for instance *Residential property*, *Commercial property*, and *Mixed residential and commercial property* (cf. IAAO, 2013a).
Figure 4. The valuation object concept
The Valuation activity term illustrated in Figure 5 covers Valuation approaches, Single property appraisal, Mass appraisal and Valuation date. The Valuation approach specifies the Sales comparison approach, the Cost approach and the Income approach, terms that represent the traditional valuation approaches or methods, used in both Single property appraisal and Mass appraisal.

The Sales comparison approach compares the subject property with other similar properties that have been recently sold which are termed as Comparable sales. It estimates the Value of the subject property by making Adjustments in the Sales prices of the comparable properties in terms of their differences from the subject property. Adjustments are usually made for the Sale date, location and physical characteristics (e.g. Parcel characteristics, Construction characteristics, and Locational characteristics) (IAAO, 1999).

The Cost approach, which is also known as the Summation approach, provides an indication of the Value based on the economic principle that a buyer will pay no more for a property than the cost to obtain a property of equal utility (TEGoVA, 2016). According to this, the Market value of an improved parcel can be estimated as the sum of the value of the Parcel and the depreciated value of Construction (Eckert et al., 1990, p. 205). A differentiated version of the Cost approach, the Abstraction method or Residual method can also be used for valuation of unimproved land in the absence of vacant land sales. The Cost approach requires estimation of the current Cost of Construction which covers expenses, direct and indirect, of constructing an improvement (IAAO, 2013a). Two types of Cost can be used: Reproduction cost and Replacement cost. The former refers to the current Cost of creating a replica of the asset, while the latter means the current Cost of a similar asset offering equivalent utility (IVSC, 2016). This method also requires determination the extent of Obsolescence occurred in the Construction. Obsolescence, which is also known as Depreciation, refers to loss in value of an object, relative to its Replacement cost, Reproduction cost, or original cost (IAAO, 2013a). It can be decomposed into Physical obsolescence, Functional obsolescence, and External obsolescence (IVSC, 2016).

The next, Income approach converts the present or prospective stream of income derived from property into capital value through Direct capitalization or Yield capitalization (Shugrue, 1963). The Direct capitalization can be applied with Net income and Capitalization rate or Gross income and Gross rent multiplier. The Capitalization rate is the ratio of net operating income to market value (IAAO, 2013a), while the Gross income multiplier represents the ratio of potential gross income or its effective gross income to market value. The second capitalization approach, Yield capitalization (Discounted cash flow analysis) is used to calculate the present value of anticipated future Cash flows (IAAO, 2010). Future Cash flows are converted to value through Rate of return (Discount rate) of the investment. A Rate of return is an amount of income (loss) and/or change in value realized or anticipated on an investment, expressed as a percentage of that investment (IVSC, 2016). It consists of Internal rate of return, Risk free rate and Risk Premium. Internal rate of return is the discount rate at which the present value of the future cash flows of the investment equals the acquisition cost of the investment. The Risk free rate is the rate of return available in the market on an investment free of default risk. The Risk premium is a rate of return added to a risk-free rate to reflect risk (IVSC, 2016).

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Figure 5. The Valuation activity concept
Above outlined Valuation approaches are employed in both Single property appraisal and Mass appraisal. The Single property appraisal estimates value of a particular property on a given date, while the Mass appraisal values a group of properties on a given date and using common data, standardized methods, and statistical testing (IAAO, 2013a; 2013b). The term of Computer aided mass appraisal (c.f. IAAO, 2003; 2013a) is used when Mass appraisal is performed by means of computer-supported statistical analyses.

The main component of Mass appraisal is the Mass appraisal model which explains the relationship between Value and variables representing factors of supply and demand (IAAO, 2013a). Model specification and Model calibration are distinct steps in the modeling. Model specification is the formal development of a model in a statement or equation, based on data analysis and appraisal theory (IAAO, 2003; 2013a). Models may be specified for group of properties that have similar characteristics, in the form of Additive model, Multiplicative model, and Hybrid model. Grouping of properties according to the selected variable (e.g. location, size, age, and construction quality) is called as Stratification and can be realized with Cluster analysis (see, IAAO, 2003). The specified models are supplemented through the Model calibration stage, which according to IAAO (2003; 2013a) is the development of adjustments, or coefficients, based on market analysis, that identifies specific factors with an actual effect on market value. Several statistical techniques can be applied in this stage, such as Multiple regression analysis, Adaptive estimation procedure, Location value response surface analysis, Time series analysis, and Artificial network analysis. A Mass appraisal may further include a performance analysis stage, the Ratio study, to compare the appraised values with market values for determining the accuracy of the appraisal (Gloudemans, 1999). The Ratio study, which also termed as Appraisal ratio study or Sales ratio study, is a study of the relationship between appraised values and market values (IAAO, 2003; 2010; 2013a). A Ratio study estimates an Appraisal ratio which refers to the ratio of the appraised value to an indicator of market value (IAAO, 2013a; 2013b). Two aspects, Appraisal level and Appraisal uniformity are analyzed in the Ratio study in order to measure the accuracy of the Mass appraisal. The Appraisal level is an indicator that show the overall or typical ratio of the appraised values to the market values. It is ascertained by central tendency measures such as, mean, median, weighted mean. The second indicator, Appraisal uniformity defines appraisal consistency and equity between and within groups of properties. It could be expressed for instance, by the coefficient of dispersion, coefficient of variation, or price-related differential measures (Gloudemans, 1999).

Information used in or produced through the Valuation activity are represented or kept in Valuation records. These records may be in the form of Valuation reports or in the form of Valuation databases, which records the Locational, Parcel, and Construction characteristics of Valuation objects, or provides Sale statistics about property market, such as the Purchase Price Collections in Germany, or the Sales Price Register in Slovenia (see Figure 5).
The SKOS encoding of above described Immovable Property Valuation Thesaurus is online accessible at http://cadastralvocabulary.org/IPVT.rdf. Table 1, below, provides an extraction from this SKOS encoding.

Table 1. The SKOS encoding of the Immovable property valuation term extracted from IPVT

<table>
<thead>
<tr>
<th>Concept</th>
<th>Label</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;skos:Concept rdf:about=&quot;<a href="http://cadastralvocabulary.org/IPVT/ImmovablePropertyValuation%22%3E">http://cadastralvocabulary.org/IPVT/ImmovablePropertyValuation&quot;&gt;</a></td>
<td>ImmovablePropertyValuation</td>
<td><a href="">skos:definition</a>(1) The process of establishing the value of an asset or liability; OR (2) The amount representing an opinion or estimate of value (Source: International Valuation Standards Council, 2016). &lt;/skos:definition&gt;</td>
</tr>
<tr>
<td><a href="">skos:altLabel</a>RealEstateAppraisal&lt;/skos:altLabel&gt;</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;skos:narrower rdf:resource=&quot;<a href="http://cadastralvocabulary.org/IPVT/Valuer%22/%3E">http://cadastralvocabulary.org/IPVT/Valuer&quot;/&gt;</a></td>
<td></td>
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</tr>
<tr>
<td>&lt;skos:narrower rdf:resource=&quot;<a href="http://cadastralvocabulary.org/IPVT/Value%22/%3E">http://cadastralvocabulary.org/IPVT/Value&quot;/&gt;</a></td>
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<tr>
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5. CONCLUSIONS

This paper introduces a domain thesaurus for immovable property valuation, which has been developed according to the ANSI/NISO Z.39.19-2005 ‘Guidelines for the Construction, Format, and Management of Monolingual Controlled Vocabularies’, and represented through the Simple Knowledge Organization System (SKOS) formalism. The terms of the thesaurus are derived from international valuation standards issued by the International Valuation Standards Council, The European Group of Valuers’ Associations, and the International Association of Assessing Officers.

The Immovable Property Valuation Thesaurus is an output of a collaborative research which aims at developing an international Valuation Information Model based on ISO 19152:2012 Land Administration Domain Model (LADM). It reveals the core semantic of the immovable property valuation domain, and therefore support the identification of candidate classes, class attributes and relationships for the further elaboration of LADM Valuation Module. It may also be used for classification and indexing of domain resources in a Linked Data environment.
Future research includes the refinement of the Immovable Property Valuation Thesaurus, as well as mapping its terms with the terms of the Cadastre and Land Administration Thesaurus (CaLAThe) and the ISO LADM, addressing also the code list issue mentioned at end of Section 2.

REFERENCES


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BIOGRAPHICAL NOTES

Volkan Çağdaş has been working as associate professor in Department of Surveying Engineering, Yıldız Technical University (YTU) since 1999. His research interests cover the technical and the institutional aspects of cadastre and land administration.

Abdullah Kara has his BSc in Geomatics Engineering from İstanbul Technical University and his MSc degree in Geomatics Programme of Yıldız Technical University (YTU). He worked as an engineer in the Development of Geographical Data Standards for Turkey National GIS Infrastructure (TUCBS), supported by the Ministry of Environment and Urbanization. He has been working as a research assistant at YTU since 2013. His research field includes land administration, property valuation and geo-spatial data modelling.

Ümit Işıkdağ has his MSc in Civil Engineering and PhD (from the University of Salford) in Construction Information Technology with his work on integration of BIM with 3D GIS. His research interests include BIM / IFC, 3D GIS, Internet of Things, RESTful Architectures, BIM 2.0, and Spatial Web Services. He is lecturing in Mimar Sinan Fine Arts University Department of Informatics and actively involved in the organization of 3D GeoInfo and GeoAdvances Conferences, editorship of International Journal of 3D Information Modeling, and also serving as the Secretary of ISPRS WG II/2.

Peter van Oosterom obtained an MSc in Technical Computer Science in 1985 from Delft University of Technology, the Netherlands. In 1990 he received a PhD from Leiden University. From 1985 until 1995 he worked at the TNO-FEL laboratory in The Hague. From 1995 until 2000 he was senior information manager at the Dutch Cadastre, where he was involved in the renewal of the Cadastral (Geographic) database. Since 2000, he is professor at the Delft University of Technology, and head of the ‘GIS Technology’ Section, Department OTB, Faculty of Architecture and the Built Environment, Delft University of Technology, the Netherlands. He is the current chair of the FIG Working Group on ‘3D Cadastres’.

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Erik Stubkjær is an emeritus professor for Cadastral Science at the Aalborg University, Denmark. He originated the idea and performed the preparation of the COST-action G9 and served as its chairman. He is member of the Danish Association of Chartered Surveyors, and of the ITsection of the Society of Danish Engineers.

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A Knowledge Organization System for the Development of an ISO 19152:2012 LADM Valuation Module (8904)
Volkan Cagdas, Abdullah Kara (Turkey), Peter van Oosterom, Christiaan Lemmen (Netherlands) and Erik Stubkjær (Denmark)

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