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Spatial data quality impacts on the efficiency of the property tax system: The case of construction land fees

Spatial data are directly linked to spatial planning, and to spatial management in general, including the property tax system. Spatial data quality impacts the efficiency of the property tax system, as well as its equity and reasonability. This article presents a methodological approach to analysing the quality of spatial databases managed by municipalities for assessing construction land fees. Adjusted Jaccard and Czekanowski indices were defined and applied for data quality analysis because they are applicable in cases in which differences between the data compared amount to less than 5%. The indices were used to establish the level of matching for areas of buildings and the unbuilt construction land in the municipal construction land fee assessment databases and in the real estate register. Based on an analysis of the completeness, logical consistency, and thematic accuracy of municipal construction land fee assessment databases, municipal databases were updated. Modifications to the municipal databases were analysed following updating in terms of the number of persons subject to construction land fee payment and the construction land fee amount payable. The results of the first study of this type have been obtained on a small sample, but the methodology is also applicable for analysis on a large sample or in all Slovenian municipalities. As such, the analysis may be of help to experts at municipal offices, spatial planners, and decision-makers in taxation policies.

Keywords: spatial management, spatial planning, spatial data quality, property tax

1 Introduction

Spatial data describe the material world from various perspectives, directly or indirectly linking spatial features to locations, thus creating a basis for determining the characteristics of real estate (Yomralioglu et al., 2007; Ažman, 2011). Spatial data are directly linked to spatial planning and spatial management in general (Zakrajšek, 1999). Mangioni (2012), Mantey and Tagoe (2012) and Çağdaş (2013) point out the importance of use of spatial data and GIS technology in establishing and managing a real estate property tax system as part of the spatial management system. They point out that the use of quality spatial data significantly impacts the efficiency of the system and its scope, equity, and reasonability. Droj and Droj (2010) highlight the importance of spatial data for good management and quality decision-making for property tax. Robbins (2014) confirms the positive impact of using spatial data, GIS technology, spatial expertise, and appropriate accessibility and cartographic presentation of real estate data for spatial management, spatial planning, and property tax (Zavodnik Lamovšek et al., 2012). Maher et al. (2005) and Robbins (2014) highlight the role of GIS technology and (horizontal and vertical) linking of various spatial databases at the local and national levels. Jankovič Grobelšek and Gajšek (2014) point out that effective real estate legislation should be based on integrally regulated data from the spatial information system.

Property tax is linked to the requirement for high-quality real estate data. In Slovenia and in many other countries, the property tax systems are undergoing certain reforms. The effectiveness of implementing property tax reforms also depends on the availability of sets of spatial and other data on real estate, and on their quality. The better the accuracy and completeness of the real estate recording system, the higher the level of legal security of legal relations, and the higher the level of confidence in the system and its applicability (Starček, 2017). In dealing with spatial phenomena, a complex and intersectoral spatial data system normally applies, in which data quality is an important factor of the quality and efficacy of the system that applies such data. Thus, as highlighted by van der Molen (2002), special attention needs to be dedicated to ensuring quality and reliable spatial data on real estate that is interconnected and consistent although it is managed as part of different databases.

The study presented here focuses on an analysis of the impact of spatial data quality on the property tax system in Slovenia. Property tax systems are subject to constant changes (Slack & Bird, 2014). The efficacy of reforms and subsequent efficiency of the property tax system also depend on the quality of real estate databases. Like many countries of eastern and central Europe, in Slovenia as well for more than two decades a transition process has been under way from the old area-based property tax system to a new ad-valorem system. In Slovenia, the property tax system has become obsolete, non-harmonized, non-transparent, and unadjusted to new economic conditions (Vlada Republike Slovenije, 2013). The first attempt at introducing the new property tax method was made in 2013 by adopting the Real Property Tax Act (Sln. *Zakon o davku na nepremičnine*, Ur. l. RS, no. 101/2013, 22/2014 – odl. US), which was abolished in its entirety by the Constitutional Court (Ustavno sodišče Republike Slovenije, 2014), principally due to its non-conformity with the constitution. In its decision, the Constitutional Court (Ustavno sodišče Republike Slovenije, 2014) highlighted, among other factors, the need to improve real estate data quality.

The impact of spatial data on the efficiency of the property tax system can be analysed only based on data that are managed by municipalities for assessing construction land fees (hereinafter: the CLF). The CLF is a contribution that, in addition to the property tax under the Civil Tax Act and the forest road maintenance fee, collectively constitutes the property tax that has been in force since 1984. The CLF has been levied in all of Slovenia's municipalities. Since its introduction, the revenue from the CLF has constituted one of the major and most stable public financing sources for the municipalities. Based on income from the CLF, municipalities provide for appropriate development of building land and for economic and social development. According to data from the Ministry of Finance (Ministrstvo za finance, 2017), on average revenue from the CLF amounts to almost 90% of all revenue from the municipal property taxes, or 15% of total municipal tax revenues. Legal entities constitute 4% of all entities subject to CLF payment. The assessment of CLF for business purposes constitutes 70.5% of the total assessment.

The aim of this study was to establish whether improving the quality of municipal CLF assessment databases with data from the real estate register and the cadastre of economic public infrastructure contributed to an increase in the CLF amount payable. The study hypothesized (Hypothesis 1) that the absence of records on buildings and unbuilt construction land in the municipal CLF assessment databases was on average more than 10% higher compared to the status in the real estate register. It was further hypothesized (Hypothesis 2) that data matching for the areas of buildings and unbuilt construction land between the municipal CLF assessment databases and the real estate register was relatively low, which means that the value of the adjusted Jaccard index and of the adjusted Czekanowski index was less than 0.33. It was also hypothesized (Hypothesis 3) that updating municipal datasets with data from the real estate register resulted in an increase in the

number of persons subject to CLF payment and in the CLF amount payable.

2 Spatial data quality and relevant studies

Spatial data tend to be rather diverse in terms of positional quality, temporal quality, or quality of semantic definition of concepts (notions). The definition of the quality of spatial data depends on the discourse, purpose, requirements, and expectations of users and other subjective factors. In general, the quality of spatial data reflects the totality of the characteristics of a database in terms of its capability to comply with the expressed or incorporated set of requirements. There then exists a difference between the data and the material world represented by such data. The greater the difference, the lower the quality of data, and thereby the lower the usable and overall value of such data (Triglav, 2012).

The quality of data is also defined by its purpose, origin, and use, including descriptive and quantitative elements (Morrison, 1995; Veregin, 1999; Šumrada, 2005; Ivánová, 2007). The international and Slovenian standard SIST EN ISO 19157:2015 Geographic Information – Data Quality defines a unified quality model for spatial data and the basic methodology for determining their quality. According to the quality principles of the SIST EN ISO 19157:2015 standard, data quality is the difference between a database and the material or hypothetical world, the "universe of discourse", defined by data specifications. Basic elements of quality, as defined by SIST EN ISO 19157:2015, include positional accuracy, thematic accuracy, logical consistency, temporal quality, completeness, and usability.

Several studies have been conducted in relation to spatial data on real estate for assessment and taxation purposes (Kokkonen, 2006; Tomić, 2010). Barańska (2004) studied the elements of data quality sets and stochastic models of real estate market value predictions. Barvika et al. (2013) studied interlinks between real estate databases and real estate mass appraisal data for property tax purposes. Mangioni (2012) studied the impacts of informatization and accessibility of data on real estate, and the principles of a good property tax system. Several studies focused on the development of methods for evaluation or quality assessment of spatial data (Pipino et al., 2002; McKay, 2003; Cerovski, 2010; Xia, 2012). Numerous automated methods and tools have been developed in support of data quality assessment (Podobnikar, 2001; Li et al., 2012) or a selected quality element (Goodchild & Hunter, 1997; Ariza-López & Mozas-Calvache, 2012; Hast, 2014; Hashemi & Abbaspour, 2015). Maggio (2012) highlighted the significance of improving real estate data quality in Italy for municipal property tax assessment, and for a waste deposit tax that is assessed depending on the area of the property. Based on data submitted by owners of land and buildings, data from other official sets, and orthophotos, the quality of graphic and descriptive data of the cadastre of buildings and land was improved. Improving the completeness of real estate databases resulted in higher income from relevant taxes and in a higher number of illegal construction projects detected. Caeiro et al. (2016) highlight the effect of improving data quality in the real estate cadastre in Portugal on real estate assessment and property tax assessment. In the Lisbon area, the completeness, thematic accuracy, logical consistency, and positional accuracy of real estate data were improved through active involvement of real estate owners, gathering data on real estate ownership, and field geodetic measurements. Real estate data quality improvement significantly influenced the favourable regulation of ownership relations and usability of data for other purposes. Completeness of databases on land and buildings, which significantly influences the income from taxation, differs between European Union countries. According to data from the United Nations (2014), more than 80% of all land has been registered in European Union countries. The highest percentage has been recorded in central Europe and Scandinavia. In Armenia, the majority of non-recorded land is state-owned. In Malta, findings show that the percentage of recorded land is higher in urban areas. Around 2% of the land in Spain is not recorded, mostly in the countryside.

In the years after independence, Slovenia invested substantial funds into developing and setting up various spatial databases. As reported by Petrovič (2006), these were set up rather quickly, but frequently lacked sufficient and appropriate quality assurance. Many studies of spatial database quality have been conducted in Slovenia. The Geodetic Institute of Slovenia (2003) found that around one-fourth of data in the land cadastre were of poor or very poor quality, in particular in rural areas and in areas of less intensive use. Ferlan (2005), Čeh et al. (2011), Ferlan et al. (2011), and Bohak (2016) highlighted that the set of digital cadastral plans was inconsistent, and they pointed out differing positional accuracies. Frequent subjects of studies are the building cadastre (Geodetic Institute of Slovenia, 2015; Triglav Čekada et al., 2016) and the real estate register (Lisec et al., 2015; Mitrović, 2015; Požun, 2015; Starček, 2017). Smodiš (2011) pointed out that the quality of determining the mean market value of real estate depended on the quality of data on real estate in the real estate register. Mitrović (2015) pointed out the low quality of data submitted by persons subjected to property tax payment into the Real Estate Market Register.

Regarding spatial data, Kobetič (2014) found that data required for CLF assessment either did not exist, were not managed in an appropriate format, or were poorly maintained. Grilc (2017) and Ziherl (2017) found that updating the database of the Municipality of Kranj with data from the real estate register resulted, among other things, in an increase in the number of persons subject to CLF payment, and subsequently in increased income from the CLF. For effective improvement of data quality, Grilc (2017) also points out the significance of public display of data on real estate, and cooperation of real estate owners and spatial data experts. Gerčer (2017) particularly pointed out the discrepancies between data on construction land areas in the municipal CLF assessment database and the real estate register data. Mivšek and Radovan (2017) pointed out that differing data quality impacted irregularities in CLF assessment. Urankar (2016) assessed that, on account of incompleteness of municipal databases, income from the CLF was 20% to 30% lower. Slovenia's Financial Administration (Finančna uprava Republike Slovenije, 2014) reported that persons subject to CLF payment failed to promptly notify the communities of any changes impacting the CLF assessment. In this respect, Režek et al. (2015) highlighted that a multitude of providers of spatial databases and modern technology for acquiring spatial data may cause a lack of a critical approach to the use of spatial data. Thus, solutions, proposals, and measures based on such data may be of disputable quality. All of the above underlines the significance of providing quality spatial data.

3 Databases for property tax purposes in Slovenia

In case of the CLF, the subject of taxation is built-up and/or unbuilt construction land. Areas intended for residential or business purposes may be classified as built-up construction land. The tax base is the area of unbuilt construction land and the residential or business area of a building. Municipalities tend to define the areas of land, residences, and buildings for business purposes in different ways. Based on the ordinance on the CLF, municipalities define the criteria and the number of points depending on the characteristics of construction land and its advantages or disadvantages. The Construction Land Act (Sln. *Zakon o stavbnih zemljiščih*, Ur. l. SRS, no. 18/1984 and Ur. l. RS, nos. 44/1997, 67/2002, and 110/2002) did not define all the criteria for setting the CLF, on account of which the municipalities may frequently arbitrarily define the criteria and the number of points. To this end, municipalities have in place their own CLF assessment databases, which in most cases, as reported by Kobetič (2014), do not link to the reference databases (land cadastre, building cadastre, and real estate register). This, as pointed out by Grote et al. (2015), significantly impacts the illogical nature and non-transparency of the property tax system in Slovenia. The Construction Act (Sln. *Zakon o graditvi objektov*, Ur. l. RS, no. 102/2004, with changes) finally required the use of official databases (land cadastre, cadastre of buildings, and the real estate register) in managing the CLF system, which is not observed by all the municipalities.

The data required for CLF system management differ between the municipalities and depend on provisions of the ordinances or the criteria. Among the criteria, municipalities take into account in particular the location, utility connections, functional advantages of construction land location, intended use according to spatial implementing acts, density of public functions and business activities, and constant excessive impediments in construction land use. Certain municipalities also take into account the configuration of the terrain, occupation of buildings and land, number of private parking spaces, accessibility by public transport, impediments in the use of construction land, density of public functions, abandonment and wear and tear of a facility, and other factors. The building cadastre, land cadastre, and real estate register do not include all the data required by municipalities for defining the number of points and the CLF. In addition to data from the reference spatial databases, the municipalities also acquire data from the graphic section of the land cadastre, from digital bases of valid spatial elements in the long-term and medium-term social plan, and from other sources.

Data on real estate in Slovenia are maintained in several reference databases that are used in the property tax process; specifically, in the land cadastre, building cadastre, land register, consolidated cadastre of economic public infrastructure, real estate register, real estate assessment set, real estate market records, register of spatial units, and set of topographic and cartographic data. Cadastres contain data on rights and legal relations that are recorded by the land register office. The cadastre constitutes the original records for data on real estate as the subject of rights. The real estate register constitutes the public records on all real estate that is recorded as real estate. It is defined as an open system that allows various users, based on their respective regulations and purposes, to expand its multiple purposes by defining additional data on real estate (Geodetska uprava Republike Slovenije, 2013). As a database, the real estate register is in itself incomplete on account of the incompleteness of the records that data are taken from, and it has limited quality, which is mostly due to the inappropriately implemented inventory of real estate and the prescribed method for modifying data. Nevertheless, in our opinion, it is a higher-quality database than the CLF assess-

ment database. This may also be inferred from the systemic CLF improvement recommendations (Ministrstvo za okolje in prostor et al., 2016).

4 Empirical study of the quality of the municipal CLF assessment database

4.1 Methodology

This study compared the datasets on residential and business buildings, and on unbuilt construction land, managed by the municipalities as part of their CLF assessment databases, with the datasets of the real estate register as the reference database. First, we analysed the ordinances on CLF assessment in the selected municipalities. We acquired data from nine municipalities that joined the project for updating the CLF assessment database and from which we could obtain appropriate data for carrying out the analysis. We analysed the types and sources of data used by municipalities in their CLF assessment. In analysing the quality of datasets managed by municipalities for CLF assessment, we focused on three essential quality elements as defined by SIST EN ISO 19157:2015: the completeness, thematic accuracy, and logical consistency of municipal databases.

Then, for all the municipalities involved, we calculated the matching of data on the number of parts of buildings and the matching of data on the area of buildings in the municipal CLF assessment databases with the data from the real estate register. Several methods for determining similarities between multitudes are known (Romesburg, 2004; Albatineh & Niewiadomska-Bugaj, 2011; Liu et al., 2014; Aamir & Bhusry, 2015). To calculate the matching of data on the number of parts of buildings between the databases, this study used the Jaccard index, which is frequently used to establish similarities between multitudes (Lee, 2017; Nowak Da Costa, 2015). The Jaccard index J, used to calculate the similarity between two datasets, A and B, is computed as follows (Jaccard, 1901):

$$J(A,B) = \frac{|A \cap B|}{|A \cup B|} \in [0,1]. \quad (1)$$

In studying similarities between two datasets, the Czekanowski index C (Wierzchoń and Kłopotek, 2018) is frequently applied as well, which is computed as follows between two datasets of A and B (Czekanowski, 1913):

$$C(A,B) = \frac{2|A \cap B|}{|A| + |B|} \in [0,1]. \quad (2)$$

The two indices accurately measure the matching of data in two datasets. However, such accuracy is not required in this study and it is not reasonable either. For this reason, we determined the matching of data on the area of buildings in the municipal CLF assessment databases and in the real estate register data by defining as matching data such data for which the area values differed by up to 5%, which is not counted as a match by the basic indices. Thus, we had to apply the adjusted Jaccard index of matching J_p and the adjusted Czekanowski index of matching C_p, which were defined and computed for the study purposes using the equation:

$$J_p = \frac{\sum_{i=1}^{n} A_{CLF\_u(i)}}{\sum_{i=1}^{n} A_{CLF(i)} + \sum_{i=1}^{n} A_{RER(i)} - \sum_{i=1}^{n} A_{CLF\_u(i)}} \quad (3)$$

$$C_p = \frac{2 \cdot \sum_{i=1}^{n} A_{CLF\_u(i)}}{\sum_{i=1}^{n} A_{CLF(i)} + \sum_{i=1}^{n} A_{RER(i)}} \quad (4)$$

where

$$A_{CLF\_u(i)} = \begin{cases} A_{CLF(i)}, & \text{if } |A_{CLF(i)} - A_{RER(i)}| \le 0{,}05 \cdot A_{RER(i)}, \\ 0, & \text{otherwise} \end{cases} \quad (5)$$

where $A_{CLF(i)}$ is the area of building i in the municipal CLF assessment database, and $A_{RER(i)}$ is the area of building in the real estate register. The determination of matching of data on building areas and on the number of parts of buildings between the municipal CLF assessment database and the real estate register is significant for evaluating the quality of the municipal CLF assessment database compared to the reference database. Analysis results of data matching constitute the basis for possible data quality improvement measures and for updating the property tax system.

The study also updated the municipal CLF assessment data with data from the real estate register and with data from the collective cadastre of economic public infrastructure. Municipal CLF assessment data were updated for data on areas and actual use, and utility connections. Following the updating, the values of the datasets compared in the relevant databases were equal.

Table 1: Basic data on municipalities in question.

Municipality	Municipality area (km²)	Population (first half of 2017)	Houses (2017)	CLF as % of all property tax revenues in 2017
Črnomelj	339.7	14,365	4,876	92.3
Divača	145.1	4,000	1,423	98.6
Dornava	28.4	2,226	974	99.6
Duplek	40.0	6,803	2,265	93.5
Mokronog–Trebelno	73.4	3,045	1,519	94.9
Sodražica	49.5	2,184	867	90.8
Središče ob Dravi	32.7	2,019	757	96.2
Vuzenica	50.1	2,670	770	98.6
Zreče	67.0	6,409	1,897	93.9

Source: Statistični urad Republike Slovenije (2017); Ministrstvo za finance (2018).

The municipal CLF assessment databases were modified through updating. Prior to updating, they contained records of an individual part of the building or ownership, and, after updating, they contain data on the building or unbuilt construction land as a whole. Thus, the number of records in the municipal CLF assessment database was decreased. There is no uniform approach for defining the tax base in determining the amount of CLF payable; that is, the area of buildings. In the ordinances on CLF assessment, municipalities define the area of residential or business buildings in different ways; for example, based on the foundation of a building, actual area, floor area, net floor area, usable area, and so on. In updating the municipal CLF assessment databases, the data from the real estate register were used for the net floor area of a part of a building. The net floor area is the area of all the rooms of a part of a building, irrespective of their actual possible use. The net floor area of a part of a building that has several floors is the sum of the areas of the rooms of this part of the building on all the floors (Geodetska uprava Republike Slovenije, 2010).

4.2 Municipalities selected and data used

The study comprised nine municipalities that joined the project of updating the CLF assessment databases: Dornava, Duplek, Sodražica, Črnomelj, Divača, Vuzenica, Središče ob Dravi, Mokronog–Trebelno, and Zreče. Table 1 presents the basic data for the municipalities.Table 1 shows that the income from the CLF in these municipalities constitutes an extremely high percentage of all property tax revenues (more than 90% in all the municipalities). The municipalities analysed levied a higher CLF on average from natural persons than the Slovenian average, and on average a lower CLF per m² than the national average for legal entities (except in the Municipality of Duplek).

The following data were applied in the study:

- Demographic data of municipalities for 2015 and 2016 (source: Statistical Office of the Republic of Slovenia);
- Data on CLF and tax revenues of municipalities for 2015, 2016, and 2017 (source: Ministry of Finance; Financial Administration of the Republic of Slovenia);
- Data from the real estate register, data on municipal boundaries and areas, and data from the collective cadastre of economic public infrastructure (source: Surveying and Mapping Authority of the Republic of Slovenia);
- Data and ordinances on CLF (source: municipal ordinances and databases).

4.3 Characteristics of the CLF system in the municipalities studied

All the municipalities studied, excluding the Municipality of Središče ob Dravi, had a CLF ordinance in place at the time the study was carried out. The Municipality of Središče ob Dravi applied the ordinance of the neighbouring Municipality of Ormož. Municipalities adopted ordinances at different times and had no uniform CLF assessment arrangement. This means that the CLF amounts for comparable pieces of land and buildings in relevant municipalities differed significantly. All the municipalities in question have a stipulation in their ordinances that the CLF is levied based on the built and unbuilt construction land. Among the municipalities studied, only the municipalities of Črnomelj, Divača, Vuzenica, and Zreče in fact also levied the CLF for unbuilt construction land. Table 2 shows the basic elements of ordinances on the CLF in relevant municipalities.

As shown in Table 2, municipalities mostly take into account the minimum scope of criteria defined in the Construction

Table 2: Number of zones and criteria of municipal ordinances for specifying the amount of CLF.

Zones and criteria	Municipality								
	Črnomelj	Divača	Dornava	Duplek	Mokronog–Trebelno	Sodražica	Središče ob Dravi	Vuzenica	Zreče
Number of zones	4	2	2	3	3	4	4	2	3
Location	•	•	•	•	•	•	•	•	•
Utility connections		•	•	•	•	•	•	•	•
Zoning	•	•	•	•	•		•		•
Exceptional advantage of location		•		•	•		•	•	•
Non-occupation of buildings and/or pieces of land	•	•			•		•		
Non-zoned use	•				•		•		
Impediments to use				•	•			•	
Expediency of exploitation					•				
Possibility of more intensive use of utility connections and other facilities					•				
Abandonment of buildings and/or pieces of land							•		
Wear and tear of buildings							•		

Source: Municipal ordinances on CLF, own analysis.

Table 3: Sources of data for determining the area of built construction land for residential and business purposes.

Municipality	Source of data
Črnomelj	Real estate register, cadastre of buildings, and land cadastre
Dornava, Duplek, Mokronog–Trebelno, Sodražica	Municipal database
Divača, Središče ob Dravi	Data from official records, and data submitted to municipal administrations by persons subject to CLF payment
Vuzenica, Zreče	Data from the direct construction land user, database on building permits granted, and other official records

Source: Municipal ordinances on CLF.

Table 4: Number of records in municipal databases prior to and after updating, number of buildings, and unbuilt pieces of construction land, compared to the status in the real estate register.

Municipality	Number of all records in municipal database:		Number of buildings and unbuilt pieces of construction land (% of all, after updating), which are:	
	Prior to updating	After updating	Not present in municipal database and present in real estate register	Present in municipal database and not present in real estate register
Črnomelj	13,179	6,300	67 (1.1%)	4 (0.1%)
Divača	3,021	1,788	3 (0.2%)	18 (1%)
Dornava	2,006	1,221	23 (1.9%)	10 (0.8%)
Duplek	4,542	2,766	55 (2%)	9 (0.3%)
Mokronog–Trebelno	3,862	1,991	6 (0.3%)	3 (0.2%)
Sodražica	1,871	1,010	7 (0.7%)	2 (0.2%)
Središče ob Dravi	1,669	1,019	23 (2.3%)	92 (9%)
Vuzenica	1,694	1,010	11 (1.1%)	9 (0.9%)
Zreče	3,815	2,301	14 (0.6%)	24 (1%)

Source: Municipal CLF databases, real estate register, own analysis.

Land Act; that is, utility connections, location, and zoning, as well as exceptional advantages linked to generating revenue through business. Municipalities also arbitrarily take into account other criteria, which tend to differ between the municipalities. In determining the area of construction land, municipalities tend to use different sources of data (Table 3), mostly based on data submitted to the municipal administration by those subject to CLF payment.

The results of the analysis of the quality of municipal databases by selected quality elements are presented below.

4.4 Completeness of municipal databases

Completeness according to SIST EN ISO 19157:2015 is the adequacy of the user data model and the presence or absence of structures, attributes, and relations, and it may have two sub-elements: omission of value or excess value. Completeness may refer to the completeness of a data model (model completeness), completeness of attributes of the structure type (attribute completeness), or the absence or excess of data values in attributes of present structures (data completeness; Šumrada, 2015). The study analysed the completeness of municipal CLF assessment databases, which is defined by the ratio between the number of buildings and the unbuilt construction land in the database, and the real estate register. Thus, it determined the deficient and/or excess data values in a database or dataset.

In all the municipalities, different levels of database completeness were established. The data in Table 4 show that, in relevant municipal CLF assessment databases, on average 1.1% of records on buildings and unbuilt construction land were absent, as compared to the data in the real estate register. In the relevant municipalities, on average, 1.5% of records on buildings and unbuilt construction land are present in the municipal CLF assessment databases that are absent from the real estate register. In the municipal databases up to several records were kept for an individual building or unbuilt construction land, depending on the number of parts of a building, or on the number of ownership shares on the real estate. Analysis of the completeness of attribute data ascribed to a particular building or to unbuilt construction land in the municipal CLF assessment databases showed the frequent absence of data on the number of points per particular criteria of the ordinance. In numerous cases, only a total number of points was ascribed.

4.5 Thematic accuracy of municipal CLF assessment databases

Thematic accuracy shows the reliability of classification of values, which are ascribed to the basic elements of data as attributes, and according to the provisions of SIST EN ISO 19157:2015 may consist of three sub-elements: accuracy of classification of data, quantitative accuracy of values of descriptive attributes, and quantitative accuracy. The study focused on comparing the accuracy of data on the area of buildings and unbuilt construction land in the municipal CLF assessment databases compared to the relevant data contained in the real estate register. When the municipal databases were set up in the 1990s, the concept of usable/effective area was applied (including correction factors for the various premises) in most cases, and thus the net floor area used in the real estate register is mostly greater than the usable/effective area.

Table 5 shows that the data on the number of parts of buildings between the municipal CLF assessment databases and the real estate register match relatively well (mean value of the Jaccard index $J_p = 0.87$). There exist minor differences between the municipalities studied. Somewhat different results were obtained in the analysis of the area of buildings and unbuilt construction land. Taking into account the hypothesized limit for the adjusted Jaccard index and the adjusted Czekanowski index, 0.33 (values below this limit denote a higher deviation of data), the highest deviation of data on the area of buildings and unbuilt construction land between the municipal database and the real estate register was established in the Municipality of Mokronog – Trebelno ($J_p = 0.15$ and $C_p = 0.27$) and in the Municipality of Dornava ($J_p = 0.31$ and $C_p = 0.47$). In other municipalities, J_p ranges between 0.41 and 0.73, and C_p between 0.58 and 0.85. Corresponding to this is the result for the mean deviation and differences in areas by more than 50%. The mean deviation of areas of buildings and areas of unbuilt construction land between the municipal CLF assessment database and the real estate register amounts to 18 m^2 in the Municipality of Sodražica, and up to 511 m^2 in the Municipality of Mokronog–Trebelno. The percentage of buildings and unbuilt construction land in the municipal CLF assessment database for which the area deviates by more than 50% from the area in the real estate register ranges between 1.01% in the Municipality of Duplek and 9.83% in the Municipality of Dornava.

4.6 Logical consistency of data in municipal databases

Logical consistency refers to the conceptual (semantics), format (record), domain (scope of values), and topological discrepancy in databases. Logical consistency shows the consistency of conceptual rules of a data model and the structure of data in a dataset (composition of classes and attributes, and relations between them; Šumrada, 2015). In analysing the logical consistency of data in municipal CLF assessment databases, it was found that the municipal databases contained several

Table 5: Matching of data on the number of parts of buildings and areas of buildings, and the area of unbuilt building land, between the municipal CLF assessment data collection and the real estate register.

	Number of parts of building	Area of buildings and unbuilt construction land			
Municipality	Jaccard index J	Adjusted Jaccard index J_p	Adjusted Czekanowski index C_p	Mean deviation [(a)] (m^2)	Difference in area more than 50% [(b)] (%)
Črnomelj	0.86	0.51	0.68	91	2.46
Divača	0.83	0.50	0.66	117	5.31
Dornava	0.80	0.31	0.47	59	9.83
Duplek	0.93	0.73	0.85	18	1.01
Mokronog–Trebelno	0.84	0.15	0.27	511	8.49
Sodražica	0.92	0.65	0.79	28	2.57
Središče ob Dravi	0.83	0.55	0.71	36	4.91
Vuzenica	0.92	0.41	0.58	138	1.88
Zreče	0.94	0.54	0.71	140	1.35

Source: own computation.
Note: [(a)] Mean deviation of areas of buildings and unbuilt construction land between the municipal database and the real estate register. [(b)] Percentage of buildings and unbuilt construction land in the municipal CLF assessment database for which the area deviates by more than 50% from the area in the real estate register.

Table 6: Data on CLF assessment prior to and after updating municipal CLF assessment databases.

	Data on CLF prior to updating					Data on CLF after updating					
	Legal entities		Natural persons			Legal entities		Natural persons			
Municipality	No. of decisions	Amt. (EUR)	No. of decisions	Amt. (EUR)	Amt. total (EUR)	No. of decisions	Amt. (EUR)	No. of decisions	Amt. (EUR)	Amt. total (EUR)	Assessment index before/after
Črnomelj	202	191,764	4,794	196,476	388,239	210	278,696	5,743	327,739	606,435	156
Divača	47	137,011	1,220	60,664	197,675	77	164,465	1,755	96,315	260,780	132
Dornava	12	5,668	801	57,475	63,143	17	19,732	1,073	86,290	106,022	168
Duplek	28	27,534	1,940	136,914	164,448	40	33,346	2,620	230,471	263,817	160
Mokronog–Trebelno	29	30,420	1,291	70,268	100,688	30	33,596	1,402	82,049	115,645	115
Sodražica	27	7,928	702	25,272	33,200	27	10,956	931	45,089	56,045	169
Središče ob Dravi	17	27,030	824	104,410	131,440	26	39,386	913	115,139	154,525	118
Vuzenica	24	131,546	579	25,924	157,470	34	126,595	1,143	50,532	177,128	112
Zreče	138	323,663	2,155	164,030	487,693	164	332,487	2,332	195,407	527,893	108

Source: Ministrstvo za finance (2017); own computation.

records for an individual building or unbuilt construction land. A number of cases on inconsistency of data were perceived for the use of a building or a part of building, and certain records on a building or unbuilt construction land were present in the real estate register but absent from the municipal database, and vice versa. Likewise, the data for house numbers were found to be absent in several cases. As already mentioned, the area of a part of building in the municipal CLF assessment database was unequal to the area of a part of building in the real estate register. Considering that in the ordinances on the CLF different criteria are taken into account by the municipalities, it is difficult to conduct a comparative analysis.

4.7 Effects of updating municipal CLF assessment databases

The central aim of this study was to determine whether updating municipal CLF assessment databases on built and unbuilt

construction land in the selected municipalities with data from the real estate register had a positive influence on the CLF amount payable, or whether, by improving data quality, the CLF amount payable in the relevant municipalities had increased. The results in Table 6 show that the use of data from the real estate register positively influenced the CLF amount payable in all the relevant municipalities.

The number of those subject to CLF payment, both legal and natural persons, increased on average by around 30% after updating the municipal databases in all the municipalities. In the municipalities studied, the CLF amount after updating municipal databases was 38% higher on average in relation to the CLF amount prior to updating. In the Municipality of Duplek, the CLF amount after updating the data increased by 60%, in the Municipality of Dornava by 68%, and in the Municipality of Sodražica by a full 69%. The greater the average deviation of the area of a building and unbuilt construction land between the municipal CLF assessment database and the real estate register, the less the increase in CLF amount after updating the data. In all the municipalities, after updating there was a relatively high increase in the CLF amount in relation to all the municipal tax revenues (mean percentage of increase t_{rev} = 51.3%).

5 Conclusion

This study analysed the quality of databases in selected municipalities that are used for CLF system management. The analysis results show that the municipalities studied keep their own databases for the CLF system management purposes. Databases were mostly set up in the 1990s based on the real estate inventory or data submitted by those subject to CLF payment. Municipal CLF assessment databases are primarily maintained at the request of those subject to CLF payment, in the case of ownership changes, or based on requirements by the taxation authority or courts of justice. Prior to updating, the municipalities were mostly keeping their databases in the form of tables, without the support of GIS technology and cartographic presentations of the spatial situation of real estate. Among the relevant municipalities, only the ordinance on the CLF for the Municipality of Črnomelj had an indication that, for determining the area of built construction land and factual use, data from the real estate register, the building cadastre, and the land cadastre were used. The study also showed that, due to the absence of a uniform identifier of buildings and parts of buildings, it would be difficult to interconnect the municipal CLF assessment databases with the real estate register.

In relation to the municipalities, the study found that the quality of the municipal CLF assessment database differed in terms of all the quality elements involved: completeness, logical consistency, and thematic accuracy. The study findings show that the municipal CLF assessment databases comprised most buildings, parts of buildings, and unbuilt construction land that are present in the real estate register and are the subject of CLF assessment, whereby Hypothesis 1 was negated. Cases of additional buildings, parts of buildings, and construction land (that are present in the municipal CLF assessment database and absent from the real estate register) were relatively few, except in the Municipality of Središče ob Dravi (9% of all the records). We established the frequent absence of attribute data, in particular the number of points per particular criteria of the ordinance on the CLF. Using the Jaccard index J we found a relatively high level of matching of the number of parts of buildings in the municipal databases and in the real estate register. We confirmed the usability of the adjusted Jaccard index J_p and of the adjusted Czekanowski index C_p. Matching of data, taking into account at least 5% of value deviation, is an acceptable measure, considering that data on the area of real estate are obtained by different methods at different times. This is also acceptable from the point of view of efficiency because the updating procedures are not implemented if deviations are less than 5%. Using J_p and C_p, we confirmed a relatively low level of matching of data on areas of buildings and unbuilt construction land between the municipal CLF assessment databases and the real estate register. Hypothesis 2 was thereby confirmed. More distinctive is also the logical inconsistency of data between the municipal CLF assessment databases and the real estate register. We confirmed Hypothesis 3; namely, that updating datasets in the municipal databases with data from the real estate register significantly influences an increase in the number of those subject to CLF payment and the CLF amount payable (on average by 38% in the municipalities studied and by more than 60% in some of them). The usability of the methodology presented was also confirmed by comparing the results. Considering the type and scope of inconsistencies between the municipal CLF assessment databases and the real estate register, and considering the percentage of increase in the CLF amount after improving the data quality, the results of the study using the method presented are rather similar to the findings by Gerčer (2017), Grilc (2017), and Ziherl (2017).

Inadequate quality of spatial data that are used by municipalities for CLF assessment purposes may have far-reaching consequences. Its direct impact may be in an increase in complaints against decisions regarding CLF assessment. This increases the probability of infringements against the principles of the modern taxation system and against constitutional principles, in particular against legality and equality before the law. Databases used by the municipalities for CLF assessment purposes are subject to constant changes. These changes require appropriate management approaches based on modern GIS technology. In

addition to the reference databases, several other data sources are also available (e.g., Google Maps, Open Street Map, and other volunteer spatial databases), which may be used for comparing the quality of selected datasets in the municipal CLF assessment bases. The method presented is especially applicable in cases in which a uniform real estate identifier has been set up for the databases compared.

It would be reasonable to conduct such a study in all Slovenian municipalities, where updating the CLF assessment databases would contribute to improving the quality of data on buildings and unbuilt construction land. A well-regulated and high-quality CLF assessment database would facilitate a more equitable, more efficient, and more reasonable property tax. This has a subsequent effect on the level of social acceptability of property tax and the stability of tax revenues, and it decreases the level of avoidance of CLF payment. A high-quality CLF assessment database would find application in other areas as well; for instance, in spatial management, spatial planning, real estate management, and so on. The challenge in carrying out such a study in all the municipalities is connected to a non-uniform data model and the demanding process of data acquisition and data collation.

Slovenia is aware of the significance of attaining an equilibrium between increased revenue and economic growth through improving taxation quality. In the process, Slovenia intends to improve the structure of individual types of taxes; among other things, with an expansion of tax bases to improve compliance with tax obligations and to strengthen the tax administration. As part of this, Slovenia plans further reforms in property tax because, as several authors (Johansson et al., 2008; Heady et al., 2009; Arnold et al., 2011) have reported, property taxes constitute the least impediment to economic growth. Considering the active economic and legislative changes at the local and national levels, the study results may provide support in decision-making processes in the relevant area. The study findings may also be used as basis in preparing modifications of the property tax system in Slovenia. In preparing a new taxation system, specific attention should be dedicated to the quality and interoperability of official real estate databases. Regular independent data quality audits performed in line with standardized methods are therefore recommended, alongside awareness-raising programmes for real estate owners on the status of data and significance of quality data on their own real estate. Of benefit in increasing the quality of official databases may be insight into real estate data and submission of requests for replacing obsolete data with accurate data via a web-based service, and user-adjusted / user-friendly cartographic data presentations.

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