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EFFICIENCY OF SLOVENIAN GENERAL PUBLIC LIBRARIES: A DATA ENVELOPMENT ANALYSIS APPROACH

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Efficiency of Slovenian General Public Libraries: A Data Envelopment Analysis Approach[1]

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Abstract

In the article, we study financing and efficiency of Slovenian General Public Libraries. We employ a rich dataset of CEZAR – Centre for Development of Libraries for the years 2008-2014 for 58 libraries and use data envelopment analysis, cluster analysis and regression methods to study the efficiency of libraries over the years. Our main results show that the problems for the libraries in this period did not lie in the lowered efficiency but more likely in other system requirements. We also provide a grouping of libraries following cluster analysis with spatial constraints and show the cluster membership had significant effects on the performance of the libraries.

Keywords: general public libraries, Slovenia, financing, efficiency, data envelopment analysis, constrained clustering

JEL codes: Z11, Z18, D61, C38, C33

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1. Introduction

Libraries are institutions that have a centuries-old tradition and are among the oldest service activities in the field of culture, education, and science. Slovenian librarianship has gradually evolved over the past into a system comparable to the library systems of other countries. It connects all types of libraries regarding collaborative and unified professional standards and shared bibliographic system.

Libraries providing public service form the core of Slovenian library system. As to the Librarianship Act (Zakon, 2001) all types of libraries (i. e. public, libraries of institutions of higher education, special libraries and the national library with exception of school libraries) providing public services have to collect, process, store and lend library materials; provide access to library material and electronic publications; produce library catalogues, databases and other information sources; provide bibliographic and other information products and services; co-operate in interlibrary loan, provide information; obtain and educate users; educate for information literacy; protect library materials, which are cultural monuments and so on. Next to general tasks, public libraries have to support their local environment by participating in lifelong learning, they manage and provide local studies collections, organize events to stimulate a reading culture among children, young adults and persons with special needs. They also have to ensure the accessibility of materials of public authorities.

Regulation on conditions for providing a library public service (Pravilnik, 2003) and Regulation on basic library services (Uredba, 2001) define basic and mandatory library services and prescribe benchmarks for material and human resources.

Public libraries are established and financed by municipalities, while the Ministry of Culture provides limited funds for library material, computer equipment and for special tasks of regional libraries. Public libraries act as independent legal persons (public institutes) and may, therefore, place (within the limits of the legislation) their financial funds to its sole discretion.

Different types of public libraries (regional-, main-, branch libraries) form library network. In 2014 there were 58 public libraries in Slovenia, providing 269 service points for 2,062,874 inhabitants (= population of Slovenia). Service points were located in 163 of 211 municipalities, another 39 municipalities were provided by mobile units, while nine municipalities had to rely on service points located in their neighbor municipalities. Following the pattern of dispersed and small settlements, most of the Slovenian libraries (48 out of 58) serve communities with less than 50,000 inhabitants. There are only two libraries located in cities (Ljubljana, Maribor) with more than 100.000 inhabitants.

In 2014, public libraries registered 491.000 active users (24 % of the population), served over 10 million visitors and loaned almost 26 million items. Libraries acquired 465.000 items (225 items per 1000 members of the population to be served) spending almost 7 million EUR. Total operating expenditure in 2014 was 47.8 million EUR.

Since public libraries provide public service, it is expected that the level of service throughout the country is comparable. Especially because the minimal conditions (above all material and human resources) are legally prescribed. However, library performance indicators show great differences among libraries and regions of Slovenia. For example, number of potential users to be served per

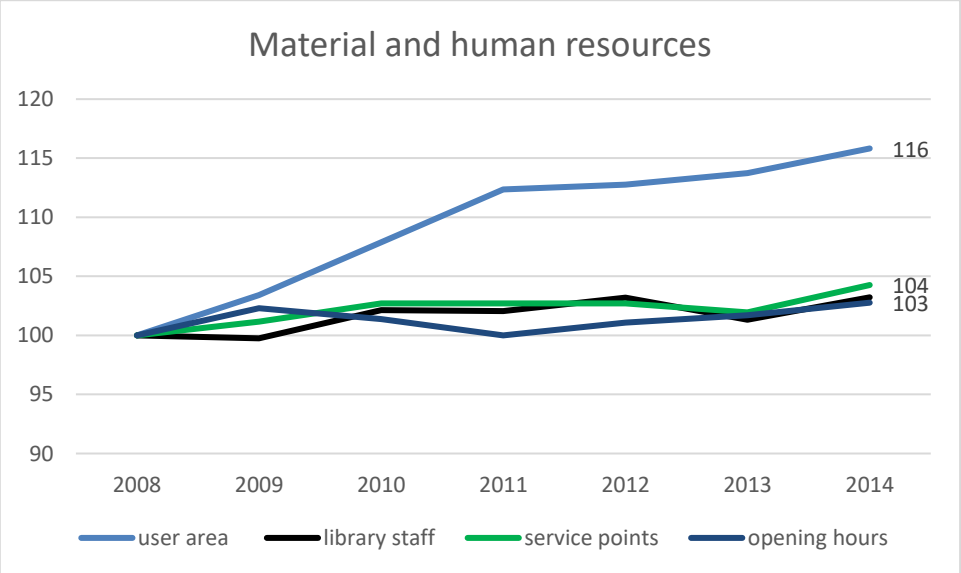
service point varies from 2,283.80 (Lendava) to 68,335.00 (Ptuj). The number of staff varies as well: from 4 (Lenart) to 188 (Ljubljana). 42 libraries (72 %) employ less than 15 workers, which significantly narrows their performance possibilities. Some libraries are well funded, while the others are not: operating expenditure per population to be served varies from 9.75 EUR (Gornja Radgona) to 33.47 EUR (Tolmin). Differences are significant even when comparing libraries with a similar number of potential users (Kazalci, 2014). Library performance indicators also confirm the general economic situation in Slovenia: developed central and Western parts against the less developed Eastern regions (Bon, 2011).

As part of a public sector, Slovenian public libraries have been carefully monitored for decades. Detailed statistical measurements based on international standards (ISO 2789: 2013 Information and documentation – International library statistics) are performed annually, and results are accurately published (Kodrič-Dačić, 2014). There have been number of studies in the field of performance measurement (Podbrežnik and Bojnec, 2013; Fras Popovič and Zavrl, 2007), but issues of efficiency have been mostly neglected. Only two general efficiency indicators have been monitored since 2011 on the national level: »cost per loan« and »cost per library visit« (Kazalci, 2011). The lowest cost per loan in 2014 was 0.97 EUR (Škofja Loka) and the highest 3.84 EUR (Lenart). Difference between the lowest and the highest cost per library visit ranges from 1.28 EUR in Lenart (minimum) and 8.90 EUR in Sevnica (maximum).

However many analyses have been done on national level calculating the cost-effectiveness of public libraries in Flanders (De Wittea and Geysc, 2011; Stroobants and Bouckaert, 2014), United Kingdom (Christopher, 2009) and United States (Hemmeter, 2006) for example.

Contrary to some European countries, Slovenian public libraries were not seriously affected by economic crisis. From 2008 until 2014 total revenue reached its peak in 2010 with almost 51 million EUR and decreased in following years but did not fall below the level of funding in 2008. The size of the library premises grew throughout the period and since 2013 positive trends in other fields are evident too.

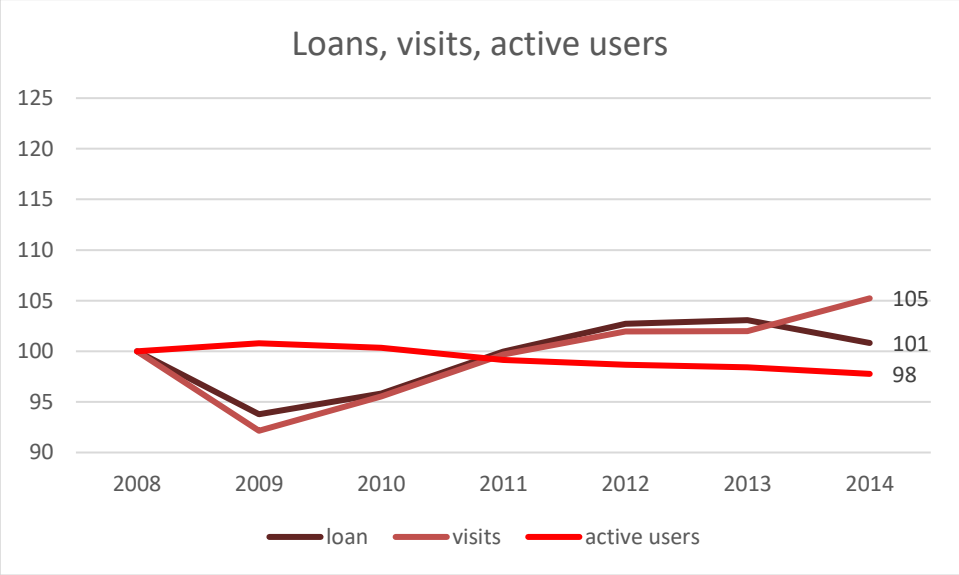
Figure 1: Growth of service points, user area, human resources and opening hours 2008 – 2014.



Source: Narodna in univerzitetna knjižnica, Center za razvoj knjižnic

On the other hand, library services faced a considerable drop in 2009, and since then the number of active users is constantly falling.

Figure 2: Growth of loans, visits and active users 2008 – 2014.



Source: Narodna in univerzitetna knjižnica, Center za razvoj knjižnic

Another issue is also the efficiency of the public libraries, denoting the performance regarding the production of required outputs with the minimal level of inputs. As found in the existing studies on the performance of the Slovenian cultural organizations (Srakar, 2015; Srakar and Bešo, 2015), during the financial crisis, no fall (sometimes even a raise) in the revenue efficiency of Slovenian public cultural institutions could be observed, which the authors attributed to the adaptive features of public cultural organization in times of financial crisis. We would, therefore, expect that the efficiency of the public libraries was raised over the years.

We would also expect that larger libraries will enjoy a sort of the economies of scale and will be more efficient in most criteria than the smaller libraries. It has to be noted that some problems exist with the existing research on economies of scale of public libraries, including the definition and measurement of outputs and the inability to measure service quality (Van House, 1984). Following this, the research findings are still inconclusive. Cooper (1979) found approximately constant returns to scale among California public libraries. From a national sample of public libraries, Feldstein (1976) concluded that there were slight economies of scale for larger libraries which were wiped out by the added costs of multibranch systems. Among academic libraries, Cooper (1983) found diseconomies of scale among smaller college and university libraries and economies of scale among larger ones. Kantor found slight diseconomies among academic libraries (see Kantor, 1989), and economies of scale in scientific and technical libraries (see Kantor, 1981).

Also, we would expect that the level of public funds and general development of the host municipality would have a positive and significant effect on the efficiency of the libraries, following some other

propositions of the literature (e.g. Shim, 2003) and general discussion in Slovenia (Brezovnik et al., 2014).

Finally, we would expect that there is a significant heterogeneity among the libraries and that it affects the results of the statistical analyses. This is supported by the findings of existing Slovenian studies (e.g. Bon, 2011; Podbrežnik and Bojnec, 2013; Kodrič-Dačić, 2014) and previously presented arguments and information on the Slovenian library system.

With this in mind we set the following as the key hypotheses of the study:
H1 – Efficiency of general public libraries was raised over the years in the study;
H2 – Efficiency of general public libraries was higher for larger libraries than for smaller;
H3 – Level of public funds and general development of the host municipality have a positive and significant effect on the efficiency of the libraries;
H4 – Heterogeneity among the libraries significantly affects the results of statistical analysis.

The article is structured as follows. In the next (second) section we provide the description of the data and used methods. In the third section, we provide results, following several used methods: efficiency calculations using DEA method; cluster analysis; and regression models. In the final section, we conclude with the discussion of the research and policy relevance of the study and limitations of the approach used.

2. Data and Method

In this section, we present an analysis of the efficiency of libraries using the most renowned and used statistical method for calculating technical efficiency – the data envelopment analysis (DEA). This analysis will provide us an illustrative and comparative view on the differences between libraries in achieving performance and what are the factors that have the greatest impact on the individual forms of efficiency. This is also one of the first applications of this method in Slovenia in the field of culture and the arts. We will also use cluster analysis to discern the heterogeneity in the general public libraries regarding their efficiency and size and use regression methodology to finally verify our set of four hypotheses.

The efficiency of public libraries was calculated according to the methodology of data envelopment analysis, following the only such previous application for the sector of culture in Slovenia in Srakar (2015). To evaluate the efficiency of institutions different techniques are possible. Thus, Farrell (1957) suggested an efficiency frontier method with estimation from sample data with nonparametric (mathematical programming) or parametric (econometrics) approaches. Two of the most widely used nonparametric methods for assessing the efficiency are the methods of data envelopment analysis (DEA) and free disposable hull (FDH) method, which is a special case of DEA. Based on the ideas of Farrell, Charnes, Cooper, and Rhodes wrote and article on »Measuring the efficiency of decision-making units« (1978), which was one of the first to use linear programming to calculate the empirical assessment of the limits of technological productivity. Ever since then, it has created a large number of discussions and contributions on various aspects and applications of DEA. The method can be used both to calculate the efficiency of public institutions and enterprises. There are several types of DEA, the most basic are called CCR (from the initials of the authors: Charnes, Cooper and Rhodes), but usually used DEA approaches are based on different returns to scale: CRS (constant returns to scale)

and VRS (variable returns to scale). The core of the debate on the method of DEA in the seventies and eighties of the last century is reported in an overview paper of Seiford and Thrall (1990).

The method of DEA consists of a combination of input(s) and output(s), with two main possibilities – either from the given input to attempt to maximize outputs (output-based approach) or trying to achieve a given output with the minimum use of inputs (input-based approach). In our case, we use a method in which efficiency means trying to achieve a given output with the minimum use of inputs, i.e. an input-based approach.

In statistical terms, it is also essential to note that DEA is a non-parametric method, which means that its usage does not require making any assumptions about the statistical distribution of the data. Mathematically speaking, this method is used to solve linear programming and optimization problem below:

$$\max w_f = \sum_{k=1}^{N} \beta_k {Y_k}^f \quad (1)$$

subject to:

$$\sum_{l=1}^{M} \alpha_l {X_l}^f = 1 \quad (2)$$

$$\sum_{k=1}^{N} \beta_k {Y_k}^f - \sum_{l=1}^{M} \alpha_l {X_l}^f \leq 0, \forall f = 1,2,\dots,F \quad (3)$$

$$\alpha_l, \beta_k \geq 0, \forall l = 1,2,\dots,M;\ \forall k = 1,2,\dots,N \quad (4)$$

The mathematical problem in (1) is CCR model, oriented to outputs. (1) tells us that we try to maximize the efficiency w_f (f being the unit of observation), whereby the efficiency is composed as a sum of weighted outputs ${Y_k}^f$ (k being the sequential identifier of the output, in our case we will always have two outputs). Equations (2)-(4) are the constraints under which we solve the optimization problem.

Because we want the calculated DEA efficiency coefficients also to be used in the regression, i.e. a stochastic analysis of the factors affecting the performance, we use the now standard methodological correction of DEA efficiency coefficients: calculation through the method of double bootstrap, following the contributions of Simar and Wilson (1998; 2000; 2007). Calculation of DEA coefficients through double bootstrap method is implemented in the statistical software package R.

The field of cultural economics saw in the recent years an upsurge of DEA analyses, particularly influential was the contribution of Italian researchers Tiziana Cuccia, Calogero Guccio and Ilde Rizzo (2013; 2016), which showed that the UNESCO list of cultural heritage does not in any way increase the efficiency of the Italian tourist destinations. Some of other notable recent (and related) studies in this area have been Zieba (2011); Guccio et al. (2014); Suominen (2014); Fernández-Blanco and Rodríguez-Álvarez (2016); Guccio et al. (2016); Guccio et al. (2017a; 2017b; 2017c); Herrero-Prieto and Gómez-Vega (2017); and Cuccia et al. (2017). As for the Slovenian studies (outside of the cultural sector), DEA analysis has been used for example to estimate the efficiency of hospitals (Došenovič Bonča, 2010), police units (Aristovnik et al., 2012) and private enterprises (Pušnik, 2008). In the field

of culture, according to our knowledge, only one such study has been completed so far and published in two separate contributions: Srakar (2015) and Srakar and Bešo (2015). This analysis was done on a sample of 70 public institutions in culture, with the data provided by the Ministry of Culture and which are funded by a national public call.

In our analysis, we used data of 58 public libraries in the period 2008-2014:
Celje, Hrastnik, Laško, Mozirje, Rogaška Slatina, Slov. Konjice, Šentjur, Šmarje, Trbovlje, Velenje, Zagorje, Žalec, Brežice, Črnomelj, Kočevje, Krško, Metlika, Novo mesto, Ribnica, Sevnica, Trebnje, Jesenice, Kranj, Radovljica, Škofja Loka, Tržič, Ajdovščina, Idrija, Nova Gorica, Tolmin, Dravograd, Radlje, Ravne, Slovenj Gradec, Ilirska Bistrica, Izola, Koper, Piran, Postojna, Sežana, Cerknica, Domžale, Grosuplje, Kamnik, Litija, Ljubljana, Logatec, Medvode, Vrhnika, Gor. Radgona, Lendava, Ljutomer, Murska Sobota, Ormož, Ptuj, Lenart, Maribor, Slov. Bistrica.

In analyzing the efficiency of public libraries, we used the variables, listed below.
Inputs:

- Total revenues in EUR, which includes: revenues from the municipal administrative bodies; revenues from the national regulatory bodies; revenues from the parent institution; own revenues from public service; compensation for membership (membership fees, registration fees, etc.); other sources;
- Total number of employees in full-time equivalent (FTE);
- Ratio of "service points" to potential users (citizens of the municipality where the library is located) of the library;
- The size of the library premises (user area in m2).

In all of the analyses, we used the same combination of input variables, which includes all four of the above variables.

Outputs:

- Efficiency in terms of visits – 2 variables:
  Overall visits to the library;
  The total number of the active library users/registered users;
- Efficiency in terms of loans – 2 variables:
  Total number of loans;
  The total number of home lending;
- Efficiency in terms of equipment – 2 variables:
  Number of units of equipment (e.g. personal computer, terminal, printer, scanner, etc.) for users;
  The total number of units of equipment;
- Efficiency in terms of ancillary activities/events – 2 variables:
  Number of events;
  Number of participants in events.

In the calculation of the DEA efficiencies, we used two assumptions:

- We used the model, oriented to inputs, which tried to achieve the required outputs with minimal inputs. This approach is different from the methods in Srakar (2015), which used the efficiency oriented to outputs. In our case, we consider that it is more essential to maintain a certain standard and that in this context, significant is the effective use of the four inputs,

mentioned above. In this context, the reference value for the outputs is the actual value in a given year (e.g. the actual amount of equipment that a public library has in a given year).
- We used a model based on the assumption of constant returns to scale. The results were also examined under the assumption of variable returns to scale without significant differences in the results.

One of the major limitations of this method is that the output is not a predetermined reference value, but the actual value in a given year. Taking account of the latter would not lead to accurate results because a lot of libraries even exceed the minimum/reference value and should, therefore, be taken into account as well. It should also be noted that, of course, the efficiency is calculated in quite a »parsimonious« model, with the help of specific (in this case only four) inputs to achieve specific outputs (in this case only two on each type of efficiency). Of course, the libraries are multifunctional units and do not only maximize efficiency, so we have to be careful with interpretations. However, the method of DEA we use is internationally recognized and long-established, which should provide sufficient ground for the correct and internationally comparable results.

3. Results

The following table shows some of the most and least efficient libraries regarding visits and ancillary activities/organizing events in 2014.

Significant differences between the libraries can be seen. The most efficient regarding visits are the following libraries: Trbovlje, Gor. Radgona, Ptuj, Hrastnik, Maribor, Postojna, Metlika, Nova Gorica, Domžale in Lenart. Worst according to this criterion are: Ravne, Jesenice, Tolmin, Sevnica, Logatec, Ribnica, Črnomelj, Radlje, Ormož in Cerknica. Among the largest libraries very efficient are both Ljubljana and Maribor.

The picture changes slightly when looking at performance regarding organizing events. Here the most efficient are the following libraries: Slovenj Gradec, Jesenice, Rogaška Slatina, Tržič, Domžale, Radovljica, Maribor, Radlje, Laško in Celje. We see that the only Maribor counts among the libraries that are at the very top of the table according to both types of efficiencies. Also, Ljubljana scores well in both types of efficiencies.

Worst libraries according to the ancillary activities are: Lenart, Sevnica, Koper, Ormož, Idrija, Tolmin, Nova Gorica, Murska Sobota, Lendava, and Gor. Radgona. Interestingly, there are some libraries that are low on both efficiencies in the table below: Ljutomer, Sevnica, Tolmin; while for some, such as Ajdovščina, Lenart, and Gornja Radgona, the efficiencies of both types differ markedly.

Table 1: Efficiencies over visits and ancillary activities, year 2014

LIBRARY	EFFICIENCY	RANK
Trbovlje	0.9027	1
Gor. Radgona	0.8833	2
Ptuj	0.8684	3
Hrastnik	0.8670	4
Maribor	0.8385	5
Postojna	0.8314	6
Metlika	0.8282	7
Nova Gorica	0.8269	8
Domžale	0.8236	9
Lenart	0.8124	10
Medvode	0.8116	11

LIBRARY	EFFICIENCY	RANK
Slovenj Gradec	0.8625	1
Jesenice	0.8518	2
Rogaška Slatina	0.8419	3
Tržič	0.8233	4
Domžale	0.8093	5
Radovljica	0.8028	6
Maribor	0.8028	7
Radlje	0.8020	8
Laško	0.7977	9
Celje	0.7538	10
Kranj	0.7482	11

Sežana	0.8115	12	Slov. Bistrica	0.7335	12
Ljubljana	0.7999	13	Ilirska Bistrica	0.7126	13
Litija	0.7994	14	Metlika	0.7090	14
Kranj	0.7991	15	Ljubljana	0.7083	15
Zagorje	0.7959	16	Novo mesto	0.6904	16
Ilirska Bistrica	0.7954	17	Krško	0.6394	17
Ajdovščina	0.7950	18	Dravograd	0.6285	18
Šentjur	0.7790	19	Hrastnik	0.6222	19
Vrhnika	0.7436	20	Cerknica	0.6180	20
Škofja Loka	0.7348	21	Škofja Loka	0.5896	21
Tržič	0.7260	22	Kamnik	0.5844	22
Slovenj Gradec	0.7216	23	Šentjur	0.5536	23
Laško	0.7192	24	Trbovlje	0.5435	24
Celje	0.7116	25	Brežice	0.5399	25
Velenje	0.7059	26	Slov. Konjice	0.5295	26
Trebnje	0.7043	27	Izola	0.5047	27
Kamnik	0.7035	28	Kočevje	0.4735	28
Slov. Konjice	0.6935	29	Zagorje	0.4725	29
Dravograd	0.6919	30	Litija	0.4627	30
Grosuplje	0.6906	31	Medvode	0.4550	31
Izola	0.6883	32	Žalec	0.4498	32
Mozirje	0.6880	33	Velenje	0.4425	33
Rogaška Slatina	0.6714	34	Ravne	0.4266	34
Lendava	0.6652	35	Grosuplje	0.4164	35
Žalec	0.6609	36	Ptuj	0.4158	36
Kočevje	0.6576	37	Ribnica	0.4071	37
Murska Sobota	0.6452	38	Piran	0.4007	38
Šmarje	0.6185	39	Sežana	0.3955	39
Brežice	0.6156	40	Vrhnika	0.3943	40
Idrija	0.6122	41	Črnomelj	0.3751	41
Krško	0.5959	42	Mozirje	0.3652	42
Radovljica	0.5949	43	Logatec	0.3609	43
Novo mesto	0.5906	44	Šmarje	0.3587	44
Koper	0.5866	45	Postojna	0.3482	45
Ljutomer	0.5781	46	Trebnje	0.3452	46
Slov. Bistrica	0.5769	47	Ajdovščina	0.3028	47
Piran	0.5657	48	Ljutomer	0.3024	48
Ravne	0.5334	49	Lenart	0.2792	49
Jesenice	0.5085	50	Sevnica	0.2498	50
Tolmin	0.4975	51	Koper	0.2249	51
Sevnica	0.4965	52	Ormož	0.2222	52
Logatec	0.4721	53	Idrija	0.2133	53
Ribnica	0.4477	54	Tolmin	0.1665	54
Črnomelj	0.4397	55	Nova Gorica	0.1570	55
Radlje	0.4318	56	Murska Sobota	0.1393	56
Ormož	0.4309	57	Lendava	0.1166	57
Cerknica	0.3346	58	Gor. Radgona	0.0575	58

Source: Own calculations on the basis of CEZAR.

Table 2 shows the performance regarding the loans and equipment in 2014. The most efficient regarding the loans are the following libraries: Ajdovščina, Sežana, Škofja Loka, Grosuplje, Domžale, Šentjur, Slov. Bistrica, Novo mesto, Medvode in Ptuj. Again, the two largest libraries, Ljubljana and Maribor, are very efficient.

The least efficient libraries regarding this criteria are the following: Ravne, Postojna, Tolmin, Velenje, Sevnica, Ormož, Koper, Cerknica, Idrija in Lenart. Interestingly, we can find libraries like Metlika, which are highly efficient, according to some criteria (visits and equipment) and extremely inefficient with other (loans).

In terms of efficient use of the equipment, the following libraries score the best: Kamnik, Jesenice, Lendava, Zagorje, Litija, Rogaška Slatina, Brežice, Škofja Loka, Metlika in Radovljica. Ljubljana public library is on this criterion slightly behind Maribor, both of which are ranked quite high. Among the least efficient regarding the equipment are: Slov. Bistrica, Postojna, Logatec, Novo mesto, Nova

Gorica, Lenart, Šmarje, Ravne, Gor. Radgona in Murska Sobota. Again, very low ranked is the library in Ormož, which is inefficient regarding all the chosen criteria.

Table 2: Efficiencies over loans and equipment, year 2014

LIBRARY	EFFICIENCY	RANK
Ajdovščina	0.8859	1
Sežana	0.8803	2
Škofja Loka	0.8797	3
Grosuplje	0.8739	4
Domžale	0.8693	5
Šentjur	0.8693	6
Slov. Bistrica	0.8484	7
Novo mesto	0.8293	8
Medvode	0.8167	9
Ptuj	0.8110	10
Maribor	0.8103	11
Celje	0.8088	12
Radovljica	0.7613	13
Žalec	0.7601	14
Ljubljana	0.7576	15
Gor. Radgona	0.7426	16
Logatec	0.7377	17
Kamnik	0.7338	18
Rogaška Slatina	0.7229	19
Slovenj Gradec	0.7004	20
Ljutomer	0.6987	21
Slov. Konjice	0.6928	22
Hrastnik	0.6609	23
Jesenice	0.6562	24
Kranj	0.6540	25
Krško	0.6538	26
Radlje	0.6529	27
Vrhnika	0.6512	28
Litija	0.6477	29
Dravograd	0.6422	30
Laško	0.6351	31
Izola	0.6274	32
Tržič	0.6034	33
Šmarje	0.5996	34
Nova Gorica	0.5956	35
Ribnica	0.5903	36
Lendava	0.5825	37
Murska Sobota	0.5665	38
Mozirje	0.5506	39
Brežice	0.5302	40
Trbovlje	0.5270	41
Zagorje	0.5155	42
Kočevje	0.4993	43
Ilirska Bistrica	0.4983	44
Trebnje	0.4880	45
Črnomelj	0.4863	46
Piran	0.4725	47
Metlika	0.4313	48
Ravne	0.4304	49
Postojna	0.4247	50
Tolmin	0.4127	51
Velenje	0.4082	52
Sevnica	0.3785	53
Ormož	0.3639	54
Koper	0.3599	55
Cerknica	0.3366	56
Idrija	0.3329	57
Lenart	0.2612	58

LIBRARY	EFFICIENCY	RANK
Kamnik	0.9371	1
Jesenice	0.9173	2
Lendava	0.9113	3
Zagorje	0.9032	4
Litija	0.9015	5
Rogaška Slatina	0.8975	6
Brežice	0.8927	7
Škofja Loka	0.8919	8
Metlika	0.8906	9
Radovljica	0.8866	10
Laško	0.8855	11
Maribor	0.8826	12
Mozirje	0.8781	13
Trebnje	0.8755	14
Domžale	0.8638	15
Trbovlje	0.8631	16
Medvode	0.8629	17
Sevnica	0.8586	18
Žalec	0.8475	19
Radlje	0.8421	20
Izola	0.8380	21
Ljubljana	0.8341	22
Kranj	0.8293	23
Slovenj Gradec	0.8068	24
Tolmin	0.7880	25
Dravograd	0.7852	26
Tržič	0.7852	27
Krško	0.7849	28
Vrhnika	0.7768	29
Koper	0.7712	30
Velenje	0.7613	31
Ljutomer	0.7540	32
Šentjur	0.7115	33
Črnomelj	0.7038	34
Piran	0.7011	35
Sežana	0.6974	36
Hrastnik	0.6908	37
Kočevje	0.6841	38
Cerknica	0.6616	39
Grosuplje	0.6577	40
Ribnica	0.6565	41
Ajdovščina	0.6467	42
Celje	0.6456	43
Slov. Konjice	0.6452	44
Ilirska Bistrica	0.6354	45
Ptuj	0.6335	46
Ormož	0.6246	47
Idrija	0.6208	48
Slov. Bistrica	0.6191	49
Postojna	0.6109	50
Logatec	0.6024	51
Novo mesto	0.5934	52
Nova Gorica	0.5769	53
Lenart	0.5254	54
Šmarje	0.4913	55
Ravne	0.4657	56
Gor. Radgona	0.3984	57
Murska Sobota	0.3982	58

Source: Own calculations on the basis of CEZAR.

Based on data from CEZAR and own calculations, the libraries are divided into five groups/clusters. In the clustering analysis, we used five main variables:

- The four previously calculated efficiencies (visits, loans, equipment, and ancillary activities) for the year 2014;
- Number of employees in the library as a measure of the size of the library.

For the cluster analysis, we used the methodology of constrained clustering (see Basu et al., 2008) which is »a new fashion of semi-supervised clustering algorithms« (Ares Brea, 2013). According to the information that they provide about the data instances, there are two kinds of pairwise constraints, introduced by Wagstaff and Cardie (2000):

- Positive (also called Must-link) constraints, ML (a, b), indicate that two data instances must (should) be in the same cluster;
- Negative (also called Cannot-link) constraints, CL (a, b), indicate that two data instances cannot (should not) be in the same cluster.

As stated by Ares Brea (2013), the degree of absoluteness of the constraints (i.e. whether a grouping of the data is acceptable if some of the constraints are not respected) typically depends on the choice of the algorithm. While some algorithms consider the constraints as absolute, and would not output a clustering in which for example data instances linked by a ML are in different clusters, most of them balance the respect of the constraints with a cluster quality objective independent from these constraints, effectively using them as a non-absolute guide to an appropriate final clustering (Ares Brea, 2013: 35).

In the analysis we used the most common constrained clustering algorithm, Pairwise Constrained Clustering by Local Search (see e.g. Khanh Hiep, Minh Duc and Quoc Trung, 2016). The choice of method, in general, has been conditioned by the geographical dependence of Slovenian libraries, more thoroughly analyzed in Vodeb (2013). We closely followed this report in constructing 14 geographical positive (Must-Link) constraints which were used in the cluster analysis.

Our five groups were assigned the following interpretations:

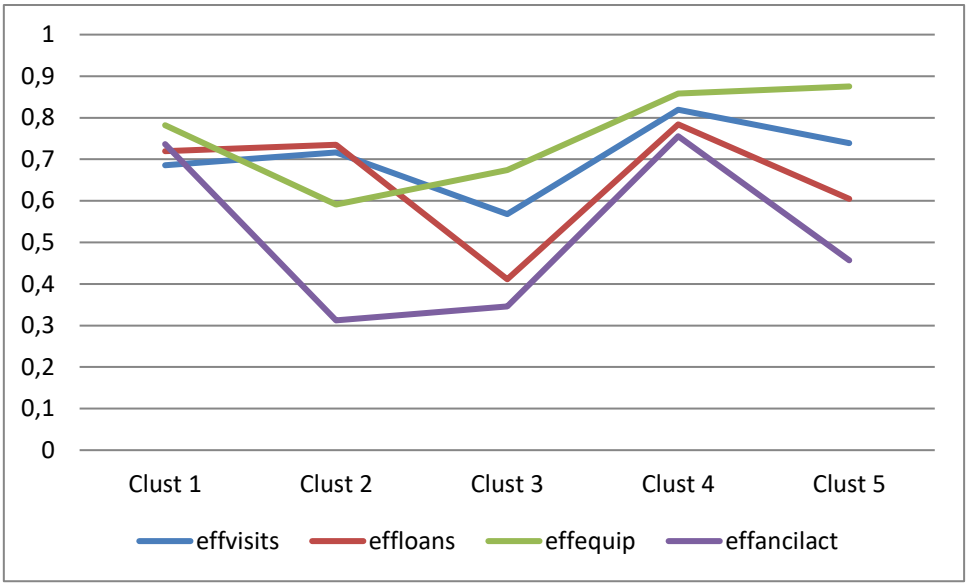
Table 3: Clusters of libraries, pairwise constrained CLS clustering

Cluster	Library	Description
Cluster 1	Celje, Domžale, Dravograd, Hrastnik, Ilirska Bistrica, Jesenice, Kranj, Krško, Laško, Novo mesto, Radlje, Radovljica, Rogaška Slatina, Slov. Bistrica, Slovenj Gradec, Tržič, Šentjur, Škofja Loka	(On average) larger and very efficient libraries
Cluster 2	Ajdovščina, Gor. Radgona, Grosuplje, Ljutomer, Logatec, Murska Sobota, Nova Gorica, Ptuj, Sežana, Slov. Konjice, Šmarje	Larger, mixed efficient libraries: efficient on loans and visits, extremely inefficient on ancillary activities and equipment
Cluster 3	Cerknica, Idrija, Koper, Kočevje, Lenart, Ormož, Piran, Postojna, Ravne, Ribnica, Sevnica, Tolmin, Velenje, Črnomelj	(On average) smaller, inefficient libraries
Cluster 4	Ljubljana, Maribor	Two largest and most efficient libraries
Cluster 5	Brežice, Izola, Kamnik, Lendava, Litija, Medvode, Metlika, Mozirje, Trbovlje, Trebnje, Vrhnika, Zagorje, Žalec	Smallest, mixed efficient libraries: efficient on equipment and visits, inefficient on ancillary activities and loans

Source: Own calculations on the basis of CEZAR.

Interpretations are based on the average values of the variables in the analysis, shortly presented in Figure.

Figure 3: Distribution of efficiencies by clusters



Source: Own calculations on the basis of CEZAR.

Central findings from the cluster analysis are:

- Large libraries are more efficient and also grouped into separate groups, but also between them, an additional stratification regarding the size can be observed;
- Smaller libraries belong to different groups, which strongly differ in efficiency, but usually smaller libraries, on average, are less efficient than the larger ones for the majority of the calculated efficiencies.

This largely confirms the hypothesis H2 and confirms that the main heterogeneity among the libraries can be found regarding the size.

On a final methodological part, we wanted to find out what factors affected the calculated efficiencies, to verify also hypotheses H1, H3, and H4. To this end, we have set up and used a panel database for the years 2008-2014, with dependent variables as all the calculated types of efficiencies, calculated for the longitudinal timeframe (with calculations of each efficiency for each year in the period), and with the following independent variables:

- "Time trend": a linear time trend, which shows how the calculated efficiency depends on the time (how to move with the time, that is, grow, decline or show no trend up or down – to satisfy H1, the coefficient should be positive and significant);
- "Pub-Cult/Tot": the share of local budget devoted to culture (i.e. programs in culture);
- "Pub-Libr/Cult": the share of the local culture budget devoted to librarianship and publishing;
- "Employees p.c.": the number of people employed in the municipality weighted by the population in the municipality;
- "Education p.c.": the number of tertiary educated people in the municipality weighted by the population in the municipality;
- "Region": a binary variable with a value of 0 for the Western Slovenian cohesion region and 1 for the Eastern Slovenian cohesion region;
- "Cluster#": dummy binary variables belonging to each of the calculated clusters/groups.

In all the regressions we included as explanatory variables also dummy variables for each municipality/library separately, so we also considered the effects of individual libraries, which may not be controlled by other variables included in the regression model. A strongly suggested specification of the linear panel data model by the results of the Hausman's test was random effects.

The results of the basic regression (Table 5) for efficiency in terms of the visits show the influence of the following variables to the calculated efficiency:

- Time trend: the efficiencies of the public libraries in terms of visits, on average, increased with time in the observed period;
- Region: Libraries in Western Slovenia were more efficient in terms of visits than the libraries in Eastern Slovenia.

Interestingly, the efficiency was not influenced by the level/share of the budget for libraries and/or culture in general. Overall, we were unable to confirm any detectable effect of the budget for libraries, which may indicate that the funds allocated for this purpose are not used very efficiently, while of course, this only applies under the assumptions used in the calculations of efficiency.

In the performance regarding the loans, the following coefficients were significant:

- Number of employees (as a measure of development of the municipality) had a positive impact on the efficiency in terms of loans;
- Region: Libraries in Western Slovenia were more efficient as regards the loans than the libraries in Eastern Slovenia.

In efficiency regarding the equipment, the following variables had an effect:

- Time trend: the efficiencies of the public libraries in terms of equipment, on average, increased with time in the observed period;
- Region: Libraries in Western Slovenia were more efficient on equipment than libraries in Eastern Slovenia.

In the performance regarding the events, the following variables had an effect:

- Time trend: the efficiencies of the public libraries in terms of ancillary activities/events, on average, increased with time in the observed period;
- Number of employees (as a measure of the development of the municipality) had a positive impact on performance regarding the events;
- The number of tertiary educated negatively affected the performance regarding the events, suggesting that the events in the libraries might have been attended by the slightly less educated - maybe here there is also an effect of the correlation with the variable of the number of employees.

Table 3: Regression results, random effects models, no clustering effects

	Visits			Loans			Equipment			Ancillary activities		
	Coeff.	Z stat.	p	Coeff.	Z stat.	p	Coeff.	Z stat.	p	Coeff.	Z stat.	p
TimeTrend	0.0060	1.68	*	0.0041	1.24		0.0071	2.35	**	0.0225	4.75	***
Pub-Libr/Cult	-0.0795	-1.27		0.0084	0.15		0.0131	0.25		-0.0619	-0.75	
Pub-Cult/Tot	-0.1518	-0.57		0.3023	1.24		0.3152	1.41		-0.0201	-0.06	
Employees p.c.	0.1019	0.31		0.6029	2.00	**	-0.1840	-0.67		1.0777	2.50	**
Education p.c.	0.0011	0.39		-0.0002	-0.07		-0.0008	-0.34		-0.0092	-2.47	**
Region	-0.3307	-6.22	***	-0.3510	-7.18	***	-0.1580	-3.54	***	-0.0309	-0.44	
Constant	0.7152	4.97	***	0.6011	4.55	***	0.8938	7.39	***	-0.0126	-0.07	
Municipality specific effects	Yes			Yes			Yes			Yes		
Nr. Obs.	405			405			405			405		

Nr. Groups	58		58		58		58	
Wald chi2	696.88	***	1301.79	***	865.91	***	877.82	***
Total R2	0.6708		0.7919		0.7169		0.7196	

Source: Own calculations on the basis of CEZAR, the asterisks denote statistical significance: *** – 1%; ** – 5%; * – 10%.

In Table 6, the results when we take into account the heterogeneity/clusters of the libraries, are presented. The comparison category is the Cluster 4 – the two largest libraries, Ljubljana and Maribor.

The results for the variables, included in the models of Table 5 do not differ much, but we nevertheless present the analysis in systematic, sequential manner.

Results for the efficiency regarding the visits show the influence of the following variables to the calculated efficiency:

- Time trend: the efficiencies of the public libraries in terms of visits, on average, increased with time in the observed period;
- Cluster 3: "*(On average) smaller, inefficient libraries*" was less efficient than Cluster 1 (Ljubljana and Maribor);

Regarding the performance on loans, the following variables had an effect:

- Pub-Cult/Tot: the share of local budget devoted to culture (i.e. programs in culture) weakly positively contributes to the efficiency on loans;
- Region: Libraries in Western Slovenia were more efficient as regards the loans than the libraries in Eastern Slovenia;
- Cluster 3: "*(On average) smaller, inefficient libraries*" was less efficient than Cluster 1 (Ljubljana and Maribor).

Regarding the performance on equipment, the following variables had an effect:

- Time trend: the efficiencies of the public libraries in terms of equipment, on average, increased with time in the observed period;
- Region: Libraries in Western Slovenia were more efficient on equipment than libraries in Eastern Slovenia.
- Cluster 2: "*Larger, mixed efficient libraries: efficient on loans and visits, extremely inefficient on ancillary activities and equipment*" was less efficient than Cluster 1 (Ljubljana and Maribor);
- Cluster 3: "*(On average) smaller, inefficient libraries*" was less efficient than Cluster 1 (Ljubljana and Maribor).

Regarding the performance on ancillary activities, the following variables had an effect:

- Time trend: the efficiencies of the public libraries in terms of ancillary activities/events, on average, increased with time in the observed period;
- The number of tertiary educated adversely affected the performance in terms of events, suggesting that the events in the libraries might have been attende by the slightly less educated – maybe here there is also an effect of the correlation with the variable of the number of employees;
- Cluster 2: "*Larger, mixed efficient libraries: efficient on loans and visits, extremely inefficient on ancillary activities and equipment*" was less efficient than Cluster 1 (Ljubljana and Maribor);

- Cluster 3: "*(On average) smaller, inefficient libraries*" was less efficient than Cluster 1 (Ljubljana and Maribor);
- Cluster 5: "*Smallest, mixed efficient libraries: efficient on equipment and visits, inefficient on ancillary activities and loans*" was somewhat less efficient than Cluster 1 (Ljubljana and Maribor).

Table 4: Regression results, random effects models, clustering effects included

	Visits			Loans			Equipment			Ancillary activities		
	Coeff.	Z stat.	p	Coeff.	Z stat.	p	Coeff.	Z stat.	p	Coeff.	Z stat.	p
TimeTrend	0.008	3.10	***	0.004	1.50		0.012	5.12	***	0.018	5.20	***
Pub-Libr/Cult	-0.097	-1.66	*	-0.022	-0.42		0.002	0.04		-0.062	-0.81	
Pub-Cult/Tot	-0.040	-0.15		0.399	1.67	*	0.254	1.11		-0.086	-0.25	
Employees p.c.	0.036	0.25		0.153	1.12		0.084	0.75		0.041	0.22	
Education p.c.	0.001	0.37		-0.001	-0.53		0.001	0.26		-0.009	-2.55	**
Region	-0.013	-0.42		-0.062	-2.04	**	-0.002	-0.10		-0.004	-0.10	
Cluster1	-0.135	-1.46		-0.025	-0.28		-0.050	-0.70		-0.098	-0.81	
Cluster2	-0.130	-1.42		-0.033	-0.37		-0.202	-2.84	***	-0.299	-2.49	**
Cluster3	-0.218	-2.36	**	-0.266	-2.94	***	-0.169	-2.36	**	-0.383	-3.17	***
Cluster5	-0.111	-1.14		-0.148	-1.55		-0.014	-0.19		-0.223	-1.74	*
Constant	0.764	5.75	***	0.677	5.28	***	0.718	6.80	***	0.691	3.98	***
Municipality specific effects	Yes			Yes			Yes			Yes		
Nr. Obs.	405			405			405			405		
Nr. Groups	58			58			58			58		
Wald chi2	27.51	***		66.83	***		74.75	***		74.36	***	
Total R2	0.164			0.416			0.337			0.332		

Source: Own calculations on the basis of CEZAR, the asterisks denote statistical significance: *** – 1%; ** – 5%; * – 10%.

Overall, the regression models provide the following main observations:

- Efficiency of the four types (especially the visit, equipment and events) grew in time, which means that the Slovenian public libraries showed at least an average improvement for all types of efficiency over the observed years – it would be therefore hard to attribute to the falling efficiency of the libraries any specific problems existing in the field od public libraries in Slovenia;
- Efficiency was also dependent on the cohesion regions – mostly better in libraries in Western Slovenia (although this effect was found minor in some robustness specifications, e.g. when considering the dependence on the previous year in dynamic panels);
- In the case of performance regarding the loans, in some robustness specifications (not shown here due to limited space) very weak positive effect of local budgets for culture was observed, but apart from that, it was very interesting to not been able to observe any effect whatsoever of the two types/shares of public budgets for culture and for libraries;
- The performance regarding the events is also influenced by the number of less educated workers, suggesting that perhaps events in libraries attract more of the latter and not higher/highly educated.

As already shortly noted above, we also did several robustness tests. Firstly, we performed the dynamic panel models using one or two lags of the dependent variable as suggested by the model statistics. No notable changes in the main results were observed. Also, we included other different specifications and control variables in the analysis, with again no notable changes in the results.

Finally, we also did a test with a spatial panel – although the results slightly changed and the spillovers of efficiency across the municipalities played a role, again most of the results remained the same.

4. Discussion and Conclusion

In conclusion, let's firstly summarize the results in terms of the verification of the hypotheses.

H1 – Efficiency of general public libraries was raised over the years in the study.

The hypothesis is clearly and strongly confirmed. In all of the regression models the coefficient was positive and either significant or strongly significant, or on the verge of significance for the efficiencies over loans. The efficiency of public libraries was growing in years in the analyzed period. This could be at least partly attributed to the closer scrutiny over the performance of the libraries, but probably also to the effects of the financial crisis. By findings for the general public institutions in culture in Slovenia (Srakar, 2015), the public institutions reacted to the financial crisis with adapting to the environment and, as a result, at least in Slovenia, we can see a raise in efficiency, which can be observed for libraries as well.

H2 – Efficiency of general public libraries was higher for larger libraries than for smaller.

We verified this hypothesis with the clustering analysis. The hypothesis is confirmed, and the cluster analysis showed a strong relationship to size, although we were able to find also heterogeneity both within large as well as small libraries. We could attribute the finding to economies of scale – larger libraries usually have easier access to financing and to other performance criteria like some users, visitors and active users, access to more modern equipment and easier possibilities to organize large events.

H3 – Level of public funds and general development of the host municipality have a positive and significant effect on the efficiency of the libraries.

Interestingly, the hypothesis was not fully confirmed. In particular, we were not able to find any evidence for the positive effects of the public funds on the efficiency of the libraries. This provides reasons for concern as, apparently, the public funds do not achieve strong effects regarding more efficiency of the libraries. This is no immediate (or even any) argument for changes in their size but much more for their better targeting. Also, we found certain positive effects of the development of the municipality regarding the level of employment in the municipality, but, interestingly, found even a negative effect of the number of highly educated people on the efficiency of organizing events (ancillary activities).

H4 – Heterogeneity among the libraries significantly affects the results of statistical analysis.

We found positive evidence for his hypothesis as demonstrated in the analysis of the results in Table 6, and the clusters in our analysis contributed to the fit of the models in Table 6 as compared to Table 5 which showed that including heterogeneity indeed contributed to the analysis.

Finally, what is the relevance of our study regarding future research and policymaking? As far as the research is concerned, this is only the second study using DEA analysis in the field of culture on Slovenia, but providing a more accurate usage of the analysis as in Srakar (2015) in particular in terms

of the complexity of the approach, selection of the variables, and, mainly, comparison across units in the analysis, and in terms of using an improved dataset. Although it does not add significant novelties in terms of approach (except for the usage of constrained clustering, so far very rarely used in cultural economics and not at all in DEA analyzes to our knowledge), it utilizes the double bootstrap technique which has become standard in more advanced DEA analyses. Finally, it is very important for policy purposes as it provides some strong information in the sector where such analyses are almost inexistent. It should guide some future policy measures to improve the situation in the field of general public libraries in Slovenia.

There are also limitations of the approach. In particular, DEA analysis is a simplified view of the process of transformation of inputs into outputs. Usage of other techniques of efficiency calculation shortly addressed in the article would be warmly recommended (see e.g. recent article of Golpîra, 2016). Also, possible calculation of different types of efficiency, like allocative efficiency or efficiency under the variable returns to scale could be recommended. Finally, other and more sophisticated methods of taking into account the heterogeneity of the data, like latent class analysis methods (already used in Srakar, 2015) would also be recommended. Nevertheless, we hope that the article contributes to the debate in cultural economics in general and on empirically following the performance of public institutions in culture in Slovenia, where the latter is a highly contested field lacking in empirical and theoretical studies.

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