

# EFFICIENCY OF PUBLIC AND PRIVATE SERVICE DELIVERY: THE CASE OF SECONDARY EDUCATION

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## ABSTRACT

A current issue is the evaluation of the efficiency of various types of education service providers. This paper aims to evaluate the efficiency of the services of secondary education provided by a variety of types of providers. The evaluation of secondary education is performed on a sample of 26 grammar schools in the Prešov region of the Slovak Republic. The method of data envelopment analysis (DEA) is used. The results of the efficiency of 26 grammar schools in the period 2012-2013 to 2016-2017 showed that grammar schools from the sample established by all providers (public, private, church entity) reached the full efficiency score. By contrast, six grammar schools were evaluated as the least efficient. The evaluation of the set of grammar schools based on the average efficiency score also showed that, from the viewpoint of the types of providers, public grammar schools reach higher efficiency scores, in comparison with church and private grammar schools. These findings expand on the theory of public goods with respect to their production and render valuable information for not only education providers but also creators of regional strategic plans in education policies.

## KEYWORDS

**Data Envelopment Analysis, efficiency, grammar schools, secondary education, Slovak Republic**

## HOW TO CITE

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## Highlights

- Evaluation of the efficiency of grammar schools by use of data envelopment analysis.
- The evaluation of the efficiency of grammar schools reflects the form of financing and volume of received financial resources.
- Comparison of the public and private provision of secondary education failed to arrive at a clear conclusion that would promote any of the forms.

## INTRODUCTION

Efficiency has been a frequently discussed topic over the past few decades also in the public sector. The reasons behind are not only threats, such as deficits in budgets of public-sector organisations, but also public demand associated with an increased interest in the quality of public services provided by public-sector organisations from the viewpoint of citizens in the role of consumers of public services (Christl, Köppl-Turyňa and Kucsera, 2020). Under the permanent pressure of the public, these organisations are forced to increase the efficiency of the provision of public services with the aim to secure a long-term existence. As a result, their activities must undergo an evaluation of their efficiency.

Efficiency is defined as extent to which organisation produces

a given output, or extent the goals defined by the organisation are fulfilled with least possible use of resources. When evaluating the fulfilment of goals, a more complex approach must be adopted in terms of the provision of public services, namely 3Es, standing for economy, efficiency, and effectiveness (Chan and Lynn, 1991; Lewis and Fall, 2017; López-Torres and Prior, 2020). The reason is that if economy or efficiency are evaluated, effectiveness must also be considered, since it plays a significant role in a complex evaluation (Kaplan and Norton, 2000; López-Torres and Prior, 2020). At the same time, the evaluation of effectiveness is inevitably related to the evaluation of economy and efficiency, since when analysing the extent of the fulfilment of the defined goals, economy and an efficient use of resources must also be taken into account

(Ittner and Larcker, 2003; Kuwaiti, 2004). It must also be said that despite a complex evaluation of economy, efficiency and effectiveness, these criteria may collide (Armstrong, 2015; Florina, 2017).

As a rule, only a specific type of educational providers is considered with respect to the evaluation of the efficiency of educational institutions (Coulson, 2009; Cherchye et al., 2010; Crespo-Cebada, Pedraja-Chaparro and Santín, 2013; Nazarko and Šaparauskas, 2014; Silvernail and Johnson, 2014; Rao, 2015; Mikušová, 2017). Research studies already carried out dealing with the evaluation of efficiency in education on the regional level in the Czech or Slovak Republics focused on various types of secondary schools, however only from the perspective of public providers (Chlebounová, 2019; Mališová and Štrangfeldová, 2020).

Outcome of the present research is evaluation the efficiency of the delivery of educational services by different type of providers (public, private, church entity) with a specific focus on high-school education (grammar schools) in regional context the Slovak Republic. On the theoretical level, the article contributes to the broadening of current knowledge regarding the use of non-parametric evaluation of technical efficiency in public services with respect to the correction of inputs and outputs in the interest of an effective provision of the analysed services secondary education. This paper aims to evaluate the efficiency of the services of secondary education provided by a variety of types of providers. The evaluation is performed at the regional level on a sample of 26 grammar schools in region of in the Slovak Republic Prešov. The authors of the paper intend answer the research question (RQ), which stems from theoretical bases of the delivery of public services and results of studies performed in the given area. RQ: *Are efficient grammar schools in the Prešov region related to the particular type of education providers (a public, private, church entity)?* A research question is suited for exploratory research, because the relationships between variables efficiency and various types of education service providers are more uncertain.

The paper is divided into six parts. The first part is introduction, which presents the given topic in broader context from the perspective of the efficiency of public services, followed by theoretical background and overview of literature on the topics of efficiency of education and efficiency of secondary education. The third part describes the applied method and data used. The fourth part presents the results about the evaluation of the efficiency of grammar schools in the Slovak Republic using the example of the Prešov region and renders suggestions and measures for the least efficient schools. The next part is discussion, where the results are discusses in a wider context. The last part is conclusion, which summarises the obtained outcomes and offers a theme for further research.

## Literature review

Efficiency is defined as the relationship between the quantity of inputs in an implementation or a process, and the quantity of outputs (Florina, 2017). Efficiency and effectiveness pursues the relationship between inputs, outputs and outcomes (Mihaiu, Opreana and Cristescu, 2010:133). The higher is the result (output) obtained in terms of prescribed resources (inputs), the

greater is the efficiency of an activity (Afonso, Schuknecht and Tanzi, 2003: 8).

Efficiency can be evaluated in various areas of economy. Education represents an area of the public sector. The sector of education includes schooling at schools at all levels and in similar facilities that are partly or fully funded from public resources. In general, it is impossible to define which educational services fall under the public sector and which do not, because systems of education vary across countries and so does the range of educational services that are covered from public resources (Stiglitz and Rosengard, 2015).

Over the past years, approaches towards the evaluation of efficiency have been increasingly discussed in the sector of education (Lockheed and Hanushek, 1994; Bohm and Bohmova, 2016; De Witte and López-Torrez, 2017; Johnes, Portela and Thanassoulis, 2017; López-Torres and Prior, 2020). Educational efficiency is frequently confused with educational effectiveness, and at times the two terms are (inappropriately) used interchangeably. Educational effectiveness is whether or not a specific set of resources has a positive effect on achievement and, if so, how large this effect is. Clearly, since effectiveness does not directly compare resource uses or costs, what is effective is not necessarily what is most efficient (Lockheed and Hanushek, 1994: 2). Thus, in the context of education, efficient use of resources (be that financial or the innate ability of students) occurs when the observed outputs from education (such as test results or value added) are produced at the lowest level of resource; effective use of resources ensures that the mix of outcomes from education desired by society are achieved. It is efficiency (rather than effectiveness) of education (Johnes, Portela and Thanassoulis, 2017: 331).

Educational institutions are seen as multi-product organisations producing an array of outputs from various inputs (Johnes, Portela and Thanassoulis, 2017: 332). According to a number of authors, the efficiency of educational institutions is a currently discussed topic (Nazarko and Šaparauskas, 2014; Mikušová, 2017; Agasisti and Zoido, 2018). Besides, there are different views on the evaluation of efficiency in education. Meričková et al. (2020) dealt with measuring and evaluating of the performance of secondary education in the Slovak Republic and proposed possible performance indicators in terms of public grammar schools.

Also other authors (Ferro and D'Elia, 2020; De La Hoz, Zuluaga and Mendoza, 2021) address the question of measuring efficiency in education from a variety of perspectives. Cordero-Ferrera, Pedraja-Chaparro and Salinas-Jimenez (2008) focused on different possibilities of measuring efficiency in the education sector, aiming to define the most appropriate model for the evaluation of schools. De Witte and López-Torres (2017) carried out an extensive review of literature on the topic of efficiency in education, summing up selected variables and adopted approaches toward the evaluation of efficiency in education.

A number of research studies deal with the efficiency of secondary education in European countries. Aristovnik and Obadić (2014) researched technical efficiency of secondary education in the EU and OECD countries. The results confirmed that technical efficiency in secondary education differs

significantly across the majority of the analyzed countries. Dincă et al. (2021) evaluate the efficiency of the education sector using a sample of 28 EU countries. An evaluation of allocation and technical efficiency was performed at different levels of education. Based on the results, the authors state that “old” member states reach a higher efficiency score compared to “new” member states. Agasisti and Zoido (2018) measured the efficiency in 8,000 schools in 30 countries (using PISA indicators). Following the results of the performance of high schools in 36 countries using PISA indicators, Cordero et al. (2018) also came to the conclusion that there exists a higher heterogeneity between countries than between schools. Differences between schools are ascribed mainly to economic indicators and cultural values. Other authors (Sarrico and Rosa, 2009; Henriques and Marcenaro-Gutierrez, 2021) offer an image of the education system by evaluating the efficiency of secondary education in selected countries. In particular, Henriques and Marcenaro-Gutierrez (2021) concentrated on the performance of high schools in Portugal, considering the variation of different indicators. The findings indicate that an average efficient public school reaches an average score, but is still below the OECD average.

A significant aspect that is reflected in the evaluation of efficiency at high schools is the manner of financing and the total volume of received financial resources with respect to the achieved results (Afonso and Aubyn, 2006; Agasisti, 2014; Bohm and Bohmová, 2016; Gavurova et al., 2017). Agasisti (2014) and Gavurova et al. (2017) evaluated the efficiency of public expenditures on secondary education in European countries and the quality of education by use of PISA indicators. Evaluation of education efficiency is associated also with the fulfilment of education goals in relation to an efficient use of public resources (Maresova and Kuca, 2019; Opletalova, Novakova and Balaban, 2019).

As regards other authors, Haelermans and De Witte (2012), for instance, assessed the impact of innovation in education on secondary school performance in the Netherlands. Their results confirm that innovation in profiling, teaching, processes and education chains is significantly related to efficiency, whereas innovation in higher qualification of teachers has an insignificant effect on schools' efficiency.

In a broader context, the efficiency of secondary education is analysed also in relation to competition between schools. Bradley, Johnes and Millington (2001) calculated the technical efficiency of all secondary schools in England in the period 1993-1998 on the basis of a range of outputs (execution of exams and visit rate). The results indicate that competition correlates with efficiency. The results also showed that competition is a significant determinant of changes to efficiency in time. Holmberg (2017) performed the measurement of relative efficiency of high schools in Sweden in the period 2006-2007 through 2015-2016 by means of stochastic frontier analysis. The significant factors were the impact of competition on the school performance and relative efficiency of public and independent schools. Also Agasisti (2013) did research into the evaluation of efficiency in relation to competition, using the example of schools in Italy. The results showed that competing schools reach higher performance and better results.

In connection with the efficiency of secondary education, other authors have examined the efficiency of public and private schools (Waldo, 2007; Millimet and Collier, 2008; Cherchye et al., 2010; Rao, 2015) or efficiency of charter schools (Silvernail and Johnson, 2014). Millimet and Collier (2008) analysed whether competition amongst public schools influences the efficiency in which these schools operate. The obtained findings suggest that there are unresolved interactions between competition, efficiency and finances of school. Waldo (2007) states that the evaluation of efficiency in Swedish public high schools at the local level is affected by competition and local policies. However, the author is of the opinion that efficiency of private schools is unrelated to competition. Cherchye et al. (2010) suggested additional criteria (efficiency and equity) for private (but publically funded) and public schools in Belgium (Flanders) to compare the performance of different school types. Their approach includes considerations, for obtaining “fair” performance comparisons in the public sector context.

The given topic provides an approach to the evaluation of the efficiency of secondary education (grammar schools) from the viewpoint of various providers in the regional context of the Slovak Republic. This view on the efficiency of secondary education (grammar schools) is significantly related to not only the manner schools are funded, but also an outline of competition conditions between the individual types of schools. In the economic environment, the aim of non-price competition is to attract demand with methods other than price (Mankiw, 2009). In the present case, secondary schools (grammar schools), when identical educational services are offered by various providers of education (public, private, church entities), apply methods of non-price competition, such as increased quality of education or innovation of educational services. The use of this competition between schools motivates the schools to increase efficiency.

## MATERIALS AND METHODS

### Data

Data from the Statistical Office of the Slovak Republic from the years 2012-2019 were used to document the number of schools (grammar schools) by type of education authority in the regions of the Slovak Republic. The database for the evaluation of efficiency is represented by secondary data obtained from the report on educational activities over the period of five school years, 2012-2013 to 2016-2017. The chosen time period for evaluating the efficiency of schools is influenced by the availability of data for all analysed variables at the time of study processing. The sources have been chosen from selected statistics and databases of the Slovak Republic. Specifically, data are drawn from the Register of Schools and School Facilities, School Reports, Eduzber (collection of data for the purposes of normative financing), Management Reports, the NÚCEM data portal, the INEKO (Institute for Economic and Social Reforms) primary and secondary schools portal and the Statistics of the Center for Social Affairs and Families.

The paper is focused on the evaluation of complete secondary general education (upper secondary), which according to Act no. 245/2008 Coll. (National Council of the Slovak

Republic, 2008) “applies to the successful completion of the last year of at least a four-year and a maximum of eight years of the grammar school educational programme”. The research sample are selected grammar schools in the Slovak Republic, specifically in the Prešov region. According to the European Commission/ EACEA/Eurydice (2020: 2) and Act no. 245/2008 Coll. (National Council of the Slovak Republic, 2008), a grammar school “is a general, internally differentiated secondary school which educates pupils in 4-year, 5-year or 8-year educational programmes and provides upper secondary general education ISCED 344. Educational programmes of grammar schools focus particularly on preparation for study at higher education institutions; they may also prepare for the pursuit of some activities in public administration and culture”.

For the research, 26 grammar schools have been chosen with three different education providers in the Prešov region. These grammar schools are located in the cities of the Prešov region. The grammar schools have been selected on the basis of random selection. At least one representative was selected for each city, provided it had its data published and available. Greater representation of grammar schools is seen in large and regional cities, such as Prešov. The set of grammar schools includes public (state), private and church four-year grammar schools. Public grammar schools (**Pu**), a total of 15, established by the Prešov self-governing region (region), eight grammar schools established by church or a church community (**Ch**), and three grammar schools which represent private establishers (**Pr**). See Table 1 for more details.

School	Education provider	Municipality
Grammar school JIRASKOVA 12 BJ	public	Bardejov
Grammar school LIPANY	public	Lipany
Grammar school J. A. RAYMAN PO	public	Prešov
Grammar school T. VANSOVA SL	public	Stará Ľubovňa
Grammar school DR. C. DAXNER VT	public	Vranov nad Toľou
Grammar school GIRALTOVCE	public	Giraltovce
Grammar school GEN. L. SVOBODA HE	public	Humenné
Grammar school SNINA	public	Snina
Grammar school J. F. RIMAVSKY LE	public	Levoča
Grammar school P.O. HVIEZDOSLAV KK	public	Kežmarok
Grammar school MEDZILABORCE	public	Medzilaborce
Grammar school KUKUCINOVA PP	public	Poprad
Grammar school SABINOV	public	Sabinov
Grammar school DUKL. HRDINOV	public	Svidník
Grammar school STROPKOV	public	Stropkov
Private grammar school BJ	private	Bardejov
Private grammar school PP	private	Poprad
Grammar school SUKROMA SPOJENA SKOLA PO	private	Prešov
Grammar school SV. MONIKA PO	church	Prešov
Evangelical grammar school - EV. SPOJ. SKOLA PO	church	Prešov
Grammar school SV. J. ZLATOUSTY HE	church	Humenné
Church grammar school SV. MIKULAS SL	church	Stará Ľubovňa
Grammar school SV. MIKULAS PO	church	Prešov
Grammar school SV. F. Z ASSISI LE	church	Levoča
Grammar school CIRKEVNA SPOJENA SKOLA HE	church	Humenné
Grammar school P.P. GOJDIC PO	church	Prešov

**Table 1: Set of grammar schools in the Prešov region (source: INEKO, 2020a)**

Input and output indicators have been selected to evaluate the efficiency of grammar schools. Input factors: the number of teachers per 100 students and Contribution to one student per school year. Output factors: Rate of students admitted to universities and University admission success rate (see Table 2).

The input and output indicators in this paper have been taken from the official database INEKO (INEKO, 2020b, 2020c). A certain limitation in connection to the applied output indicators is the admission rate of applicants to universities abroad. This the admission rate of applicants is not monitored in terms of individual secondary schools in Slovakia. However,

we do not consider it serious limitation, because the total percentage of all applicants from all schools who manage to study at universities abroad accounts represent only 17% (OECD, 2018).

The results of the correlation analysis using Pearson’s correlation coefficient (Cohen et al., 2013) have shown relations between input and output values in the period 2012-2013 to 2016-2017. A low to medium correlation can be seen between the input values in the evaluated years (maximum value of 0.44); a medium to strong correlation between output values (maximum value of 0.67); and a negative low to medium correlation between input and output values (maximum value

Variable	Description	Unit	Source
<b>Inputs</b>			
Number of teachers per 100 students	The number of teachers per 100 students at the school. For the purposes of this indicator, internal teachers, external teachers and teachers of practical subjects are considered. Numbers are tracked as of September 15th of the respective school year.	number	School portal INEKO
Contribution to one student per school year	The volume of financial resources at the school's disposal for one year. The sums are provided in the amount per student and per school year, beginning with respect to the year defined.	euros	School portal INEKO
<b>Outputs</b>			
Rate of students admitted to universities	The share of secondary school graduates accepted to at least one university in the following school year in Slovakia against the total number of graduates.	percentage	School portal INEKO
University admission success rate	The share of secondary school graduates accepted to at least one university in the following school year in Slovakia against the total number of candidates who applied for a at least one university.	percentage	School portal INEKO

**Table 2: Input and output variables of the analysis (source: INEKO, 2020b, 2020c)**

of -0.49). A medium to strong correlation was only observed between output values in the evaluated period. However, both output indicators are considered necessary for the following analysis of the efficiency of schools by use of the DEA method, which is the reason why none of the output indicators has been excluded.

## Methods

The present research applies the method of data envelopment analysis (DEA) for evaluation of technical efficiency of public services in the education sector. DEA is among the most frequently used non-parametric methods in the evaluation of technical efficiency of production units. The evaluation of the efficiency of the given production unit renders the efficiency regarding the transformation of its inputs to outputs relative to other units. Unlike the usual calculation of efficiency (productivity) rate, the DEA method applies mathematical programming, which enables the inclusion of a vast amount of inputs and outputs in the model. Unlike the ordinary calculation, the weights are variable and set to maximise the relative efficiency rate of the evaluated unit against the other units (Cooper, Seiford and Zhu, 2011; Dlouhý, Jablonský and Zýková, 2018; Melecký, Staníčková and Hančlová, 2019).

Efficiency is expressed by the transformation process of inputs to relevant outputs. For the analysis, the BCC-O (output-oriented model) is applied, which optimises the outputs. The abbreviation BCC is derived from the initials of its authors who were the first to formulate it: Banker, Charnes and Cooper (1984). This model considers variable returns to scale. It is a radial model comparing the efficiency of several  $n$ -decision units (Decision Making Units - DMU) in the transformation of  $m$  inputs of the same type to  $s$  outputs of the same type (Zhu, 2016). As there can be a large number of units whose efficiency is analysed, it is more suitable to operate with dual models. A more detailed characteristic of the BCC model is rendered by e.g. Banker, Charnes and Cooper (1984), Toloo (2014) or Zhu (2016).

$N$  is the number of units – in our case grammar schools ( $DMU_j, j=1,2, \dots, n$ ), where each consumes  $m$  different inputs ( $x_{ij}, i=1,2, \dots, m$ ) and produces  $s$  different outputs ( $y_{rj}, r=1,2, \dots, s$ ). The matrix of inputs may be marked as  $X = \{x_{ij}, i=1,2, \dots, m; j=1,2, \dots, n\}$ , while the matrix of

outputs may be marked as  $Y = \{y_{rj}, r=1,2, \dots, s; j=1,2, \dots, n\}$ . The output-oriented BCC model (dual) can be written in the following form (Cooper, Seiford and Zhu, 2011 or Dlouhý, Jablonský and Zýková, 2018: 33).

$$\begin{aligned} & \text{Maximise} && \varphi_q + \varepsilon \left( \sum_{i=1}^m s_i^- + \sum_{r=1}^s s_r^+ \right) && (1) \\ & \text{Subject to} && \sum_{j=1}^n y_{rj} \lambda_j - s_r^+ = \varphi_q y_{rq} && r=1, \dots, s \\ & && \sum_{j=1}^n x_{ij} \lambda_j + s_i^- = x_{iq} && i=1, \dots, m \\ & && \sum_{j=1}^n \lambda_j = 1 \\ & && \lambda_j \geq 0 && j=1, \dots, n \\ & && s_i^- \geq 0 && i=1, \dots, m \\ & && s_r^+ \geq 0 && r=1, \dots, s \end{aligned}$$

Where  $x_{ij}$  are inputs,  $i=1,2, \dots, m$  is the value of the  $i$ -th input for the unit  $DMU_j$ ,  $m$  - number of inputs;  $y_{rj}$  are outputs,  $r=1,2, \dots, s$  is the value of the  $r$ -th output for the unit  $DMU_j$ ,  $s$  - numbers of outputs; and where  $q$  is evaluated  $DMU_q$ ,  $y_q$  is the output of evaluated  $DMU_q$ ,  $x_q$  is the input of evaluated  $DMU_q$ ,  $\varphi_q$  - efficiency rate of the evaluated unit ( $DMU_q$ ). Depending on the character of returns to scale, a condition has been added in the model. The condition, presuming variable returns to scale, is as follows:

$$\sum_{j=1}^n \lambda_j = 1$$

$s_r^+, r=1,2, \dots, s$ , and  $s_i^-, i=1,2, \dots, m$ , are dual variables attributed to low constraints for weights of inputs and outputs. In the limiting conditions, these are slack variables for inputs ( $s^+$ ) and outputs ( $s^-$ ) and the  $\varepsilon$  is an infinitesimal constant by means of which the model secures a positive value of all weights of inputs and outputs. Components of vector  $\lambda = (\lambda_1, \lambda_2, \dots, \lambda_n)$ ,  $\lambda_j \geq 0_j$  as weights (coefficients of linear combination) assigned to the respective units of the evaluated set (Cooper, Seiford and Zhu, 2011; Dlouhý, Jablonský and Zýková, 2018).

DEA models provide the users with output information not only regarding the efficiency rate but also about how the evaluated units (grammar schools in the present

research) improve their activities to reach the efficiency frontier (Dlouhý, Jablonský and Zýková, 2018: 35). Some advantages of the DEA approach are: the sources of inefficiency can be analysed and quantified for every evaluated unit; capable of being used with any input-output measurement, although ordinal variables remain tricky (Cooper, Seiford and Zhu, 2011).

By using the DEA SOLVER software for processing the analysis, the final order of efficient grammar schools is obtained along with the answer to the question which schools (grammar schools) are efficient and which are not. Efficient units are on the verge of efficiency while efficiency is equal to 1. The outcome of the DEA analysis is a set of recommendations for inefficient units (in the present study for grammar schools) on how to streamline the production of their educational services.

## RESULTS

### Representation of the number of grammar schools by types of education provider in regions of the Slovak Republic

According to the European Commission/ EACEA/EURYDICE (2020) grammar schools in the Slovak Republic are established by the state represented by a self-governing region, or a regional or a district authority (61.7%), private entities (16.6%), the church (21.7%). It is therefore a specific combination of public/private mix of production and financing of education services with a specific focus on grammar schools.

The overview of grammar schools by the type of education provider in regions of the Slovak Republic is seen in Table 3. Years 2012, 2015 and 2019 have been chosen for the sake of comparing the trend of the number of high schools (grammar schools).

Slovakia/ regions**	2012				2015				2019			
	schools*				schools*				schools*			
	Public	Private	Church	Total	Public	Private	Church	Total	Public	Private	Church	Total
Slovakia	152	39	55	245	149	40	57	246	145	39	51	235
BR region	21	13	9	43	21	15	9	45	20	16	9	45
TRN region	16	2	4	22	16	3	3	22	16	3	2	21
TRE region	12	3	4	19	12	3	4	19	11	3	4	18
NI region	17	2	8	27	17	1	8	26	16	0	6	22
ZI region	21	2	6	29	21	2	7	30	21	2	6	29
BB region	20	5	5	30	19	5	5	29	18	6	4	28
PR region	21	6	13	40	21	5	13	39	21	5	12	38
KO region	23	6	6	35	22	6	8	36	22	4	8	34

Note:\* Number of schools as of September 15th of the respective year, Note:\*\* BR- Bratislava region; TRN- Trnava region; TRE-Trenčín region; NI- Nitra region, ZI-Žilina region, BB- Banská Bystrica region, PR- Prešov region, KO- Košice region.

**Table 3: Number of grammar schools by type of education provider in regions of the Slovak Republic (source: authors according to the Statistical Office of the Slovak Republic, 2021)**

Evaluating the number of grammar schools in the Slovak Republic, a noticeable reduction in the number of grammar schools can be seen, namely 235 grammar schools in 2019 compared to 245 in 2012, or 246 in 2015. Comparing the representation of grammar schools in the individual regions of the Slovak Republic, the largest number of grammar schools is found in the Bratislava region (approximately 18%), followed by the Prešov region (approximately 16%), and the third largest number of grammar schools (14%) is located in the Košice region. On the other hand, the lowest number of grammar schools from the regions of the Slovak Republic is represented in the Trenčín region (approximately 8%), with 19 grammar schools in 2012 and 2015, and 18 grammar schools in 2019.

As regards grammar schools by the type of education authority, public grammar schools account for the majority in regions of the Slovak Republic, followed by church grammar schools (with the exception of the Bratislava region). Private grammar schools are the least represented in most regions. The number of grammar

schools according to the specific education authorities (public, private, church) differs slightly in the respective regions, especially in the Bratislava region (private grammar schools) and in the Prešov region (church grammar schools).

The results clearly show that, specifically in the Prešov region, out of the total of 38 grammar schools 21 are public grammar schools (55.5%), 5 are private grammar schools (13.2%), and 12 are church grammar schools (31.6%). Using the example of selected grammar schools in the Prešov region, an analysis of the efficiency of secondary education is carried out in the next part of the results.

### Evaluation of the efficiency of grammar schools in the conditions of the Slovak Republic using the example of the Prešov region

In this part is presented the efficiency of 26 grammar schools in the Prešov region in the school years 2012-2013 to 2016-2017, using the BCC-O model. The score efficiency in the respective years is seen in Table 4.

Schools	Efficiency score				
	2012-2013	2013-2014	2014-2015	2015-2016	2016-2017
Grammar school JIRASKOVA 12 BJ (Pu)	1	1	1	1	0.8812
Grammar school LIPANY (Pu)	0.9666	0.9724	1	1	1
Grammar school J. A. RAYMAN PO (Pu)	1	1	1	1	1
Grammar school T. VANSOVA SL (Pu)	1	0.9647	1	0.9823	1
Grammar school DR. C. DAXNER VT (Pu)	0.9731	0.9554	1	0.9100	0.9868
Grammar school GIRALTOVCE (Pu)	1	0.9078	0.9952	0.9282	1
Grammar school GEN. L. SVOBODA HE (Pu)	1	1	0.9928	0.9960	0.9527
Grammar school SNINA (Pu)	0.9438	0.9972	0.9789	0.9907	1
Grammar school J. F. RIMAVSKY LE (Pu)	0.957	0.9718	0.9782	0.9161	0.9208
Grammar school P.O. HVIEZDOSLAV KK (Pu)	1	1	0.9773	0.9700	0.9627
Grammar school MEDZILABORCE (Pu)	1	1	0.9753	1	1
Grammar school KUKUCINOVA PP (Pu)	0.883	0.8653	0.9716	0.8466	1
Grammar school SABINOV (Pu)	0.9362	0.8936	0.9195	0.9400	1
Grammar school DUKL. HRDINOV SVIDNIK (Pu)	0.9362	0.9265	0.9636	0.8212	0.9889
Grammar school STROPKOV (Pu)	0.9574	0.9091	0.9507	0.9253	1
Private grammar school BJ (Pr)	0.8511	0.9732	0.9263	0.8500	0.9493
Private grammar school PP (Pr)	0.8617	1	0.9263	0.8900	0.9300
Grammar school - soukroma spojená škola PO (Pr)	0.8511	1	0.8316	0.9800	0.8600
Grammar school SV. MONIKA PO (Ch)	0.9409	0.9689	0.9876	0.9618	0.9083
Evangelical grammar school - EV. SPOJ. SKOLA PO (Ch)	0.8936	0.8386	0.9674	0.7900	0.9878
Grammar school SV. J. ZLAUSTY HE (Ch)	0.9761	1	0.9368	0.9400	1
Church grammar school SV. MIKULAS SL (Ch)	0.9985	0.9535	0.9368	0.9830	1
Grammar school SV. MIKULAS PO (Ch)	0.8191	0.9263	0.9847	0.8900	0.9501
Grammar school SV. F. Z ASSISI LE (Ch)	1	0.978	0.8931	0.9146	0.9296
Grammar school CIRKEVNA SPOJENA SKOLA HE (Ch)	1	1	0.8842	0.8300	0.9467
Grammar school P.P. GOJDIC PO (Ch)	1	1	0.8842	1	0.9606

Note: Pu – public grammar school, Pr – private grammar school, Ch – church grammar school

**Table 4: Efficiency score in grammar schools in the Prešov region in the school years 2012-2013 to 2016-2017 (source: authors by use of DEA SOLVER)**

Based on the overall results of success rate over the school years 2012-2013 to 2016-2017, Grammar school J. A. Rayman, having achieved the efficiency score of 1 in all evaluated years, can be considered the best efficiency model. Grammar school Jiraskova 12 in Bardejov and Grammar school Medzilaborce, both efficient four times in the course of the five years, achieved the second best results in efficiency in the evaluated years. Grammar school Lipany, Grammar school P. P. Gojdic and Grammar school T. Vansova in Stara Lubovna achieved three full efficiency scores. On the contrary, six grammar schools were inefficient in all evaluated years. These were two grammar schools established by the self-governing Prešov

region, three grammar schools established by the church, and one established by a private entity (see Table 4).

On the whole, mostly grammar schools established by the region and church reached the full score (=1), whereas private grammar schools reached full efficiency only in the school year 2013-2014. In 2012-2013, 10 grammar schools were efficient: seven public and three church. In 2014-2016, only five grammar schools were efficient each year, four of which were public and one church. The highest number of efficient grammar schools, 11, was observed in the school year 2016-2017. The number of efficient grammar schools in the observed period by the type of education provider is seen in Table 5.

Total number of grammar schools by education provider	Efficient grammar schools in the observed school years				
	2012-2013	2013-2014	2014-2015	2015-2016	2016-2017
Public (15)	7	5	5	4	9
Church (8)	3	3	0	1	2
Private (3)	0	2	0	0	0

**Table 5: Number of efficient grammar schools in the Prešov region by education provider (source: authors)**

Table 6 shows the average efficiency score of grammar schools in the Prešov region. It can be seen that in the period 2012-2013 to 2016-2017 the average efficiency score of the 26 grammar schools in the Prešov region ranged from

0.91 to 1 in 15 public grammar schools, from 0.90 to 0.92 in three private grammar schools, and from 0.90 to 0.97 in eight church grammar schools.

schools	average score	schools	average score
Grammar school JIRASKOVA 12 BJ (Pu)	0.98	Grammar school DUKL. HRDINOV SVIDNIK (Pu)	0.93
Grammar school LIPANY (Pu)	0.99	Grammar school STROPKOV (Pu)	0.95
Grammar school J. A. RAYMAN PO (Pu)	1	Private grammar school BJ (Pr)	0.91
Grammar school T. VANSOVA SL (Pu)	0.99	Private grammar school PP (Pr)	0.92
Grammar school DR. C. DAXNER VT (Pu)	0.97	Grammar school - soukroma spojená škola PO (Pr)	0.90
Grammar school GIRALTOVCE (Pu)	0.97	Grammar school SV. MONIKA PO (Ch)	0.95
Grammar school GEN. L. SVOBODA HE (Pu)	0.99	Evangelical grammar school - EV. SPOJ. SKOLA PO (Ch)	0.90
Grammar school SNINA (Pu)	0.98	Grammar school SV. J. ZLATOUSTY (Ch)	0.97
Grammar school J. F. RIMAVSKY (Pu)	0.95	Church grammar school SV. MIKULAS SL (Ch)	0.97
Grammar school P.O. HVIEZDOSLAV KK (Pu)	0.98	Grammar school SV. MIKULAS PO (Ch)	0.91
Grammar school MEDZILABORCE (Pu)	0.99	Grammar school SV. F. Z ASSISI LE (Ch)	0.94
Grammar school KUKUCINOVA PP (Pu)	0.91	Grammar school CIRKEVNA SPOJENA SKOLA HE (Ch)	0.93
Grammar school SABINOV (Pu)	0.94	Grammar school P.P. GOJDIC PO (Ch)	0.97

Note: Pu – public grammar school, Pr – private grammar school, Ch – church grammar school

Table 6: Average efficiency score of grammar schools in the Prešov region in the period 2012-2013 to 2016-2017 (source: author's calculations)

### Recommendations for inefficient grammar schools in the Prešov region by the type of education provider

Now, recommendations and suggestions are presented for the inefficient grammar schools in the school years 2012-2013 to 2016-2017, using the data presented in the output of the DEA analysis. The absolute values and recommended percentage changes to increase and achieve efficiency are provided for selected inefficient units (inefficient grammar schools). The stated values and percentage changes depend on the selection of input and output factors as well as on the selection of the model and its orientation.

In all five evaluated school years, 2012-2013 to 2016-2017, six grammar schools were inefficient. These are two grammar

schools established by a public education provider (*Grammar school in Svidnik and Grammar school J. F. Rimavsky in Levoca*), three church grammar schools (*Grammar school sv. Mikulas, Grammar school sv. Monika in Prešov, and Evangelical grammar school - Evanjelická spojená škola in Prešov*), and one private grammar school (*Private Grammar school Bardejov*). The list of the inefficient grammar schools according to the type of education provider is shown in Tables 7-9.

### Recommendations for inefficient public grammar schools

Recommendations based on the BBC-O output-oriented model for the improvement of inefficient public grammar schools in the Prešov region are captured in Table 7.

School year	Grammar school J. F. Rimavsky in Levoca				
	I1	I2	O1	O2	Score E
2012-2013	-15.6	-6.3	4.5	4.5	0.95
2013-2014	0	0	2.9	2.9	0.97
2014-2015	0	0	2.4	2.2	0.97
2015-2016	-9.2	0	11.3	9.2	0.92
2016-2017	-1.8	0	8.6	8.6	0.92
School year	Grammar school Duklianských hrdinov in Svidnik				
	I1	I2	O1	O2	Score E
2012-2013	-8.1	-5.6	10.8	6.8	0.93
2013-2014	0	-1.2	9.4	7.9	0.92
2014-2015	-7.2	0	3.8	4.5	0.96
2015-2016	-30.	0	30.3	21.8	0.82
2016-2017	0	-1.8	1.1	1.1	0.98

Note: input indicator I1 – share of teachers per 100 students; input indicator I2 – contribution to student in EUR; output indicator O1 – rate of graduates admitted to university in %; output indicator O2 – university admission success rate in %

Table 7: Projection of inefficient grammar schools (education provider is a public entity) (source: authors using DEA SOLVER)

If the suggestions for increasing the efficiency of public grammar schools are evaluated according to the BBC-O model (Table 7), a problem occurred in the case of *Grammar school J. F. Rimavsky in Levoca* in the analysed period regarding

the number of teachers per 100 students, and in each year an increase in the rate of admitted students (O1) and the percent rate of admission (O2). For the last two years analysed, the required increase ranges from 8 to 11%. To increase and

at the same time approach the patterns of efficiency, it is recommended to offer preparatory courses for universities led by teachers and professors from the required universities, which could increase interest and motivate students to be more interested in preparing for entrance exams. For the first and the last two years analysed, a reduction of the number of teachers per 100 pupils (I1) is advised, caused by the gradual reduction of the total number of pupils and school teachers over the last three years from 199 pupils to 176, and the number of teachers decreased by one each year. This phenomenon may have been caused by the lack of interest on the part of elementary-school leavers and their parents due to prejudices about the quality of church high schools in the Slovak Republic.

*Grammar school in Svidnik* was inefficient in the analysed period as a result of a high, suboptimal number of teachers per 100 pupils, and also failed to achieve a sufficient percentage of successful admission to universities and the rate of graduates

admitted to universities. In 2016-2017, compared to 2015-2016, the grammar school increased the efficiency score from 0.82 to 0.98, because the total number of school students had been reduced from 219 to 197, and also reduced the number of teachers from 24 to 22, and in turn, the number of successfully admitted graduates increased. In the school year 2015-2016, 44 out of 66 graduates were admitted and in the following year 56 out of 63 graduates. To increase efficiency, we recommend to increase (O1) the share of admitted graduates at universities and (O2) the admission rate using preparatory courses which can help graduates in university entrance exams.

### Recommendations for inefficient private grammar schools

Suggestions of the output-oriented model (BCC-O) to increase the efficiency of one private grammar school in the Prešov region are listed in Table 8.

School year	Private grammar school Bardejov				
	I1	I2	O1	O2	Score E
2012-2013	-54.0	-17.5	26	17.5	0.85
2013-2014	-14.4	0	12.5	2.8	0.97
2014-2015	-24.6	-0.99	124.4	8.0	0.92
2015-2016	-39.6	-2.0	28.9	17.7	0.85
2016-2017	-21.32	0	5.3	5.3	0.94

Note: input indicator I1 – share of teachers per 100 students; input indicator I2 – contribution to student in EUR; output indicator O1 – rate of graduates admitted to university in %; output indicator O2 – university admission success rate in %

**Table 8: Projection of an inefficient grammar school (education provider is a private entity) (source: authors using DEA SOLVER)**

In the evaluated years, the *Private grammar school Bardejov* was inefficient. It came closest to the efficiency limit in the school year 2013-2014 with the score of 0.97. Table 8 shows suggestions for input and output corrections for each year. Following the analysis through an output-oriented model, it can be seen that a year-on-year reduction (I1) of the number of teachers per 100 students is recommended. At the same time, an increase of the share of university graduates admitted to universities (O1) and of the percentage of university admission success (O2) is recommended on an annual basis. Based on these findings, it is recommended to reduce the high proportion of teachers per 100 students while it would be suitable to use the services of external teaching staff or increase the attractiveness of the school, e.g. foreign teachers, exchange stays and an increase in the number of pupils at the school and thus increase its efficiency. Once the number of students admitted to the grammar school has increased, the share of teachers per 100 pupils will decrease, and the grammar school will approach the limit of efficiency. The share of students admitted to university can be increased through preparatory courses.

### Recommendations for inefficient church grammar schools

Following the output-oriented model (BCC-O), Table 9 provides suggestions for improving the efficiency of three grammar schools, which are established by the church or church community.

Based on the output-oriented BCC-O model, reduction of inputs as well as outputs is recommended for *Grammar school sv. Mikulas*. Regarding outputs, it is recommended to engage in education through clubs, communication and exchange stays with foreign students, to create partner schools and participate in foreign projects and thus increase the chances of admission to universities. The model for the improvement of efficiency also recommends a reduction (I2) in the contribution per student. This phenomenon may be caused by the poorly stated real amount of the contribution or the student contribution comes from several sources. In the case of *Grammar school sv. Monika in Prešov*, to increase efficiency, it is recommended to reduce inputs and increase outputs. According to the analysis of the last year, this grammar school could achieve efficiency if it increases both outputs (O1, O2) by 10%. We suggest participating in projects and getting more points for the admission procedure by engaging and writing e.g. work on professional activities of the school. Based on the model, it is recommended for the *Evangelical grammar school in Prešov* to reduce both input factors (I1, I2), when in 2014-2015 and 2016-2017 the recommended reduction of the student contribution exceeded 40%. The entire contribution from public funds is broken down into the number of students in the school.

School year	Grammar school sv. Mikulas in Prešov				
	I1	I2	O1	O2	Score E
2012-2013	-6	-39.2	29.6	22.1	0.81
2013-2014	0	-41	12.8	8	0.92
2014-2015	-2.4	-36.2	27.5	11.8	0.89
2015-2016	0	-28.8	18.3	12.4	0.89
2016-2017	0	-36.5	5.3	5.3	0.95
School year	Grammar school sv. Monika in Prešov				
	I1	I2	O1	O2	Score E
2012-2013	-0.1	-10.9	6.3	6.3	0.94
2013-2014	-0.8	-13.3	3.2	3.2	0.96
2014-2015	0	-3.2	2.2	1.3	0.98
2015-2016	0	0	3.4	4.8	0.96
2016-2017	0	0	10.1	10.1	0.90
School year	Evangelical grammar school - Evanjelicka spojená škola in Prešov				
	I1	I2	O1	O2	Score E
2012-2013	-16.8	-27.7	19.5	11.9	0.89
2013-2014	0	-37.4	34.1	19.3	0.83
2014-2015	-20.7	-49.8	3.4	5.6	0.96
2015-2016	-23	-29.8	51.6	26.6	0.79
2016-2017	-8.8	-40.5	1.24	1.24	0.98

Note: input indicator I1 – share of teachers per 100 students; input indicator I2 – contribution to student in EUR; output indicator O1 – rate of graduates admitted to university in %; output indicator O2 – university admission success rate in %

Table 9: Projection of inefficient grammar schools (education provider is a church entity) (source: authors using DEA SOLVER)

## DISCUSSION

Public service delivery arrangements, as a mix of the public sector and the private sector reflecting the economic and organisational service conditions, should increase allocation and technical efficiency in the delivery of public services (Afonso, Schuknecht and Tanzi, 2003; Mihaiu, Opreana and Cristescu, 2010; Rao, 2015; Stejskal et al., 2017). The present research addressed the efficiency of secondary education in the regional context of the Slovak Republic, using BCC of an output-orientated model. With respect to the defined goal, the following research question was answered: ‘Are efficient grammar schools in the Prešov region related to the particular type of education provider (a public, private, church entity)?’

It can be said that selected grammar schools established by each education provider (a public, private, church entity) reached full efficiency scores in the school years 2012-2013 to 2016-2017 (Table 4 and 5). When comparing score efficiency of grammar schools by the form of education authority in the years 2012-2013 to 2016-2017 (Table 4), score efficiency of public and private grammar schools ranges between 0.82-1. However, when comparing the average score efficiency in school years 2012-2013 to 2016-2017, public grammar schools demonstrate better average results of efficiency, followed by church grammar schools, whereas private grammar schools reach the lowest average score of efficiency (Table 6). Still, the answer to the research question is negative (NO).

At the same time, in terms of the evaluation of efficiency, it must be taken into consideration that the grammar schools by an education authority were not evenly distributed in the analysis, which is also associated with the representation of the individual education authorities regarding high schools in the Slovak Republic.

As regards the results of the present research and the applied method, it is necessary to realise that ‘DEA models estimate an efficiency threshold on the basis of a data set with decisive units that must be homogeneous and involve the same activity. DEA models evaluate relative efficiency of the given set of units. By expanding the set by another unit (a grammar school in this particular case) the efficiency may or may not lead to a change to the efficiency frontier estimated by the particular DEA model’ (Dlouhý, Jablonský and Zýková (2018: 21). The authors are inclined towards the opinion that in terms of the efficiency score of 0.99 a school can be deemed rather efficient despite not being considered fully efficient unit from the economic standpoint.

As a result, it can be stated that in search of the answer as to why some organisation units are more efficient than others, the right selection of input and output indicators is vital, such as type, teachers, education processes, education policies and educational programmes, which affect the process of schooling and learning (Lockheed and Hanushek, 1994; Haelermans and De Witte, 2012). The main issue is whether the regional education system or local education system fulfil the goals for which they were created and whether schools make the most efficient use of public resources. According to Seiler et al. (2006), one approach is inclined towards the fact that inefficient and ineffective schools are unable to improve their situation on account of a larger amount of public financial resources. Another approach supports the idea that a larger amount of supportive resources (such as the size of classrooms, quality of teachers) improves education.

A more detailed comparison with the present research is relatively difficult, since research dealing with evaluation of efficiency in education focuses on other types of secondary

schools and applies different input and output indicators, or observes different time periods. Research performed in, for instance, the Czech Republic mostly concentrates on the efficiency in secondary schools. Provazníková and Chlebounová (2018) researched efficiency of high schools (using the example of grammar schools and high schools) at the regional level in the Czech Republic. Their results show that, on average, grammar schools use 80% of their capacity, whereas high schools only 60%, while this situation is mainly affected by demographic factors.

Based on research by Chlebounová (2019), performed on the example of Pardubice region in the Czech Republic, it can be stated that grammar schools show significantly better students' results and also lower expenditure on teacher salaries compared to vocational secondary schools. Conversely, marked differences in students' results and expenditure on teacher salaries were confirmed in the case of vocational secondary schools. From the viewpoint of efficiency, grammar schools reach higher similarity between one another compared to secondary vocational schools, which demonstrate stronger differences in efficiency between one another. The same author (Chlebounová, 2019) argues that public secondary schools are mainly funded according to the number of students, and financial resources are allocated centrally. This form of funding renders it impossible for schools to affect the volume of financial resources; however, the numbers of students peak, in spite of the fact that this may lead to worse outputs of these schools.

When comparing the results of the present research of the efficiency of secondary education using the example of grammar schools with similar research on the regional level in the Czech Republic or Slovak Republic, it can be said that the efficiency of the specific secondary schools (grammar schools, business academies, vocational secondary schools) differs significantly. Such research (Provazníková and Chlebounová, 2018; Štrangfeldová et al., 2018 or Mališová and Štrangfeldová, 2020) shows that grammar schools reach higher efficiency in comparison to the other types of secondary schools in secondary education. These differences are associated with factors that affect total efficiency of the evaluated secondary schools. It can be the number of input and output indicators applied, but also various qualitative indicators. It must also be considered that an application of another combination of indicators in the evaluation of efficiency can result in differences in the efficiency of secondary schools.

Based on foreign research dealing with evaluation of efficiency in secondary education (e.g., Coulson, 2009; Crespo-Cebada, Pedraja-Chaparro and Santín, 2013; Masci, De Witte and Agasisti, 2018; Margaritis, Tsamadias and Argyropoulos, 2021) in the regional context it can be stated that public financing with private management can result in greater efficiency. Other author Rao (2015) states that some findings provide evidence about the support of greater efficiency of private schools; others findings confirm that public schools are more efficient. Private schools government-funded must strive to acquire students and to make an efficient use of public finance, unlike public schools. At the same time, private schools must provide a more innovative education service more frequently. By contrast, Silvernail and Johnson (2014) confirmed that public

charter schools and traditional public schools differ in their quality. Success of schools depends upon a variety of factors and, therefore, each school should be judged on its output and reached performance.

Also, other research confirms that also other factors come into play in the evaluation of the performance of the individual types of schools (private, public, church), such as competition between schools, innovation features or local and regional conditions (Waldo, 2007; Millimet and Collier, 2008; Haelermans and De Witte, 2012; Holmberg, 2017).

## CONCLUSION

In the current theory of public goods, which also encompasses public services, including education, the major question is the selection of a suitable form of the production of public goods – delivery of services. The comparison of the public and private form of the delivery of public services, including education, failed to reach a clear conclusion. Nevertheless, it has opened the question of the evaluation of efficiency reached by the individual producers of public services. Currently, emphasis is placed on a complex evaluation of efficiency of educational organisation in the provision of public services. Most research on efficiency in education, specifically focused on types of schools, focus on particular conditions in the given countries. The aim of the paper was to evaluate the efficiency of services in high-school (secondary) education by various producers in the conditions of the Slovak Republic with a focus on the Prešov region. In this respect, the results bring interesting findings as a national case study and offer possibilities of evaluating various producers of educational services in the form of a replicable methodology.

In school years (2012-2013 to 2016-2017), out of the 26 evaluated grammar schools in the Prešov region, selected grammar schools in each category of education provider (a public, private, church entity) reached a full score. In contrast, in all evaluated years, six grammar schools were inefficient (i.e., two public grammar schools out of 15, three church grammar schools out of eight, and one private grammar school out of three). The results based on the average efficiency score have also shown that public grammar schools demonstrate better efficiency with respect to the form of education provider in comparison to church and private grammar schools. The present research is limited by the applicability of the results, which only concern one form of high schools, i.e. grammar schools, and by the regional context. Future research could provide a more extensive analysis of evaluated schools, including other types of high schools (e.g. selected high schools) represented in the respective regions of the Slovak Republic and could add the evaluation of high-school efficiency in time by use of the Malmquist index, or add the aspect of quality in the evaluation of schools in the public sector.

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