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Lean Tools for Improving the Teaching Process in Serbia - Empirical Research

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Abstract:

Research Question: This article identifies the most prominent lean wastes in the education process in primary schools in Serbia and the most efficient lean tools for their reduction. **Objective:** Lean management has been recognized as a valuable strategy suitable for application in various fields. Its implementation in the field of education has shown a rather slow progress, and the Serbian education system is not an exception. **Idea:** The idea of the research was to investigate the possible outcomes of the lean management implementation in primary schools in Serbia, and its possible benefits. **Data:** For this purpose, a specialized questionnaire concerning lean wastes and lean tools was designed intended for class and subject teachers. **Tools:** Statistical data analyses were used to determine the relationships between variables, and the Weighted Scoring method was applied to identify the most represented lean wastes in the education process, as well as the prioritization of lean tools. **Findings:** According to the results, the factor of the lean tools impact in regard to the lean wastes reduction was evaluated as "higher than 3" (on a scale of 1-5), which confirmed the efficiency of the considered lean tools in the lean wastes reduction. Also, the significant differences between the public and the private education sectors in terms of the lean application are shown, especially regarding the type of curriculum present (national or international). **Contribution:** The research has shown that lean management could be successfully applied in primary schools, in order to improve school organization and the teaching process flow, which highly contributes to the school's overall competitiveness. The guidelines for the lean management implementation are given as well as the recommendations to the creators of education policies. Certain limitations should be taken into account, regarding the restricted number of schools involved and specific sample group.

Keywords: lean management, primary schools in Serbia, lean wastes, lean tools, weighted scoring method

JEL classification: I21, C14

1. Introduction

Lean is a concept for productivity improvement. This approach deals with elimination or reduction of wastes from the production process, maximizing activities that add value to a product / service, from the user's perspective (Dragomir & Surugiu, 2012). The term lean means „thin“ or „slim“ (Zvorc, 2013). The term wastes refers to the production process activities that do not contribute to the final value of the product (Womack, Jones, & Roos, 1990). It was originally developed as an innovative manufacturing methodology in Japan automobile industry in the 1950's (Cecevic, 2016). In this manner, high quality products could be delivered on short notice and with minimal costs (Danes, Manfe & Romano, 2018). The resources saved by the waste elimination could be reinvested in higher priority processes (Radosevic, Baosic & Radicevic and etc., 2011). According to various studies, this allows the level of the lean production increase to go up to 25% (Kolberg, Knobloch & Zuhlke, 2017). Adequately trained employees and properly organized working environment contribute to the effectiveness of lean principle within the following model: human capital – production capital – working environment (Kirin, Vasojevic & Vucetic, 2019).

Globally, different sectors strive to implement the best lean practices (Parkes, 2015). Recently, the lean approach has spread from the industry sector to public services, health care and education. These sectors imply systems similar to complex organization of the same scope production process (Kadarova & Demecko, 2016). Education involves a continuous process flow, as well as the resources of time, cost and human capital, and the final value of the product – knowledge. As in a common production process, certain wastes could be

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identified in the field of education as well. The aim of this study is to show that lean management could provide useful tools for creating better teaching and learning conditions. Identification of the actions that do not contribute to the learning process quality, considering learning content, time and resources management, teaching methods and students' motivation, and elimination of non-value-added administration, preparation, and searching issues, would provide students with better functional knowledge, required for students' qualifications (Wang, 2011; Maksimovic & Osmanovic, 2018). This contributes to the main goal of learning which implies knowledge preservation, transmission and creative application (Oyeniran et al., 2020). The main objective of lean implementation may be to increase the learning output for the students and teachers more time for learning, more time for teaching, increasing the quality of teaching by removing issues that are not strictly connected to learning (Netland, 2015) as well as to create a better work environment (Berner, 2014).

2. Theoretical Context

The constantly increasing number of students has made the education system part of the mass production system of knowledge. In order to be sustainable in increasingly competitive markets the education sector needs new ways to attract students (Sremcevic et al., 2018). The state of affairs in the education sector is determined by numerous factors concerning socio-economic conditions (Stamatovic & Milosevic, 2017:9). Nowadays, besides the increasing competition, educational institutions are facing the lack of public funding as well. The studies showed that the common driver for the lean management implementation in education was budget reduction (Dragomir & Surugiu, 2012). Also, it is shown that in order to make an educational institution prominent and sustainable, it is necessary to introduce innovative schooling methods (Santin & Sicilia, 2018). Improving the quality of education allows students to better their performance and increase the school's prominence. Since the lean approach promotes the idea of ongoing research the benefits of the lean educational model are indefinitely sustainable (Tilfarlioglu & Karagucuk, 2019). This is in consent with the sustainable business model, which Ludeke-Freund defined as one that "creates competitive advantage through superior customer value and contributes to the sustainable development of the company and society" (Small-Warner, 2018). This value is cited as the received knowledge that a student can apply in future (Sremcevic et al., 2018). The lean educational model can create additional value raising the productivity degree on operational, administrative and strategic levels (Vukadinovic, Macuzic & DJapan, 2017). It implies time and cost reductions and training for the employees (Tilfarlioglu, 2017).

Contemporary theoretical studies showed the success of the lean principle implementation in various institutions and industries (Radosevic, Baosic, Radicevic, Ikonov & Matic, 2011). According to the Scopus database search results, lean management in education is a very popular topic worldwide. On the other hand, almost none of the national studies on the education system in Serbia deals with this subject. The overall success of the lean implementation highly depends on the extent to what the employees are included in the process and willing to accept change (Biazzo & Panizzolo, 2000). Therefore, teachers should be actively engaged in decision making and planning (Longonia, Pagellb, Johnston & Veltrid, 2013). It is very important that the lean adaptation begins with the teacher evaluation of the existing educational model and identification of its shortcomings, in order to identify lean wastes and define adequate lean tools (Vasojevic, Vucetic & Kirin, 2019).

Based on the assumption that the lean approach elements are represented at different levels in schools in Serbia, the following hypotheses were made.

General hypotheses are as follows:

1. There is a difference in applying the lean approach depending on the characteristics of the school.
2. Types of lean waste can be identified in schools in Serbia, as well as the most effective lean tools to eliminate them.

Specific hypotheses are the following:

1. The type of curriculum (national or international) influences the elements that characterize the implementation of lean approaches.
2. Elements of lean access are differently represented in private and public schools

3. Research Methodology and Data Sources

3.1. Research organization

The aim of the questionnaire was to identify lean wastes in primary schools in Serbia, and the possibilities of the lean educational model introduction. It investigates the intensity of the negative impact of lean wastes on the teaching process flow, together with the success rate of the lean tools implementation in reducing lean

wastes and improving the education process. Empirical data concerning lean management in the field of industry, where lean strategy was first introduced and adapted, identified several types of lean wastes. Six out of seven of them relevant for the education process are set aside. Also, with reference to literature, twelve lean tools relevant for the education field are defined (Muthu Baskaran, 2018: 1108). Apart from the questions concerning general socio-demographic data (6 questions), the questionnaire included 53 specialized questions related to the teaching process organization.

The research was conducted in schools on the territory of The Republic of Serbia in 2019/2020. The data were processed using the 'IBM SPSS19' statistic program.

The research started with examining the attitudes of the primary school teachers in Serbia (N=213), employed both in public (82,6%) and private sectors (17,4%). In regard to the selection criteria, the sample of respondents included lower grade elementary school teachers (33,3%) and classroom teachers (66,7%), who are engaged in national (92%) and international (8%) education programmes. Considering the gender criteria, the sample is rather uneven (33 male and 180 female respondents). In terms of work experience, the most widely represented group is that of 5-15 years (36,2%), followed by the groups of 16-25 years (27,2%), less than 5 years (21,6%), 26-35 years (12,7%) and over 35 years (2,3%) of work. A significantly large number of respondents work in urban areas (81,7%), compared to those working in suburban (3,3%) and rural areas (15%).

3.2. Results

Using the T-test of independent samples, the results of the application of the observed lean approach elements were compared, depending on whether a national or international program was implemented in the school.

Table 1: Statistically significant differences depending on the plan and programme.
Method: Independent samples t-test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
Too much teaching material	EVA	0.66	0.42	2.23	211.00	0.03	0.57	0.26	0.07	1.08
	EVNA			1.97	18.14		0.57	0.29	-0.04	1.18
Too much preparation of teaching material	EVA	1.45	0.23	2.19	211.00	0.03	0.48	0.22	0.05	0.91
	EVNA			1.83	17.86		0.48	0.26	-0.07	1.03
Intensive curriculum	EVA	0.08	0.78	2.71	211.00	0.01	0.69	0.25	0.19	1.19
	EVNA			2.51	18.40		0.69	0.27	0.11	1.26
Too much administration	EVA	10.98	0.00	3.77	211.00	0.00	0.92	0.24	0.44	1.40
	EVNA			2.62	17.18		0.92	0.35	0.18	1.66
Lack of indicators of students' satisfaction with teaching and their performance	EVA	1.02	0.31	2.11	211.00	0.04	0.57	0.27	0.04	1.11
	EVNA			1.87	18.16		0.57	0.31	-0.07	1.21
Insufficient communication between students, teachers and parents	EVA	0.55	0.46	2.72	211.00	0.01	0.75	0.28	0.21	1.30
	EVNA			2.24	17.79		0.75	0.34	0.04	1.46
Unused school building space	EVA	1.02	0.31	2.11	210.00	0.04	0.66	0.32	0.04	1.29
	EVNA			2.60	20.91	0.02	0.66	0.26	0.13	1.20

EVA=Equal variances assumed; EVNA=Equal variances not assumed

The obtained results, table 1, show that there is a statistically significant difference in the application of certain elements of the lean approach, depending on whether a national or international programme was implemented. This is primarily related to the degree of administration present, with it being much more extensive in schools implementing the national programme. Also, a significant difference in the intensity of communication between students, teachers and parents is noticed, where schools operating under the international programme appear to focus on it more. In schools operating under the national programme, more time is spent on teaching materials preparation; there are more intensive curricula, more extensive learning material and more unused building space. Figure 1 shows the nature and magnitude of this difference. Based on the obtained results, it can be said that the first specific hypothesis was confirmed.

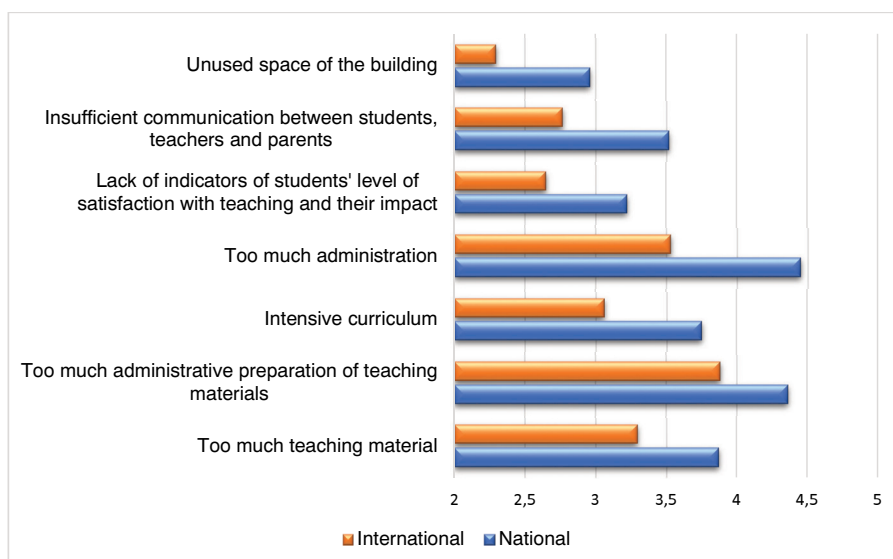


Figure 1: Statistically significant differences depending on the plan and programme. Method: Independent samples t-test

T-test of independent samples is used too, the test the level of application of the lean approach elements, depending on whether the school is state or privately owned.

The obtained results, table 2, show that there is a statistically significant difference in the application of certain elements of the lean approach in state and privately owned schools. In private schools less teaching material, less administrative preparation of teaching materials, less intensive curricula, less classroom equipment, less unused building space and less time spent for the administrative part of the class are present. It was an interesting and a bit unexpected result that state-owned schools appear to possess better classroom equipment, as well as that teaching materials in private schools appear not to follow the social needs as successfully as in those publicly owned. Figure 2 shows the nature and magnitude of this difference.

Based on these results, it can be said that the second specific hypothesis was confirmed.

Table 2: Statistically significant differences in publicly and privately owned schools: independent sample t-test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
Too much teaching material	EVA	0.01	0.94	3.90	211.00	0.00	0.70	0.18	0.35	1.05
	EVNA			4.02	53.98	0.00	0.70	0.17	0.35	1.05
Too much preparation of teaching material	EVA	0.48	0.49	3.16	211.00	0.00	0.49	0.16	0.18	0.80
	EVNA			2.90	48.33	0.01	0.49	0.17	0.15	0.83

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
Intensive curriculum	EVA	2.91	0.09	3.57	211.00	0.00	0.64	0.18	0.29	0.99
	EVNA			3.95	58.73	0.00	0.64	0.16	0.32	0.96
Classroom equipment	EVA	0.07	0.79	2.68	211.00	0.01	0.58	0.21	0.15	1.00
	EVNA			2.60	50.64	0.01	0.58	0.22	0.13	1.02
Spatial-programme organization of the building	EVA	1.78	0.18	2.67	211.00	0.01	0.58	0.22	0.15	1.01
	EVNA			2.51	49.34	0.02	0.58	0.23	0.12	1.05
Textbooks do not follow social needs	EVA	1.31	0.25	-2.28	211.00	0.02	-0.48	0.21	-0.89	-0.06
	EVNA			-2.16	49.62	0.04	-0.48	0.22	-0.92	-0.03
Insufficient communication between students, teachers and parents	EVA	0.77	0.38	2.28	211.00	0.02	0.45	0.20	0.06	0.84
	EVNA			1.99	46.44	0.05	0.45	0.23	-0.01	0.91
Waiting for the administrative part of the class to finish	EVA	0.00	0.97	2.73	210.00	0.01	0.66	0.24	0.18	1.13
	EVNA			2.81	54.07	0.01	0.66	0.23	0.19	1.12

EVA-Equal variances assumed; EVNA-Equal variances not assumed

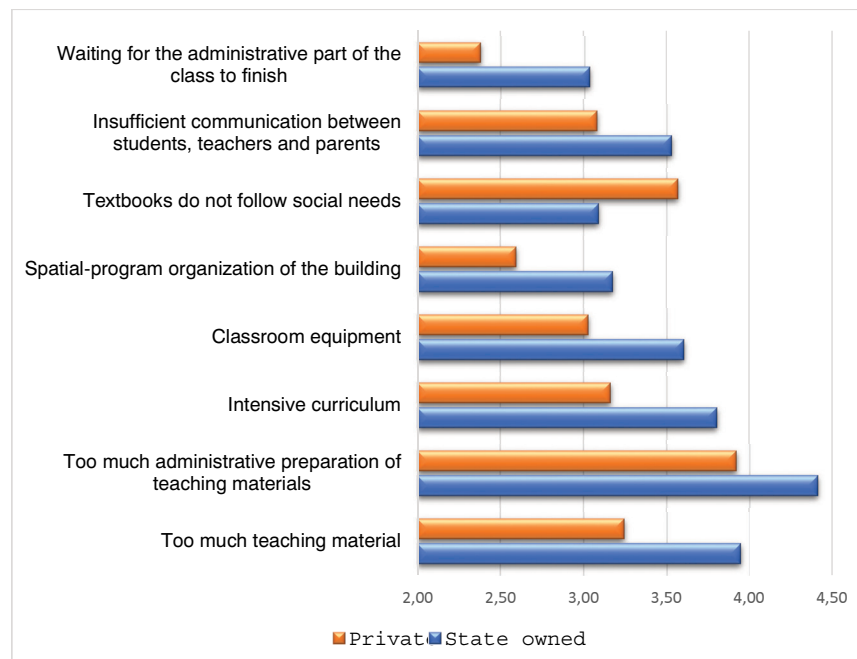


Figure 2: Statistically significant differences in publicly and privately owned schools: independent sample t-test

The obtained results show that the application of lean elements is influenced by the characteristics of a school such as its curriculum and the fact that the school is state and privately owned and it can be said that the first general hypothesis was confirmed.

3.3. Weighted scoring method

The weighted scoring method is a multi-criteria decision-making method used to define the relationship between the criteria and the alternatives. According to this method, the weights of the criteria (here: % of lean wastes) are multiplied with the values of the alternatives (here: lean tools impact rates) and the weighted sum indicates the overall sum of a process (Muthu Baskaran, 2018: 1110).

As a referent model for the research methodology the study in manufacturing industry is used, whose principle was tested in different sectors (Muthu Baskaran, 2018; Wan, Sahasrabudhe & Rivera, 2014). In order to evaluate the capability of lean tools eliminating lean wastes the multi-criteria decision-making is applied. A self-assessment model was developed using a questionnaire of a five-point scale to rate the efficiency of lean tools. The level of consent to the statement listed was rated using the 5 degree Likert scale (1 -strongly disagree; 5 - strongly agree). The final results were processed using Weighted Scoring method ranking model.

Step 1: 6 types of lean wastes were identified. with reference to lean wastes in industry and manufacturing study and ranked in regard to the extent of the negative_impact and representation (%) in the teaching process, which is shown in Table 3.

The results show that the most represented waste in the teaching process is caused by a wide range of teaching activities (20.6%) followed by the waste caused by too many teaching activities and extracurriculars (17.72%). The unnecessary motion and poor teaching organization participate in the overall lean waste with 16.3%. unutilized resources with 15.07% and 'bottlenecks' with 14.5%. The span between the most and the least represented wastes is around 6%.

Table 3: The Lean Wastes and their Percentage

Sl.No.	Wastes	Number	M	SD	Percentage
1	Wide Range of Teaching Activities	203	4.07	0.77	21
2	Too Many Teaching Activities and Extracurriculars	203	3.52	0.72	18
3	Unnecessary Motion	203	3.29	1.07	16
4	Poor Teaching Organization	203	3.27	0.8	16
5	Unutilized Resources	203	2.9	1.26	14
6	'Bottlenecks'	203	3.08	1	15

M-medium. SD- standard deviation. Sl.No.- serial number

Step 2: 12 lean tools that contribute to wastes elimination in the teaching process are identified. Table 4.

Table 4: The Lean Tools and Description

	Lean Tools	Description
A1	Efficiency method	School order, organization and equipment Maintenance
A2	Quality process	Tests and extracurriculars
A3	Computer equipment	PC work cells and Internet access
A4	Teaching process line balancing	Work plan, achievement and student interests balancing
A5	Standard work	Predefined class structure, internal communication system, interactive class
A6	Quick changeovers	Classroom and teacher quick replacement
A7	Standard work improvement and maintenance	Efficient didactic tools, timetable and school building layout
A8	Continuous flow	Uninterrupted Teaching Process
A9	School – student relation	Student oriented education system
A10	Levelling	Balanced and modern teaching programme
A11	Training	Adequate training for employees
A12	School – student – parent alliances	Affirmative student – teacher – parent relations

The level of impact of every single lean tool on 6 identified lean wastes altogether is shown in Table 5. The impact span rate was given in the interval from 1 to 5. If lean tool is rated 5, it shows a higher level of impact on lean wastes. If it is rated 1, it shows a very low level of lean impact on lean wastes (1 - no impact. 5 - very significant impact).

Table 5: The Cross Tabulation of Lean Tools and Lean Wastes

Wastes	Weights	Tools											
		A1	A2	A3	A4	A5	A6	A7	A8	A9	A10	A11	A12
1.	0.21	3.47	3.4	4.06	3.82	3.66	3.64	3.66	3.97	3.99	3.99	3.73	3.99
2.	0.18	3.46	3.29	4.05	3.81	3.65	3.63	3.65	3.96	3.99	3.99	3.73	3.99
3.	0.16	3.46	3.39	4.06	3.82	3.66	3.64	3.66	3.97	4	4	3.73	3.77
4.	0.16	3.45	3.39	4.05	3.81	3.66	3.63	3.66	3.96	3.99	3.99	3.74	4
5.	0.14	3.09	3.39	4.05	3.82	3.66	3.33	3.66	3.97	4	4	3.73	3.99
6.	0.15	3.46	3.41	4.05	3.82	3.66	3.64	3.67	3.98	4	4	3.74	4
\bar{x}		3.4	3.38	4.05	3.82	3.66	3.59	3.66	3.97	4	4	3.73	3.96

x - weighted mean

Step 3: Using the results of the previous steps, prioritization of lean tools is performed defined by the ability to improve the teaching process. Lean tools are sorted out by the level of efficiency in reducing 6 lean wastes altogether. Using the lean wastes – lean tools matrix, the lean tools are ranked by the priority of being *lean*. The lean tool with the highest value of the weighted score is ranked as No. 1, and the lean tool with the lowest value of the weighted score is ranked No. 12, in regard to the possibility of a lean tool to reduce all 6 wastes. The lean tools prioritization is given in Table 6.

Table 6: The Lean Tools Prioritization

Rank	Lean tools	Weighted sum
I	A3. Computer Equipment	4.05
II	A9. School – Student relation	4.00
III	A10. Levelling	4.00
IV	A8. Continuous Flow	3.97
V	A12. School – Student – Parent Alliances	3.96
VI	A4. Teaching Process Line Balancing	3.82
VII	A11. Training	3.73
VIII	A5. Standard Work	3.66
IX	A7. Standard Work Improvement and Maintenance	3.66
X	A6. Quick Changeovers	3.59
XI	A1. Efficiency Method	3.40
XII	A2. Quality Process	3.38

This proves the second general hypothesis, that types of lean waste can be identified in schools in Serbia, as well as the most effective lean tools to eliminate them.

4. Discussion

The study results indicate the presence of administration excess in state-owned national programme schools. A significant difference in the intensity of communication between students, teachers and parents in favour of international programme private schools is shown. In schools operating under the national programme more time is spent on teaching material preparation; a more intensive curriculum is present, as well as more extensive learning materials and more unused building space. In private schools less teaching material is present, less administrative preparation of teaching materials, a less intensive curriculum, less classroom equipment, less space in the building and less time spent for the administrative part of the class. Consequently, the first and the second specific hypothesis are proven. The application of lean elements is influenced by school characteristics, which confirms the first general hypothesis.

Since the most significant problems identified are related to a wide range of teaching activities and too many teaching activities, it is important to analyze the teaching process on a deeper level. The fast pace of

technology shifts also requires faster changes in the education system and more adequate curricula. According to the research results, the major contribution to the optimal teaching process flow comes from the equipment of classrooms with PC work cells and Internet access, student oriented education system, balanced and modern teaching programme, continuous teaching process flow and the establishment of an affirmative student – teacher – parent relations. This implies the understanding of structure, organization, use, curriculum and alignment. In similar studies modern technology was also identified as a useful tool for the learning process improvement (Lochner, Conrad & Graham, 2015) with a positive effect both on students' benefit and cultural outcomes (Joksimovic, Robertson, Djokic & Drazeta, 2019). The research results show that the impact of lean tools on the identified lean wastes reduction is scored as "higher than 3" (on a scale of 1-5), proving the efficiency of the considered lean tools in the lean wastes reduction and their significant contribution to the teaching process improvement, which confirms the second general hypotheses.

When interpreting the survey results, it should be noted that the survey sample was limited to schools that took part on a voluntary basis and that only teachers participated in the survey.

Conclusion

The study has shown that, according to teachers' opinions, the lean management implementation in primary schools can be a successful method for the educational process improvement, which is in consent with the previous study results according to which the lean education is highly estimated by academics (Alves, Leao, Uebe-Mansur & Kury, 2020). Lean wastes should be revised primarily in the state owned schools, as the research results showed significantly more prominent presence of the identified lean wastes. The highest percentage of lean wastes implies a wide range of teaching activities and too many teaching activities and extracurriculars. The successful lean management implementation should be based on, first of all, enhancing computer equipment. developing student oriented education system and establishing a balanced and modern teaching programme.

The investment in quality education is essential for a country's development and economic growth (Barro & Lee, 1996; Hanushek & Kimko, 2000; Hanushek & Woessmann, 2012; Hanushek & Rivkin, 2012; De la Fuente, 2011). According to the human capital literature, a country can benefit in terms of competitiveness through educational policy, since the investment in education seems to have a positive impact on economic development, contributing to economic performance in the long run. As a policy implication for the emerging countries, Serbia among others, it would be recommended that the share of government expenditure on education should be increased (Nistor, Mera & Pop Silaghi, 2018). It should primarily refer to primary education, since it is shown that in emerging economies, those that have invested heavily in education in the last few decades, the gross enrollment ratio for primary education in low-income countries has exceeded 100 percent (Tan et al., 2016). Having in mind the possible lack of public funding in emerging countries such as Serbia, it may be useful to consider the alternative ways of the education system improvement.

Therefore, it will be beneficial for the current Serbian education system to review the education methods and consider the possibility of lean evaluation implementation in primary schools. In order to investigate more deeply into the effects of the lean-methodology application in education, the future research should include other education process stakeholder, and students' school achievement should also be considered.

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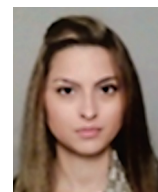
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