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The Importance of R&D Projects in Serbia – The Role of Human Capital

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Abstract: *Research and development (R&D) projects are crucial for the implementation of a company's strategy and a prerequisite for achieving a competitive advantage. In globalized conditions, the success of R&D projects significantly depends on the capabilities of human capital. Human capital is the most valuable resource of any country, therefore, the cooperation of scientific-research organizations with companies from the private sector in the field of realization of R&D projects has become inevitable. The primary goal of this paper is to examine the relationship between R&D project investments and human capital (employees in the R&D area and highly-educated employees), from 2008 to 2021. For that purpose, multivariate linear regression has been applied. The results revealed that a highly educated workforce is of key importance for the growth of investments in R&D projects, hereby, the proposal for policymakers would be to encourage greater investments in higher education, as well as to strengthen better cooperation between science and business.*

1. INTRODUCTION

R&D projects are at the forefront of innovation, promoting the creation of new technologies, products and processes. R&D initiatives are commonly acknowledged as the main forces of innovation and technical advancement, which facilitate industry diversification and transformation. The effective implementation of R&D projects depends heavily on human capital. R&D initiatives often involve highly technical expertise in fields such as science, engineering, and technology. R&D projects are essentially inventive, knowledge-intensive efforts designed to develop new products, innovations, technologies, or methods. The abilities, knowledge, and inventiveness of the people engaged in undertaking R&D projects have a significant impact on the effectiveness of these projects. Human resources with excellent project management abilities can effectively assess resources, define goals, manage timeframe, and adjust to unforeseen challenges to keep the project on track.

The research paper is organized into a few parts. Firstly, after the introduction, the literature review, i.e. the relationship between R&D projects and human resources is given. The analysis of R&D projects and human capital in Serbia is also presented. The next section presents the data and methodology of the research, followed by the results of empirical analysis. The final section provides discussions of theoretical and empirical findings.

2. LITERATURE REVIEW

In the conditions of a sharp and intensive competitive environment, firms and countries are constantly under pressure to innovate (Parikh, 2001) and undertake R&D activities. R&D activities

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are often directed toward resolving particular, unstructured, and difficult issues (Drongelen et al., 2000), and they are frequently carried out in the form of projects. Nowadays, organizations implement R&D projects and activities to identify and solve challenges caused by rapid changes in customer requirements and the competitive environment of domestic and international markets (Bican & Brem, 2020). Understanding how firms and countries use their workforce to promote innovation and technological growth, requires an awareness of the link between R&D initiatives and human capital.

As endogenous growth models have evolved, economists have begun to place a greater emphasis on innovation performance as a fundamental driver of economic growth. At the macro and micro level, a factor considered an important determinant of R&D investment is human capital. Human capital has long been recognized as one of the key factors influencing an organization's capacity for innovation. In order to improve innovative performance and economic growth, human capital has become crucial. The ability of a company to innovate depends heavily on its human capital, which is considered the collective and individual expertise of its personnel (Mariz-Perez et al., 2012). For stimulating creativity, promoting collaboration, and successfully managing the complex processes involved with R&D operations, it is essential to have skilled, motivated, and well-managed human resources. Some researchers have concluded that people engaged in R&D activities have explanatory power for models of research outputs including patents and publications (Ayan et al., 2023).

In a sample of 1666 Spanish industrial firms, some researchers (Martínez-Sánchez et al., 2020, p. 431) examined how some human resources (HR) flexibility mediates the association between R&D efforts and the absorptive capacity of knowledge (AC). The findings indicate that temporary employment of human resources does not moderate the relationship between R&D efforts and AC, although core employee training and external R&D specialists do. Integrating temporary human resources into R&D projects and contributing to the AC is more challenging for firms with a large proportion of temporary employees (Martínez-Sánchez et al., 2020, p. 434). According to Un (2017), companies that engage more in internal R&D and have more trained and qualified employees are also likely to invest more in external R&D. Some authors (Honjo et al., 2014, p. 207) concluded that the success of R&D projects is anticipated for companies led by founders with greater levels of human capital. Wu and Sun (2006) have created a mixed nonlinear program to minimize outsourcing expenses and to take into account the impact of staff learning on R&D multi-project scheduling and staffing issues.

3. ANALYSIS OF R&D PROJECTS AND HUMAN CAPITAL IN SERBIA

Serbia, located at the crossroads of Europe, is transitioning to a knowledge-driven economy. An essential pillar of this journey are R&D projects, which fuel the country's goals of greater competitiveness, industry diversification, sustainable growth, and human capital, pivotal in shaping the success of R&D endeavors. Serbia's dedication to encouraging innovation and using its intellectual resources is taking shape through an increasing focus on R&D efforts, against the backdrop of changing global dynamics.

Based on the data shown in Figure 1, it can be concluded that the value of R&D projects in Serbia has been steadily increasing during the analyzed period. Observing the data from 2008 to 2021, there were a few minor decreases in the value of R&D projects, recorded in 2008, 2010, 2013 and 2016. The highest value of RSD 62,330,472 was achieved in 2021.

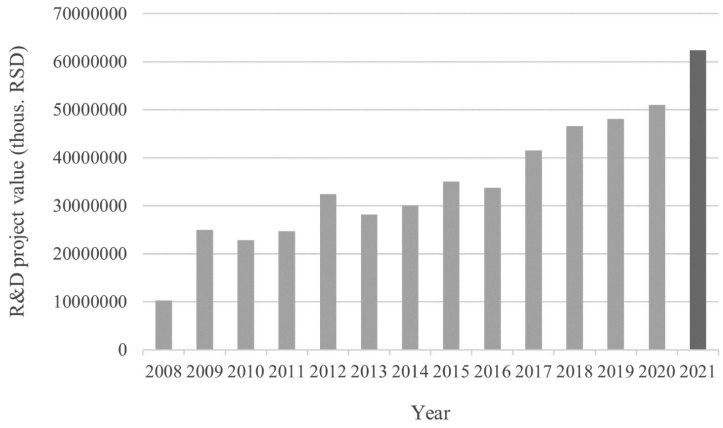

Figure 1. The value of R&D project per year

Source: Statistički godišnjak – Republički Statistički Zavod (2009, 2010, 2011, 2012, 2013, 2014, 2015, 2016, 2017, 2018, 2019, 2020, 2021, 2022)

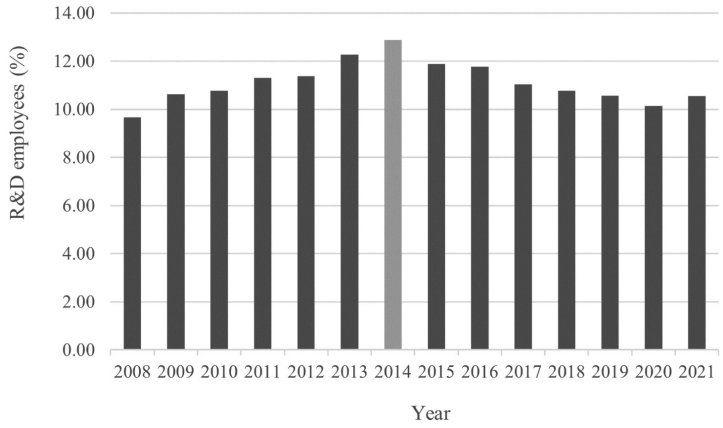

Figure 2. R&D employees (%)

Source: Statistički godišnjak – Republički Statistički Zavod (2009, 2010, 2011, 2012, 2013, 2014, 2015, 2016, 2017, 2018, 2019, 2020, 2021, 2022)

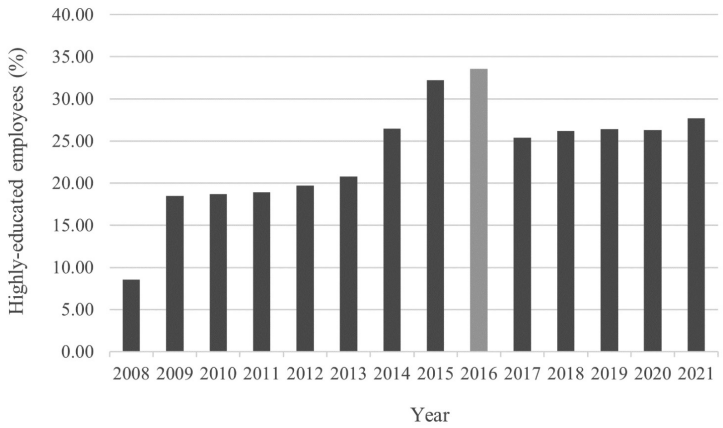

Figure 3. The share of highly-educated employees in total R&D employment

Source: Statistički godišnjak – Republički Statistički Zavod (2009, 2010, 2011, 2012, 2013, 2014, 2015, 2016, 2017, 2018, 2019, 2020, 2021, 2022)

R&D personnel refer to all individuals who are directly involved in R&D and who provide direct support for implementing those activities, such as R&D managers, researchers, technicians, administrators and support staff (Ayan et al., 2023). The data in Figure 2 primarily lead to the

conclusion that the number of R&D employees has been steadily declining in 2010, 2011 and 2012, probably due to the brain drain and ageing of the research population. The highest value was achieved in 2014, and after that, a gradual decline of this value was recorded, while in 2021 a significant increase was recorded again.

Implementing R&D and innovation activities, as well as accelerating technological progress requires the skills, competencies and knowledge of highly-educated employees. Observing the data shown in Figure 3 it can be stated that the share of highly-educated employees in total R&D employment from 2008 to 2016 had a rising trend. According to the data given in Figure 3, the share of highly-educated employees in total R&D employment began to have a downward trend from 2017 until 2020, before a slight increase in 2021.

4. DATA AND METHODOLOGY

This paper aims to explore the relationship between R&D project investments and human capital. The research is based on the data of the following indicators: The share of R&D employees in total employment, The share of highly-educated employees in total employment, the Knowledge-intensive sector's Gross Value Added and the Value of R&D projects.

In the research of this paper, secondary data was obtained from the official website of The Statistical Office of the Republic of Serbia, by studying the Statistical Yearbooks to calculate research variables and conduct analysis. The analysed period covers the data from 2008 to 2021. In the model of the research, InRD_Emp (the share of R&D employees in total employment), InHE_Emp (the share of highly-educated employees in total R&D employment), InKIS_GVA (knowledge-intensive sectors Gross Value Added) are independent variables, while InRDP_Inv (the value of R&D projects) is the dependent variable. Statistical data processing was done with IBM SPSS Statistics 25 software. Firstly, in order to achieve linearity, all raw data was transferred in natural logarithm values. Secondly, in the research model, multivariate linear regression was performed, to evaluate the impact of the independent variables (lnRD_Emp, lnHE_Emp, lnKIS_GVA) on the dependent variable (lnRDP_Inv).

Table 1. Definition of variables, type, unit and data source

Variable	Definition	Unit	Type	Source
lnRDP_Inv	The value of R&D projects	Thous. RSD	Dependent	SYRS
lnRD_Emp	The share of R&D personnel in total employment	%	independent	SYRS
lnHE_Emp	The share of highly-educated employees in total employment	%	independent	SYRS
lnKIS_GVA	Knowledge-intensive sectors' Gross Value Added, as a share of GDP	%	independent	SYRS

Source: Own calculations

Therefore, the research was conducted according to the following model:

$$lnRDP_{Inv_t} = \beta_0 + \beta_1 lnRD_{Emp_t} + \beta_2 lnHE_{Emp_t} + \beta_3 lnKIS_{GVA_t} + \varepsilon_t \quad (1)$$

5. RESULTS

Descriptive statistical analysis was performed to present the minimum, maximum, mean, and standard deviation values of researched variables. The descriptive statistics of the variables analysed in this paper are shown in Table 2. The data on the value of R&D projects implies that

the variable's mean value is 17.2511 (SD = 0.46500). The share of R&D employees in total employment varies between 2.27 and 2.56 with a mean value of 2.480 (SD = 0.07728). The share of highly-educated employees in total employment ranges from 2.14 to 3.51 (SD = 0.34118). Lastly, the average value of knowledge-intensive sectors gross value added is 3.4347 (SD = 0.12753).

Table 2. Descriptive statistics

Descriptive statistics	lnRDP_Inv	lnRD_Emp	lnHE_Emp	lnKIS_GVA
Mean	17.2511	2.4080	3.1122	3.4347
Std.	0.46500	0.07728	0.34118	0.12753
Min	16.14	2.27	2.14	3.14
Max	17.95	2.56	3.51	3.60
Observations (N)	12	12	14	14
Valid N (listwise)	12			

Source: Own calculations

Table 3 reflects descriptive statistics from the regression output. Based on the coefficient of determination ($R^2 = 0.897$), which is a measure of "explained variation", about 90% of the total variation in RDP_Inv is explained by the regression. The standard error of estimate as a measure of "unexplained variation" is 0.17515.

Table 3. Descriptive statistics from the regression output

R	0.947
R^2	0.897
Adjusted R^2	0.858
Standard error	0.17515
Observations	12

Source: Own calculations

In Table 4, the F-test was used to determine the validity of the entire regression model (1) and the presence of regression dependence. The results of the F-test (F = 23.176) point out that the regression is statistically significant at the significance level $\alpha = 0.05$ because the p-value is less than 0.05 (0.000). As a result, the validity of the regression model is confirmed, and the null hypothesis can be rejected because there is a regression dependence between the observed variables.

Table 4. F-test

Model	F	Significance
Regression	23.176	0.000

Source: Own calculations

To examine the individual effectiveness of the independent variables in predicting the dependent variable, a t-test was conducted (Table 5). Additionally, t-tests are used to compare the significance of different model variables, which might help to determine which factors are most crucial for forecasting the dependent variable.

Table 5. Regression coefficients and t-test

Model	B	t	Significance
Constant	16.069	6.421	0.000
lnHE_Emp	1.666	6.242	0.000
lnKIS_GVA	0.583	1.028	0.334
lnRD_Emp	-2.463	-2.836	0.022

Source: Own calculations

Based on the results shown in Table 5, it can be concluded that it is not possible to reject the null hypothesis for the variable lnKIS_GVA, due that the p-value is 0.334 > 0.05. This indicates that this variable should be excluded from the regression model since it is not statistically significant, i.e. not useful for predicting the dependent variable ln RDP_Inv. For the variables lnHE_Emp and ln RD_Emp, the null hypothesis can be rejected because the p-values are 0.000 < 0.05 and 0.022 < 0.05, thus, these variables can be useful for predicting the dependent variable lnRDP_Inv. The model predicts that with an increase in the number of employees who have higher education by 1%, there will be an increase in investments in R&D projects by RSD 1,666, as well as with an increase in the number of employees in the field of R&D by 1%, there will be a decrease in investments in R&D projects for 2463 RSD, provided that all other variables in the model are constant.

6. CONCLUSION

In the contemporary global landscape, R&D projects have become important engines of innovation, economic expansion and societal progress in the modern world. The essential role of people involved in R&D activities, i.e. human capital and their knowledge, skills, expertise and capabilities are at the core of these revolutionary endeavors. Serbia is one of the Western Balkans' top R&D investors, yet it ranks behind the majority of EU members. Spending levels are relatively modest, have not expanded steadily, and are heavily concentrated in the public sector, which is governed by the Ministry of Education and Science. While the country has been utilizing foreign (particularly EU) resources, private sector investment in R&D has been limited (World Bank, 2013, p. 12).

The research conducted in this paper has confirmed that there is a strong positive connection between higher education and R&D projects, i.e. the increase in the highly-educated workforce in Serbia leads to an increase in R&D project investments. However, it was revealed that there is a negative association between the observed variables, i.e. the increase in the number of employees in the R&D sector leads to a decrease in R&D projects investments. This could lead to the conclusion that there is not a sufficient number of highly-educated employees in the R&D sector in Serbia. There are certainly employees, which is good, and the R&D sector in Serbia is slowly developing and growing. However, it is necessary to stimulate the employment of highly-educated young people in the mentioned sector. Thus, Serbia has a large number of experts from various scientific fields, researchers and PhDs, and many of them are still waiting for a job, or are not paid enough for their work. Given that, the R&D sector is an excellent opportunity for such experts.

Unfortunately, there is a lack of research from this important area in Serbia – the area of R&D investments and higher education, therefore, the recommendation to future researchers in this area from Serbia and the region would be to deal with this issue in the future.

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