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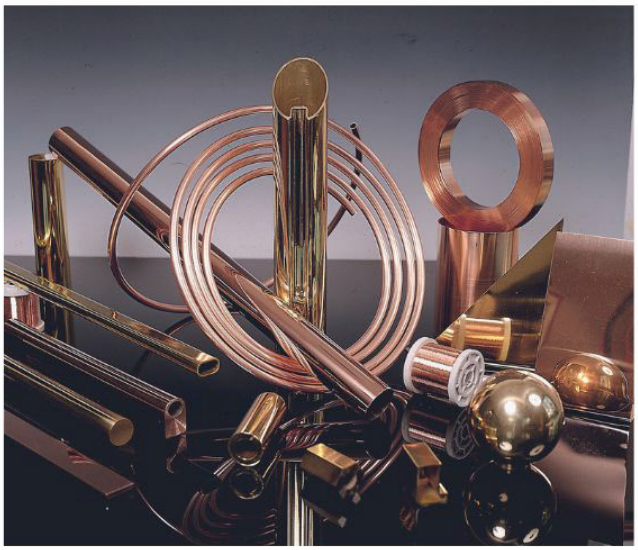

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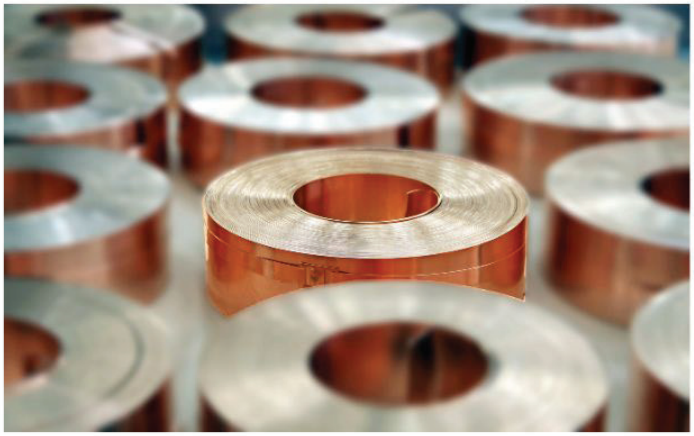

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This issue of *Ekonomika preduzeća* begins with three exploratory papers in the *Finance* section. In the first paper, a duo of authors, *S. Janković* and *M. Todorović*, analyses the effects of the inflation targeting strategy in Serbia from the perspective of behavioral economics. Their empirical study underscores the complex relationship between inflation expectations, actual inflation, and the central bank's monetary policy. The authors point out that success in achieving inflation targeting objectives largely depends on clear communication, credible strategy, and the right understanding of the behavior of market participants. In the next paper in this section, *S. Balaban, B. Stoiljković* and *L. Madžar* deal with the influence of working capital management on the profitability of 141 Serbian companies with the highest level of business income in the period from 2016 to 2020. The results of their research show that the longer inventory conversion cycle had a negative and statistically significant impact on the profitability of these companies, while the other control variables, such as liquidity, financial leverage, activity and sales growth did not affect profitability. The third paper, written by *J. Radojičić, M. Jemović* and *T. Stojanović,* evaluates the impact of digital distribution channels on the profitability of the banking sector in EU countries in the period 2015-2020. Their findings confirm that innovations brought by the digital transformation of banking services positively affected ROA and ROE of the observed banks, which justifies further investment in digitalization.

In the *Organizational Design and Change* section, the team of authors, including *M. Mosurović Ružičić, M. Ignjatović, V. Obradović* and *M. Lazarević Moravčević*, gauges the impact of certain factors of strategic project management on organizational design of scientific research organizations in Serbia. Their study has demonstrated that the most critical factors in shaping organizational design and innovation climate in SROs are external and internal environment, project portfolio, resources, monitoring, methods, and techniques.

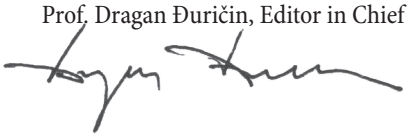
The paper presented in the *Strategic Management* section, written by *M. Aleksić, N. Berber, A. Slavić* and *D. Gašić,* examines the relationship between employee commitment, corporate social responsibility and organizational citizenship behavior, with a particular focus on the processing sector in Serbia. The positive correlation between these variables calls for greater mobilization of companies when it comes to socially responsible behavior and activities as well as the empowerment of their workforce to embrace the same values.

In the *Tourism and Hospitality Management* section, *N. Stanišić* and *N. Radović* in their paper explore the influence of social environment factors and basic psychological needs on job satisfaction in the hospitality industry in Serbia. According to the results of their survey, the satisfaction of basic psychological needs and a conducive work environment have positive effects on work performance. Also, the authors provide some valuable recommendations to hotel managers aimed at creating an environment that boosts employee satisfaction, motivation and productivity.

The paper in the *Information Technologies* section, by a trio of authors *A. Zečević, Đ. Stakić* and *D. Đurđić,* gives an overview of available ERP solutions, with special emphasis on the role and importance of programming languages in unleashing the full potential of ERP systems.

In the last paper of this issue, in the *Sustainability and Climate Risks* section, the group of authors, *F. Kiss*, *M. Tomić, R. Romanić*, *I. Pavkov* and *N. Đurišić Mladenović*, assesses the economic feasibility of producing biodiesel in small-scale production plants in Serbia. Bearing in mind that the competitiveness of biodiesel is primarily determined by the retail price of fossil diesel, the amount of state levies (excise and VAT), and the unit cost of biodiesel, heavily affected by the price of the input raw material, it is evident that small-scale domestic biodiesel producers cannot produce biodiesel at competitive prices without substantial state incentives.

Prof. Dragan Đuričin, Editor in Chief



NEWS

We would also like to inform you that the Editorial Board of Ekonomika preduzeća has decided to introduce new sections following the latest trends in economic theory, policy and practice. The updated nexus of sections is as follows:

1. International Economics and Business
2. Transition and Restructuring
3. Economic Growth and Development
4. Finance
5. Accounting, Auditing and Forensics
6. Tax and Law
7. Strategic Management
8. Marketing
9. Trade and Logistics
10. Tourism and Hospitality Management
11. Technology Change and Innovation
12. Information Technologies
13. Sustainability and Climate Risks
14. Organizational Design and Change
15. Risk Management
16. Industry Analysis

We look forward to receiving your latest manuscripts, hoping to pave the way for new actionable ideas that will contribute to advancements in economics and society as a whole.

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BEHAVIOURAL PERSPECTIVE OF THE INFLATION TARGETING STRATEGY: THE CASE OF SERBIA

Bihevioralna perspektiva strategije inflacionog ciljanja – slučaj Srbije

Abstract

Regarding inflation, the lion's share of theory and literature refers to the analysis of its economic determinants. In our empirical analysis, we emphasized some behavioural factors embodied in the short-term inflation expectations of banks and companies, which are regarded as one of the essential factors for reaching desired current inflation dynamics. We considered whether and how the central bank can, through inflation targeting as monetary strategy, nudge the inflation expectations of market participants in the preferred direction. In the paper, we looked into the performances of inflation targeting in the case of Serbia and considered potential explanations of the given (un)success from both a neoclassical and a behavioural theoretical perspective. We found that in the case of Serbia market participants' expectations in one year ahead strongly influences the actual year-on-year inflation rate. Obviously less influence on actual inflation that comes from inflation expectations of the real economic sector in comparison to the financial sector could be attributed to both economic and psychological phenomenon of downward price rigidity in the internal environment of companies, which adjust with a delay to changes in market prices. The success of inflation targeting soundly depends on the way the central bank manages the formation and influences the movements of inflation expectations of market participants, especially banks which could be seen as professional forecasters.

Keywords: *inflation targeting, inflation expectations, ARDL regression, behavioural economics, heuristics*

Sažetak

Značajan deo teorije i literature u oblasti inflacije odnosi se na analizu njenih ekonomskih determinanti. U našoj empirijskoj analizi, naglasili smo pojedine bihevioralne faktore sadržane u kratkoročnim očekivanjima inflacije banaka i kompanija, koja se smatraju jednim od ključnih faktora za postizanje željene dinamike tekuće inflacije. U radu se razmatralo da li i na koji način centralna banka može putem monetarne strategije ciljanja inflacije uticati na kretanje inflacionih očekivanja učesnika na tržištu u preferiranom smeru. U radu smo se bavili performansama ciljanja inflacije u slučaju Srbije i izneli potencijalna objašnjenja datog (ne)uspeha kako iz neoklasične, tako i iz bihevioralne teorijske perspektive. Ustanovili smo da u slučaju Srbije promena inflacionih očekivanja učesnika na tržištu za godinu dana unapred snažno utiče na stvarnu, međugodišnju stopu inflacije. Očigledno manji uticaj na stvarnu inflaciju koji dolazi od očekivanja inflacije privrednog sektora u poređenju sa finansijskim sektorom mogao bi se povezati i sa ekonomskim i psihološkim fenomenom „rigidnosti cena naniže" u internom okruženju kompanija, koje se sa kašnjenjem prilagođavaju promenama u tržišnim cenama. Uspeh ciljanja inflacije u velikoj meri zavisi od načina na koji centralna banka upravlja procesom formiranja i utiče na kretanje inflacionih očekivanja učesnika na tržištu, posebno banaka, koje se mogu smatrati profesionalnim prognositičarima.

Ključne reči: *ciljanje inflacije, inflaciona očekivanja, ARDL regresija, bihevioralna ekonomija, heuristike*

Introduction

Inflation expectations and actual inflation are closely related. When inflation expectations rise, it can lead to higher actual inflation as people and businesses adjust their behaviour accordingly. Inflation expectations, even though they do not always match reality [12, p. 4], significantly affect price dynamics in a country, because companies set their prices and project cash flows regarding the achieved and expected inflation, which banks include in interest rates and into the price of various financial services. With regard to this, it is recommended that the central bank in inflation targeting (hereinafter: IT) regime should steer the expectations of market participants towards unique numerical target for inflation or numerical target with tolerance band in the shortest possible time interval and with as few limitations as possible. As of 2021 and 2022, inflation targets or target ranges were pursued by central banks in 72 countries (34 advanced economies and 38 major emerging market and developing economies)[1]. Effective inflation targeting regime and a rise in the central bank's transparency are associated with better anchoring of inflation expectations in both advanced economies and emerging and developing markets [39, p. 16]. Besides classical economic foundations, in this paper we try to examine some features of IT strategy in Serbia from the perspective of behavioural economics.

Briefly explained, behavioural economics tends to integrate experimental results in the fields of psychology and sociology with the application in microeconomics and macroeconomics. According to the protagonists of behavioural theory, economic people (*homo economicus*) make decisions dominantly relying on scientific facts, which put them in the privileged position of rational individuals. In contrast to them, behaviour of ordinary people (*homo sapiens*) is often bounded-rational or irrational in many ways. A key assumption derived from behavioural empirical research is that people value differently the gains and losses of available alternatives, with the majority naturally being oriented towards avoiding change due to prevailing loss aversion. The reason for this is that, in most cases, limitedly rational people attach a higher specific weight to potential loss compared to gain of the choice with same value, under the influence of numerous psychological factors – emotional, cognitive, and sociological [60, p. 431]. Many individual behaviours have implications for private and public sector organisations, since personal reactions to gains and losses are likely to be congruent with assessments of their executive boards [44, p. 22]. Most economic decision-makers comply with proponents of libertarian paternalism that self-aware individuals, private sector organisations and public sector institutions, such as central banks, have task and legitimate right (but no responsibility) to direct, steer or 'nudge' people's behaviour in a predictable way by small and seemingly insignificant changes in choice architecture, but without limiting or eliminating the options available to them, and with no significant impact through economic incentives. In this way, efforts are made to improve the level of well-being of people and society in terms of wealth, health, and happiness, whereby the judgment about this should be made by every individual and society. Consciously nudging subjects toward a favourable outcome is especially important in cases where they are prone to extremely bad choices due to the lack of attention, incomplete information, insufficient self-control, and limited cognitive reasoning. In this regard, the golden rule says: '*Provide incentives when the decision-makers can be helped to the greatest extent, that is, when they can be harmed to the least extent*' [59, p. 72], meaning the right incentive is the one simple to carry out and avoidable with minimum costs.

From behavioural economics point of view, IT strategy can be understood as the approximation of the central bank's behaviour and decision-making process towards public [63, p. 93]. In that sense, central bank is committed to follow publicly announced inflation target or target range, which enables it to, within its mandate, form and steer inflation expectations by transparent and regular communication with the public. In practice, conducting IT is related to the determining of an optimal level of the key policy rate as the main instrument in achieving low and stable inflation. To do so, central bank makes short and medium-term inflation forecasts based on certain assumptions and then compares the

1 Retrieved from [35], considering the IMF's classification of advanced and emerging and developing countries.

outcomes with inflation target – if projected inflation is above target, the key policy rate is usually raised and vice versa. IT strategy is thus forward-looking and its effects on the real economy are often postponed from one to two years, depending on the efficiency of monetary policy transmission mechanism and intensity of transfer from the key policy rate (and interest rates on lending and deposit facilities) to the market interest rates. However, the whole central bank's judgement process is not purely objective, but prone to subjective assessments of the people who are responsible for making decisions, which is where the insights from the behavioural economics may step in. In parallel with that, market participants do not always respond to the central bank's choices in rational way, since their expectations are also influenced by different psychological factors. In the case of Serbia, it is especially embodied in households' attitudes toward high inflation, as they are still strongly affected by the previous episodes of high inflation during 1990s. Hereof, the empirical analysis in this paper entails only the inflation expectations of the financial and corporate sector.

Literature review

Although many emerging countries, like Serbia, have adopted IT as monetary strategy to ensure price stability in the first place and then pursue other economic goals, there is mixed evidence about the achieved results. Rose [55] concluded that countries with inflation targeting are found to be less prone to sudden capital outflows and consequently less exposed to financial crisis. Mishkin and Schimidt-Hebbel [48] pointed to strong empirical evidence in favour of implementing IT strategy in emerging countries. They recorded close to a 0.8% reduction in headline inflation just after adopting strategy and a 7.0% reduction in the long term compared with non-targeting emerging market countries (results obtained from panel VAR on the sample of 34 industrial and emerging countries before and after the oil-price and exchange-rate shocks). Fifteen years later, Duong [20] showed that IT can help emerging countries to reduce an increase in inflation rate during crises without many trade-offs in the output growth (results obtained from balanced panel data of 54 countries with 15 inflation-targeting countries for the period 2002-2010). On the contrary, Zhang and Wang [65] found that IT framework does not improve countries' macroeconomic performance in terms of growth and inflation (results obtained from dynamic panel on dataset of 68 major advanced countries and emerging markets from 1990 to 2019).

The lion's share of economic theory and literature refers to the analysis of inflation determinants. In our analysis, we put emphasis on inflation expectations of two groups of economic agents – banks and companies. Anchoring these expectations is one the essential factors for inflation controllability and successful implementation of IT strategy in small and open economies like Serbia. The effects of expected inflation on actual inflation were brought up by Phelps [54] and Friedman [24]. Bernanke [7] claimed that the state of inflation expectations largely influences actual inflation and thus the central bank's ability to achieve price stability. Fuhrer [25] investigated short-run relationship between inflation expectations and actual inflation in the US. Salle et al. [56] confirmed strong and positive correlation between inflation and inflation expectations, suggesting predominance of the expectations channel in the monetary policy transition mechanism. Lagoa [40] and Marfatia [46] focused on a strong nexus between inflation expectations and actual inflation by analysing the data for the Eurozone and the UK. Hommes et al. [32] examined how subjects in the experiment create expectations of inflation and output in similar ways. Gülsen and Kara [29] estimated that inflation expectations in Turkey are significantly related to macro-variables such as exchange rates, oil prices, inflation realisations and inflation targets. Verbrugge and Zaman [62] elaborated on the strong influence of inflation expectations on subsequent inflation, so that central banks view them as critical to the monetary policy functioning. Schafer [57] marked inflation expectations as an important factor affecting decisions that determine actual inflation, referring to the classical New Keynesian Phillips curve model in which a firm's expectations of future prices affect its pricing decisions in the current period.

Additional understanding of the monetary policy decision-making in the scope of IT strategy has been

recently offered by the behavioural economists, peculiarly in the domain of the inflation expectations formation. In that sense, influencing the inflation expectations can be used as a measure of success in conducting IT strategy. Vega and Winkelried [61] detected that the anchoring of expectations to a defined nominal level can reduce the persistence of inflation if flexible IT is practiced i.e. by slow adjustment to shocks that displace inflation from target. Gnan et al. [26] confirmed that formation process of agents' inflation expectations involves uncertainty and changes over time and may be influenced by non-rational expectations and behavioural heuristics. Bruine et al. [9] argued that individual memories of the past year's changes in prices are biased towards those goods and services that have shown the largest price changes, consequently affecting surveyed inflation expectations. Lambsdorff et al. [41] explained how subjects in the experimental conditions become able to form rational expectations when they learn about inflation dynamics after some repetition. This contemplating process is related to adaptive expectations or trial-and-error learning mechanism that is opposed to the fully rational expectations based on all available information. Lima et al. [43] brought forth the uncertainty in decision making resulting in the formation of norm-based inflation expectations (heterogeneous and time-varying), though their dynamics need not obstruct successful monetary policy measures. Salle et al. [56] observed that inflation expectations and inflation are highly and positively correlated in different scenarios, implying that the expectations channel is predominant in the determination of inflation in the empirical model. Da Silva and Da Silva [16] verified that the inflation target is unlikely to be achieved when private forecasters rely on anchoring heuristics, i.e. favour information they received earlier in the decision-making process. Ehrmann [21] examined behaviour of inflation expectations depending on the inflation level and its persistence – if inflation is low, and particularly in longer period, inflation expectations become more dependent on achieved inflation and vice versa. De Grauwe and Ji [17] assumed in their behavioural macroeconomic model that agents do not have rational expectations because of inherent cognitive limitations, so they reach out simple rules-of-thumb, the so-called 'heuristics', to make personal forecasts. Hommes et al. [32] pointed out that a key difference in outcomes between the macroeconomic models with rational and behavioural expectations is the way of treatment for inflation volatility.

Research methodology

We analysed the results of inflation targeting in the case of Serbia and brought up potential explanations of the (un)success from both a neoclassical and a behavioural theoretical and empirical perspective. The focus was on examining whether and in what way the short-term expectations of inflation rate among companies and banks affect the actual year-on-year inflation, and consequently the targeting of inflation by the central bank. The empirical research covered a fairly lengthy period from January 2009 to December 2021 (before the emergence of multiple global crises and change in the monetary policy stance). Data were used on actual inflation rates and output gap estimates (source: the central bank), expected inflation rates by market participants – companies and banks (source: specialised agencies surveys conducted on behalf of the central bank), real unit labour costs (source: official statistical office and the central bank's estimates). The empirical model is consisted of only domestic determinants of inflation that can be influenced by sovereign monetary policy. In the first part of the research, we estimated linear regression equation with the aim of testing the impact of the short-term inflation expectations of market participants on the actual inflation, measured as year-on-year percentage change in Consumer Price Index. Additionally, real unit labour costs and output gap were inserted in the regression as they are often used as determinants of inflation in empirical analyses. In addition, the analysis carried out in the second part of the research involved examination of the short-term inflation expectations of the financial and corporate sector in the observed thirteen-year period, their deviations from the target inflation and tolerance band, as well as deviations from the actual (year-on-year) inflation with quarterly dynamics.

The National Bank of Serbia (hereinafter: the central bank) has been applying an IT strategy as of 2006 implicitly and then explicitly starting from January 1, 2009, with

the priority to achieve and preserve low and stable overall price movements in accordance with the criteria defined under the EU accession process. The main principles of IT strategy have been gradually introduced into practice by the central bank's 'Memorandum on Inflation Targeting as Monetary Strategy': (1) the inflation target, defined in terms of the annual percentage change in the Consumer Price Index, is the only numerical guideline for the monetary policy, (2) the inflation target will be achieved by changing the interest rate when conducting main monetary policy operations (currently the interest rate on one-week repo operations), (3) managed floating exchange rate regime will be pursued and (4) transparency of monetary policy will be enhanced and efficient communication with the public upgraded. Besides the priority of reaching and preserving price stability prescribed by the law, IT regime should have contributed to ensuring financial stability in the long term, boosting confidence in the domestic currency and thus encouraging its greater use in everyday transactions, as well as increasing the economy's resistance to different endogenous and exogenous shocks. IT strategy in Serbia was adopted after the failure of the previously applied monetary strategies, namely targeting the exchange rate and targeting monetary aggregates, to deal with relatively high and volatile inflation and pronounced internal and external imbalances in a sustainable manner. Strengthening credibility, as the ability of the central bank to anchor the medium- to long-term inflation expectations of market participants and to avoid persistently high or extremely low inflation rates, was one of the key reasons to reorient towards IT strategy. The decision of the central bank's executive board to switch to new monetary framework was also supported by solid experiences of the central banks in emerging and transition economies comparable with Serbia, which already recorded some positive macroeconomic changes following fixed target or target range for inflation.

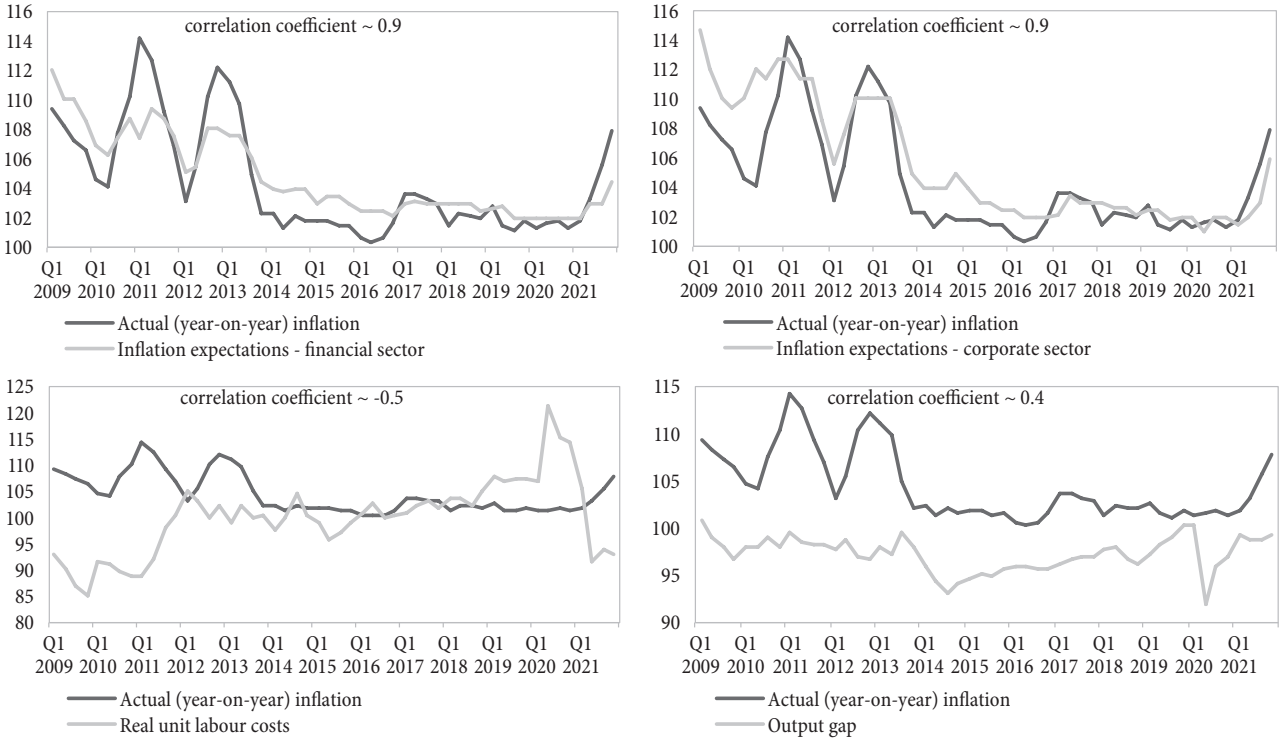
Results and discussion: Part 1

Taking into account empirical findings of the studies which focused on the inflation determinants (particularly [42], [50] and [3]) as a convenient econometric approach we constructed an Autoregressive Distributed Lag (ARDL) model applicable for both non-stationary time series as well as for times series with mixed order of integration [58, p. 79], given the fact that real economic data do not often express stationary behaviour. In case of selected variables for Serbia, most time series expressed non-stationary nature in the observed period (from Q1 2009 to Q4 2021), which was the main reason we opted for the ARDL model, which could have provided realistic and efficient estimates. Another reason was to deliberately separate short-run and long-run effects between variables. Besides it can be applied whether the regressors are $I(1)$ and/or $I(0)$, ARDL possesses other important features: 1) it is more statistically significant approach to determine the cointegration relation in small samples like ours – around 50 observations [28, p. 265], [18, p. 316]; 2) it allows that the variables may have different optimal lags, 3) it is useful to track dynamic adjustments between variables over time and 4) it employs a single reduced form equation instead of a system equations requested by conventional procedures [51, p. 1939].

We employed the ARDL regression to estimate the existence of the short- and long-run dynamics between the actual inflation (measured as year-on-year percent change in Consumer Price Index) and its determinants – short-term inflation expectations of corporate and financial sector in Serbia, real unit labour costs and output gap. In our focus were the short-term inflation expectations instead of the medium/long-term on account of two main reasons: 1) longer and uninterrupted data series (from 2009) in case of short-term inflation expectations in comparison to shorter and interrupted data series (from 2013) in case of medium-term inflation expectations and 2) IT strategy effectiveness from the moment it was adopted in 2009 onwards can be assessed only in case of the short-term inflation expectations. Besides expectations, real unit labour costs and output gap are also added in the regression analysis, thereby, we encompassed only domestic factors of inflation, similar to Mihajlović [47]. These factors can be influenced to a certain extent by monetary policy of the NBS, without considering global factors (e.g. import prices, foreign trade balance, risk premia, price movements on global commodity and financial markets, etc.). It seems that the

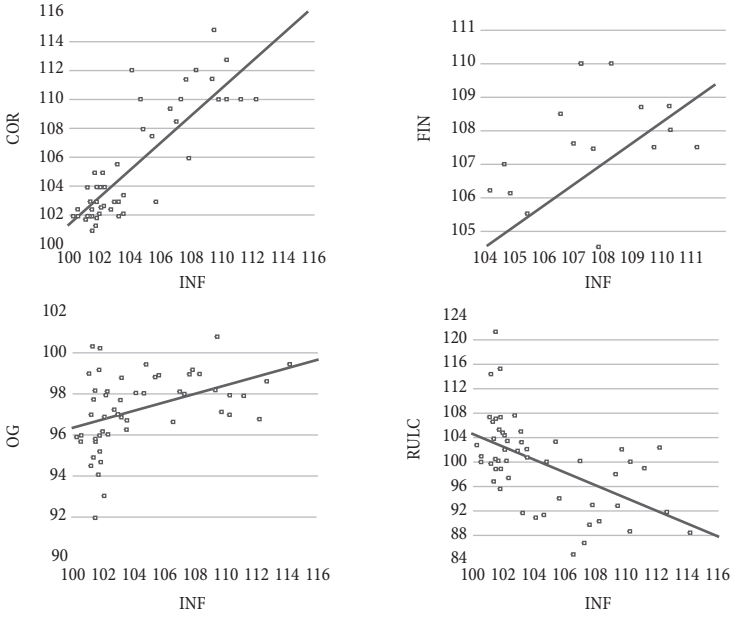
actual inflation in year-on-year terms and the expected inflation of both financial and corporate sector had very similar movements, and after 2014 their values converged even more (see Figure 1), which can be an initial signal of a significant relationship. In the same period there was also a positive relationship between the output gap and the actual inflation, while the ordinary correlation with real unit labour costs was negative. Another preliminary analysis of the relationships between the observed variables, through scatter diagrams, also indicated that there was a positive connection between the actual inflation and almost all independent variables, except real unit labour costs (see Figure 2).

Figure 1: Dynamics of the actual inflation and independent variables



Source: Central bank's databases and authors' calculation and illustration in EViews.

Figure 2: Scatter diagrams of the actual inflation and independent variables



Source: Central bank's databases and authors' calculation and illustration in EViews.

We conducted two types of tests to check for the stationarity of the selected variables – Augmented Dickey-Fuller (ADF) tests (results presented in Table 1) and Kwiatkowski-Phillips-Schmidt-Shin (KPSS) tests (results presented in Table 2). To decide on whether intercept or intercept with trend should be reported as deterministic components, common Stock-Watson test was carried out and approved of using intercept component (noted as τμ) instead of intercept and trend component (noted as τt statistic). The results of all ADF and KPSS tests indicated that almost all series, except output gap, exhibit non-stationary movements in level. Our finding that inflation exhibited non-stationary movements in the observed period is in accordance with Charemza et al. [11], who tested 107 world-wide inflation series for unit roots by using ADF tests and found non-stationarity in 93 inflation series, while 14 series were proved to be stationary. Among others, Evans and Lewis [22], Crowder and Hoffman [14], Crowder and Wohar [15] also identified unit root in the inflation series. The unresolved question of whether inflation series should be regarded as stationary or nonstationary has varying test results across countries and is heavily influenced by the specific statistical methods employed. While it is impossible to comprehensively review the extensive literature on this subject here, it is noteworthy that a paper by Ng and Perron [49] applied a range of unit root tests to quarterly inflation data from G7 countries and failed to arrive at firm conclusions regarding the inflation stationarity. As previously noted, in order to apply ARDL model, it is necessary that underlying variables are *I*(0), *I*(1) or a combination of both, which was verified by obtaining first differences of the selected variables within both tests (ADF and KPSS).

Taking into account the results of unit root testing, we specified the regression equation ARDL (1, 4, 1, 2, 2) for the actual (year-on-year) inflation:

$$INF_i = \beta_0 + \beta_1 INF(-1) + \beta_2 FIN + \beta_3 FIN(-1) + \beta_4 FIN(-2) + \beta_5 FIN(-3) + \beta_6 FIN(-4) + \beta_7 COR + \beta_8 COR(-1) + \beta_9 RULC + \beta_{10} RULC(-1) + \beta_{11} RULC(-2) + \beta_{12} OG + \beta_{13} OG(-1) + \beta_{14} OG(-2) + \beta_{15} V_1 + \beta_{16} V_2 + \beta_{17} V_3 + \beta_{18} V_4 + \varepsilon_i$$

where: FIN represent the short-term inflation expectations of the financial sector (in %); COR are the short-term inflation expectations of the corporate sector (in %); RULC are the real unit labour costs (in %); OG is the output gap (in %); V1, V2, V3 and V4 are dummy variables related to the highest levels of inflation in Q1 2011, Q4 2012, Q1 2013 and Q3 2021, respectively, while ε_i is random error of the model. Using Akaike Information Criterion, ARDL (1, 4, 1, 2, 2) was chosen as an optimal model among total of 2,500 models and top 20 models (see Figure 3), where

Table 1: Results of unit root testing using ADF test

Variables	in level			1st difference		
	t-Statistic	critical values	unit root	t-Statistic	critical values	unit root
Actual inflation	$\tau_\mu = -2.38$	$\tau_\mu^k = -2.93$	I(1)	$\tau_\mu = -3.70^{(**)}$	$\tau_\mu^k = -2.93$	I(0)
Financial sector inf. expect.	$\tau_\mu = -1.61$	$\tau_\mu^k = -2.92$	I(1)	$\tau_\mu = -6.28^{(**)}$	$\tau_\mu^k = -2.93$	I(0)
Corporate sector inf. expect.	$\tau_\mu = -2.56$	$\tau_\mu^k = -2.93$	I(1)	$\tau_\mu = -4.18^{(**)}$	$\tau_\mu^k = -2.93$	I(0)
Real unit labour costs	$\tau_\mu = -2.55$	$\tau_\mu^k = -2.93$	I(1)	$\tau_\mu = -5.74^{(**)}$	$\tau_\mu^k = -2.93$	I(0)
Output gap	$\tau_\mu = -3.88^{(**)}$	$\tau_\mu^k = -2.92$	I(0)	/	/	/

Note: The results are statistically significant at **5%.
Source: Authors' calculation in EViews.

Table 2: Results of unit root testing using KPSS test

Variables	in level			1st difference		
	t-Statistic	critical values	unit root	t-Statistic	critical values	unit root
Actual inflation	LM = 0.59	$LM^k = 0.46$	I(1)	LM = 0.21(**)	$LM^k = 0.46$	I(0)
Financial sector inf. expect.	LM = 0.86	$LM^k = 0.46$	I(1)	LM = 0.36(**)	$LM^k = 0.46$	I(0)
Corporate sector inf. expect.	LM = 0.83	$LM^k = 0.46$	I(1)	LM = 0.28(**)	$LM^k = 0.46$	I(0)
Real unit labour costs	LM = 0.57	$LM^k = 0.46$	I(1)	LM = 0.12(**)	$LM^k = 0.46$	I(0)
Output gap	LM = 0.24(**)	$LM^k = 0.46$	I(0)	/	/	/

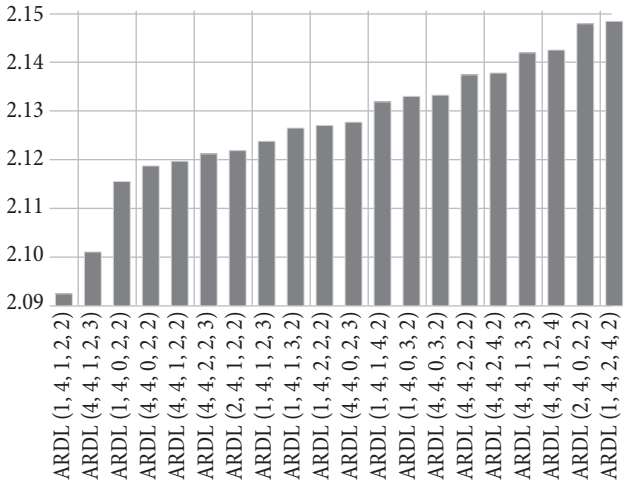
Note: The results are statistically significant at **5%.
Source: Authors' calculation in EViews.

the number in brackets denotes the number of lags for each explanatory variable.

The estimated equation of ARDL (1, 4, 1, 2, 2) with the lowest value of AIC and Newey-West procedure to provide robust standard errors in the presence of autocorrelation or/and heteroskedasticity is as follows:

$$\widehat{INF} = -44.04 - 0.03INF(-1) + 1.95FIN - 0.67FIN(-1) + 0.51FIN(-2) - 0.28FIN(-3) - 0.48FIN(-4) + 0.39COR - 0.18COR(-1) + 0.05RULC - 0.08RULC(-1) + 0.10RULC(-2) + 0.10OG - 0.05OG(-1) + 0.23OG(-2) - 5.62V1 - 2.76V2 - 1.40V3 - 1.28V4$$

Figure 3: Criteria graph for top 20 ARDL models



Source: Authors' illustration in EViews.

Table 3: Estimated ARDL (1, 4, 1, 2, 2) – short-run dynamics

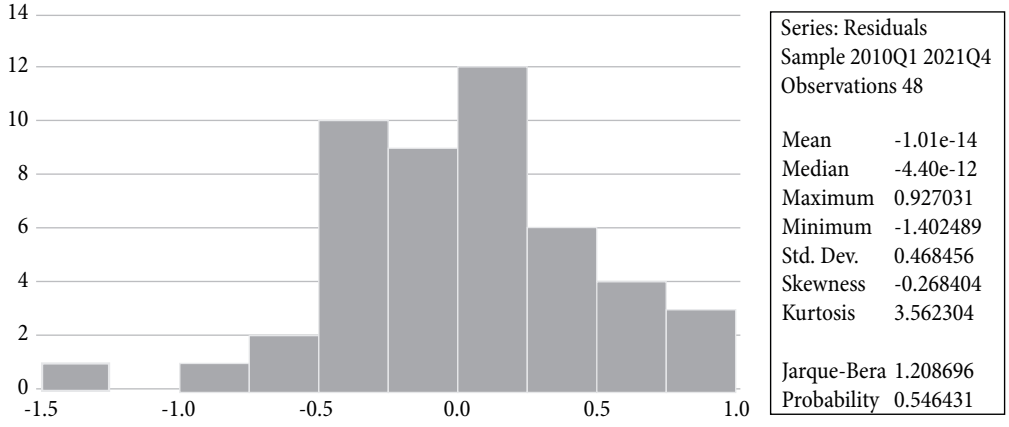
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-44.03597	16.59799	-2.653090(**)	0.0128
INF (-1)	-0.028918	0.103481	-0.279455	0.7819
FIN	1.950706	0.276551	7.053704(***)	0.0000
FIN (-1)	-0.670614	0.151912	-4.414478(***)	0.0001
FIN (-2)	0.507475	0.130134	3.899647(***)	0.0005
FIN (-3)	-0.275784	0.176968	-1.558388	0.1300
FIN (-4)	-0.484483	0.122949	-3.940502(***)	0.0005
COR	0.393148	0.131918	2.980239(***)	0.0058
COR (-1)	-0.179998	0.128744	-1.398107	0.1727
RULC	0.049927	0.033550	1.488142	0.1475
RULC (-1)	-0.083640	0.062288	-1.342806	0.1898
RULC (-2)	0.095805	0.046253	2.071349(**)	0.0473
OG	0.100792	0.079470	1.268300	0.2148
OG (-1)	-0.054269	0.089708	-0.604955	0.5499
OG (-2)	0.227167	0.076823	2.957005(***)	0.0061
V1	-5.619051	0.781125	-7.193539(***)	0.0000
V2	-2.761329	0.470120	-5.783669(***)	0.0000
V3	-1.400059	0.457256	-3.061870(***)	0.0047
V4	-1.279778	0.775396	-1.648357	0.1101
R-squared	0.983775	Mean dependent var		104.1553
Adjusted R-squared	0.973704	S.D. dependent var		3.678351
S.E. of regression	0.596482	Akaike info criterion		2.092227
Sum squared resid	10.31795	Schwarz criterion		2.832911
Log likelihood	-31.21346	Hannan-Quinn criter.		2.372133
F-statistic	97.68595	Durbin-Watson stat		1.691264
Prob(F-statistic)	0.000000			

Note: The results are statistically significant at ***1% and **5%.
Source: Authors' calculation in EViews.

Estimated coefficients of the explanatory variables in Table 3 represent short-run effects on the actual inflation. Positive signs of the estimated coefficients for variables FIN and COR correspond to the economic theory and experience of countries with IT regime. In other words: 1) the higher short-term inflation expectations of the financial sector, the higher the actual inflation and 2) the higher short-term inflation expectations of the corporate sector, the higher the actual inflation. The model also showed that the increase in the real unit labour costs and the output gap impact actual inflation in the short run. The results of *t*-tests indicate that the inflation expectations of both financial and corporate sector for one year ahead have statistically significant impact on the actual inflation. On the contrary, the real unit labour costs and the output gap do not show significant influence on the actual inflation in this model (observed in level). The results of *F*-test indicate that all independent variables in the model make statistically significant impact on actual inflation (at 1% level of significance). The movements of independent variables in the model account for around 97% of all variations in the actual inflation, according to the adjusted R-squared (see Table 3). The estimated ARDL regression equation has passed standard diagnostic statistical tests conducted in EViews (results presented in Table 4).

Breusch-Godfrey Serial Correlation LM test for autocorrelation reported that the null hypothesis cannot be rejected, hence there is no serial correlation among random errors in model at up to two lags. Furthermore, Breusch-Pagan-Godfrey test and Glejser test for heteroskedasticity reported that the null hypothesis cannot be rejected, so random errors possess constant variances for all observations. Jarque-Berra test for normality also showed that the null hypothesis cannot be rejected, hence empirical distribution of the residuals in the model does not significantly deviate from normal distribution (see Figure 4). The absolute values of *t*-statistics for statistically significant explanatory variables in the estimated regression equation are greater than two, which empirically indicates the absence of multicollinearity.

Figure 4: Results of the statistical test for normality



Source: Authors' illustration in EViews.

Table 4: Results of the statistical tests for autocorrelation and heteroskedasticity

Breusch-Godfrey Serial Correlation LM Test			
F-statistic	0.344745	Prob. F(2,27)	0.7115
Obs*R-squared	1.195237	Prob. Chi-Square(2)	0.5501
Glejser Test			
F-statistic	0.858176	Prob. F(18,29)	0.6259
Obs*R-squared	16.68192	Prob. Chi-Square (18)	0.5451
Scaled explained SS	11.27696	Prob. Chi-Square (18)	0.8822
Breusch-Pagan-Godfrey			
F-statistic	0.392745	Prob. F(18,29)	0.9792
Obs*R-squared	9.407749	Prob. Chi-Square (18)	0.9495
Scaled explained SS	4.385443	Prob. Chi-Square (18)	0.9995

Source: Authors' calculation in EViews.

Finally, Ramsey RESET test has shown that the null hypothesis cannot be rejected, hence the model has correct specification, meaning that the linear regression on the whole is statistically significant (based on *F*-test); evaluated coefficients of all independent variables of interest – short-term financial sector and corporate sector inflation expectations – are statistically significant (based on *t*-tests) and have the appropriate positive sign in relation to the actual inflation; there is no autocorrelation and heteroskedasticity in the model while residuals are normally distributed (see Table 5).

Table 5: Results of the Ramsey RESET test

Specification: INF INF(-1) FIN FIN(-1) FIN(-2) FIN(-3) FIN(-4) COR COR(-1) RULC RULC(-1) RULC(-2) OG OG(-1) OG(-2) V1V2 V3 V4 C			
	Value	**df**	**Probability**
t-statistic	0.053426	28	0.9578
F-statistic	0.002854	(1,28)	0.9578
Likelihood ratio	0.004893	1	0.9442

Source: Authors' calculation in EViews.

Relationship between variables in the short run

From the estimated ARDL regression equation and the obtained results in case of Serbia, it can be concluded that the financial and corporate sector expectations for one year ahead have statistically significant and positive impact on the actual inflation in the short run, which is in line with economic literature and empirical evidence in Serbia. Specifically, if the short-term financial sector inflation expectations are raised by 1.00%, actual inflation rises by about 1.95%, while the uptick in the short-term corporate sector inflation expectations by 1.00% affects the rise in actual inflation by about 0.39%. A noticeable lower impact on actual inflation that comes from the corporate sector inflation expectations in comparison to financial sector inflation expectations could be attributed to the economic and behavioural phenomenon of downward price rigidity in the internal environment of companies, which adjust with a delay to changes in overall market prices. Some companies continue to set prices based on outdated information, as their past expectations of current economic conditions become relevant to current behavior and account for the sluggishness of adjustments [41, p. 3]. Therefore, it is not surprising that the inflation expectations of companies were moving on the higher levels in contrast to the expectations of banks and consequently above the actual inflation for the largest number of quarters, especially during 2009 and 2010. It is unveiled that the inflation expectations of the corporate sector were above achieved inflation for 36 months out of a total 48 months in the observed subperiod of 2009-2012, while the inflation expectations of the financial sector exceeded achieved inflation for 26 months (see Table 6). It is consistent with

Table 6: Deviation from actual inflation* of short-term inflation expectations of the financial and corporate sector in Serbia in the observed subperiod 2009-2012 (in percentage points)

Inflation expectations	**Jan.2009**	**Feb.**	**Mar.**	**Apr.**	**May**	**June**	**July**	**Aug.**	**Sep.**	**Oct.**	**Nov.**	**Dec.**
Financial sector (Bloomberg)	-	-	-	-	-	-	-	-	-	-	-	-
Financial sector (Ipsos)	0.5	0.7	-2.6	-3.0	-0.9	-1.7	-1.5	-2.0	-2.7	-3.8	-2.1	-1.9
Corporate sector (Ipsos)	-2.0	0.7	-5.3	-3.2	-2.9	-3.7	-3.5	-3.0	-2.7	-4.8	-3.1	-2.8
Inflation expectations	**Jan.2010**	**Feb.**	**Mar.**	**Apr.**	**May**	**June**	**July**	**Aug.**	**Sep.**	**Oct.**	**Nov.**	**Dec.**
Financial sector (Bloomberg)	-	-	-	-	-	-	-	0.9	1.4	2.4	2.3	3.1
Financial sector (Ipsos)	-3.2	-3.7	-2.3	-1.9	-2.5	-2.0	-2.4	-0.8	0.2	1.5	2.2	1.5
Corporate sector (Ipsos)	-4.1	-6.2	-5.3	-5.7	-6.3	-7.8	-4.9	-4.7	-3.7	-1.8	-0.4	-2.4
Inflation expectations	**Jan.2011**	**Feb.**	**Mar.**	**Apr.**	**May**	**June**	**July**	**Aug.**	**Sep.**	**Oct.**	**Nov.**	**Dec.**
Financial sector (Bloomberg)	3.7	5.1	5.8	6.7	5.4	4.7	4.1	2.5	1.3	1.7	1.4	1.0
Financial sector (Ipsos)	3.8	5.2	6.7	7.3	5.3	3.3	3.4	2.4	0.6	1.3	-0.4	-0.6
Corporate sector (Ipsos)	-4.2	1.2	1.4	3.3	-2.0	1.3	0.7	0.5	-2.1	-1.3	-0.9	-1.5
Inflation expectations	**Jan.2012**	**Feb.**	**Mar.**	**Apr.**	**May**	**June**	**July**	**Aug.**	**Sep.**	**Oct.**	**Nov.**	**Dec.**
Financial sector (Bloomberg)	-0.4	-1.1	-2.6	-3.5	-1.6	-0.5	0.1	1.6	3.0	5.8	3.9	4.2
Financial sector (Ipsos)	-1.4	-1.1	-1.9	-2.3	-0.1	0.0	-0.9	1.4	2.3	4.9	3.9	4.2
Corporate sector (Ipsos)	-2.0	-3.1	-2.4	-1.8	0.2	-2.0	-1.9	-2.1	0.3	2.9	1.9	2.2

Source: Authors' calculation on the NBS data. *Note: Negative deviations display inflation expectations above the actual inflation.

the observation that there is much more volatility in the inflation expectations of households and firms than of informed agents [13, p. 2] like banks and professional agencies, more disagreement both in terms of their beliefs about future as well as past inflation, and more uncertainty in their individual forecasts.

On the contrary, the real unit labour costs and the output gap did not exhibit statistically significant influence on the actual inflation in this model. There can be several reasons for such an outcome. Concerning output gap, since it is not subject to direct measuring, it was obtained by applying the Hodrick-Prescott filter, which tries to identify a linear trend at the series [2, p. 17] and whose estimates of output gap are often highly persistent [27, p. 2]. Hodrick-Prescott filter sets the potential component of output to minimise the loss function. The application of other time series decomposition techniques, such as Kalman filter, Band-pass filter, etc. would potentially generate different output gap estimates and inevitably lead to inconsistent results. Concerning real unit labour costs, it should be noted that the real wage growth in the observed period Q1 2010 – Q4 2021 was not followed by the inflation growth of similar intensity, which complies with the latest empirical finding of the IMF staff [34] of low probability wage-price spiral opening in the long term. Dynamic interaction between prices and wages is time-varying and depends on the state of the economy, thereby pass-through is systematically lower in periods of low inflation [7, p. 33], which were predominant for the observed period.

Relationship between variables in the long run

Although they are not in the focus of our analysis, the ARDL method estimates the long-run effects jointly with the short-run effects. Based on the values of the ARDL Bounds Test presented in Table 7, the *F*-statistic is above the upper bound *I*(1), at all levels of significance. This implies the rejection of the null hypothesis, which means that the observed variables express meaningful cointegration relationships. Hence, the ARDL model is also appropriate for examination of the long-run relationships between variables.

Table 7: ARDL *F*-Bounds Test

Null Hypothesis: No long-run relationships in the level

Test Statistic	Value	k
F-statistic	16.15769	4
Actual Sample Size = 48 Critical Value Bounds		
Significance	I(0) Bound	I(1) Bound
10%	2.20	3.09
5%	2.56	3.49
2.5%	2.88	3.87
1%	3.29	4.37

Source: Authors' calculation in EViews.

The long-run relationship between the actual inflation and the explanatory variables is estimated by the ARDL (1, 4, 1, 2, 2) regression. Table 8 displays the estimates of long-run variables, their standard errors computed using delta method as in Pesaran-Shin [53], their *t*-statistics, as well as the appropriate *p*-values. Underneath *Error Correction* equation is provided, which refers to the nexus between short-run and long-run dynamics.

Table 8: Estimated ARDL (1, 4, 1, 2, 2) – long-run dynamics

Variable	Coefficient	Std. Error	t-Statistic	Prob.
FIN	0.998428	0.252691	3.951180(***)	0.0005
COR	0.207159	0.148815	1.392058	0.1745
RULC	0.060347	0.018333	3.291663(***)	0.0026
OG	0.265997	0.067466	3.942670(***)	0.0005
C	-42.79832	13.13228	-3.259017(***)	0.0029

Note: The results are statistically significant at ***1%.
Source: Authors' calculation in EViews.

Cointegration Equation (EC) = INF – (0.9984*FIN + 0.2072*COR + 0.0603*RULC + 0.2660*OG – 42.7983)

According to the results of estimated long-run effects of ARDL (1, 4, 1, 2, 2) regression shown in Table 8 and the following cointegration equation, the coefficients of the variables FIN, RULC and OG have positive and statistically significant influence on INF, at 1% level of significance (the estimated coefficient of COR is also positive, but statistically insignificant). These results suggest that there is a long-run positive relationship between FIN (the financial sector inflation expectations for one year ahead), RULC (the real unit labour costs) and OG (the output gap) as independent variables and INF (the actual inflation expressed in year-on-year terms) as dependent variable. Specifically, 1.00% increase in FIN, RULC and OG leads to around 1.0%, 0.06%

and 0.26% increase in INF, respectively. The corporate sector inflation expectations for one year do not impact the actual inflation in the long run. By running ARDL Error Correction Regression, we obtained Error Correction Term (ECT_{t-1}), which indicates the speed of adjustment from short run to long run equilibrium [5, 3,984]. High estimated coefficient of the ECT_{t-1}, which is both negative and statistically significant (at 1% significance level), revealed that potential disequilibrium in the ARDL model can be adjusted in the long run with higher speed in case of any type of shock in the explanatory variables [10, p. 147].

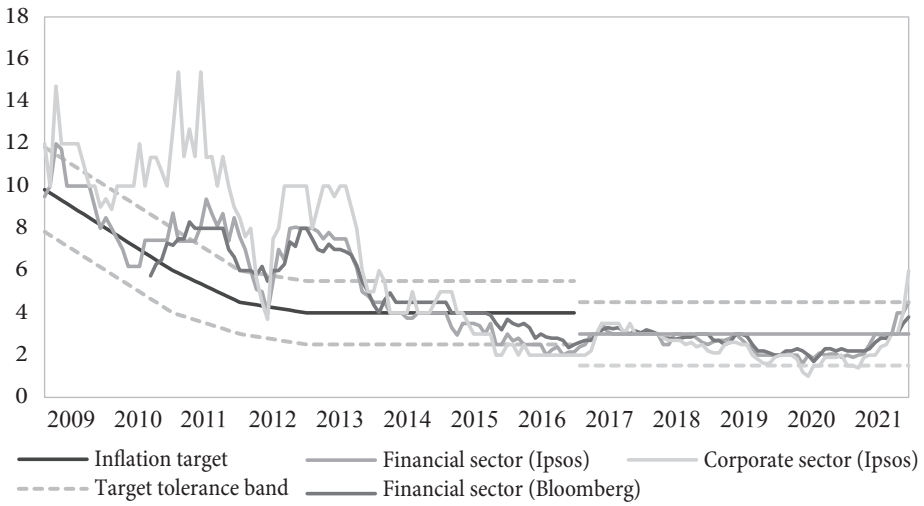
Results and discussion: Part 2

Credibility and transparent communication are preconditions for less uncertain and more predictable monetary and financial conditions, strengthening of institutional trust in the monetary authorities and effective anchoring of expectations among market participants. In the case of Serbia, inflation expectations dynamics of the financial and corporate sector is shown in Figure 5, together with inflation target and tolerance band. At first glance the inflation expectations of both financial and corporate sector exhibited quite volatility from 2009 to 2013, i.e., the first years of the inflation targeting.

In the first years of inflation targeting from 2009 to 2012, the inflation expectations of the corporate sector were only 9 months within the target tolerance band out of a total 48 months, while the inflation expectations of the financial sector were within the range for 29 months (see Table 9). According to the results of surveys carried out by the specialised agencies under the auspices of the central bank, the majority of companies in Serbia perceived inflation to be higher than the upper bound of the target tolerance band in the observed subperiod (2009-2012), while the net percentage of banks which projected inflation above the upper bound of the tolerance band increased, especially during 2011 and 2012. Therefore, short-term inflation expectations were not well anchored for both groups of market participants. After that, they stabilised throughout eight-year period in parallel with lower inflation target and range, till the very end of 2021, when global energy crisis hit.

Economic reasons for notable deviation of inflation expectations from target tolerance band can be found in 1) frequent alternation of tight and expansionary monetary policy, 2) pronounced short-term volatility of year-on-year inflation and foreign exchange rate, as well as 3) incomplete coordination of fiscal and monetary policies. It is important to highlight that the inflation expectations growth from 2009 to 2012 was dominantly stimulated by unfavourable international circumstances and the far-reaching consequences of the Global Financial Crisis (GFC) that were unexpected and inevitable. The central

Figure 5: Inflation expectations of the financial and corporate sector in Serbia for one year ahead, according to the official survey results* (in %)



Source: Specialised agencies' surveys held on behalf of the central bank of Serbia.

bank did not manage to lower the elevated inflation expectations of companies permanently and keep them within the target tolerance band. In addition, the central bank had only partial success in reducing the short-term inflation expectations of the banks, in part thanks to their better reasoning of the context and more direct reaction on the regulatory measures taken to mitigate the negative effects of the GFC. Evident volatility and occasional anchoring of short-term inflation expectations of both financial and corporate sector in the first years of inflation targeting might also point to the lack of more effective and transparent communication between the central bank on the one side and market participants on the other side. This might mean that proclaimed inflation target had not yet become a nominal anchor for inflation expectations by binding them to the unique numerical target value (inflation rate in level or range). Aversion to the unknown could have certain effect on the central bank executive board's decision to pay more attention to assessments of leading analysts and credit rating agencies at that time, which proved to be wrong and misleading at global and local level. With a certain degree of narrowed focus, the central bank allowed foreign exchange rate fluctuations and thus further induced price pressures. In the episodes of pronounced inflation upswings, foreign exchange interventions are not in a strong conflict with the inflation targeting regime, according to three basic criteria: target consistency, regime consistency and procedural transparency, as verified in case of Czech Republic [30]. Moreover, the reluctance of the central bank to raise key interest rates earlier and with stronger intensity could be related to empirical finding that board members rely on professional status and beliefs [8, p. 370] rather than taking timely responses to the seriously and deeply transformed macroeconomic setup.

The decision-making process of the central bank is not solely based on objective criteria, but rather intertwined with subjective assessments. In this context, some insights from behavioural economics may prove useful. Alongside, the market participants' responses to the central bank's decisions are not always rational, since their expectations can be affected not only by purely rational but also by non-rational and irrational factors. Using specific behavioural models, some authors [23, p. 227] concluded that the monetary policy could have more permanent effects on the real and financial sector than predicted by standard macroeconomic models with the underlying assumption of utility (rather than value) maximization. A lot of researchers and practitioners are turning to behavioural economics postulates to look into microeconomic foundations for better macroeconomic predictions, which imply the examination of different equilibrium models, market expectations formation and nominal wages determination policies [19, p. 135]. An

Table 9: Deviations from the upper bound of the target tolerance band* of short-term inflation expectations of the financial and corporate sector in Serbia in the observed subperiod 2009-2012 (in percentage points)

Inflation expectations	**Jan.2009**	**Feb.**	**Mar.**	**Apr.**	**May**	**June**	**July**	**Aug.**	**Sep.**	**Oct.**	**Nov.**	**Dec.**
Financial sector (Bloomberg)	-	-	-	-	-	-	-	-	-	-	-	-
Financial sector (Ipsos)	2.3	1.7	-0.5	-0.4	1.2	1.0	0.8	0.7	0.5	1.3	2.2	1.5
Corporate sector (Ipsos)	-0.2	1.7	-3.2	-0.7	-0.8	-1.0	-1.2	-0.3	0.5	0.3	1.2	0.6
Inflation expectations	**Jan.2010**	**Feb.**	**Mar.**	**Apr.**	**May**	**June**	**July**	**Aug.**	**Sep.**	**Oct.**	**Nov.**	**Dec.**
Financial sector (Bloomberg)	-	-	-	-	-	-	-	2.9	2.2	1.8	0.9	0.8
Financial sector (Ipsos)	1.8	2.2	2.5	3.1	3.0	2.8	1.4	1.2	1.1	0.9	0.7	-0.7
Corporate sector (Ipsos)	0.9	-0.3	-0.5	-0.7	-0.8	-3.0	-1.2	-2.7	-2.8	-2.4	-1.8	-4.7
Inflation expectations	**Jan.2011**	**Feb.**	**Mar.**	**Apr.**	**May**	**June**	**July**	**Aug.**	**Sep.**	**Oct.**	**Nov.**	**Dec.**
Financial sector (Bloomberg)	0.3	0.2	-0.8	-0.7	-0.8	-1.0	-1.2	-1.3	-1.5	-0.7	-0.5	0.0
Financial sector (Ipsos)	0.4	0.3	0.1	-0.1	-0.9	-2.4	-1.9	-1.4	-2.2	-1.1	-2.3	-1.6
Corporate sector (Ipsos)	-7.6	-3.7	-5.2	-4.1	-8.2	-4.4	-4.6	-3.3	-4.9	-3.7	-2.8	-2.5
Inflation expectations	**Jan.2012**	**Feb.**	**Mar.**	**Apr.**	**May**	**June**	**July**	**Aug.**	**Sep.**	**Oct.**	**Nov.**	**Dec.**
Financial sector (Bloomberg)	0.0	-0.1	0.1	-0.4	0.3	-0.3	-0.3	-0.6	-1.7	-1.6	-2.5	-2.5
Financial sector (Ipsos)	-1.0	-0.1	0.8	0.8	1.8	0.3	-1.3	-0.8	-2.4	-2.5	-2.5	-2.5
Corporate sector (Ipsos)	-1.6	-2.1	0.3	1.3	2.1	-1.8	-2.3	-4.3	-4.4	-4.4	-4.5	-4.5

Source: Authors' calculation on the NBS data. *Note: Negative deviations display inflation expectations above the upper bound of the target tolerance band.

empirical micro-foundation, using laboratory experiments, survey data and other micro data, should play a pivotal role in developing behavioural agent-based macro models for more realistic analysis [31, p. 86]. Incompletely rational behaviour of market participants is significantly tested by the neo-Keynesian inflation projection model, which is elaborated in detail by Yellen [64] with special emphasis on the redesign of the Phillips curve and the pricing policy of companies. The phenomena such as the downward price and wage rigidity, the illusion of money and fairness affect the inflation-unemployment dynamics and their trade-off [1, p. 420]. In the standard neo-Keynesian model that combines rational expectations from new classical macroeconomics and the Keynesian concept of rigid prices and wages, companies only occasionally change the prices, while regularly updating their inflation expectations. However, some authors reversed the previous setting, so that resistance to changes is more manifested in current information and expectations than in prices and wages [45, p. 1296]. When the previous assumption is valid, the Phillips curve can more accurately reflect inflation dynamics than the models. Another observation is that economic agents form inflation expectations based on the historical values of a single obvious variable [4, p. 9] rather than reviewing a wider set of economic factors. During the past half century, such an approach has been widely used to examine a close relationship between previous and current inflation, which could be disrupted only in the event of a forced change in the monetary policy stance and abrupt destabilisation of inflation expectations. Apart from that, noticeable deviation of inflation expectations from the central bank's target tolerance band and actual inflation from 2009 to 2012 (see Figure 5, Table 6, and Table 9) was also consequence of inertia in prices usually passed onto inflation expectations, which reversely caused persistent inflation pressures.

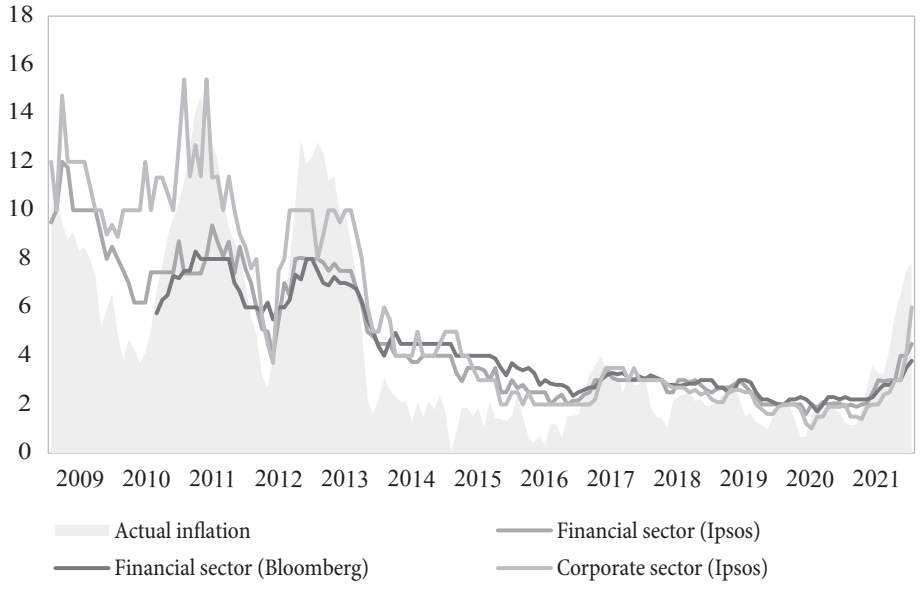
Unlike the classical model which assumes that managers are highly rational and sophisticated in deciding on wages and prices of products and services and recognising relevant constraints, they are often guided by mental shortcuts or heuristics that often cause significant errors in evaluations and plans. One of the possible behavioural explanations is that managers are frequently bad at forecasting due to their overconfidence. Huffman et al. [33] found that managers make overconfident predictions about future performance and have overly positive memories of past performance, hence these findings can be traced to an individual level. Close to this is over-optimism of decision-makers when projecting outcomes of their plans and trying to control for the factors out of their reach, e.g. price movements on international financial and commodities markets. Market participants already had numerous difficulties operating in the conditions of a strong exogenous shock that was soon transmitted to the domestic macroeconomic environment. In such circumstances characterised by heightened uncertainty, market participants provided considerably divergent estimates of price trends in Serbia in comparison to target tolerance band of the central bank, especially in short-term. They were heavily relying on the last available information when making personal assumptions, which may be a consequence of the availability heuristics. Once their short-term inflation expectations were lifted and breached inflation target, it could have induced higher expectations in the long term, which behavioural economists label as momentum. Additionally, it evoked conservatism in the behaviour of banks and companies, even though the actual inflation gradually returned to the target tolerance band, which could be the upshot of ignoring ongoing data, in contrast to the heuristic of representativeness. That created dilemmas and misjudgements in responses of companies and banks in the surveys about their expectations of future inflation, though they seemed rather uncertain about the actual inflation movements in the first years of inflation targeting (see Figure 6).

In the period 2013-2021, the priorities of the central bank, defined as maintaining price and financial stability, were gradually achieved by the continuous relaxation of the monetary policy for almost nine years (ending in April 2022) while ensuring the relative stability of the exchange rate by timely interventions on the FX market. In that way, banks in Serbia were spurred to provide favourable financing and lending conditions, and at the same time companies in Serbia were provided with more stimulating business and investment ambience. According to the surveys of specialised agencies carried out on behalf of the central bank, out of a total of 108 months short-

term inflation expectations of the banks were within the target for 99 months from the beginning of 2013 to the end of 2021. At the same time, the short-term inflation expectations of the companies were within the target range for 96 months (see Table 10). More effective and consistent implementation of the IT strategy contributed to successful anchoring of inflation expectations (yet closer to the lower limit of the target tolerance band), that was backed up by more intensive and transparent communication with the market participants and wider public. Effective anchoring of the inflation expectations contributed to low year-on-year inflation (2% on average) from middle of 2013 to summer of 2021, when headline inflation started to rise in Serbia prompted by the sharp increase in the world prices of energies and industrial inputs due to the escalation of energy crisis and unresolved "bottlenecks" in global supply channels.

It is important to say once more that aim of the central bank in IT regime is to achieve and maintain low and stable actual (year-on-year) inflation rate by managing and directing inflation expectations of the market participants towards publicly announced inflation target. In our analysis, we intended to demonstrate the importance of inflation expectations of the financial and corporate sector for managing inflation dynamics in the short run, with repercussions in the long run. The expected rate of inflation, which is usually affected by mixed economic and behavioral factors, can be viewed, to a certain extent, as a measure of the monetary policy credibility and its (un) success to anchor inflation expectations. In other words, the more credible the monetary policy is, the closer the inflation expectations are to declared inflation target. Deviations between actual and expected inflation during the observed period (2009-2021) can be explained not only by macroeconomic circumstances and policy decisions, but also by psychological biases and heuristics of the decision makers in both central bank and other public institutions, on the one side, and financial and corporate sector in Serbia on the other side. Taking into account that inflation expectations are not merely an economic phenomenon, but also fundamentally influenced by psychological factors, we judge that central banks may have some benefits from behavioral insights applied to the decision-making process of the executive board, as well as in the rapidly developing area of communication channels with market participants [37, p. 49]. Identifying and addressing the psychological aspects of inflation expectations can lead to more effective monetary policy implementation and economic stability not only in the short term, but rather in the long term.

Figure 6: Actual inflation and short-term inflation expectations of the financial and corporate sector in Serbia in the period 2009-2021 (in %)



Source: Central bank of Serbia

Table 10: Deviation of short-term inflation expectations of the financial and corporate sector in Serbia from the upper bound of the target tolerance band* in the observed subperiod 2013-2021 (in percentage points)

Inflation expectations	Jan.2013	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.
Financial sector (Bloomberg)	-2.0	-1.5	-1.4	-1.8	-1.5	-1.5	-1.4	-1.3	-0.8	0.0	0.5	1.1
Financial sector (Ipsos)	-2.5	-2.4	-2.0	-2.3	-2.0	-2.0	-2.0	-1.3	-0.6	0.5	0.7	1.0
Corporate sector (Ipsos)	-2.5	-3.5	-4.5	-4.5	-4.0	-4.5	-4.5	-3.5	-2.5	-0.5	0.5	0.5
Inflation expectations	**Jan.2014**	**Feb.**	**Mar.**	**Apr.**	**May**	**June**	**July**	**Aug.**	**Sep.**	**Oct.**	**Nov.**	**Dec.**
Financial sector (Bloomberg)	1.5	0.9	0.6	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Financial sector (Ipsos)	1.0	1.0	1.5	1.5	1.5	1.8	1.8	1.5	1.5	1.5	1.5	1.5
Corporate sector (Ipsos)	-0.5	0.0	1.5	1.5	1.5	1.5	0.5	1.5	1.5	1.5	1.0	0.5
Inflation expectations	**Jan.2015**	**Feb.**	**Mar.**	**Apr.**	**May**	**June**	**July**	**Aug.**	**Sep.**	**Oct.**	**Nov.**	**Dec.**
Financial sector (Bloomberg)	1.0	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.6	2.0	2.3	1.8
Financial sector (Ipsos)	1.5	2.2	2.6	2.0	2.0	2.0	2.1	2.5	2.0	3.0	3.0	2.5
Corporate sector (Ipsos)	0.5	0.5	1.5	1.5	2.0	2.5	2.5	2.5	2.5	3.5	3.5	3.0
Inflation expectations	**Jan.2016**	**Feb.**	**Mar.**	**Apr.**	**May**	**June**	**July**	**Aug.**	**Sep.**	**Oct.**	**Nov.**	**Dec.**
Financial sector (Bloomberg)	2.0	2.1	2.0	2.2	2.7	2.5	2.7	2.7	2.7	2.8	3.2	3.0
Financial sector (Ipsos)	2.8	2.7	3.0	3.0	3.0	3.0	3.5	3.3	3.1	3.5	3.4	3.4
Corporate sector (Ipsos)	3.0	3.5	3.0	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5
Inflation expectations	**Jan.2017**	**Feb.**	**Mar.**	**Apr.**	**May**	**June**	**July**	**Aug.**	**Sep.**	**Oct.**	**Nov.**	**Dec.**
Financial sector (Bloomberg)	1.9	1.8	1.8	1.5	1.3	1.2	1.3	1.2	1.4	1.5	1.4	1.5
Financial sector (Ipsos)	2.1	2.0	1.5	1.5	1.0	1.4	1.5	1.5	1.5	1.5	1.5	1.5
Corporate sector (Ipsos)	2.5	2.5	2.3	1.5	1.0	1.0	1.0	1.0	1.5	1.0	1.5	1.5
Inflation expectations	**Jan.2018**	**Feb.**	**Mar.**	**Apr.**	**May**	**June**	**July**	**Aug.**	**Sep.**	**Oct.**	**Nov.**	**Dec.**
Financial sector (Bloomberg)	1.3	1.4	1.5	1.7	1.7	1.8	1.7	1.7	1.7	1.5	1.5	1.5
Financial sector (Ipsos)	1.5	1.5	1.5	2.0	2.0	1.5	1.5	1.6	1.5	1.7	1.9	2.0
Corporate sector (Ipsos)	1.5	1.5	1.5	1.7	1.8	1.8	1.8	2.0	1.9	2.1	2.0	2.3
Inflation expectations	**Jan.2019**	**Feb.**	**Mar.**	**Apr.**	**May**	**June**	**July**	**Aug.**	**Sep.**	**Oct.**	**Nov.**	**Dec.**
Financial sector (Bloomberg)	1.8	1.8	2.0	1.9	1.5	1.5	1.6	2.0	2.3	2.3	2.4	2.5
Financial sector (Ipsos)	1.9	1.8	1.8	1.7	1.5	1.8	2.0	2.2	2.5	2.5	2.5	2.5
Corporate sector (Ipsos)	2.4	2.4	2.0	1.9	1.9	2.0	2.0	2.5	2.7	2.9	2.9	2.6
Inflation expectations	**Jan.2020**	**Feb.**	**Mar.**	**Apr.**	**May**	**June**	**July**	**Aug.**	**Sep.**	**Oct.**	**Nov.**	**Dec.**
Financial sector (Bloomberg)	2.5	2.3	2.3	2.2	2.3	2.5	2.8	2.5	2.2	2.2	2.3	2.2
Financial sector (Ipsos)	2.5	2.5	2.5	2.5	2.9	2.5	2.7	2.4	2.5	2.5	2.5	2.6
Corporate sector (Ipsos)	2.5	2.5	2.5	2.7	3.3	3.5	3.0	3.0	2.6	2.6	2.6	2.5
Inflation expectations	**Jan.2021**	**Feb.**	**Mar.**	**Apr.**	**May**	**June**	**July**	**Aug.**	**Sep.**	**Oct.**	**Nov.**	**Dec.**
Financial sector (Bloomberg)	2.3	2.3	2.3	2.3	2.2	1.9	1.7	1.7	1.5	1.5	1.0	0.7
Financial sector (Ipsos)	2.5	2.6	2.5	2.5	2.0	1.5	1.6	1.5	1.5	0.5	0.5	0.0
Corporate sector (Ipsos)	3.0	3.0	3.1	2.6	2.5	2.5	2.1	2.0	1.5	1.5	0.5	-1.5

*Note: Negative deviations display inflation expectations above the actual inflation.
Source: Authors' calculation on the NBS data.

Conclusion

Our analysis plunged into the effectiveness and implications of the inflation targeting regime in Serbia, which the central bank has been explicitly applying from January 2009. The study took a multi-dimensional approach, considering both neoclassical and behavioural theoretical frameworks, alongside empirical findings. Through meticulous examination of the relationship between short-term inflation expectations of market participants, actual year-on-year inflation, and the central bank's efforts to target inflation, this study shed light on their interactions within the Serbian economy. The empirical research spanned a substantial period from Q1 2009 to Q4 2021, incorporating data sources on actual inflation rates, real unit labour costs and output gap estimates, as well as inflation expectations from both corporate and financial sectors. Employing the ARDL regression, the study assessed the intricate relationships between these variables, providing insights into the short term and the long term. The study's findings revealed that short-term inflation expectations of the financial and corporate sectors hold a statistically significant influence on actual inflation in the short run. The real unit labour costs and the output

gap, however, did not exhibit a significant impact on actual inflation within this model. The examination of the long-run relationships suggested a positive and significant influence of the financial sector inflation expectations, the real unit labour costs, and the output gap on the actual inflation. These results underline the complex interplay between inflation expectations, as economic fundamentals, and the actual inflation rate.

Furthermore, the analysis delved into the credibility and transparency of the central bank's decisions. In the early years of inflation targeting, inflation expectations often deviated from the target tolerance band due to a range of factors including market volatility, incomplete coordination of fiscal and monetary policies, and communication challenges. However, the analysis emphasizes that inflation expectations are not solely driven by economic factors but are profoundly influenced by psychological biases. Recognizing and addressing these behavioural aspects could enhance the effectiveness of monetary policy implementation and foster long-term economic stability. The study acknowledged the importance of behavioural aspects on market participants' expectations, highlighting phenomena like overconfidence, momentum, and conservatism that can influence inflation expectations. In subsequent years, more effective implementation of inflation targeting strategies, coupled with enhanced communication with market participants, led to better anchoring of inflation expectations within the target range. The central bank's approach of gradually relaxing the monetary policy while maintaining the exchange rate stability contributed to successful inflation targeting and low year-on-year inflation rates, thereby achieving the goals set forth in the IT monetary framework.

This study's examination of Serbia's inflation targeting experience can provide valuable insights for policymakers and economists alike. It underscores the intricate relationship between inflation expectations, actual inflation, and the central bank's monetary policy, while recognizing the importance of behavioural aspects in shaping market prices dynamics. The findings emphasize a critical role of clear communication, credible inflation targeting strategy, and a nuanced understanding of the market participants' behaviour in achieving successful inflation targeting outcomes.

Since ARDL model assumes a linear relation between variables, the constraint of our research from the econometric perspective could be the lack of inspection into non-linear relation between the variables of interest. From the perspective of economic theory and empirical evidence, the drawback of the model could be the absence of assessing the reverse causal relationship between actual inflation and expectations. Proper looking into research limitations can sow the seeds for future research.

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ROLE OF WORKING CAPITAL MANAGEMENT IN ACHIEVING PROFITABILITY IN SERBIA

Uloga upravljanja obrtnim kapitalom u ostvarivanju profitabilnosti preduzeća u Srbiji

Abstract

Most authors argue that working capital management has a significant role in achieving profitability. The aim of this research is to determine an influence of working capital management on the profitability of 141 Serbian companies with the highest level of business income that operate in the domestic manufacturing sector. Based on the applied System generalized method of moment (SYS-GMM) model, the authors show that the longer inventory conversion cycle has a negative and statistically significant impact on the profitability of the observed companies, while the other control variables, such as liquidity, financial leverage, activity and sales growth do not affect profitability. Based on the obtained results, the authors may conclude that the role of working capital management in achieving profitability in Serbian manufacturing companies is relatively significant during the period from 2016 to 2020. The obtained findings are significant for financial managers of manufacturing companies in the Republic of Serbia since they provide useful information about the intensity and direction of certain determinants of profitability. On the other hand, the results of this research are also of interest to wider public and policymakers, considering the fact that profitable manufacturing companies provide jobs, pay taxes, produce necessary goods and services and contribute to the creation of social well-being.

Keywords: *working capital management, profitability, manufacturing companies, Serbia*

Sažetak

Većina autora smatra da upravljanje obrtnim kapitalom ima značajnu ulogu u ostvarivanju profitabilnosti. Cilj ovog rada je da ispita uticaj upravljanja obrtnim kapitalom na profitabilnost 141 proizvodnog preduzeća sa najvećim poslovnim prihodima sa teritorije Republike Srbije. Na osnovu primenjenog sistemskog GMM modela, iz analize proizilazi da duže vreme trajanja jednog ciklusa vezivanja zaliha ima negativan i statistički značajan uticaj na profitabilnost posmatranih preduzeća, dok ostale kontrolne varijable, kao što su likvidnost, finansijski levridž, aktivnost i rast prodaje nemaju uticaj na profitabilnost. Na osnovu dobijenih rezultata može se zaključiti da je uloga upravljanja obrtnim kapitalom u ostvarivanju profitabilnosti proizvodnih preduzeća u Srbiji relativno važna u periodu od 2016. do 2020. godine. Dobijeni rezultati su značajni za finansijske menadžere pomenutih kompanija budući da obezbeđuju važne informacije o intenzitetu i smeru uticaja pojedinih determinanti profitabilnosti. Sa druge strane, nalazi ove studije mogu biti od koristi i široj publici, kao i donosiocima ekonomskih odluka, budući da profitabilne proizvodne kompanije obezbeđuju radna mesta, poreske prihode državi, proizvode neophodne proizvode i doprinose blagostanju šire društvene zajednice.

Ključne reči: *upravljanje obrtnim kapitalom, profitabilnost, proizvodne kompanije, Srbija*

Introduction

Working capital management (WCM) has a significant role in achieving and maximizing the companies' profitability with the aim of avoiding excessive investment in short-term assets, as well as maintaining optimal liquidity. Working capital management implies regulation level and structure of current assets in order to achieve an adequate balance between the risk and return. Efficient working capital management leads to higher level of profitability and, at the same time, it increases the value of the shareholders. It is recognized as a significant determinant of profitability during the economic crisis as an internal force for increasing profitability. Most of authors state that the role of working capital management in achieving profitability is significant and that the shorter cash conversion cycle, as a measure of the adequacy of working capital management, leads to profitability growth. According to Alsulayhim [5] the most frequent measures of working capital management include cash conversion cycle and its elements. Following research results and findings of Mazanec [22], Alvarez et al. [6], Kafeel et al. [20], Alsulayhim [5], Agegnew [2], Evci and Şak [16], Şamiloğlu and Akgün [28], Seyoum et al. [30] and Agha [3] the authors defined the following hypotheses:

First hypothesis: The role of working capital management in achieving profitability in Serbian manufacturing companies is significant.

Second hypothesis: There is a negative relationship between inventory conversion cycle as a component of working capital management and Serbian manufacturing companies' profitability calculated by ROE.

Third hypothesis: There is a negative relation between receivable collection period as a component of working capital management and Serbian manufacturing companies' profitability measured by ROE.

Fourth hypothesis: There is a positive relationship between payable conversion cycle as a component of working capital management and Serbian manufacturing companies' profitability calculated by ROE.

In accordance with the findings of Alvarez et al. [6], Alsulayhim [5], and Şamiloğlu and Akgün [28], the authors employ return on equity (ROE) as a measure of Serbian manufacturing companies' profitability. After an introduction, the second section of this paper provides an extensive literature review in a field of the working capital management role in achieving the companies' profitability, including an overview of the widely used independent variables in the recent empirical literature. The third part of this study presents the description of the data used and the applied research methodology, while the fourth section discusses the obtained results, comparing them with the research results of other authors. Finally, the last part of this paper concludes, provides suggestions for future research and states the limitation of this study.

Literature review

The examination of the role of working capital management in achieving profitability has inspired numerous authors so far. In order to determining the empirical evidence about the impact of working capital management on the profitability of large non-financial Serbian companies in the period from 2016 to 2019, Milošev [23] conducts a study whose results show a non-linear relationship between two observed indicators. The obtained findings imply the existence of a net working capital optimal level. Consequently, it can be concluded that working capital increase has a positive effect on large non-financial Serbian companies' profitability up to the optimal level, above which the further growth of working capital has a negative effect on profitability. Similar to previous research, the purpose of the study conducted by Anton and Nucu [7] is to examine the relation between working capital and profitability in a sample of 719 Polish companies listed on the stock exchange in the period from 2007 to 2016. The authors use different panel data analysing techniques, and the empirical results reveal an inverted U-shaped relationship, which means that working capital has a positive effect on the profitability of Polish companies up to the optimal level. After the optimal level, the observed impact is negative. On the other hand, on the example of 362 Czech companies, including 20 companies with the EFQM (European Foundation for Quality Management) certificate, Yousaf and Bris [38] find a negative link between working capital and companies' profitability

during the period from 2015 to 2019. The authors employ the SYS-GMM model. Jaworski and Czerwonka [19] also contribute to the verification of theories that connect the companies' profitability with the working capital management by emphasising that the companies listed on the WSE (Warsaw Stock Exchange) should shorten the cash conversion cycle in order to increase profitability. Employing dynamic panel data model Arnaldi et al. [8] show a negative relationship between profitability of the 105manufacturing small and medium-sized companies (SMEs) in the Czech Republic, on the one side, and their cash conversion cycle, inventory conversion cycle and payable conversion cycle, on the other side, covering the period from 2014 to 2018. On the example of 141 Serbian companies, Milovanović et al. [25] show that the quality management system (QMS) certification to ISO 9001 has a positive impact on profitability. It is worth to mention that the following findings are not the same from all companies' size and industry types. Additionally, on the example of SMEs in Poland, Zimon and Hossein [39] conclude that the Covid-19 pandemic had no impact on the working capital management strategy; the companies with a high cash conversion cycle ratio had a higher level of profitability. Employing regression analysis Högerle et al. [17] show that shorter cash conversion cycle positively affects profitability of 115 companies listed on German Prime Standard in the period from 2011 to 2017.

Analysing Romanian coal mining companies, Batrancea et al. [11] show that there is a concave relation between variable costs and output, indicating that Romanian coal companies have an optimal production level that maximizes both variable; costs and their profitability. Vuković and Jakšić [36] support the hypothesis that almost all analysed working capital management variables have a statistically significant impact on companies' profitability. This research was conducted on the example of the food companies in the Southeast Europe, while the authors conclude that a more aggressive working capital management strategy is closely related to a higher profitability. Using panel data on the sample of the high-growth companies from the region of the Central, Eastern and South-Eastern Europe (the CESEE countries) in the period from 2006 to 2015, Boțoc and Anton [12] also tried to quantify an impact of adequate working capital management on profitability. The high-growth companies are included in the panel due to the fact that they have a great potential for creating new jobs, introducing innovations, and influencing the economic development. According to the obtained results, the authors draw a conclusion that there is a concave relation between working capital management and profitability, namely the inverted U-shaped relation. This finding obviously indicates that the high-growth companies from the CESEE countries should have an optimal level of working capital that maximizes their profitability. Evci and Şak [16] discovered the existence of trade-off between working capital management and profitability on the example of 41 companies listed on the Borsa Istanbul Industry Index in the period from 2005 to 2016. Nguyen [26] shows that shorter cash conversion cycle positively affects profitability of 54 companies listed on Vietnam Stock Market from 2011 to 2016. Additionally, Şamiloğlu and Akgün [28] find a negative relationship between receivable collection period and profitability in the manufacturing companies in Turkey. The authors consider that managers can create value for the shareholders by reducing receivable collection period and cash conversion cycle. In addition, analysing a sample of 17 companies listed on the Bucharest Stock Exchange in the period from 2011 to 2015, Cristea and Cristea [14] find a negative relationship between the cash conversion cycle and profitability. Based on the results obtained from the analysis of companies listed on the Belgrade Stock Exchange, Barjaktarović Rakočević et al. [10] conclude that financial managers can increase profitability by reducing the receivable collection cycle. On the other hand, delay in paying to suppliers does not affect the profitability of the observed companies. Singhania et al. [31] reveal that the cash conversion cycle has a negative impact on profitability of Indian manufacturing companies. Following the obtained results, the authors claim that it is necessary to reduce the receivables collection cycle and to extend the time of payment of obligations to suppliers in order to increase profitability.

Ceylan [13] empirically proves that there was a unidirectional causal link between the brand value and corporate profitability in Turkey in the period from 2008 to 2018. Milošević Avdalović [24] examines the determinants

of profitability on the example of 62 industrial grinding companies listed on the Belgrade Stock Exchange in the period from 2008 to 2014 employing the ordinary least squares (OLS) method. According to these findings, variables such as leverage, number of shares and book value per share are inversely related to profitability, while the size and age of the observed companies have no influence on profitability. At the same time, Vučković [37] emphasizes that agricultural companies in Vojvodina, despite having similar arable land and operating in the same geographical area, may have different level of profitability due to the differences in their financial structure, asset structure, activity indicators and liquidity. The author claims that a positive effect on the profitability of the agricultural companies in Vojvodina can be attributed to a higher level of the equity capital in the total assets and a higher liquidity ratio. Janda et al. [18] believe that the success of the food processing micro-companies in the rural areas of the Eastern Europe is to the greatest extent related to the characteristics of the owner, that is, the manager itself. The key characteristic of the owner/manager is a risk-taking behaviour as the main motive for establishing the company. The characteristics of the company that determine profitability are caused by factors such as the company's location, the size and organizational form of the company, technological progress, and whether or not the company has products' certifications. These findings were obtained from the research conducted on 300 agricultural micro-enterprises in Poland for the period from 2002 to 2006.

Data description and employed methodology

With the intention of examining the role of working capital management in achieving profitability, the authors analyse a sample consisting of 141 companies in the manufacturing sector with the highest level of the business income from the territory of the Republic of Serbia. The time span of the research refers to the period from 2016 to 2020.[1] According to the authors' calculation on the basis of data available on the official Serbian Business Registers Agency website, the average profitability measured by the ROA (Return on Assets) of the 141 largest companies from the Serbian manufacturing sector in the observed period was 6.5%, average ROE (Return on Equity) was 10.6%, average EBITDA (Earnings before Interest, Taxes, Depreciation and Amortization) was 10.2%, while the average net profit margin was 5.3%. Considering the effectiveness of working capital management, the authors came to the following results: the average inventory conversion cycle in the observed Serbian manufacturing companies was 126 days; the average receivable collection period was 66 days, while the average payable conversion cycle was 117 days covering the period from 2016 to 2020. In accordance with these results, the average cash conversion cycle for 141 observed Serbian manufacturing companies with the highest level of the business income in observed period was 74 days. On the other hand, when analysing the liquidity indicators of the Serbian manufacturing companies, as possible explanatory variables that may have an impact on the profitability of the observed companies, the authors conclude that the average current liquidity ratio was 2.1, while the average quick liquidity ratio was 1.3 covering the observed time interval. By statistical analysis of the observed companies' business activities, the authors concluded that the average total asset turnover in the period from 2016 to 2020 was 1.3. The examination of the financial leverage leads to conclusion that the average debt to equity ratio was 0.18, which means that the Serbian manufacturing companies with the highest level of the business income used 18% of debt on average during the observed period.

Table 1 shows the annual indicators of the business activity of all Serbian manufacturing companies (sector C) in the period from 2016 to 2020. The data from Table 1 indicate that in the observed period there was a decrease in the number of the registered companies in this sector from 16,978 in 2016 to 15,613 in 2020, which represents a drop of about 8%. Despite this, there was an increase in the value of their production from 2,503,550 million RSD in 2016 to 3,089,134 million RSD in 2020, which represents a growth of 24%. At the same time, the value added of these companies increased by as much as 38%,

1 The data used in the research were collected from the official financial reports of the observed companies in the period from 2016 to 2020, which are publicly available on the official website of the Serbian Business Registers Agency. Individual indicators are the result of the authors' calculations.

indicating a possible increase in their productivity, business efficiency and improvement of overall business performance. However, these trends were also accompanied by a decrease in the share of the manufacturing industry in the country's GDP by 1.5%, pointing to the conclusion that in the observed period some other sectors of the economy might contributed greatly to its generation and growth. In addition, in the meantime, the real growth rate of companies from the manufacturing industry dropped from 3% in 2016 to only 0.5% in 2020. Among other things, this trend could have been influenced by the 2020 Covid-19 pandemic, which is widely known to have slowed down the economic activities worldwide. The pandemic also triggered a consequent reduction in demand for the products of the manufacturing industry. Finally, in the period from 2016 to 2020, the gross salaries and wages of the employees increased by as much as 53%, while this trend was followed by the growth of the total number of the employees in the manufacturing industry by 23.2%.

Table 2 summarizes the most recent empirical studies that examine the relationship between profitability and working capital management. It can be concluded that

Table 1: Annual indicators on business activities of companies in the Republic of Serbia – sector C

Year	Number of enterprises	Production value (mil RSD)	Value added (mil RSD)	Share of GDP (%)	Real growth rates (%)	Gross salaries and wages (mil RSD)	Number of persons employed
2016	16,978	2,503,550	578,998	14.8	3	256,325	336,075
2017	15,797	2,826,522	656,230	15.1	4.5	289,041	356,817
2018	15,831	3,015,600	699,974	14.5	1.5	317,371	377,984
2019	15,678	3,134,343	744,029	13.7	0.1	362,668	400,710
2020	15,613	3,089,134	798,723	13.3	0.5	392,273	414,078

Source: [32]

Table 2: The role of working capital management in achieving profitability

Author(s)	Measure of WCM	Profitability measures	WCM and profitability
Mazanec [22]	*Inventory turnover, Accounts receivable turnover, Current liabilities turnover, Days inventory outstanding, Days current assets outstanding, Days receivable outstanding, Days payable outstanding, Cash conversion cycle*	ROA	Different results
Demiroj et al. [15]	*Inventory conversion cycle* *Receivable collection period* *Payable conversion cycle* *Cash conversion cycle*	Negative Negative Negative Negative	ROA
Stoiljković et al. [33]	*WCM = Inventory turnover cycle + Average collection period − Account payable period*	ROA	No effect
Milošev [23]	$WKCR = \frac{Inventory + Account\ Receivables - Account\ Payable}{Sales}$ $WKCR_{sq} = \left(\frac{Inventory + Account\ Receivables - Account\ Payable}{Sales}\right)^2$	ROA	Inverted U shape
Anton and Nucu [7]	$WKCR = \frac{Inventories + Debtors - Creditors}{Sales}$ $WKCR_{sq} = \left(\frac{Inventories + Debtors - Creditors}{Sales}\right)^2$	ROA	Inverted U shape
Jaworski and Czerwonka [19]	$CCC = Inventory\ turnover\ cycle + Average\ collection\ period - Account\ payable\ period$ $Working\ capital = \frac{Current\ assets - Current\ liabilities}{Sales\ revenue}$	ROA	Negative Positive
Alvarez et al. [6]	*Inventory conversion cycle, Receivable collection period, Payable conversion cycle, Cash conversion cycle*	ROA ROE	Positive
Arnaldi et al. [8]	*Inventory conversion cycle* *Receivable collection period* *Payable conversion cycle* *Cash conversion cycle*	EBITDA	Negative Negative No effect Negative

Author(s)	Measure of WCM	Profitability measures	WCM and profitability
Högerle et al. [17]	*Cash conversion cycle*	ROCE	Negative
Kafeel et al. [20]	*Inventory conversion cycle, Receivable collection period, Payable conversion cycle, Cash conversion cycle*	ROA	Positive
Alsulayhim [5]	*Receivable collection period* *Inventory period* *Account payable period*	ROA ROE ROCE GOP/NOP	Positive
Agegnew [2]	*Inventory conversion cycle, Receivable collection period, Payable conversion cycle, Cash conversion cycle*	ROA	Negative
Boțoc and Anton [12]	$WKCR = \frac{Stocks + Debtors - Creditors}{Sales}$ $WKCR_{sq} = \left(\frac{Stocks + Debtors - Creditors}{Sales}\right)^2$ $CCC = Account\ receivable + Inventory - Payable$ $CCC_{sq} = (Account\ receivable + Inventory - Account\ payable)^2$	ROA ROIC	Inverted U shape
Evci and Şak [16]	*Inventory conversion cycle* *Payable conversion cycle* *Cash conversion cycle*	ROA	Negative Positive Negative
Şamiloğlu and Akgün [28]	*Inventory conversion cycle, Receivable collection period, Payable conversion cycle, Cash conversion cycle*	ROA ROE OPM NPM	Different results
Seyoum et al. [30]	*Inventory conversion cycle* *Receivable collection period* *Payable conversion cycle* *Cash conversion cycle*	ROA	Negative Negative No effect Negative
Singhania et al. [31]	*Cash conversion cycle*	GOP	Negative
Agha [3]	*Creditors turnover ratio, Debtors turnover ratio, Inventory turnover ratio*	ROA	Negative

Note: The presented abbreviations refer to the following profitability indicators: ROA – Return on Assets, NPR – Net Profit Ratio, ROE – Return on Equity, EBITDA – Earnings before interest, taxes, depreciation and amortization, ROCE – Ratio of the Return on Employed Capital (liabilities and equity), GOP – Gross Operating Profit, NOP – Net Operating Profit, ROIC – Return on Invested Capital, OPM – Operating Profit Margin and NPM – Net Profit Margin.
Source: The authors' systematization.

there is no consensus about the role of working capital management in achieving profitability. However, most of authors argue that the shorter cash conversion cycle has positive impact on profitability of the company. However, some authors prove that there is an inverted U shape between working capital and profitability. Inverted U shape relationship means that there is an optimal level of working capital. Namely, below that level, the growth of working capital has a positive impact on profitability, while above its optimal level further growth of working capital has a negative impact on profitability. As is the case of the most empirical studies, the authors assume that a longer cash conversion cycle has a negative effect on profitability.

According to Alsulayhim [5] the most frequent measures of working capital management are the cash conversion cycle (CCC) and its main elements (inventories, receivables, and payables). Many authors have used the same measures, such as Mazanec [22], Demiroj et al. [15], Alvarez et al. [6], Kafeel et al. [20], Alsulayhim [5], Agegnew [2], Evci and Şak [16], Şamiloğlu and Akgün [28], Seyoum et al. [30], Agha [3] and Taurianga and Adjapong [34]. Consequently, in this paper, the authors use:

- the inventory conversion period (ICP),
- receivable collection period (RCP), and
- payable conversion period (PCP).

as approximate indicators of working capital management. The cash conversion cycle is not included in the estimated model due to the fact that this variable is collinear with the ICP, RCP and PCP. Following Alvarez et al. [6], Alsulayhim [5] and Şamiloğlu and Akgün [28] the authors employ return on equity (ROE) as a measure of Serbian manufacturing companies' profitability.

Jaworski and Czerwonka [19], Anton and Nucu [7], Arnaldi et al. [8], Boțoc and Anton [12] and Afrifa and Padachi [1] estimate dynamic panel model, such as GMM, in order to control for endogeneity. Consequently, to examine the role of working capital management in achieving profitability in the manufacturing companies in the Republic of Serbia the authors employ the following System Generalized Method of Moments (SYS-GMM) estimation model:

$$y_{i,t} = \beta y_{i,t-1} + \theta'(L)WCM_{i,t} + \varphi'(L)x_{i,t} + \gamma_t + \alpha_i + \varepsilon_{i,t}$$

for

$$i = 1,\ldots,N \text{ and } t = q + 1,\ldots,T$$

where

$y_{i,t}$ – is the profitability of the manufacturing company i at time t,

$WCM_{i,t}$ – are the measures of working capital management of the manufacturing company i at time t,

$x_{i,t}$ – is a vector of other explanatory variables,

$\theta(L)$ and $\varphi(L)$ – are vectors of associated polynomials in the lag operator,

q – is the maximum lag length,

γ_t – is the time-specific effect,

α_i – is an unobserved country-specific effect, and

$\varepsilon_{i,t}$ – is the white noise error term.

Following Mazanec [22], Alvarez et al. [6], Alsulayhim [5], Vuković and Jakšić [36], Boțoc and Anton [12], and Stoiljković et al. [33], the authors include liquidity as a control variable in the model due to the fact that this variable may have an impact on profitability. According to Kuč [21] the largest companies in Serbia were overextended with an unfavourable term structure during the period from 2008 to 2014. Following Mazanec [22], Milošev [23], Jaworski and Czerwonka [19], Alvarez et al. [6], Högerle et al. [17], Vuković and Jakšić [36], Milošević Avdalović [24], Boțoc and Anton [12] and Şamiloğlu and Akgün [28] the authors introduce a financial leverage as a possible determinant of Serbian manufacturing companies' profitability. Furthermore, following Mazanec [22], Alarussi and Alhaderi [4] and Stoiljković et al. [33] the authors introduce an activity measure as a control variable in the model. Finally, following Milošev [23], Högerle et al. [17] and Boțoc and Anton [12] the authors employ a sales growth as a possible determinant of Serbian manufacturing companies' profitability. Table 3 presents in detail the independent variables introduced in the estimated model, their measures as well as the expected signs.

In accordance with the available theoretical and empirical literature, the authors reasonably expect that

Table 3: Independent variables and expected signs

Variable	Measure	Expected sign
Profitability*	$Return\ on\ Equity = \frac{Net\ income}{Shareholders'\ equity}$	+
Inventory conversion period	$Inventory\ conversion\ period = \frac{365}{Inventory\ turnover}$	-
Receivable collection period	$Receivable\ collection\ period = \frac{365}{Account\ receivable\ turnover}$	-
Payable conversion period	$Payable\ conversion\ period = \frac{365}{Account\ payable\ turnover}$	+
Liquidity	$Quick\ ratio = \frac{Current\ assets - Inventory}{Current\ liabilities}$	+
Financial leverage	$Debt\ to\ equity = \frac{Debt}{Shareholders'\ equity}$	-
Activity	$Total\ asset\ turnover = \frac{Revenues}{Total\ assets}$	+
Sales growth	$Revenues\ growth = \frac{Revenues_t - Revenues_{t-1}}{Total\ assets}$	+

*Note: The authors employ the lag of profitability measured by ROE as an independent variable.

higher profitability from the previous period positively affects the profitability in a current year. In order to investigate the issue of the influence of the working capital components on profitability, the authors assume that the inventory conversion cycle and receivable collection period negatively affect profitability, while the payable conversion cycle has a positive impact on Serbian manufacturing companies' profitability. These assumptions concerning the working capital components imply that a shorter cash conversion cycle has a positive effect on profitability. Regarding the controlling variables, the authors assume that the higher liquidity, lower level of debt and higher growth of sales revenue positively affect profitability. It is important to mention that Mazanec [22], Milošev [23], Yousaf and Bris [38], Jaworski and Czerwonka [19], Alvarez et al. [6], Tomašević et al. [35], Vuković and Jakšić [36], Milošević Avdalović [24], Şamiloğlu and Akgün [28] and Stoiljković et al. [33] employ the companies' size as a possible determinant of profitability. However, in this paper, the authors decide not to include the companies' size as a control variable in the model bearing in mind that most of the mentioned authors showed that this variable does not have any effect on profitability. Furthermore, this variable is proved to be highly correlated with the sales growth hence, the authors decide to eliminate it. The majority of researchers use the internal variables as determinants of profitability, which is also the case in this study. Contrary to that, Milošev [23] and Jaworski and Czerwonka [19] employ an external variable such as GDP growth as a control variable in the estimated model. Although the authors of this paper had an intention to introduce an inflation and GDP growth rate as control variables in the model, they still did not employ them taking into account that these variables had a unit root even in the third order differential.

Results and discussions

In the first step, a correlation analysis was conducted with the aim of revealing a potential problem of multicollinearity between the observed variables, which can lead to a wrong interpretation of the estimated parameters, as well as

Table 4: Correlation matrix

	ROE	Inventory	Receivables	Payables	Liquidity	Leverage	Activity	Growth
ROE	1.000000	-0.050751	-0.021360	0.052401	0.049045	-0.608736	0.096520	0.002274
Inventory	-0.050751	1.000000	0.040394	0.321520	0.108614	-0.015014	-0.427302	-0.006918
Receivables	-0.021360	0.040394	1.000000	0.159812	0.231783	-0.017169	-0.300088	0.049428
Payables	-0.052401	0.321520	0.159812	1.000000	-0.170807	0.018795	-0.278733	0.215351
Liquidity	0.049045	0.108614	0.231783	-0.170807	1.000000	-0.143173	-0.053772	-0.059660
Leverage	-0.608736	-0.015014	-0.017169	0.018795	-0.143173	1.000000	-0.022304	0.016388
Activity	0.096520	-0.427302	-0.300088	-0.278733	-0.053772	-0.022304	1.000000	0.032817
Growth	0.002274	-0.006918	0.049428	0.215351	-0.059660	0.016388	0.032817	1.000000

Source: The authors' calculation based on the Serbian Business Registers Agency database, EViews 12 program.

Table 5: Cross-section dependence and unit root tests

Variables/Tests	Pesaran CD test	Im, Pesaran and Shin t-bar statistics	
		Individual intercept	Individual intercept and trend
ROE	2.241693 (0.0250)	-2.48049 (0.0000)	-5.51587 (0.0000)
Inventory	1.758401 (0.1197)	-2.37508 (0.0000)	-6.73680 (0.0000)
Receivables	2.135862 (0.0327)	-2.17524 (0.0000)	-3.61448 (0.0000)
Payables	0.812437 (0.4165)	-2.76108 (0.0000)	-5.96939 (0.0000)
Liquidity	1.518967 (0.1288)	-1.74217 (0.0000)	-2.2e+11 (0.0000)
Fin. leverage	1.804159 (0.0952)	-4.0e+13 (0.0000)	-1.9e+13 (0.0000)
Activity	2.008101 (0.0407)	-2.4e+11 (0.0000)	-1.6e+12 (0.0000)
Growth	0.765124 (0.3785)	-1.57598 (0.0036)	-4.09687 (0.0000)

Note: Pesaran CD test Null Hypothesis: No cross-section dependence.
Note: IPS Null Hypothesis: Unit root (individual unit root process). Exogenous variables: Individual effects, automatic selection of maximum lags, Automatic lag length selection based on SIC.
Source: The authors' calculation on the base of the Serbian Business Registers Agency database, EViews 12 program.

their corresponding standard errors and p-values. Based on the data from Table 4, it can be concluded that there is no correlation between the observed variables, which implied the absence of multicollinearity in the estimated regression model.

In the next step, the authors employed Pesaran CD cross-section dependence test in order to detect the cross-sectional dependence. Such a choice was made taking into account the fact that this test is suitable for almost all types of panel data, as well as dynamic heterogeneous short panels with a small number of observed time periods (*T*) and a large number of cross-sectional units (*N*) [27]. As can be seen from Table 5, there was no cross-sectional dependence between the observed variables. Therefore, the authors employed the first-generation unit root test. According to Barbieri [9] the Im, Pesaran & Shin (IPS) unit root *t-bar* statistic has a higher power than Levin, Lin & Chu unit root statistic for panels with short observed time periods (*T*). Consequently, in this paper the IPS test was used in order to examine the stationarity of the observed indicators. The results from Table 5 show that all observed variables are stationary.

Based on the obtained results of the evaluated SYS-GMM model shown in Table 6, the authors may draw a conclusion that the shorter inventory conversion cycle, i.e. accelerating inventory turnover has a positive impact on the Serbian manufacturing companies' profitability. On the other hand, other explanatory variables have no influence on profitability. Namely, although the coefficients of the remaining observed explanatory variables have a sign in accordance with the authors' expectations their p-values indicate that they do not have a statistically significant impact on profitability of the Serbian manufacturing companies. It is worth to mention that, based on the applied diagnostic tests (AR(2) and Sargan test), it can be concluded that the model is well specified. In other words, in the estimated model, there is no second-order serial correlation in first differences, and the over-identifying restrictions are valid.

Table 6: SYS-GMM model estimation

Variable	Coefficient	p-value
ROE (-1)	0.213440	0.3875
Inventory	-0.001796	0.0327
Receivables	-0.000669	0.7297
Payables	0.000344	0.7805
Liquidity	0.031889	0.4980
Fin. Leverage	-0.001145	0.6666
Activity	0.129558	0.1997
Growth	0.017084	0.2829
Diagnostic tests		
AR(2) (p-value)	-0.176817	0.1032
Sargan test (p-value)	6.543230	0.256886

Note: The Null Hypothesis of the AR(2) test implies that there is no second-order serial correlation in first differences. The Null Hypothesis of Sargan test implies that overidentifying restrictions are valid.
Source: The author's calculation based on the Serbian Business Registers Agency database, EViews 12 program.

Concluding remarks

The majority of the authors agree with the fact that efficient working capital management is important for achieving the profitability of companies in the long run. At the same time, it can be concluded that there is no consensus among them about the role of working capital management in achieving profitability. However, the most authors claim that the shorter cash conversion cycle has a positive impact on the profitability of the companies all around the world. Still, some authors prove that there is an inverted U shape between working capital and profitability. Inverted U shape relationship means that there is an optimal level of working capital. As is the case in most of the empirical studies, the authors of this article assume that a longer cash conversion cycle has a negative effect on profitability. The aim of this research is to determine an influence of effective working capital management on the profitability of the Serbian companies that operate in the domestic manufacturing sector. The considered sample consists of 141 domestic companies from the manufacturing sector with the highest level of the business income. According to Alsulayhim [5] the most frequent measures of working capital management are the CCC and its main elements. Many authors have used the same measures, such as Mazanec [22], Demiroj et al. [15], Alvarez et al. [6], Kafeel et al. [20], Alsulayhim [5], Agegnew [2], Evci and Şak [16], Şamiloğlu and Akgün [28], Seyoum et al. [30] and Agha [3]. Consequently, in this paper, the authors use: the inventory conversion period,

receivable collection period, and payable conversion period as the approximate indicators of working capital management. The cash conversion cycle was not included in the estimated model due to the fact that this variable is collinear with the ICP, RCP and PCP. Following Alvarez et al. [6], Alsulayhim [5] and Şamiloğlu and Akgün [28] the authors employ return on equity (ROE) as a measure of Serbian manufacturing companies' profitability. Following Jaworski and Czerwonka [19], Anton and Nucu [7], Arnaldi et al. [8], Boțoc and Anton [12] and Afrifa and Padachi [1] in order to examine the role of working capital management in achieving profitability in the manufacturing companies in the Republic of Serbia the authors employ the SYS-GMM estimation model.

In accordance with the available theoretical and empirical literature, the authors defined four hypotheses that cover the period from 2016 to 2020. Considering the First hypothesis the authors may conclude that the role of working capital management in achieving profitability in the Serbian manufacturing companies is relatively significant. This claim stems from the fact that only one component of working capital management has an impact on profitability. Regarding the other hypotheses, the authors can make the following statements. There is a negative relationship between the inventory conversion cycle as a component of working capital management and Serbian manufacturing companies' profitability calculated by ROE. This fact implies that the longer inventory conversion cycle reduces the profitability. According to obtained results, the authors show that there is no relation between the receivable collection period and payable conversion cycle as two other components of working capital management, on one side, and Serbian manufacturing companies' profitability computed by ROE, on the other side. Although the coefficients of both variables have the expected sign, their p-values show that they have no effect on profitability. Based on the obtained results of the System GMM model, it may be concluded that the shorter cash conversion cycle has a positive and statistically significant impact on the profitability of the observed companies covering the period from 2016 to 2020. On the other hand, the other control variables included in the model, such as liquidity, financial leverage, activity and sales growth, have no impact on Serbian manufacturing companies' profitability. Besides, the diagnostic tests indicate that the used SYS-GMM model was adequately specified and valid.

The wider implications of this study refer to the fact that it contributes to expanding the base of the theoretical and empirical knowledge of working capital management. The obtained findings are significant for the financial managers of the manufacturing companies in the Republic of Serbia, since they provide useful information about the intensity and direction of the certain determinants of profitability. On the other hand, the results of this research are also of interest to wider public and policy makers, considering the fact that the profitable manufacturing companies provide jobs, pay taxes, produce necessary goods and services and contribute to the creation of social well-being.

The objective limitation of this study is related to the data availability on the official website of the Serbian Business Registers Agency. For further research, the authors suggest an examination of the existence of an inverted U shape relationship between working capital and profitability in the Serbian manufacturing sector.

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THE INFLUENCE OF DISTRIBUTION CHANNELS ON THE PROFITABILITY OF BANKS

Uticaj kanala distribucije na profitabilnost banaka

Abstract

The introduction of digital channels for the distribution of banking services has become a necessity in the conditions of growing digitization and changed customer requirements. Without denying the importance of other marketing mix instruments, banks are increasingly basing their strategic competitive advantage on digital distribution channels. This regularity is especially emphasized given the emergence of digital technology companies (fintech and bigtech) which, owing to the development of digital distribution channels, are gradually taking over numerous financial services from banks. Nevertheless, for certain forms of banking services, traditional distribution channels and personal contact with the banker remain indispensable. The aim of the paper is to examine the impact of the introduction of digital distribution channels on the profitability of banks. The analysis covers the banking sector of the European Union member states in the period 2015-2020. In order to examine the influence of distribution channels (number of branches, number of ATMs, number of POS terminals and number of internet banking users) on the profitability of banks, measured by the return on assets (ROA) and return on equity (ROE), panel regression is used. The results confirm the significant and positive impact of digital distribution channels on bank profitability.

Keywords: *banking service, digital distribution channel, ROA, ROE*

Sažetak

Uvođenje digitalnih kanala distribucije bankarskih usluga nametnulo se kao nužnost u uslovima rastuće digitalizacije i promenjenih zahteva klijenata. Ne sporeći značaj ostalih instrumenata marketing miksa, banke sve više svoju stratešku konkurentsku prednost baziraju upravo na digitalnim kanalima distribucije. Ovakva pravilnost je posebno naglašena sa pojavom organizacija iz oblasti digitalnih tehnologija (fintech i bigtech) koje zahvaljujući upravo razvoju digitalnih kanala distribucije postepeno preuzimaju brojne finansijske usluge od banaka. Ipak, za pojedine oblike bankarskih usluga, tradicionalni kanali distribucije i lični kontakt sa bankarom ostaju nezaobilazni. Cilj rada je da ispita uticaj uvođenja digitalnih kanala distribucije na profitabilnost banaka. Analizom je obuhvaćen bankarski sektor država članica Evropske unije u periodu od 2015-2020. godine. Da bi se ispitao uticaj kanala distribucije (broja filijala, broja bankomata, broja POS terminala i broja korisnika internet bankarstva) na profitabilnost banaka, merene putem stope prinosa na ukupnu aktivu (ROA) i stope prinosa na akcijski kapital (ROE), korišćena je panel regresija. Rezultati su potvrdili značajan i pozitivan uticaj digitalnih kanala distribucije na profitabilnost banaka.

Ključne reči: *bankarske usluge, digitalni kanali distribucije, ROA, ROE*

Introduction

The dominant role of banks in the market of financial services has long resulted in insufficient customization of banking services. After financial deregulation and increased competition from non-banking financial institutions, banks integrated the marketing concept into their business processes in order to adapt their services as much as possible to customer requirements. By implementing marketing mix instruments, i.e. product, price, place, promotion and distribution channels, banks can more easily define and monitor customer requirements. The rapid technological development and the globalization of financial services have given special importance to the distribution channels of banking services. While other marketing mix instruments are mostly used as a source of competitive advantage, the distribution channels of banking services are still unexplored in terms of their effects on banking operations. Certainly, they have a synergistic effect with information and communication technologies. Today, banking activities are carried out in an extremely globalized environment, so the role of technology is of crucial importance. In the context of the distribution channels themselves, technology plays a very important role as it enables a high degree of flexibility. In this sense, the basic research question is the correlation between the profitability of banks and the specific distribution channels through which banks provide their services. The paper tests this correlation based on an example of the banking sector of the European Union member states. The starting hypothesis is that the application of digital distribution channels of banking services increases the profitability of banks. The structure of the paper consists of two units. In the first one, the evolution of the distribution channels of banking services will be presented in the context of applied banking strategies, together with the review of literature on previous research on the influence of distribution channels on the profitability of banks. In the second part of the paper, an empirical examination of the impact of digital distribution channels on the profitability of the banking sector in EU member states will be conducted.

Review of literature

The development of banking in the last few hundred years can be analyzed by looking at three development phases. The first phase, marked as rural banking, completed its formation in the last decades of the 19th century. The second phase, designated as the phase of structural and market consolidation, marked the end of the 19th century and lasted until the 1960s [14, p. 46]. The last stage in the development of banking covers the period after the second half of the 20th century and authors mostly associate it with the process of globalization. In this phase, banks reorganized their operations, with powerful global financial institutions standing out among them. The development process of banks largely modified the distribution channels of banking services. In the initial stages of development, the insufficient connection of banks made it difficult for them to provide a higher level of services. Since the economic conditions were also insufficiently developed, such banking infrastructure met the client needs of the time. In the mid-20th century, banking operations changed, primarily their business orientation, to abandon the previous production or sales orientation of banks [31, p. 94]. After that, the marketing concept found its path, entailing a detailed assessment of the needs of existing and potential clients, and the creation of an offer in accordance with their requirements. In such business conditions, marketing played one of the leading roles [32, p. 108]. Producing satisfied clients became a long-term strategy of banks [33, p. 36]. To this end, banks applied new technologies and applications, optimized their products and services, developed adequate financial infrastructure and enabled the exchange of information about clients and their behavior in all distribution channels [33, p. 36]. In that process, technology played the key role, influencing the formation of complex distribution channels and increasing the banks' chances to meet the complex needs of their clients in an international framework.

The marketing orientation of financial institutions implies their connection to the needs of clients and continuous market analysis, with a carefully selected performance strategy [32, p. 108]. The last century was marked by a drop in the number of banks, caused by

the process of consolidation and the creation of new organizational forms, such as holdings, within which banks operate today [16, p. 27]. Tinnila [29, p. 13] systematizes trends in modern distribution channels in banking and singles out the following: change in the population age structure; availability of banking services 24/7/365; increasing application of information and communication technologies; increasingly demanding clients; growth in the share of e-commerce; globalization of business. The aforementioned factors represent the general framework in which the banks redesigned, among other things, their distribution channels, in order to apply the marketing concept to the greatest extent possible. Today, banks distribute their products and services within complex systems, where close relationships with clients greatly facilitate that process and make it more flexible. The constant availability of services is a factor that clients especially value in the era of digitalization. The active role of clients in creating an offer of banking services has imposed the need to develop distribution channels that would respond to the changed client demands. In this sense, the following text will give an account of the evolution of the distribution channels, conditioned by the intensive technological development, with an analysis of the impact of this trend on the profitability of banks.

Evolution of distribution channels and selection of appropriate strategy for providing banking services

In a general sense, distribution channels represent the path by which goods or services move from producers through marketing intermediaries (wholesalers, distributors and retailers) to the end user [21, p. 788]. Applied to banks, the supply chain implies the dual role of banks: as production centers and intermediaries to the end users of banking services. In banking, distribution channels mean mechanisms for establishing contacts with clients in order to provide services. In this sense, there are traditional distribution channels that assume personal contact with the client and modern distribution channels, where personal contact with clients practically does not exist.

Marketing channels have changed dramatically due to numerous technological solutions and innovations during the last century [10, p. 27]. Their inclusion in the competitive strategy and consideration of optimization opportunities has a great advantage for the banks themselves, which is reflected not only in lower operating costs, but also in the impact on the overall performance and improvement of the bank's reputation. When looking at the distribution channels of banking services, there are those that assume the physical presence of the client, the so-called off-line systems, and those that rely on the application of information systems, the so-called online systems. Traditional banking systems imply personal contact with clients and physical presence, which in a globalized environment can be a barrier to meeting specific client requirements. Online banking, on the other hand, enables a high degree of flexibility in meeting the needs of clients, without territorial and time limitations in communication with clients. Internet banking has, at least to some extent, become the norm for many simple banking transactions [12, p. 54].

In traditional systems, the branch is a preferred channel for the distribution of banking services when personal contact with the banker is particularly valued. In direct contact with bank employees, information about the client needs is obtained and an offer is created accordingly. The Accenture research shows that this channel is most preferred when delivering more complex banking products to clients, non-standardized deposit-credit contracts, obtaining financial advice, and solving specific client requests [19, p. 1086]. The psychological effect of contracting certain activities with the bank is in focus here. In order to respond to the specific client requests, banks often form specialized branches, adapted to work with a certain group of clients. Most often, these are branches for working with legal or natural persons. Another interesting model of distribution of banking services is the so-called banking cafés. This model emerged as a result of a fast and busy lifestyle, so banks used an unusual place to connect with their clients. On the American market, *Capital One* is a pioneer in this type of banking. In 2017, this company owned about 30 facilities, which were particularly interesting to clients in terms of bank account opening services. The following text gives an analysis of the distribution channels of banking

services in the EU countries for a ten-year period, in order to observe the trend in the representation of individual distribution channels on the EU market, but also by individual countries (Figures 1-5).

The number of branches operating on the territory of the European Union has been constantly decreasing in the last decade (see Figure 1). The number of branches per 100,000 inhabitants fell from 34.2 in 2010 to 20.9 in 2020. Some of the factors that could influence the trend of the decline in the number of branches are the change in the user demands for financial services, cost reduction and the general trend of increasing digitization in the banking industry. Among the EU countries, in 2020 this type of distribution of banking services is most represented in Bulgaria (60.3 bank branches per 100,000 adults), as well as Luxembourg (59 bank branches per 100,000 adults) and Spain (45.5 bank branches per 100,000 adults) and it is the smallest in Finland (4 bank branches per 100,000 adults) [27].

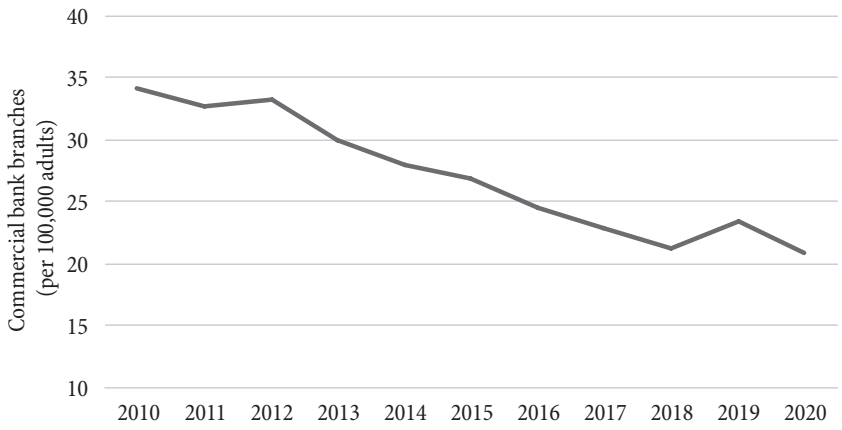
Numerous technological solutions have made it possible to reduce direct contact between the bank and clients, in order to achieve a greater degree of flexibility. All these innovative solutions led to the digital transformation of banks, [9, p. 48], which caused the transition to digital channels of distribution of banking services. Shaikh et al. single out the basic models of digital banking, namely [22]: ATMs; POS terminals; Telephone banking; Internet and mobile banking; Branchless banking; Banking through social networks.

ATMs (Automatic teller machines) represent the first automated distribution channel in retail banking, which enables a greater degree of flexibility and reduces personal contact with clients [3, p. 43]. As the main advantages of this channel, Mwatsika states the following [18, p. 27]: adaptation of the system to users; speed of operations; cash availability; transaction accuracy; shorter customer service time. Historically, ATMs were the first place to provide services, excluding branches, and were first used by Barclays Bank in England in 1967 [11, p. 374]. ATMs enable basic financial transactions, such as checking account balances or withdrawing cash. More complex ATM devices also offer the possibility of depositing money. Access to funds is provided by debit or credit card.

The number of ATMs per 100,000 people has decreased in the European Union in the last decade (see Figure 2), but the trends regarding changes in the number of ATMs differ from country to country. In some countries, the value of this indicator decreases in the period from 2010 to 2020, as is the case in Austria, Belgium, Cyprus, Estonia, Spain, France, Sweden and Italy, while in some countries it records growth (for example, in Germany, Finland, Greece, Croatia and the Czech Republic) [26]. The decline in the number of ATMs may indicate an increasing acceptance of cashless payments, while the maintenance of the size of the ATM network, and even its increase in certain countries, may be related to the greater use of more modern ATM devices, which to a greater extent represent a substitute for services that can be obtained in bank branches.

Point of sale terminals (POS terminals) are designed to enable cashless payments in retail. These devices enable easy transactions in real time. On the territory of the EU,

Figure 1: Commercial bank branches (per 100,000 adults) in the EU from 2010 to 2020



Source: [27]

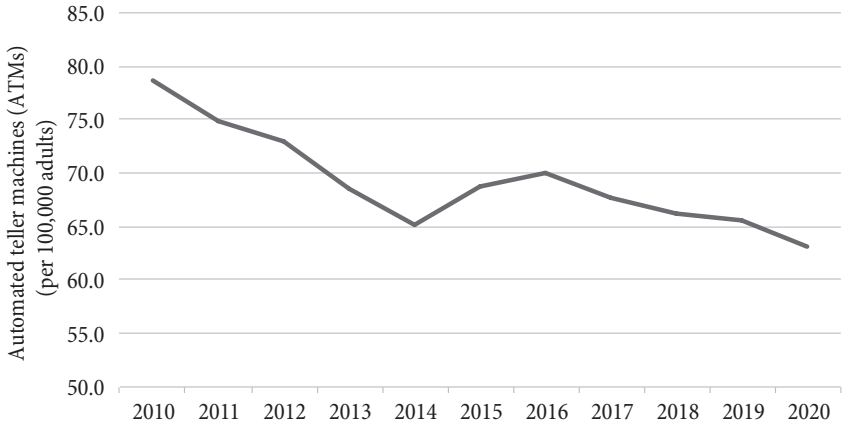
the number of POS terminals is constantly increasing, so there were 12.54 million POS terminals in 2015, and 14.65 million in 2020 [24]. The number of transactions performed through POS terminals also increased, together with the increase in their value (see Figure 3).

Compared to 2019, in 2020 the number and value of transactions at POS terminals decreased. The reason for this can be found in the COVID-19 pandemic outbreak and the restriction of movement in order to prevent the spread of the coronavirus (lockdowns). Also, in the conditions of the pandemic, the demand for contactless payments increased, and thus POS terminals, equipped with technologies that support contactless payments, gained importance.

Banking by phone, mobile center or interactive voice response involves either an automated telecommunications machine, i.e. IVR, or an agent. The IVR can talk to clients, give them access to their banking information and help them complete their service. This is a significant step forward in the development of digital banking, where the role of the clerk is taken over by a machine. Special programs, which in their essence mark artificial intelligence in its infancy, process client requests at a higher level and help satisfy client needs.

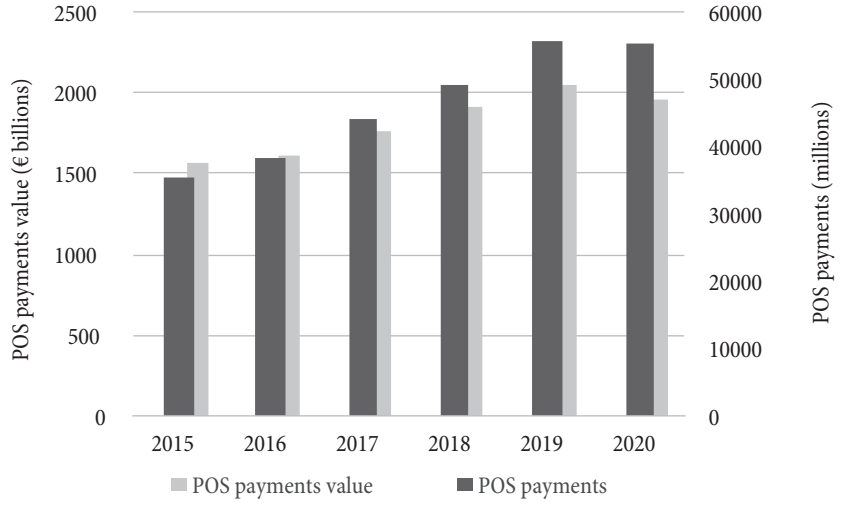
Internet banking enables the bank's clients to access banking information and carry out transactions using a computer or laptop at any time and at any place. The introduction of the Internet as a channel for the distribution of banking services represents a revolution in the provision of banking services and changes the very position of clients, because they get an active role in that process. In this way, clients can independently carry out banking transactions: make payments, convert currencies, submit loan applications and get other

Figure 2: ATMs per 100,000 population in the EU from 2010 to 2020



Source: [26]

Figure 3: Number and value of transactions at POS terminals in the EU in the period from 2015 to 2020



Source: [7]

banking products. This allows for the full application of the marketing concept, given that clients can create personalized requests. The increasing importance of the Internet as a channel for the distribution of banking services is shown in Figure 4.

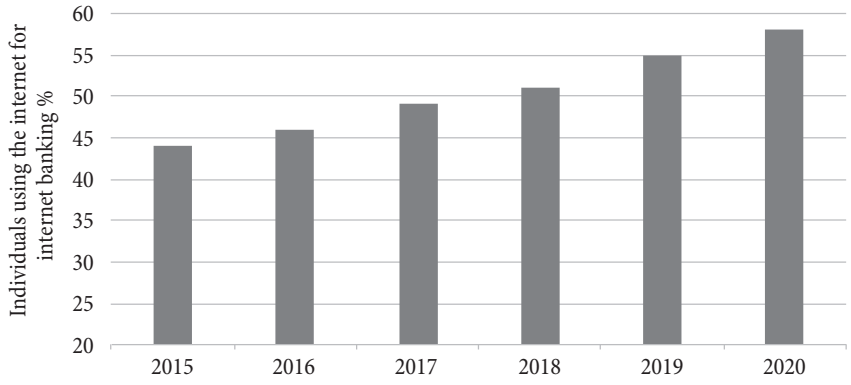
On a country basis, there is a noticeable difference in the use of the Internet as a channel for accessing banking services (see Figure 5). In 2020, 94 percent of the Danish population accessed online banking sites, followed by Finland with 92% and the Netherlands with 89%. Individuals use the internet for internet banking the least in Bulgaria (13%) and Romania (12%).

Even greater comfort and better customization come from mobile banking, in which clients can use banking services using their mobile phones and tablets [13, p. 1042]. Banks are investing significant resources in creating applications through which clients can satisfy an increasing number of banking services.

Branchless banking means a concept in which a bank or microfinance institution, in cooperation with a mobile telecommunications company or a mobile network operator, gives clients an opportunity to transfer and pay relatively small amounts. It is primarily intended for a group of clients with low incomes and remote areas. This distribution channel is of particular importance, because in this way banks expand their network of clients, overcoming territorial limitations. In addition, this way even low-income clients can effectively use banking services.

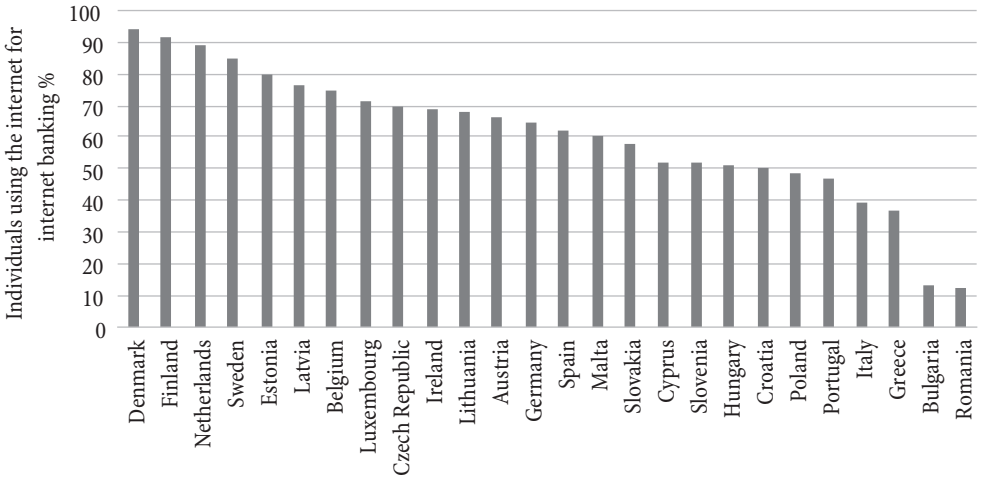
In recent years, social networks are increasingly replacing traditional media, so banking through social networks has established itself as a special type of digital banking [4, p. 770]. Parusheva singles out the following as the main advantages of this distribution channel [20, p. 127]: offering up-to-date information; quick response to changed client requirements; greater coverage, in terms of providing banking services to a wider circle of clients.

Figure 4: Individuals using the internet for internet banking (%) in the EU



Source: [8]

Figure 5: Individuals using the internet for internet banking (%) in selected European markets in 2020



Source: [8]

Practice shows that this way of distributing banking services has a positive effect on the bank's performance. More modern models of communication between banks and clients enable a greater degree of flexibility and personalization. A Deutsche Bank Research study shows that social media users have a greater demand for financial information and that personal contact with a bank employee is less important to such users [28].

The list of possible models through which banks achieve the goals of the digital agenda does not end here. There are a large number of hybrid models, because banks in the constant battle with the competition come up with new solutions through which they achieve higher levels of satisfaction for their clients. Bearing in mind the aforementioned systems for the distribution of banking services, the bank must choose an appropriate strategy for serving clients. Viewed from the perspective of distribution channels, there are three types of banks today [15, p. 54]:

- Banks that operate solely through branches;
- Banks that operate through branches and the Internet (dual strategy);
- Banks that operate solely through digital platforms, the so-called digital banks.

The first strategy belongs to the group of traditional strategies and is effective when banks can control operating costs. However, the globalization of the financial market, competition from non-banking financial institutions, as well as digital technology companies, require large investments by banks, which in conditions of saturated markets can not only reduce the profitability of banks, but also call into question their market position. In this sense, banks are forced to switch to a dual strategy, and some to digital channels only. The paper aims to empirically verify the influence of distribution channels on the profitability of the banking sector of EU member states.

The influence of distribution channels on bank performance

Numerous authors have researched the impact of banking service distribution channels on bank performance. Table 1 summarizes the conclusions of individual research

Table 1: Review of the literature on the influence of distribution channels on bank performance

Author/-s	Year	Title of the paper	Research subject	Research result
Campebell, D. Frei, F.	2009	Cost Structure, Customer Profitability, and Retention Implications of Self-Service Distribution Channels: Evidence from Customer Behavior in an Online Banking Channel	Change in clients' habits in using online banking services and assessment of the degree of adoption of new electronic models	The degree of adoption depends on: costs, increased use of services through more expensive distribution channels, and increased volume of transactions
Auta, E.	2010	E-banking in developing economy: Empirical evidence from Nigeria	Effects of e-banking on bank performance in Nigeria	E-business is a key element of banks' development strategy
Chavan, J.	2013	Internet banking - benefits and challenges in an emerging economy	Advantages and challenges in electronic banking, business models	Multichannel approach proved to be the most desirable for bank performance
Stoica, O., Mehdian, S. & Sargu, A.	2015	The impact of internet banking on the performance of Romanian banks: DEA and PCA approach	Analysis of financial innovations and their contribution to the efficiency of Romanian banks	Multichannel approach proved to be the most desirable for bank performance
Akhisar, I., Tunay, B. & Tunay, N.	2015	The Effects of Innovations on Bank Performance: The Case of Electronic Banking Services	The impact of electronic distribution channels on bank performance on a sample of 23 developed and developing countries	Due to differences in the infrastructure of electronic distribution channels, the legal framework, as well as client habits, the impact of electronic distribution channels on bank performance is not positive in all observed countries
Sindani, M., Muturi, W. & Ngumi, P.	2019	Effect of financial distribution channels-Evolution on financial inclusion in Kenya	Looking at the effects of modern distribution channels on banking in Kenya	Internet banking had a positive impact on bank performance
Motondi, F.	2020	A research project report submitted in partial fulfilment of the requirement of Master of Business Administration in Strategic management of Kenyatta University	Assessment of the impact of distribution channels on the performance of commercial banks in Nairobi City District, Kenya	Electronic distribution channels have a positive impact on the financial performance of banks
Uche, D. Anene, J. Nnabugwuc, E.	2022	Effect of Distribution Channel Strategies on the Performance of Banks	Determination of distribution channel strategies applied by banks in Nigeria and effects on profitability	1. Commercial banks use different marketing strategies to gain competitive advantage. 2. Strategies that use a multi-channel approach with reliance on electronic distribution channels significantly increase the profitability of banks

Source: [5], [2], [6], [25], [1], [23], [17], [30]

dealing with this topic, which will be taken as a starting point for examining the impact of electronic distribution channels on the profitability of the banking sector of EU member states.

Analyzing the influence of distribution channels on the profitability of banks, most authors confirm the positive influence of electronic channels on the profitability of banks [1, p. 372]. Auta [2] observes a sample of 25 commercial banks to prove that banks in Nigeria achieved positive effects after the introduction of digital channels, not only through greater client satisfaction, but also better financial performance. Frei and Campbell [5] study the factors that depend on the level of acceptance of online banking systems, observing the clients of an American bank over a period of 30 months. The analysis shows that the effects of innovations in modern distribution channels can only be seen in the long run, through the influence on the growth of the bank's profit through the retention rate of clients. Most authors confirm the dominant presence of multichannel systems for the distribution of banking services. Chavan [6] rates the mixed approach as the most desirable model for increasing profitability in the Indian banking sector. Stoica et al. [25] come to the same conclusion observing the performance of Romanian banks. Motondi [17] proves that the positive impact on the performance of banks comes first with the use of ATMs, and then with the increasing use of mobile and internet banking. He also points out that accelerated interoperability among different distribution channels would have a positive impact on the entire banking system. For the success of commercial banks in Nigeria, Uche et al. [30] highlights the need to combine traditional and digital distribution channels, more specifically branch network and electronic banking. The subject of this paper is the influence of distribution channels on the profitability of the banking sector of EU member states.

Research methodology

The paper analyzes the influence of the distribution channel of banking services on the profitability of the banking sector of EU member states. Basic indicators of bank profitability, return on assets (ROA) and return on equity (ROE) are dependent variables. Independent variables are: Number of branches per 100,000 adults, Number of ATMs per 100,000 adults, Number of POS terminals, Individuals using the internet for internet banking. In order to examine the influence of the number of branches, the number of ATMs, the number of POS terminals and the number of internet banking users, while controlling the amount of loans, deposits, assets and equity on the profitability of banks, measured by ROA and ROE indicators, a panel regression is used.

Data collection and sample

This research focuses on data on the banking sector of EU member states in the period from 2015-2020. The data is taken from the website of the European Central Bank. Descriptive statistics of the variables used is shown in Table 2.

Table 2: Descriptive statistics

Variable	Result variation	M	SD	Minimum	Maximum	N
branches	Total	27.222	15.726	4	76.8	161
	between		15.554	5.933	69.517	27
	within		3.426	16.373	39.406	5.923
atm	Total	81.240	37.511	28.3	183.27	165
	between		37.745	32.847	170.083	28
	within		5.144	60.417	98.695	5.893
pos	Total	497,590.4	715,085.5	18,123	361,709.8	142
	between		674,551.1	18,123	284,106.9	27
	within		162,694.3	-364,054.6	127,361.9	5.259
internet	Total	54.114	22.638	4	94	167
	between		22.205	7.167	89.5	28
	within		5.625	40.447	72.447	5.964
loans	Total	866,754.7	143,727.8	15,167	569,679.1	167
	between		147,321.7	18,281.5	513,221.2	28
	within		112,023.2	199,857.7	143,133.4	5.964
deposit	Total	831,194.2	140,299.5	13,180	596,758.7	166
	between		142,869.4	15,362.33	489,434.3	28
	within		150,604.7	193,244.8	209,319.3	5.929
assets	Total	154,237.1	258,551.4	22,719	1.05e+07	167
	between		267,746.3	26,541.83	9141028	28
	within		185,945.9	766,262.6	310,693.4	5.964
equity	Total	125,147.9	195,189.8	2,736	818,316	140
	between		197,002.5	3,067	00501.2	28
	within		20146.38	40,442.67	242,962.7	5
ROA	Total	0.599	0.571	-2.823	1.614	167
	between		0.468	-6.769	11.679	28
	within		0.335	-1.456	1.444	5.964
ROE	Total	6.349	5.304	-24.217	14.685	167
	between		4.228	-6.769	11.679	28
	within		3.275	-11.099	15.175	5.964

Source: Results of authors' research.

The table shows the average values of all variables, where the variation of results between countries is greater than by year within one country. Therefore, Table 3 shows the average values of the observed variables in EU member states.

In order to examine the influence of the number of branches, the number of ATMs, the number of POS terminals and the number of internet banking users, while controlling the amount of loans, deposits, assets and equity, a panel regression is used (see Table 4).

The fixed effects model (FEM) is adequate for assessing the impact of the number of branches, the number of ATMs, the number of POS terminals, and the number of internet banking users, while controlling the amount of loans, deposits, assets and equity on ROA (see Table 5). The result of the *Breusch-Pagan*

Table 3: Arithmetic means of dependent and independent variables in EU member states

	roa	roe	branches	atm	pos	internet
Austria	0.622	7.326	11.633	170.083	150695.2	58
Belgium	0.612	8.445	34.36	84.394	218945	68
Bulgaria	1.247	9.570	55.133	93.198	173938	7.167
Croatia	0.696	5.099	30.683	139.345	110220.7	40.167
Cyprus	-0.277	-1.759	38.317	45.567	28944.33	33.667
Czech Republic	1.047	11.679	21.267	55.232	181837.7	59.333
Denmark	0.486	8.088	21.517	47.472	138950	89.5
Estonia	1.22875	8.753	9.7	68.09	35337.67	80
Finland	0.465	7.446	5.933	34.62	144678.5	88.5
France	0.383	6.051	35.5	100.335	1794286	61.6
Germany	0.151	2.265	12.033	128.23	1339802	57.5
Greece	-0.767	-6.770	22.1	61.508	567753.5	25.5
Hungary	1.082	10.521	17.567	59.847	171231.3	41
Ireland	0.575	4.079	20.633	80.733	291233.7	59.167
Italy	0.195	2.369	43.283	92.517	2841069	32.833
Latvia	1.077	9.454	13.85	60.538	39458.5	66.833
Lithuania	0.975	10.880	12.267	44.537	53583	59
Luxemburg	0.470	5.911	69.517	111.982	196670.3	70.333
Malta	0.848	5.526	30.683	51.857	18123	51.5
The Netherlands	0.422	6.991	10.917	43.323	486577.8	88
Poland	0.710	6.524	29.283	70.34	723609.2	41.667
Portugal	0.086	0.261	36.683	168.57	324350.8	36
Romania	1.261	11.422	25.883	65.692	198180.2	7.333
Slovakia	0.793	8.620	26.2	61.182	63068.67	49.333
Slovenia	1.028	8.786	28.567	90.085	36259.83	41.5
Spain	0.382	5.003	56.35	109.95	1615622	49
Sweden	0.655	10.907	16.35	32.847	248472.2	83.667

Source: Results of authors' research

Table 4: Results of the model adequacy test of the dependent variable ROA

Breusch-Pagan LM	Hausman test	Wooldridge test	Wald test
48.90 (0.000)	13.08 (0.011)	F (1.21) =10.883 (0.003)	$\chi^2(26)$ = 3.4e+32 (0.000)

Source: Results of authors' research.

Table 5: Dependent variable ROA

Variable	B (95% CI)	p
Number of branches per 100000 adults	0.002 (-0.234; 0.028)	0.885
Number of ATM per 100000 adults	0.021 (0.005; 0.038)*	0.012
Number of POS terminals	5.16e-07 (-8.70e-07; 1.90e-06)	0.451
Individuals using the internet for internet banking	0.028 (0.003; 0.054)*	0.032
Loans	1.28e-06 (-1.03e-06; 3.58e-06)	0.264
Deposits	-1.00e-06 (-4.84e-06; 2.84e-06)	0.595
Assets	-8.92e-07 (-2.10e-06; 3.21e-07)	0.142
Capital and reserves	-7.62e-07 (-4.59e-06; 3.07e-06)	0.685

Note: * level of significance α = 0.05
Source: Results of authors' research.

LM ($\chi^2(1) = 48.90$; $p = 0.00$) and Hausman tests ($\chi^2(4) = 13.08$; $p = 0.01$) support the panel regression model with fixed effects (*FEM).* The fixed effects model is significant, $F(8, 25) = 3.34$; $p = 0.01$, and explains a total of 5.6% ($R^2 = 0.0564$) of the variation in the dependent variable ROA.

The variation of the criterion variable is significantly affected by the number of ATMs (B = 0.021; 95% CI= 0.005 – 0.038; p = 0.01) and the number of internet banking users (B = 0.028; 95% CI = 0.003 – 0.054; p = 0.03). Increase in Number of ATMs per 100,000 adults by 1 increases ROA by 0.02. As the number of internet banking users increases by 1, ROA increases by 0.03.

In order to examine the influence of the number of branches, the number of ATMs, the number of POS terminals, the number of internet banking users, while controlling the amount of loans, deposits, assets and equity on ROE, a panel regression is used (see Table 6).

The fixed effects model (FEM) is adequate to assess the impact of the number of branches, number of ATMs, number of POS terminals, and number of internet banking users while controlling the amount of loans, deposits, assets, and equity on ROE (see Table 7). The result of the *Breusch-Pagan LM* ($\chi^2(1) = 46.06$; $p = 0.00$) and Hausman tests ($\chi^2(4) = 13.40$; $p = 0.01$) support the panel regression model with fixed effects (*FEM).* The fixed effects model is significant, $F(8, 25) = 5.99$; $p = 0.00$ and explains a total of 3.3% ($R^2 = 0.0333$) of the variation in the dependent variable ROE.

The variation of the criterion variable is significantly affected by the Number of ATM per 100000 adults (B = 0.174; 95% CI = 0.055 – 0.293; p = 0.01) and the number of internet banking users (B = 0.286; 95% CI = 0.082 – 0.491; p=0.01). Increase in the Number of ATM per 100000 adults by 1 increases ROE by 0.17. When the number of Internet users increases by 1, ROE increases by 0.29.

Conclusion

The trend of digitization and the increasing share of digital channels in the distribution of banking services leads to lower transaction costs. However, the introduction of these channels requires bank investments in the development of digital platforms and adaptation of banking services to new trends. In the entire process of digital transformation of banks, the ultimate goal is to secure a base of loyal clients and improve the bank's overall performance, primarily its profitability. In this sense, the paper analyzes the impact of digital distribution channels on the profitability of the banking sector in EU countries. In order to examine the influence of the number of branches, the number of ATMs, the number of POS terminals and the number of internet banking users, while controlling the amount of loans, deposits, assets and equity on ROA and ROE, a panel regression is used. The results confirm a positive and significant impact on both bank profitability indicators. However, the dilemma about the greater efficiency of traditional or digital distribution channels and their impact, primarily on the

Table 6: Results of the model adequacy test of the dependent variable ROE

Breusch-Pagan LM	Hausman test	Wooldridge test	Wald test
46.06 (0.000)	13.40 (0.009)	F (1, 21) = 5.680 (0.027)	$\chi^2(26) = 1.3e+28$ (0.000)

Source: Results of authors' research.

Table 7: Dependent variable ROE

Variable	B (95% CI)	p
Number of branches per 100000 adults	0.075 (-0.181; 0.331)	0.552
Number of ATM per 100000 adults	0.174 (0.055; 0.293)*	0.006
Number of POS terminals	4.97e-06 (-6.79e-06; 0.000)	0.392
Individuals using the internet for internet banking	0.286 (0.082; 0.491)*	0.008
Loans	0.000 (-9.97e-06; 0.000)	0.275
Deposits	-7.68e-06 (-0.001; 0.000)	0.633
Assets	-9.81e-06 (-0.001; 3.67e-06)	0.146
Capital and reserves	-0.00001 (-0.0001; 0.0000)	0.412

Note: * level of significance α = 0.05
Source: Results of authors' research.

profitability of banks, can only be analyzed if traditional and online systems are viewed as mutually exclusive. By properly analyzing clients, banks select requests and create a strategy accordingly. There is always a certain number of clients who do not require customization, and they will also accept traditional distribution channels. Sophisticated clients who demand a higher level of service will prefer to turn to modern systems, and the speed of the service will be the dominant performance indicator on the basis of which they will choose a specific bank. Since banks today mainly apply dual strategies in the distribution of their services, it is difficult to make a final judgment as to which form of banking is more prevalent, that is, which distribution channel contributes more significantly to the profitability and overall performance of banks. The fact is that the role of the Internet has largely moved banking services to a new, virtual market. Likewise, a large number of banks, according to the stage of development in a certain market, choose traditional models in the distribution of services. The question is to what extent the penetration of a certain market can be covered by online systems because the issue of trust in the initial phase is crucial. It is considered that these systems are adaptable when trust in the bank's operations already exists, and when the bank already has a significant client base.

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WHAT CREATES THE INNOVATIVE ORGANISATIONAL DESIGN IN SCIENCE AND RESEARCH ORGANISATIONS (SROs) IN SERBIA? THE INFLUENCE OF STRATEGIC PROJECT MANAGEMENT FACTORS

Šta oblikuje inovativni organizacioni dizajn u naučnoistraživačkim organizacijama u Srbiji? Uticaj faktora strateškog upravljanja projektima

Abstract

Efficient strategic project management in SROs (Science and Research Organisations) implies the existence of an integrated strategic management concept closely linked to an innovative organisational design. The aim of the paper is to examine the influence of certain factors of strategic project management on creating an organisational design that encourages innovation in scientific research organizations. An empirical research in SROs in Serbia has been conducted as well. Our research is empirically presented on the example of SROs in Serbia as a representative of developing countries. Our findings show that the external and internal environment, project portfolio, resources, monitoring, methods, and techniques mainly influence an organisational design. These elements of strategic project management account for 67.3% of the explained variability in a developed regression model. This paper extends the current strategic and project management literature with a new conceptual model on the link between strategic project management factors and an innovative organisational design in SROs. The presented analysis can help strategic and project managers establish adequate strategic guidelines for organisational development activities to improve the efficiency of scientific research results and the level of their innovativeness.

Keywords: *organizational design, strategic management, project management, scientific-research organizations (SROs)*

Sažetak

Efikasno strateško upravljanje projektima u NIO (naučnoistraživačkim organizacijama) podrazumeva postojanje integrisanog koncepta strateškog upravljanja koji je usko povezan sa inovativnim organizacionim dizajnom. Cilj rada je da se ispita uticaj određenih faktora strateškog upravljanja projektima na kreiranje organizacionog dizajna kojim se podstiču inovacije u naučnoistraživačkim organizacijama. U radu je sprovedeno i empirijsko istraživanje u naučnoistraživačkim organizacijama u Srbiji. Naši nalazi pokazuju da eksterno i interno okruženje, portfolio projekata, resursi, monitoring i metode i tehnike utiču na organizacioni dizajn. Ovi elementi strateškog upravljanja projektima čine 67,3% objašnjene varijabilnosti u razvijenom regresionom modelu. Ovaj rad proširuje trenutnu literaturu o strateškom i projektnom menadžmentu novim konceptualnim modelom o povezanosti faktora strateškog upravljanja projektima i inovativnog organizacionog dizajna u NIO. Prikazana analiza može pomoći strateškim i projektnim menadžerima da postave adekvatne strateške smernice za aktivnosti organizacionog razvoja u cilju poboljšanja efikasnosti naučnoistraživačkih rezultata i stepena njihove inovativnosti.

Ključne reči: *organizacioni dizajn, strateški menadžment, projektni menadžment, naučnoistraživačke organizacije*

Introduction

For a long time, in literature, scholars observed the innovative behaviour of companies mainly through a technological dimension. Organizational elements (organizational structure, organisational culture, organisational learning, teamwork, leadership, and motivation), which belong to non-technological dimension, began to be considered essential factors of success in innovative companies at the end of the twentieth century. Moreover, organisational design is becoming a necessary factor for strategically managed innovative companies. Since 2006, Community Innovation Survey – the statistical report on companies' innovation activity data has incorporated the part related to the organisational components of innovative companies [76].

Organizational design is a framework in which certain behaviours occur in organisations, at the individual, group, and corporate (organisational) levels. The innovative behaviour of a company is a strategic commitment of the management to be innovative, whether the company is a companion to others, i.e. an imitator, or a leader in creating new products and services, new managerial technologies and style leadership, i.e. an innovator [67].

The organizational design provides the guidelines for a decision-making process in an organisation [25]. Designing scientific-research organisations (SROs) represents a complex process that involves fitting these organisations' technological and non-technological dimensions. It means encompassing scientific research activities, engaging highly competent workers, and society needs. It is necessary to direct the creative potential of these organisations toward the market and social demands without losing scientific curiosity.

Nowadays, SROs are facing challenges and remodelling as a result of a new form of supply and demand in a volatile environment, especially in developing countries. In the economies facing privatisation, liberalisation, and lack of public funds, the organisations dealing with scientific research are forced to develop cooperation with other national innovation stakeholders, e.g. the economy, governments, and civil society. All these activities demand well-educated strategic management. One of the mistakes developing countries make is merely copying the models from developed countries. On the contrary, scientific research and development need to be aligned with the identified needs within the national innovation system [7]. SROs are one of the leading actors of the national innovation system that reflect considerable external changes. These include political, economic, and demographic changes, as well as the need to maximize the utilization of science and research activities to operate most effectively and efficiently (see [24], [36], [40], [48], [53], [62], [74], [85], [96]). Understanding the performance of SROs is a very demanding task because it involves simultaneous consideration of researchers' characteristics, the organisational characteristics of the SRO itself, and the characteristics of a particular industry [51]. The results of the scientific research in these organisations occur as an interaction between different decisions and choices, including the size and location of research and development (R&D) capacity, division of labour among different groups, technological development and the use of different technologies, staffing, resource allocation, project management, a process design, and other factors. Establishing operational coherence and synergy to achieve the best possible results indicates the importance of strategic project management in SROs [81]. It integrates the concept of strategic management and project-based scientific research work comprehensively.

The link between strategic and project management has become increasingly important, as it can be seen from the extensive literature related to different aspects of these topics [44], [63], [77]. A significant contribution to understanding project management in SROs is the evaluation of research and development (R&D) project management approaches, from the traditional one focusing on completing project tasks within the timeframe and budget to the modern approach focusing on meeting the market needs [88]. Due to its increasing importance, numerous scholars have focused on the relationship between strategic orientation and the organisational elements in SROs. Effective strategic management in SROs mainly involves organisational design that encourages innovations. Creating and developing new ideas and the success of innovation are closely connected with an organisational context [95]. A large number of studies in management have shown managerial harmonisation between

individual components of a management process and the establishing of close links between corporate functions and R&D activities. This enables power dispersion from the top management to the management of departments leading to the improvement of a R&D process and a flexible search for business opportunities [71].

This paper contributes to the existing theory and practice by extending the current strategic and project management literature with a new conceptual model on the association between strategic project management factors in SROs and an innovative organisational design. It considers the influence of strategic management by selecting relevant strategic management factors and examining their contribution to an organisational design. The next chapter offers a profound literature review on the presented topic and develops the research hypotheses. The third chapter presents the research methodology, while the fourth one shows the results. Finally, the discussion and conclusion sections are given.

Theoretical background and hypothesis

Organisational design

For a long time, organisational structure and design were considered synonymous in economic literature [65]. With the development of organisation theory, especially with the appearance of contingency theory, the term organisational design has become more than an organisational structure [42]. The strategy has become the main driver for creating an organisational design. Many factors enable running an organisation besides its formal structure and the internal relationships between the units within the organisation as usually presented in a typical organisation chart [32].

An organisational design is a tool for aligning all the components of an organisation towards goal implementation, defining the success of organisations, and shaping their performance [17], [72], [89]. In the literature, there is no universal model of organisational design which can be implemented in practice. The model components differ from one organisation to another and are grounded on logic and principles [32]. It is noticed that the greater the number of stakeholders involved, the greater is the efficiency of organisational design application [89]. An organisational design involves specific types of organisational behaviour of employees aiming to enhance organisational effectiveness. The influences from the modern economy place emphasis on knowledge as a factor of competitive advantage. The focus has shifted from organisation's material resources towards employees' skills and competencies and new forms of organisational structure [79]. Numerous research examined how particular organisational design components affect organisations' innovative behaviour. Some authors examined the relationship between leadership, innovations, and organisational culture as a component of organisational design directed towards employees [43], [78], [84], [86], [91]. Organisational culture influences strategic and operational decisions, activities and interactions, and determines organisational performance. Moreover, organisational culture determines the character of interpersonal relations, the reward and motivation system, influences the reduction of conflicts, and facilitates coordination. However, organisational culture is determined by numerous factors, especially by a leadership style – "leaders create organisational culture according to their own personal traits, values, and style" [39]. It was shown that organisational culture fosters innovation and creativity within organisations [2], [56], [58], [59], [100]. Other authors underlined that the size of a company is also crucial for developing an organisational culture that fosters innovation [49], [50]. The impact of organisational culture on project execution is widely recognised [8], [90]. The organisational culture in SROs, such as institutes and universities, is seen as a tool for fostering the implementation of technological innovation and knowledge sharing, as well as a response to globalisation [6], [13], [29], [52], [57], [101]. Managing "knowledge workers", performance, and rewards highlights the importance of people management in the knowledge economy [93]. Human resource development and its link with innovation ought to be analysed within the context of organisational culture and leadership capabilities [41], [14], [87]. Creating the successful organisational design which encourages innovation is a very complex process that involves aligning a set of organisational components, which should be combined in the best possible way to

create and improve the environment that encourages innovation in the first place [67], [14], [94], [69], [4], [61].

An innovative organisational design means that structure, processes, rewards, and people should be managed towards innovation. At a strategic level, there is a need for a skill to combine two antagonistic capabilities of an organisation: innovative and operative [30], [92]. The organisational context of SROs implies a set of instruments that enables a smooth running of all phases of a R&D process. SROs strive to institutionalise their R&D management components through an appropriate organisational context that enables them to maximise the efficiency of an entire R&D process. The organisational component integrates scientific research specifics, such as project management, cooperation within and between project teams, budget management, a human resources development plan, linking strategic and operational activities by creating a project management unit, etc. Structuring science and research activities effectively implies overcoming the resistance to change, willingness to take risks, and encouraging innovative behaviour of employees in organisations.

The innovative organizational design in the context of this paper implies an organisational concept that encourages innovativeness in an organization.

SROs, strategic project management, and innovation

As previously mentioned, SROs are significant actors within the national innovation system. They represent the knowledge base and foster innovation and the performance of national economies. Research institutes in the narrow sense, are recognisable, strategically-oriented research organisations that perform crucial functions within European innovation systems [7]. The importance of these institutions is, foremost, in engendering knowledge, which presents the critical component of technological progress. Faculties create highly educated staff and engineers who can create new knowledge. Institutes, research centres, and universities alike perform the function of knowledge-engendering and inciting technological progress [15], [60], [73]. SROs' scientific work aims to improve the existing knowledge base, whereas R&D activities aim to direct research towards market demands.

A major imperfection of most strategic management models in SROs, especially in developing countries, indicates that neither a scientific research process nor a strategic management process is viewed in a sufficiently analytically comprehensive framework. In most cases, only specific components of these processes are described, further implying that strategic management in these organisations has been facing numerous organisational challenges [10].

For SROs, project management is seen as a core competence [55]. Effective management of individual projects and entire project programs and portfolios has become necessary in modern management practice. In SROs, effective project management generally improves the scientific knowledge base and the efficient use of scientific research results, especially considering the high costs involved [23], [87]. The approach of managing a project influences project performance in an organisation [21]. Project managers should support the creative thinking of project team members and turn it into concrete scientific results (scientific papers, reports, journal articles, etc.) or concrete technologies or technological processes within the appropriate timeframe and budget [23].

In addition, the fact that the research results of SROs should be further applicable indicates the need for professional development of the management of SROs. In developing countries, SROs management has evolved under the influence of the changes that are taking place in the field of R&D. The abbreviation R&D puts together pure research and innovation activities with cost and product optimization [64]. Nowadays, R&D is seen as an input to innovations, not only in terms of their impact on organizations but also on society as a whole. The importance of market information in defining scientific research projects was pointed out long ago [27], [28]. For this reason, understanding the project management process in SROs involves understanding strategic orientation in managing innovations [19], [38]. Innovation management is closely connected with assigning responsibility for innovation within a company to develop, organise, and manage innovation activities in line with its organisational context [14], [5], [11], [46]. This should be enabled through

organisational adaptation to new concepts or behaviour typical for innovative organisations [17]. According to the literature, innovation can be defined as measuring the efficiency of R&D activities in organisations that can lead to technological and organisational changes [76], [14], [97]. Nevertheless, besides technological innovations, non-technological innovations are also crucial for organisations. Organisational innovations are seen as a business process which comprises activities such as strategic management and human resource management [76].

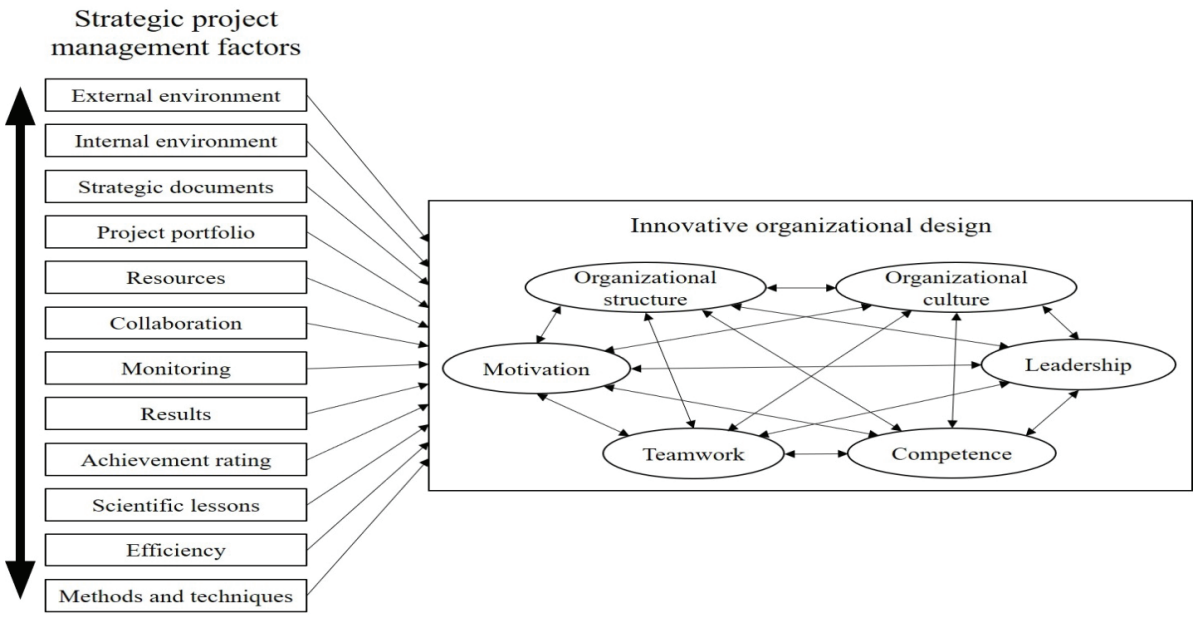
Hypothesis development

It is a significant challenge to develop a comprehensive framework for strategically managed scientific and research work in SROs. There is a consensus in the literature that organisational innovativeness is crucial for long-term sustainability [66]. According to the literature, we incorporated the strategic and project management components in our model [63], [98] to examine their influence on an innovative organisational design. Most researchers suggest that organisational design is multidimensional, and a large scale of organisational factors can influence scientific and research work and their utilization. This literature review has focused on understanding the content of the organisational dimension that will enable an organization to be innovative.

An integrated strategic management model in SROs represents a system of several interconnected elements which describes the core elements of strategic management in an organization: planning, implementation, and evaluation. The development of such a model is a challenging task. It connects the concept of strategic management and project-oriented scientific research activities. The general shortcomings of most strategic management models in SROs relate to the process of R&D itself and the fact that a strategic management process needs to be viewed in a more integrated, analytically acceptable framework. In literature, frequently, only some of the phases of this process are described, which does not provide detailed insight into the importance of strategic management with all its components in SROs, further implying that strategic management in these organisations faces numerous methodological and organisational challenges.

In this paper, we aim to examine the relationship between the selected components of strategic project management in SROs and the organisational design that fosters innovation, with a specific focus on Serbia. A significant challenge was to describe a conceptual framework of strategic management in SROs. After a detailed theoretical analysis and taking into account the specificity of the scientific research system in Serbia, relevant factors that describe the process of strategic management in this type of organisation were selected

Figure 1: Research model framework



and presented by several consistent variables: external environment, internal environment, strategic documents, project portfolio, resources, collaboration, monitoring, results, achievement rating, scientific lessons, efficiency assessment, and strategic management methods and techniques (see Table 3 and Figure 1).

The paper is based on the hypothesis that certain factors of strategic project management influence the creation of the organizational design that encourages innovation in scientific and research organizations. A successful organisational design that fosters innovation means aligning the organisational components in a way that enables creating and improving the innovation-induced environment. Based on the previous literature review, we developed the concept of the organisational design that triggers innovation in SROs, as presented in Table 2 and Figure 1, which includes: organisational structure, organisational culture, leadership, teamwork, and employees' motivation ([4], [14], [57], [67], [69], [94]). Within this framework, we aim to investigate whether and how particular components of strategic project management interact to enhance an innovative organisational design.

This hypothesis proposes that the application of the strategic management model in SROs involves the implementation of an innovative organisational design of the organisation. Figure 1 proposes the conceptual model. It presents the defined indicators that describe the strategic management process and their connection to organisational design and its components (see Table 2).

Methodology

The research was conducted in Serbia as a representative of developing countries. The data used in this research are part of a broad national survey investigating various aspects of strategic project management in SROs in Serbia. The survey's focal point were specific projects managed and completed in different SROs in Serbia. The problem of strategic management in SROs is recognized in Serbia at a strategic level, within the Strategy of Scientific and Technological Development of the Republic of Serbia for the period from 2016 to 2020 – Research for Innovation: "Most scientific research organisations do not have a strategic approach to managing research and directing research toward innovation" [33], [34, p. 31].

There is also an ongoing project SAIGE (Serbia Accelerating Innovation and Growth Entrepreneurship), which aims to present clear guidelines when it comes to implementing innovation in business environment.

Data collection

The survey sample counts 187 respondents from different SROs in Serbia that participated in the distinctive projects. The assumption foreshadowing the survey was that strategic project management in SROs should be understandable to all employees in an organisation regardless of their project role. The questionnaire was distributed to employees in SROs that participated in separate projects. The characteristics of the sample are summarized in Table 1.

Most of the participants come from SROs that are scientific institutes (48.1%), then faculties (34.2%), while 10.2% are research and development (R&D) institutes,

Table 1: Sample characteristics

Characteristics	N	% of N
Project participation		
Principal investigator	27	14.4
Project participant	155	82.9
Other	5	2.7
SRO employment		
Researcher – Scientific title	100	53.5
Researcher – Teaching title	58	31.0
Researcher – Research title	25	13.4
Expert associates	4	2.1
Type of SRO		
Scientific institute	90	48.1
R&D institute	19	10.2
Institute of National Importance	14	7.5
Faculty	64	34.2
Scientific area of an SRO		
Natural sciences	55	29.4
Technological sciences	73	39.0
Social sciences	59	31.6
Number of employees in an SRO		
Less than 50 employees	56	29.9
50-250 employees	80	42.8
More than 250 employees	51	27.3
Sex		
Male	83	44.4
Female	104	55.6

and 7.5% are institutes of national importance. By the size of SROs, 27.3% have more than 250 employees, 42.8% are medium size counting 50-250 employees, and 29.9% are small SROs, with less than 50 employees. From the respondents' outlook, 14.4% are principal investigators of the beheld projects, while 82.9% are project participants. The percentage of scientific areas of the respondents is balanced (29.4% natural sciences, 39% technological sciences, 31.6% social sciences). Additionally, the average age of the respondents is 44 years, while 44.4% are male and 55.6% are female.

The empirical research framework is primarily based on integrated strategic management model elements. The big challenge was determining the variables describing strategic project management in SROs. Following an extensive literature review and the specificity of Serbia's scientific research system, appropriate indicators of strategic management in SROs were selected. The indicators are first systematized at the general level within the primary phases of strategic management and then within the thematic units within these phases.

We established the main dependent variable – *Organisational design*. It consists of 6 sub-elements measured on a 5-point Likert scale (1 – 'strongly disagree' to 5 – 'strongly agree'). The structure of the measure is given in Table 2. The components of organizational design are also visible in the research model framework, presented in Figure 1. The Cronbach's alpha of the scale organizational design is 0.885 (see Table 3), which exceeds the threshold [54] and designates the very good internal consistency of the scale [18], [45].

Table 3 presents the exhaustive set of measurement scales that describe strategic project management in SROs. Measurement scales are created after an extensive analysis of organizational elements that encourage innovative behaviour in an organization ([4], [14], [61], [67], [69], [94]). Each variable consists of 4-13 sub-elements measured on the 5-point Likert scale, in the same way as the main dependent variable, as described above (the complete list of the variable sub-elements is available upon request). The Cronbach's alpha internal consistency scale measures are larger than 0.8 for almost all the variables (minimal

Table 2: Organisational design sub-elements

Organisational design	
Organisational structure	The organisational structure is adequate and facilitates the implementation of project tasks
Organisational culture	The business culture of the organisation enables the successful completion of project tasks
Leadership	Principal investigator is a leader with strong professional and operational skills
Competence	Human resources expertise is adequate and facilitates project tasks
Teamwork	Effective teamwork enables successful completion of project tasks
Motivation	Employee motivation is adequate and facilitates project tasks

Source: Adjusted from [4], [14], [57], [67], [69], [94]

Table 3: Measurement scales, mean, SD, number of sub-elements, Cronbach's alphas, Harman's unrotated single factor test

Variable	Mean	SD	No. of sub-el.	Cronbach's alpha	CMB Harman's test
External environment	2.92	0.882	10	0.891	33.295%
Internal environment	2.79	0.619	11	0.782	
Strategic documents	2.91	1.245	4	0.888	
Project portfolio	2.83	1.086	7	0.901	
Resources	2.83	0.996	5	0.803	
Collaboration	3.05	0.942	5	0.795	
Monitoring	2.68	1.149	4	0.878	
Results	3.34	1.011	7	0.836	
Achievement rating	2.72	1.109	6	0.902	
Scientific lessons	2.41	1.186	4	0.933	
Efficiency	3.21	1.125	13	0.963	
Methods and techniques	2.19	1.145	3	0.869	
Organizational design	3.35	1.057	6	0.885	

Source: Adjusted from [4], [14], [61], [67], [69], [94]

value is 0.782), which designates very good to excellent internal consistency [18], [45], [16].

Results

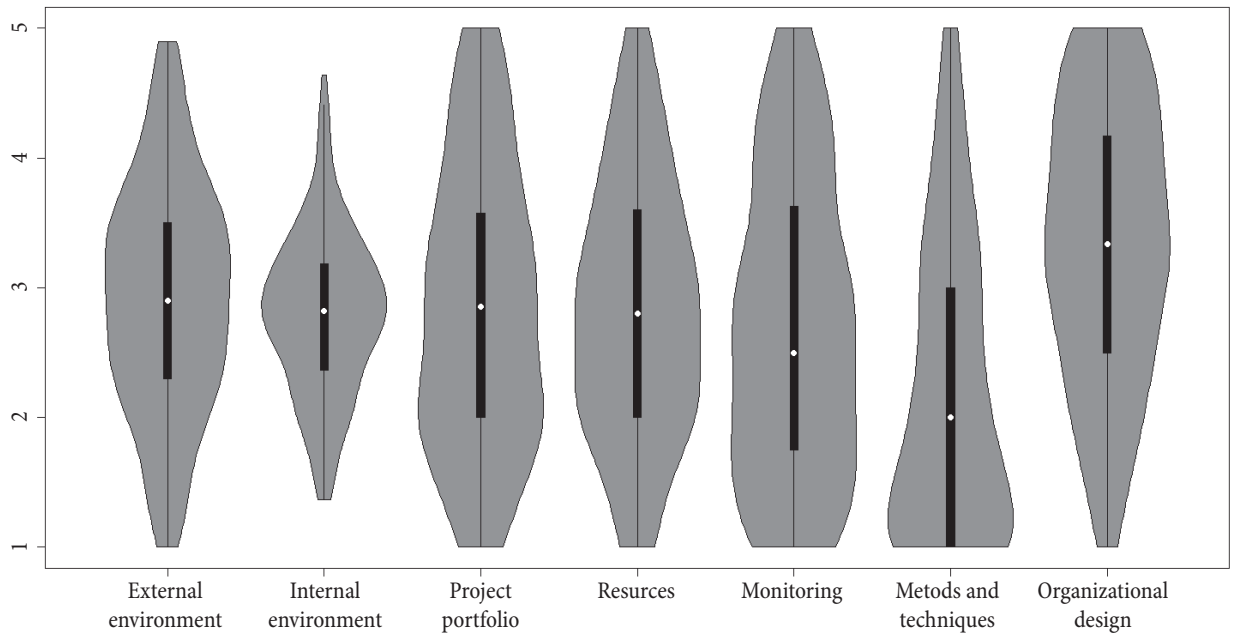
Since all the answers in the questionnaire were collected simultaneously, regardless of the dependent or independent variables, we tested if the responses in our research were facing the common method bias (CMB) [82], [83]. CMB is observed through the presence of a systematic variance [9] that can inflate or deflate a relationship among variables [20] which can lead to unsound conclusions. We wanted to check whether the variations in responses are caused by the instrument rather than the actual predispositions of the respondents. To do so, we performed Harman's unrotated single factor test. The test showed that a single factor accounts for 33.295% of all the variables in the model. Since it is less than 50%, our research instrument is showed to be free from significant common method bias effects. Therefore, we can conclude that there is no substantial CMB present in the data.

The correlation coefficients among the research variables are presented in Table 4. All the correlation coefficients among variables are statistically significant. One of them is significant at the 0.05 level of significance (Project portfolio and Achievement rating, r = 0.184), while all others are significant at 0.001 level of significance. The strongest correlation is found between pairs of variables Project portfolio and Achievement rating (r = 0.845), Project portfolio and Recourses (r = 0.828), as well as Achievement rating and Recourses (r = 0.828). Organizational design, as the main dependent variable, is weakly correlated with the variable Results (r = 0.263). It is moderately correlated with External environment (r = 0.492), Internal environment (r = 0.545), Strategic documents (r = 0.614), Collaboration (r = 0.544), Scientific lessons (r = 0.651), Efficiency (r = 0.361), and Methods and techniques (r = 0.595). Withal, it is strongly correlated with Project portfolio (r = 0.768), Resources (r = 0.771), Monitoring (r = 0.744), and Achievement rating (r = 0.722).

To further test the central hypothesis of this research and examine which factors mutually shape organizational design in SROs, we have performed a multiple backward regression analysis. The regression model was used to eliminate all the nonsignificant duplicated effects of the hypothesized predictor variables from the initial model. The results of the analysis are presented in Table 5.

The initial model includes the variables that are the elements of strategic project management examined in this survey, as presented in the conceptual model given in Figure 1. As shown in Table 5, this model is statistically significant at 0.001 level ($F = 29.930$, $p < 0.001$). The

Figure 2: Violin plot of the variables included in the final regression model



coefficient of determination is 0.67, suggesting that the initial model accounts for 67% of the variability of innovative organizational design. However, this model suffers from other drawbacks; about 33% of the initially included variables are statistically significant in the model.

Multiple backward regression model was performed in seven iterations. All the nonsignificant variables were iteratively excluded from the model. As presented in Table 5, the final model is statistically significant at 0.001 level ($F = 59.760$, $p < 0.001$). The coefficient of determination shows that the predictors that were kept in the final model account for 67.3% of the explained variability in the model. The most significant influence is found with Project portfolio (stdB = 0.384, t = 3.818, $p < 0.001$) and Resources (stdB = 0.327, t = 3.960, $p < 0.001$), where a better Project portfolio and a more intensive resource allocation account for better Organizational design. The descriptive violin plots of the variables that are included in the final regression model are given in Figure 2.

Figure 2 further examines the structure of the variables in the final model. From Figure 2 and Table 3, it can be noted that the dependent variable organizational design has the highest mean value and is skewed to the right. Resources are closest to normally skewed, while

Table 4: Correlation coefficients

	Variable	Correlation coefficients												
		1	2	3	4	5	6	7	8	9	10	11	12	13
1	External environment	-												
2	Internal environment	0.712***	-											
3	Strategic documents	0.607***	0.550***	-										
4	Project portfolio	0.639***	0.613***	0.768***	-									
5	Resources	0.567***	0.571***	0.762***	0.828***	-								
6	Collaboration	0.531***	0.639***	0.464***	0.546***	0.537***	-							
7	Monitoring	0.551***	0.468***	0.688***	0.793***	0.765***	0.558***	-						
8	Results	0.318***	0.266***	0.184*	0.306***	0.245***	0.398***	0.274***	-					
9	Achievement rating	0.562***	0.552***	0.729***	0.845***	0.828***	0.510***	0.788***	0.268***	-				
10	Scientific lessons	0.452***	0.437***	0.602***	0.754***	0.685***	0.501***	0.756***	0.275***	0.762***	-			
11	Efficiency	0.286***	0.348***	0.305***	0.447***	0.397***	0.413***	0.436***	0.364***	0.455***	0.437***	-		
12	Methods and techniques	0.551***	0.482***	0.764***	0.811***	0.730***	0.447***	0.720***	0.271***	0.808***	0.673***	0.346***	-	
13	Organizational design	0.492***	0.545***	0.614***	0.768***	0.771***	0.544***	0.744***	0.263***	0.722***	0.651***	0.361***	0.595***	-

Note: *p < 0.05, **p < 0.01, ***p < 0.001

Table 5: Results of the multiple backward regression model for Organizational design

	Initial model		Final model	
Variables	B	StdB	B	StdB
Intercept	3.535*		3.381*	
External environment	0.091	0.122	0.089*	0.119
Internal environment	0.123	0.130	0.140*	0.149
Strategic documents	-0.069	-0.053		
Project portfolio	0.328***	0.385	0.328***	0.384
Resources	0.397***	0.300	0.432***	0.327
Collaboration	0.081	0.059		
Monitoring	0.382**	0.269	0.427***	0.301
Results	0.024	0.027		
Achievement rating	0.116	0.118		
Scientific lessons	0.009	0.007		
Efficiency	-0.033	-0.075		
Methods and techniques	-0.370*	-0.194	-0.340*	-0.178
Model statistics				
ANOVA F	29.930***		59.760***	
R^2	0.693		0.685	
Adjusted R^2	0.670		0.673	

Note: *p < 0.05, **p < 0.01, ***p < 0.001; B - Unstandardized Coefficients, StdB - Standardized Coefficients

project portfolio that mostly affects the organizational design and the monitoring is slightly skewed to the left. From Figure 2 and Table 3, it can also be noted that the internal environment has the lowest variance among the hypothesized variables, followed by the external environment, which makes them most stable.

Based on all stated above, we find that the most important strategic project management factors that shape innovative organizational design are external and internal environment, project portfolio, resources, monitoring, and methods and techniques.

Discussion

Based on the findings of this research, it was shown that the empirical results mainly support our study framework and the research hypothesis. The organizational design was significantly correlated (Table 3) with all the strategic project management factors in SROs. However, when disposing of the duplicity of the variability, regression analysis shows that variables that are significant in the final model are the internal environment, external environment, project portfolio, resources, monitoring, and methods and techniques. Our findings are supported in the literature to a large extent.

SROs' resources take a significant place as a factor of strategic management that influences organizational design ($r = 0.771$, Tables 4 and 5). This finding is in accordance with the previous literature [1]. Taking into consideration SROs characteristics, the main resources in SROs are people. Employees in SROs are mainly highly educated, trained to have great work autonomy and to show initiative. They are career-oriented rather than company-oriented [26]. Knowledge is recognised as a very important resource in today's economy and can be assessed as the fourth factor of manufacturing (besides capital, land, and labour) [80], [99]. Nowadays in business world, knowledge as an element of "intangible assets" has become a key resource of an organisation and a basic source of its competitive advantage [22]. Thus, it can be assumed that the pillars of organizational design in SROs are human resources. Unfortunately, it was observed in post-communistic economies that young, educated experts are more and more commonly leaving their home countries. Many scientists who had the will and desire to make a change left SROs and moved to either a foreign company representative or abroad, where better work conditions are offered both financially and intellectually [85]. Still, the situation has been improving in Serbia in the last ten years. Our research results show that the SROs management is becoming more aware of the human resources management significance.

The phase of strategy implementation is a challenging task for the management of SROs. It implies the process of "reviving" the strategy. Within this phase of strategic management, there are activities connected to the efficient allocation of resources in a way that encourages creative behaviour and provides support for joint initiatives for the development and commercialization of the results of scientific research. Strategy implementation in SROs should consider the complexity of managing technological innovations and the problems associated with uncertainty, the specific nature of knowledge, and unpredictable costs and risks [37]. Next to human resources, financial resources are equally important for innovative organizational design. Science, Research and Innovation activities, which require a large share of financial resources to generate new knowledge, technologies, and innovations, are mostly project-oriented and are mainly performed by enterprises, higher education institutions, and research institutes [12], [47], [75].

In the operational aspect, project management and a project portfolio are found to be highly important aspects of the strategic management model in SROs of Serbia ($r = 0.768$). Management in SROs often considers multiple and conflicting goals to choose a desirable project portfolio. Multi-project aspects of SROs lead to an increasing need for coordination and control of complex projects, as well as their alignment with strategic goals of an organization, aimed at choosing a project with the best chances of success, avoiding risk accumulation, and realizing project management synergy [12], [31]. In addition, the significant influence of methods and techniques ($r = 0.595$) on organizational design indicates the SROs management awareness about the importance of using certain methodological tools applying to project

management, which, eventually, has a positive impact on all the components of organizational design. However, in the final regression model, when combined with other predictors in the model, methods and techniques seemed to have a negative influence on organizational design. This is probably due to the fact that well-addressed project portfolio and resources allocation in SROs successfully determine organizational design, with fewer requirements for a specific methodological approach.

R&D activities are risky by themselves, and their results are difficult to measure and evaluate. Strategic management of SROs should be flexible so as not to limit the autonomy of researchers too much as it could badly affect their creativity. Also, SROs must serve both public and private interests, further complicating the strategic management process [75], [35]. The control and evaluation of the strategy implementation are a significant part of strategic management of SROs. They apply mechanisms to monitor the success of previously taken steps. To perform this process successfully, it is also necessary to define critical factors of organization success [3]. Monitoring and evaluation enable an organization, based on previous and current activities, to select relevant information which can be later used to fine-tune and plan future activities. In this context, it is encouraging that monitoring ($r = 0.744$) and achievement rating ($r = 0.722$) significantly influence organizational design in SROs.

In Serbia, for long period, science was considered an activity whose purpose is itself and whose functioning would be impossible through projects financed by the Ministry of Science, Technology, and Innovation. This was a consequence of a centralistic approach to making decisions. Investments in science were almost invisible since positive effects were only seen through the efficient workings of the national innovation system. The main driver of investments in science was increasing pressure on the market, which progressively lead to strategic research integration, developments, innovations, and commercial strategies. Research has proven that factors such as innovations, knowledge, competitiveness, internal relationships between employees, and environmental influences greatly determine the relationship between strategic orientation and performance [70]. Establishing the connection between R&D policy and other policies (education, economic development et al.) is crucial for Serbia.

An application of a comprehensive approach in managing projects in SROs should enable their efficient organisational restructuring. In Serbia, most research institutes are financed by public funds, setting their missions at the moment of their creation. These facts indicate that in addition to their scientific significance SROs are often directed towards a general significance and are often aligned with the needs of a society and its citizens. Nevertheless, their mission has evolved over time, and they have started shifting their activities towards the market. To successfully integrate market needs into scientific research results, organisational acclimatisation of SROs is necessary.

Moreover, all activities in the environment should be aligned with the specific nature of SROs. The strategic orientation of SROs needs to be seen as a set of components that could direct the organisational design to create effective scientific and research results. The main goal of strategic management in SROs is efficient and effective management of a R&D process, which contributes to advanced usage of scientific research results, leading to cost reduction, and increased key knowledge bases [76].

In Serbia, project activities are mostly realised through partnerships made among SROs (faculties, universities, institutes, and the economy). Managers of organisations that develop innovation should consider organisational design an essential factor to capitalise on their collaborative innovation practice [24]. Even though cooperation was correlated to organizational design ($r = 0.544$), it was not found to be influential in our final regression model. Nevertheless, the cooperation should be marked as a significant strategic component of SROs that impacts an organizational design. One of the future directions of the research includes further investigation of this affiliation since the integrated approach to strategic management enables establishing the cooperation with all stakeholders outside an organisation and encourages technology transfers [68].

This research adds new empirical evidence to understanding project management concepts in SROs.

The presented theoretical approach enables easier understanding of R&D processes and has far-reaching implications for management practice. As mentioned before, employees in SROs are mostly highly educated, so they demand significant autonomy in their work. In the context of strategic management, the organisational design represents a complex topic for further research. It also has to be considered in different contexts. This especially applies to human resource development and functional organisation of project activities at an organisational level.

Conclusion

Since the second half of the last century, the scientific research system in Serbia has been experiencing the process of transformation from a planning system to a market-driven system. Developing an integrated model of strategic management applicable to SROs in Serbia should enable the efficient restructuring of these organisations. All changes and macroeconomic impacts from the transition economy have influenced strategic management development within SROs. In addition to investing within scientific research capacities and practice, it is important to invest in improving the quality of the management of its scientific research organization. One way is by highlighting the importance of a strategic approach to an organisational design.

An integrated approach to strategic management in SROs implies the organisational design which creates innovation. Our research has shown that, regarding SROs in Serbia, all components of strategic project management impact an organisational design, yet some are more influential than others. The most critical factors include environment, project portfolio, resources, and monitoring. The external environmental impacts lead to scientific results guiding market needs and society. Having in mind the specific nature of scientific research work, the efficient allocating of available resources leads to efficient strategic management in SROs, creating benefits not only for the organisation's management but also for the decision-makers at a national level by maximizing the horizontal coordination quality of policies, planning, and budget management. The research refers to Serbia, but the results can be helpful for most developing countries where a planned system has been transformed to a market-based system since these countries do not have sufficiently developed incentive mechanisms for adjusting R&D within SROs to market demands.

This research presents a step forward compared to the research conducted so far. It contributes by adding the connection between strategic management and organisational design to the theory of strategic project management, with special regard to the nature of SROs in developing countries such as Serbia. It makes the strategic design management components more concrete, which has a decisive impact on an innovative organisational design. The field of strategic management is a relatively new specialised management area. Through the development of integrated models, strategic management inevitably contributes to organisational development's constant growth and sustainability.

Complex strategic management in SROs is determined by the organisational design which incites innovation. This concept needs to be analysed further in theory. The reasons lie in the fact that a strategic management process is complex, and it will take some time to adapt it to specific characteristics of SROs. Therefore, at a conceptual level, this paper has contributed to the knowledge fund in this area and, consequently, boosted it. The presented analysis can help strategic and project managers of SROs to set adequate strategic guidelines for organisational development activities to improve the efficiency of scientific research results and the level of their innovativeness.

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THE RELATIONSHIP BETWEEN EMPLOYEE COMMITMENT, CORPORATE SOCIAL RESPONSIBILITY AND ORGANIZATIONAL CITIZENSHIP BEHAVIOR IN SERBIA

Relacije između posvećenosti zaposlenih, korporativne društvene odgovornosti i organizacionog građanskog ponašanja u Srbiji

Abstract

Companies are increasingly facing various challenges and opportunities in global business, and one significant aspect affecting their reputation, success, and sustainability is corporate social responsibility (CSR). Corporate social responsibility in the processing industry in Serbia is becoming an increasingly important topic both for companies themselves and for the broader community. CSR refers to the awareness and obligation of companies to take steps toward sustainable business practices that consider economic, social, and environmental aspects. The aim of this research is to examine the relationship between dimensions of corporate social responsibility and organizational citizenship behavior (OCB), as well as the mediating effect of employee commitment in the relationship between dimensions of corporate social responsibility and organizational citizenship behavior. This is important because CSR has a positively predictive impact on OCB, especially when employees are committed. The sample includes a total of 72 large companies in the processing sector operating within the territory of the Republic of Serbia. The dataset was compiled between November 2019 and August 2021, and Partial Least Squares Structural Equation Modeling (PLS-SEM) analysis was employed to examine the relationships between variables. The authors determined a positive direct impact of CSR on organizational citizenship behavior as well as a positive direct impact on employee commitment. Furthermore, a positive indirect effect of employee commitment on the relationship between CSR and organizational citizenship behavior was revealed. The concluding section of the study encompasses theoretical and practical implications, recommendations for future research and acknowledges research limitations.

Keywords: *corporate social responsibility, organizational citizenship behavior, employees commitment, PLS-SEM*

Sažetak

Kompanije se sve više suočavaju s različitim izazovima i prilikama u globalnom poslovanju, a jedan od značajnih aspekata koji utiče na njihovu reputaciju, uspeh i održivost jeste korporativna društvena odgovornost kompanija. Korporativna društvena odgovornost (KDO) u prerađivačkoj industriji u Srbiji postaje sve važnija tema, kako za same kompanije, tako i za širu zajednicu. KDO se odnosi na svest i obavezu kompanija da preduzmu korake ka održivom poslovanju koje uzima u obzir ekonomske, socijalne i ekološke aspekte. Cilj istraživanja ovog rada je odnos između dimenzija korporativne društvene odgovornosti i organizacionog građanskog ponašanja (OCB), kao i medijacijski efekat posvećenosti zaposlenih u odnosu između dimenzija korporativne društvene odgovornosti i organizacionog građanskog ponašanja. Ovo je važno jer CSR ima pozitivno prediktivno dejstvo na OCB, naročito ukoliko su zaposleni posvećeni. Ukupno je uključeno 72 velikih kompanija u sektoru prerade koje posluju na teritoriji Republike Srbije. Skup podataka je formiran između novembra 2019. i avgusta 2021. godine, a za analizu veza između varijabli primenjena je PLS-SEM analiza. Autori su utvrdili da postoji pozitivan direktni uticaj KDO na organizaciono građansko ponašanje, kao i pozitivan direktni uticaj na posvećenost zaposlenih. Takođe, otkriven je pozitivan posredni efekat posvećenosti zaposlenih na vezu između KDO i organizacionog građanskog ponašanja. Zaključni deo rada obuhvata teorijske i praktične implikacije, preporuke za buduća istraživanja i ograničenja istraživanja.

Ključne reči: *korporativna društvena odgovornost, organizaciono građansko ponašanje, posvećenost zaposlenih, PLS-SEM*

Introduction

Corporate social responsibility (CSR) has a long history but began to develop in a modern sense over the last few decades. At the beginning of the 20th century, CSR focused on philanthropic activities and donations [13]. In the 1960s and 70s, public awareness of the adverse effects that companies could have on the environment and society increased. This led to the concept of "social responsibility," a precursor to modern CSR [27]. In the contemporary business world of today, corporate social responsibility is being researched, refined and applied with more and more frequency. Conceptually, CSR refers to the obligation of organizations to engage in responsible business practices that contribute to society, protect the environment, and positively impact stakeholders. Through CSR, companies recognize that their success depends not only on financial performance but also on the social and environmental effects they have on the community and the environment in which they operate [36], [38]. Implementing the CSR concept brings numerous benefits for companies. The benefits that companies achieve include the fact that implementing CSR often positively influences reputation-building and trust among their stakeholders. Furthermore, implementing the idea of social responsibility has a favorable impact on retaining employees within the organization [5], [22]. Organizations that adhere to CSR can reduce the risk of crises and improve relationships with regulatory bodies [37].

Organizational Citizenship Behavior (OCB) is a concept that is increasingly being researched and recognized as an important aspect of successful organizational functioning. OCB refers to the additional behavior of employees that is not formally part of their job duties but contributes to efficiency, productivity, and a positive organizational climate [23]. OCB plays a crucial role in achieving organizational success. When employees exhibit OCB, it means they go beyond the boundaries of their formal job duties and actively contribute to the organization and its goals. OCB can include situations where employees assist colleagues in problem-solving, propose innovative ideas, volunteer to perform additional tasks, provide constructive suggestions for improvement, and support organizational values [7]. This behavior leads to increased team spirit, improved work relations, and enhanced employee satisfaction.

Employee commitment has a significant impact on an organization. Committed employees are more inclined to innovate, take initiative, and contribute to organizational goals outside of their formal job duties. They actively participate in improving processes and organizational efficiency. Also, committed employees are less prone to negative behaviors such as tardiness or inadequate task performance [28], [1].

The main objective of this research is to examine the relationship between the concept of CSR and OCB, as well as the mediating effect of employee commitment. The authors conducted an analysis using the PLS-SEM method to determine the relationships between the observed variables. The dimensions of CSR represent an independent variable, while employee commitment and organizational citizenship behavior represent dependent variables. The study was carried out within the business landscape of the Republic of Serbia, utilizing a sample of 72 large organizations in the manufacturing sector. It relies on the perspectives of management teams within these organizations concerning corporate social responsibility, employee commitment, and organizational citizenship behavior.

The study is structured into three main segments. The initial part provides an overview of prevailing attitudes related to corporate social responsibility, employee commitment, and organizational citizenship behavior. The second segment concentrates on the employed statistical analysis method, and the third part delves into the analysis of the research results, offers recommendations for future studies, and draws conclusions.

Theoretical background

Contemporary organizations wield substantial influence on the global stage, shaping economic, societal, and ecological dynamics. Against this backdrop, an escalating number of companies are embracing corporate social responsibility as an approach to acknowledge their societal and environmental roles and responsibilities. CSR embodies a business strategy transcending the conventional emphasis

on profit, encompassing endeavors that foster beneficial outcomes for both society and the environment [8]. Business entities that practice CSR recognize the importance of sustainable business, employee well-being, adherence to ethical standards, promoting diversity and inclusiveness, supporting local communities, reducing ecological risks, and responsible resource utilization [2], [17].

Recognizing the manufacturing industry's influence on society and the environment, the importance of incorporating corporate social responsibility is especially noteworthy. The manufacturing industry encompasses the production, processing, and distribution of various products, including food, textiles, electronics, the automotive industry, etc. [25]. The manufacturing industry worldwide is increasingly acknowledging the importance and impact of CSR on business. CSR doesn't solely pertain to philanthropy but extends to broader engagement of organizations in adopting sustainable business practices that contribute to a better future for all. Through continuous advancement and transparency in relation to CSR, organizations can gain competitive advantages and become industry leaders [32], [33].

CSR pertains to the activities and practices that companies undertake to recognize their responsibility towards society and the environment, while OCB involves voluntary positive actions and contributions by employees to the organization that goes beyond their formal job duties [24]. The ways in which these two concepts are connected relate to social awareness and organizational identification. In this regard, companies that practice CSR and show concern for social issues often attract employees who share similar values and goals. Individuals who perceive their organization as having a commitment to social responsibility are more inclined to cultivate a heightened organizational identification and a sense of belonging to something beyond the scope of their specific job.

Furthermore, organizational fairness and support also play a role. Companies that implement CSR usually focus on fairness toward employees, supporting their development and well-being [35], [12], [11]. Such organizational fairness and support are associated with a greater inclination of employees towards OCB, as they feel valued and motivated to contribute to the organization beyond their formal obligations. Organizations that embrace the CSR concept often strive for long-term success and sustainability. In this context, employees who perceive that their company cares about the environment and society are more likely to invest more effort and time into OCB because they believe in the goals and values of the organization [6], [10]. The mentioned relationship can contribute to the creation of a positive working climate and long-term success of the organization.

Employee commitment plays a pivotal role in linking the concepts of CSR and OCB. When employees harbor a strong commitment to the organization, they are more prone to demonstrating elevated levels of OCB, with CSR serving as a significant contributing factor to that commitment [19], [30]. Employee commitment can serve as a mediator in the relationship between CSR and OCB. This means that CSR activities that enhance employees' commitment to the organization can result in greater OCB among those employees. Through greater commitment, employees may better understand the importance of OCB to the organization and be more motivated to engage in such behaviors.

The study conducted by Choi & Yu [9] with Chinese companies affirms that empirical findings reveal a noteworthy impact of dimensions within employees' corporate social responsibility on both their organizational commitment and organizational citizenship behavior. Regarding the mediation model, the research identifies that organizational citizenship behavior partially mediates the connection between socially responsible business practices and organizational performance. Studies have shown a positive correlation between CSR, employee commitment, and OCB. Companies that focus on socially responsible business practices often have more satisfied and engaged employees who are willing to provide additional contributions to the organization [36]. This integrated approach can bring numerous benefits to the organization, including improved reputation, productivity, and long-term success. Therefore, the key focus of managers should be directed towards fulfilling employees' personal needs in order to encourage their greater dedication to performing diverse business tasks [29, pp. 315].

Methodology

This research was conducted in large manufacturing companies operating in the territory of the Republic of Serbia. The study involved 72 companies, with one top-level manager from each company providing responses to the questions. Specifically, the "large organizations" sector in Serbia is defined as those with more than 250 employees, in line with previous research [31], [3, p. 98].

The questionnaire is structured into four segments. The first segment focuses on the participants' social-demographic characteristics as well as the type of economic activity and markets where the company operates. The second segment encompasses the concept of CSR, which comprises 6 dimensions. The first dimension relates to community responsibility and consists of four questions labeled as Soc1, Soc2, Soc3, Soc4. The second dimension pertains to environmental responsibility and includes four questions labeled as Envir1, Envir2, Envir3, Envir4. The third dimension centers around employee responsibility, with questions labeled as HR1, HR2, HR3, HR4. The fourth dimension concerns investor responsibility and contains questions marked as Invest1, Invest2, Invest3, Invest4. The fifth dimension addresses customer responsibility and consists of four questions labeled as Consumer1, Consumer2, Consumer3, Consumer4. The final dimension relates to supplier responsibility and contains five questions labeled as Suppl1, Suppl2, Suppl3, Suppl4, Suppl5 [3, p. 98].

The third segment pertains to the questionnaire evaluating employees' attitudes and behaviors and consists of two main parts. The first part focuses on employee commitment and comprises a total of 3 questions, which is a concept developed by the author team Rettab et al. [34]. The questions and labels in this section are as follows: "Employees often go beyond their responsibilities for the benefit of the organization," labeled as Commitment1. The second question is: "The bonds between employees and the organization are very strong," with the label Commitment2. The third question relates to "Employees are very devoted to the organization," labeled as Commitment3. The second part addresses organizational citizenship behavior, developed by the research team [18]. The questionnaire used in the study consists of 7 questions and focuses on the interaction between the company and its employees. The first question is "Employees contribute to the development of the organization with their work," labeled as OCB1. The second question is "Employees defend the organization when other employees criticize it," labeled as OCB2. The third question is "Employees show pride when representing the organization in public," labeled as OCB3. The fourth question is "Employees propose ideas to improve the functioning of the organization," labeled as OCB4. The fifth question is "Employees express loyalty to the organization," labeled as OCB5. The sixth question is "Employees take actions to protect the organization from potential issues," labeled as OCB6. And the seventh and final question is "Employees show concern for the organization's image," labeled as OCB7.

The questions in the questionnaire are structured as closed-ended questions with a Likert scale ranging from 1 to 5, where the options are labeled as follows: 1 - strongly disagree; 2 - disagree; 3 - neither agree nor disagree; 4 - agree; 5 - strongly agree [34]. This questionnaire structure allows the quantitative measurement of participants' attitudes and perceptions related to the concept of CSR.

Drawing from the theoretical perspectives and research methodology discussed earlier, the authors of this paper propose the following research hypotheses:

H_1: The positive influence of incorporating dimensions of the corporate social responsibility concept on the manifestation of organizational citizenship behavior is observed within large organizations in the manufacturing sector in Serbia's business landscape.

H_2: There is a positive influence of applying the dimensions of corporate social responsibility on the level of employee commitment in the manufacturing sector within large organizations in Republic of Serbia.

H_3: Corporate social responsibility, through the mediation of employee commitment, has a positive impact on the manifestation of organizational citizenship behavior in the Republic of Serbia.

Research results and discussion

The authors of the paper employed the aforementioned research methodology to validate and test the questionnaire as well as to analyze internal consistency. Internal consistency

was assessed by calculating Cronbach's Alpha values, Composite Reliability (CR), and the Average Variance Extracted (AVE) for each construct in the model [14], [15], [16]. Variables whose indicators had values below 0.728 were excluded from further analysis. Based on this criterion, the authors excluded the indicator HR1 from the study. Considering all the mentioned aspects, Figure 1 illustrates the research model.

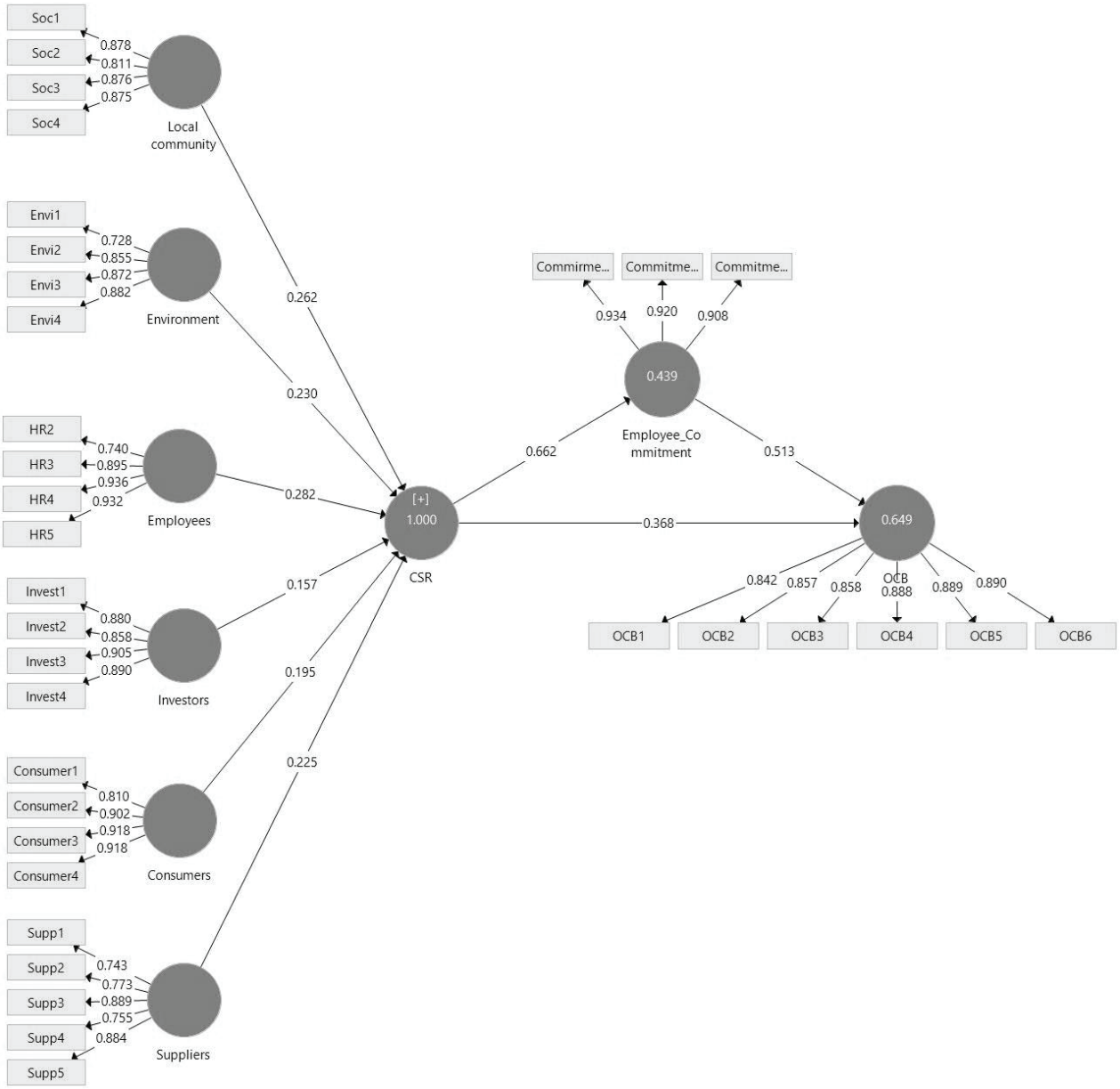
Measurement characteristics for various constructs in the research use the Smart Partial Least Squares (PLS) method for structural modeling analysis. Table 1 presents Cronbach's Alpha analysis with values ranging from 0.855 to 0.936. As Cronbach's alpha represents a measure of internal consistency (reliability) of the total questions measuring the same construct, values above 0.7 are generally considered

Table 1: Cronbach's Alpha, CR, AVE

Factor	Cronbach's Alpha	CR	AVE
Consumers	0.910	0.937	0.789
Employees	0.900	0.931	0.773
Environment	0.855	0.903	0.700
Investors	0.906	0.934	0.780
Local community	0.883	0.919	0.741
Suppliers	0.869	0.905	0.658
Employee commitment	0.910	0.944	0.848
OCB	0.936	0.950	0.758

Source: Authors' calculation

Figure 1: Calculations of path coefficients



Source: Authors' calculation

acceptable for research; all values are above 0.85, indicating high measurement consistency for all constructs [26]. Composite reliability assesses the overall consistency of constructs in terms of explaining variability among the variants that are part of that construct. Values above 0.7 are deemed acceptable, and the values shown in Table 1 are all above 0.9, demonstrating very high reliability of the constructs in the research. Average Variance Extracted (AVE) measures the percentage of variance explained by the construct relative to the variability of measurement error. All values above 0.5 are acceptable; AVE values range from 0.658 to 0.848 for all specified constructs.

The discriminant validity criterion, which is alternatively called the heteroperson-monocrit criterion, will be presented in Table 2.

This criterion suggests that all values are below 0.9, indicating that the defined components, or constructs, are adequately distinct from one another and represent different phenomena [15], [16]. From the findings in Table 2, it is evident that all values are below 0.9, thereby fully satisfying the discriminant validity criterion as per the HTMT indicator.

Within the analytical framework, the Variance Inflation Factors for distinct formative constructs are presented in Table 3. To effectively evaluate multicollinearity, it is crucial to take into account the predefined threshold for VIF values, as established by previous research, with a specified limit set at less than 3. [21], [39]. When VIF values are below this defined threshold, it is generally considered that there is no serious issue of multicollinearity among the variables.

Based on the indicators presented in Table 3, it can be concluded that multicollinearity is not present between the formative constructs. In this regard, the low VIF values indicate that the variables do not exhibit a high level of mutual correlation.

Table 4 presents the results concerning the relationship between dimensions of corporate social responsibility and organizational citizenship behavior, the relationship between CSR and employee commitment, as well as the relationship between CSR and OCB through employee commitment. Based on the obtained results, it can be concluded that the first research hypothesis H_1 is accepted, indicating a statistically significant positive relationship between CSR and OCB (T = 3.194; $p = 0.001$) in the processing companies in the Republic of Serbia. The second research hypothesis H_2 is accepted, showing a statistically significant positive relationship between CSR and employee commitment (T = 8.748; $p = 0.000$) in the processing companies. Lastly, the third research hypothesis H_3 is accepted, indicating a statistically significant relationship between CSR and OCB through employee commitment (T = 3.194; $p = 0.001$).

Table 2: Discriminant validity: Heterotrait-monotrait

	CSR	Consumers	Empl_Comm	Employees	Environment	Investors	Local comm.	OCB
Consumers	0.772							
Empl_Comm	0.689	0.394						
Employees	0.786	0.418	0.707					
Environment	0.840	0.484	0.568	0.741				
Investors	0.697	0.437	0.262	0.234	0.345			
Local comm.	0.858	0.487	0.604	0.611	0.671	0.410		
OCB	0.715	0.384	0.816	0.751	0.644	0.321	0.755	
Suppliers	0.830	0.513	0.549	0.434	0.416	0.557	0.552	0.377

Source: Authors' calculation

Table 3: Variance inflation factor

Formative construct	CSR
Consumers	1.481
Employees	1.975
Environment	2.115
Investors	1.443
Local community	1.907
Suppliers	1.696

Source: Authors' calculation

Table 4: Results of bootstrapping analysis

	(O)	(M)	(STDEV)	T Statistics	p Values
CSR -> OCB	0.340	0.346	0.106	3.194	0.001
CSR -> Employee Commitment	0.662	0.667	0.076	8.748	0.000
CSR -> Employee Commitment -> OCB	0.340	0.346	0.106	3.194	0.001

Source: Authors' calculation

Conclusion

The concept of socially responsible business is becoming more and more pronounced in companies. This implies that economic entities deliberately and voluntarily direct their activities towards creating positive effects towards the entire society. This type of behavior stems from an increasing awareness of the role organizations play in modern society. In the field of research from the manufacturing industry, the authors of this study conclude that there is a clear and positive influence of companies that, through the application of CSR dimensions, influence employee commitment and OCB. These results emphasize the key role of CSR in shaping employee engagement and encouraging their positive contributions within the organization. It is important to point out that employee commitment has been identified as a significant mediator through which the positive influence of CSR encourages organizational citizenship behavior, further supporting the importance of commitment in this dynamic.

The positive correlation between organizational citizenship behavior and corporate social responsibility underscores the influence of the latter on the former. Through the analysis of various research works, it is underscored that the implementation of CSR practices can positively affect OCB, and at the same time it can provide the opportunity to create sustainable and ethically empowered work environments [4], [20].

The analysis of the relationship between corporate social responsibility and employee commitment has shown that organizations are undertaking socially responsible actions and are integrating these values into their operations in order to positively influence employees' perception of their role within the organization. Employees can feel more connected to their company, motivated, and satisfied when they realize that the organization is contributing to the community and society. Ultimately, further research will enrich the understanding of how CSR can positively shape employee commitment, providing valuable guidance for organizations to create a better work environment and increase employee engagement.

In conclusion, this study provides a significant contribution to the understanding the relationship between CSR, employee commitment, and organizational citizenship behavior, yet further research should focus on clarifying specific mechanisms and contextual variations to better manage critical aspects of organizational dynamics. Different industries, cultures, and geographic regions may have varying perceptions and effects of CSR on OCB. Future research should aim to understand contextual differences in order to develop targeted strategies.

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THE INFLUENCE OF PSYCHOLOGICAL NEEDS AND WORK CLIMATE ON JOB SATISFACTION OF EMPLOYEES IN THE HOSPITALITY INDUSTRY

Uticaj psiholoških potreba i radne klime na zadovoljstvo poslom zaposlenih u hotelijerstvu

Abstract

Employee satisfaction is a key factor to achieving high work performance results and service provision efficiency, which directly contributes to the increase in organizational productivity. For the purpose of this paper, in addition to the theoretical postulates of self-determination theory, we analyzed the impact of social environment factors and basic psychological needs on job satisfaction. The sample included 150 employees in hotels in the Republic of Serbia. According to the research results, there is a statistically significant positive correlation between the work climate, i.e., the perceived autonomy support for employees, and extrinsic and intrinsic satisfaction, as well as overall job satisfaction. On the other hand, the results show that general job satisfaction (as well as extrinsic and intrinsic job satisfaction) is largely associated with the degree of psychological needs' satisfaction. From the aspect of the type and content of the job, it was determined that jobs which by their nature differ in terms of complexity and imply the freedom of choice and creativity in performing tasks, provide more possibilities for the fulfillment of basic psychological needs and job satisfaction. It is expected that the results of this research will contribute to better human resource management practices in the hospitality industry wherein employees are the key to success.

Keywords: *job satisfaction, basic psychological needs, work climate, self-determination theory, workplace*

Sažetak

Zadovoljstvo zaposlenih je ključan faktor za postizanje visokih radnih performansi i efikasnosti pružanja usluga, što direktno doprinosi povećanju produktivnosti organizacije. Za potrebe ovog rada, uz teorijske postulate Teorije samodeterminacije, analiziran je uticaj faktora socijalnog okruženja i bazičnih psiholoških potreba na zadovoljstvo poslom. Uzorak je obuhvatio 150 zaposlenih u hotelima u Republici Srbiji. Prema rezultatima istraživanja, postoji statistički značajna pozitivna korelacija između radne klime, odnosno percepcije podrške autonomiji zaposlenih, i ekstrinzičkog i intrinzičkog zadovoljstva, kao i ukupnog zadovoljstva poslom. Sa druge strane, rezultati pokazuju da je generalno zadovoljstvo poslom (kao i zadovoljstvo poslom ekstrinzičnim i intrinzičnim faktorima) u velikoj meri povezano sa stepenom zadovoljenja psiholoških potreba. Sa aspekta vrste i sadržaja posla, utvrđeno je da poslovi koji se po svojoj prirodi razlikuju u pogledu složenosti, koji po svojoj prirodi podrazumevaju slobodu izbora i kreativnost u obavljanju zadataka, daju više mogućnosti za zadovoljenje bazičnih psiholoških potreba i zadovoljstvo poslom. Očekuje se da će rezultati ovog istraživanja doprineti boljim poslovnim praksama upravljanja ljudskim resursima u hotelijerstvu gde su zaposleni ključ uspeha.

Ključne reči: *zadovoljstvo poslom, bazične psihološke potrebe, radna klima, teorija samodeterminacije, radna pozicija*

Introduction

In the hospitality industry, the quality of the service provided is a key driving factor in maintaining competitive advantage. The assessment of quality of the service extended by hotel employees is subjective, as it largely depends on the customer, i.e., hotel guest. It is up to the human resource managers to provide, through adequate policies and practices, incentives to create an environment that fosters customer-oriented behavior [19]. The provision of services by the hotel to the customer, i.e., hotel guest, is primarily achieved through employees. Consequently, job satisfaction in the hospitality industry is an important factor as it is precisely this factor that determines the quality level of services provided by employees. Given that the hospitality industry is characterized by a high degree of the workforce turnover which is expected to meet various job-related requirements and to strictly observe the established work schedule, which calls for a compromise between private and professional life [16], a question arises as to what factors affect job satisfaction. According to Nedeljković Knežević et al. [24], job satisfaction is an important predictor of business success of an organization operating in a modern business environment.

Drawing on self-determination theory, this paper investigates the satisfaction of employees in the hospitality industry viewed from the aspect of psychological needs and work climate. Additionally, the paper will analyze whether job satisfaction and psychological well-being (fulfillment of the basic psychological needs) differ across different groups according to the type of work (managers and service providers). Self-determination theory in the work environment has so far been explored by certain authors [13], [26], [2], [10], [34], [24], [3]. With respect thereto, several research questions were set:

H1: Job satisfaction is related to the fulfillment of basic psychological needs – the more the basic psychological needs for autonomy, competence and relatedness are fulfilled, the greater the job satisfaction.

H2: Perceived support for employee autonomy is related to job satisfaction – the greater the perceived support for employee autonomy, the more satisfied they are with their job.

H3: Job satisfaction differs depending on the content of the job, i.e., among employees in different positions.

H4: There is a difference in job satisfaction depending on the type of job – employees in managerial positions are more satisfied with their jobs compared to other employees.

The aim of this research is reflected in the analysis of the impact of work climate, appropriate from the aspect of satisfaction of basic psychological needs (competence, autonomy, relatedness to other people), on overall job satisfaction, involving both extrinsic and intrinsic job satisfaction, which indirectly affects performance. The results of this research have a scientific and practical contribution. The scientific contribution of the paper is reflected in systematic presentation and integration of research work on self-determination theory, including empirical research, conducted for the first time, on the influence of psychological needs and work climate on job satisfaction of employees in the hospitality industry, with recommendations to managers in the said industry for future business operation. The practical contribution is reflected in the possibilities of use of obtained research results by hotel companies.

Literature review

Self-determination theory

Self-determination theory, taken as a conceptual framework for research herein, represents a comprehensive and corroborated theory [34], [5]. Empirical research studies drawing on self-determination theory as a conceptual framework have confirmed its key theoretical propositions [32]. It is increasingly used in the field of organizational behavior, as the key to a successful company lies in well-motivated and satisfied employees. This theory postulates that a work environment which creates favorable working conditions, in the sense that employees feel competent, that their views and opinions are respected, that they are given autonomy in the performance of their tasks,

will positively influence the satisfaction of the basic psychological needs of employees and thereby produce positive work outcomes. According to the authors of this theory [5], these three psychological needs are innate and universal to human beings [25]. Basic psychological needs include the need for autonomy, competence and relatedness. They constitute building blocks for personal growth and development [4]. Since basic psychological needs are essential for the functioning of an individual, the focus of self-determination theory is not on the strength of the needs but on their satisfaction. What is important is the degree of their fulfillment. Hence, the focus is on the satisfaction of these needs or their thwarting [7], and the extent to which an individual is able to satisfy the needs in the social environment [10]. For instance, the possibility of choice and positive feedback are considered to be useful for all employees as they satisfy the inherent needs for autonomy and competence [30]. All three needs are therefore considered equally important, because it is assumed that none of them can be neglected in terms of achieving well-being and personal growth and development [27]. Self-determination theory emphasizes that managers who focus on satisfaction and preservation of these needs can count on better performance, greater commitment to the organization and involvement by employees.

The theory of basic psychological needs determines three dimensions of the social context which facilitate the satisfaction of the said needs [34]. An autonomy-supportive context facilitates autonomy, a well-structured context facilitates competence, and a relevant context enhances relatedness. Autonomy supporters thus provide opportunities for choice, meaningful and realistic reasoning when the said choice is constrained, and try to understand the views and opinions of others. Conversely, a controlling environment exerts pressure and directs thoughts, feelings and behaviors of individuals using external pressure tactics (e.g., punishments) or more covert, subtle manipulation techniques, including conditional regard [1], imposing of feelings of guilt [35] and shame [28]. Several studies in various fields have revealed that perceptions of autonomy support (relative to control) are associated with greater well-being, better performance and greater behavioral persistence. The theory of basic psychological needs holds that autonomy support does not imply a lack of guidelines and unlimited freedom in performing activities, which would certainly reflect the opposite of a well-structured environment [15]. Although guidelines may limit behavior, such a form of restriction is not necessarily perceived as controlling. People are rather more likely to personally support and volitionally follow social norms that are introduced in an autonomy-supportive fashion [32]. According to self-determination theory, social support is important and necessary for the satisfaction of the need for relatedness, as it fosters a sense of connectedness and understanding with others.

Need satisfaction versus need thwarting has been used to explain both positive and negative outcomes. Within a work context, need satisfaction has been shown to be positively related to the well-being of an individual in terms of the outcomes of work such as job satisfaction, employee attitudes regarding self-esteem, customer relations, organizational commitment and self-rated performance [2], [33].

Self-determination theory suggests that these three needs can be fulfilled while an individual is being involved in various forms of behavior which may differ among people and may be differently manifested in different cultures, but in any case, the satisfaction of these needs is essential for the development and well-being of an individual regardless of the culture they belong to. Basic psychological needs are considered important for all individuals and, in accordance therewith, self-determination theory, within its research studies, focuses on the extent to which individuals can satisfy their needs in a social environment [10].

In terms of applicability, the concept of basic psychological needs predicts whether management styles, organizational structures and educational practices will promote optimal outcomes [32]. Within the theory of basic psychological needs, researchers have focused on specific situations, thus the comparison of findings across different studies has been rendered difficult, such as studies in the field of sports [38] and organizations [31]. Therefore, there is certainly room for further research in different fields [34].

The application of self-determination theory within hotel companies can be used as a good framework for

understanding the factors that influence the behavior of hotel employees and the conditions that facilitate or thwart prerequisites for job satisfaction.

Job satisfaction

Literature provides a large number of definitions referring to job satisfaction. Locke [18] defines job satisfaction as a positive state resulting from an individual's appraisal of his/her job or job experience. According to Mullins [23], job satisfaction is an internal state and could be associated with a personal feeling of accomplishment. It is a complex concept, and it is hard to measure it objectively as it is influenced by individual, social, organizational and cultural factors. Spector [29] describes job satisfaction as a person's overall feeling towards a job as a whole and various job facets. In other words, job satisfaction is a degree to which a person likes their job, while job dissatisfaction represents the opposite.

Job satisfaction is the area of psychology that can be said to have the highest number of empirical studies published [37]. In addition to the employee motivation and performance measurement, this area is of exceptional importance in the management of human resources in a company, particularly in the hospitality industry, where the quality of service delivery depends precisely on employees, their motivation and subjective satisfaction with business activities.

There are two approaches to the study of job satisfaction: the first refers to the overall job satisfaction, while the second involves satisfaction with certain facets of the job which represent the attitude towards pay, managers, working conditions, the content of the job itself, communication, and similar. An individual can have different levels of satisfaction with various aspects of the job [29].

A large number of factors influence job satisfaction, and they can be classified into two categories [37], originally according to [11] in:

- organizational factors
- personal job satisfaction factors.

Organizational factors include the nature of work in terms of autonomy, task variety, feedback, reward systems, working conditions, interpersonal relations, etc. Personal factors refer to the position in the society, harmony between personality traits and the job, age, work experience, and other. Lawler and Porter indicate that personal factors such as age, gender, work experience and job characteristics affect the degree of job satisfaction [17].

Managers cannot influence the personal characteristics of employees, but they can influence the work environment, which can have a positive effect on job satisfaction and productivity. A large number of research studies measure general, i.e., overall job satisfaction in relation to satisfaction with specific aspects of the job. However, overall job satisfaction does not measure all aspects of a person's satisfaction/dissatisfaction with his/her job. Hence, in addition to overall job satisfaction, it is important to examine which aspects have an intrinsic/extrinsic influence on an employee's attitude towards job.

In addition to the work environment, job redesign can lead to increased employee satisfaction and productivity. [26]. Along with job satisfaction, job redesign can provide an employee with the opportunity for personal growth and development [13].

The dominant approach to job enrichment is based on the job characteristics' model developed by Hackman and Oldham [12], [13]. This model includes environmental aspects of work and personal aspects, arguing that a well-designed task can have an impact on satisfaction with the job and can thereby satisfy psychological needs of employees [12]. Job characteristics include the content and nature of the task. According to the authors, there are five core dimensions of the task: skill variety, task identity, task significance, autonomy, and feedback. The first three dimensions contribute to job meaningfulness. Skill variety represents the extent to which a job requires different activities and abilities as well as the skills needed to complete the task. Task identity represents features of the job that enable or prevent employees from having a complete picture of the job they perform. Task significance is reflected in the impact of the employee's job on other people in the organization as well as on the external environment. The autonomy afforded to an employee when performing work tasks contributes to a sense of responsibility, while giving feedback provides insight into work results and outcomes. By giving autonomy

and feedback, managers allow employees to experience a certain degree of freedom in carrying out assignments with a view to increasing their performance.

Early works by Hackman and Oldham [13] highlight autonomy and task identity as important aspects of work that enhance performance, while Deci, Olafsen and Ryan [8], in their review of self-determination theory in work environment, view them as a support to the need for autonomy provided by managers through their leadership. Regarding the provision of feedback, it is seen as supporting the need for competence, while task significance entails supporting the need for autonomy as well as the need for relatedness. Consistent with this view, several studies have shown that facilitative job characteristics have improved the satisfaction of basic psychological needs, autonomous motivation and positive work outcomes including job satisfaction and performance [9], [20], [8].

Morgeson et al. [21], [22] expanded the list of job characteristics and introduced social aspects of work as well as specific task characteristics. At the same time [8], [14] came to the conclusion that different job characteristics refer to satisfying one or more basic psychological needs for autonomy, competence and relatedness. Job satisfaction depends on understanding and fulfilling the needs of employees whose priority is determined by managers [36].

Despite theories that still question the best way to manage an organization in order to achieve both job satisfaction and productivity, it is up to the managers to provide appropriate level of autonomy to employees through job enrichment. In addition to this, it is necessary to also consider the contextual factors which include management styles, culture and trends in human resource management.

Methodology

The aim of this research is reflected in the analysis of the impact of work climate, appropriate from the aspect of satisfaction of basic psychological needs (competence, autonomy and relatedness with other people), on overall job satisfaction, which refers to both extrinsic and intrinsic satisfaction factors.

Research methods employed in this paper include analysis of scientific literature, application of three instruments - the work climate questionnaire (WCQ) [2], basic psychology need satisfaction at work scale (BPNS) [5], [6], and Minnesota satisfaction questionnaire (MSQ)[1], then statistical data processing, comparative analysis and correlation analysis using a statistical package.

Independent variables in our research are work climate and job content.

The work climate, which we defined as the respondent's assessment of the degree of perceived autonomy supportiveness, based on one's own experience with a direct manager, is measured by the WCQ, used by the respondents to assess the extent to which the management in an organization supports the autonomy of employees, based on one's own experience with the manager.

We defined the job content through two variables: the hotel sector in which the respondent is employed, and the job position, i.e., the type of work performed by the employee.

For the variable 'satisfaction of basic psychological needs for competence, autonomy and relatedness', we employed the BPNS instrument.

Job satisfaction is defined as a degree of overall job satisfaction, which represents the average degree of satisfaction with various factors, extrinsic and intrinsic factors that affect the satisfaction of various needs of employees in a work organization related to the performance of their job. This was tested using the MSQ.

The research was conducted in the form of an online anonymous questionnaire sent to hotel establishments, while the sample included 150 respondents.

The obtained results were processed by using SPSS 23.0 statistical software. In the process of data analysis, the following were processed: descriptive analysis (arithmetic mean, standard deviation), Cronbach's Alfa-coefficient for determining the reliability of scales used on the tested sample and inferential statistics. The Pearson correlation coefficient, t-test and analysis of variance were employed to examine the correlation as well as the differences in the measured properties, with a statistical significance of $p < 0.05$. All results are illustrated in the form of tables and comments.

1 MSQ, Retrieved from https://vpr.psych.umn.edu/node/26, August 2023.

Research results

An analysis was conducted on the basis of gathered data. Table 1 shows demographic characteristics of the sample of the respondents who took part in this survey.

Following the research work and processing of collected data, research questions were defined and analyzed.

H1: Job satisfaction is related to the fulfillment of basic psychological needs – the more the basic psychological needs for autonomy, competence and relatedness are fulfilled, the greater the job satisfaction.

According to the results referred to in Table 2, processed on the basis of the research data, a very high correlation was determined between extrinsic job satisfaction factors and overall job satisfaction ($r (150) = +0.95, p < .01$), as well as between intrinsic job satisfaction factors and overall job satisfaction ($r (150) = +0.963, p < .01$), including a very high correlation between extrinsic job satisfaction factors and intrinsic job satisfaction factors ($r (150) = + 0.838, p < .01$). Therefore, it is justified to consider job satisfaction as a unique variable.

Overall job satisfaction is highly positively correlated with satisfaction of basic psychological needs at work ($r (150) = +0.73, p < .01$). This indicates that a higher degree of job satisfaction is often accompanied by a higher degree of satisfaction of basic psychological needs at work and vice versa; those respondents who are less satisfied with their job often expressed a lower degree of satisfaction of basic psychological needs.

Even when job satisfaction is broken down into intrinsic satisfaction factors and extrinsic satisfaction factors, a high positive correlation with the satisfaction of basic psychological needs is obtained. A high positive correlation was found between satisfaction of basic psychological needs and intrinsic satisfaction factors ($r (150) = +0.71, p < .01$), as well as between extrinsic

Table 1: Demographic characteristics of the sample

	N	%
Gender		
Male	72	48.0
Female	78	52.0
Age		
up to 30 years of age	52	34.7
30-40	62	41.3
40-50	16	10.7
50+	20	13.3
Level of education		
Primary school	1	0.7
Secondary school	41	27.3
Two-year post-secondary school or undergraduate studies	83	55.3
Master's degree studies	25	16.7
Sector of work		
Accommodation	53	35.3
Food and beverages	34	22.7
Human resources	19	12.7
Marketing and sale	24	16.0
Supporting services	20	13.3
Job position		
Receptionist	32	21.3
Waiter	13	8.7
Hotel housekeeping and technical maintenance staff	21	14.0
Manager	84	56.0
Years of service in the current hotel		
1 – 3	74	49.3
3 – 5	34	22.7
5 – 10	35	23.3
10 +	7	4.7

Sources: Authors' calculation.

satisfaction factors and satisfaction of basic psychological needs (r (150) = +0.68, p < .01).

This result is logical considering a high intercorrelation obtained between intrinsic and extrinsic job satisfaction and a high correlation between each one individually with overall job satisfaction. Certainly, it seems that there is a basis for the conclusion that the satisfaction of basic psychological needs greatly influences the creation of job satisfaction, and that this influence is reflected in both intrinsic and extrinsic satisfaction factors. However, the opposite interpretation is also possible, i.e., that intrinsic satisfaction factors affect the satisfaction of psychological needs, from which it follows: the more employees are satisfied with intrinsic aspects, the more their basic psychological needs at work are satisfied and vice versa. Likewise, the more employees are satisfied with extrinsic aspects related to the work and the job they perform, the more likely is that the conditions for greater satisfaction of psychological needs are met.

The results in Table 3 show that there is a high positive correlation between overall job satisfaction and the BNPS subscale – satisfaction of the need for autonomy (r (150) = +0.77, p < .01), as well as the BPNS subscale - satisfaction of the need for competence (r (150) = +0.68, p < .01), while a moderate positive correlation was found between the variables of overall satisfaction and the BPNS subscale – satisfaction of the need for relatedness (r (150) = +0.48, p < .01).

A high positive correlation was also found between the variables of intrinsic satisfaction and satisfaction of the need for autonomy (r (150) = +0.75, p < .01), as well as intrinsic satisfaction and satisfaction of the need for competence (r (150) = +0.68, p < .01), while there is a moderate positive correlation between intrinsic job satisfaction and the satisfaction of the need for relatedness (r (150) = +0.45, p < .01).

Extrinsic job satisfaction is highly positively correlated with satisfaction of the need for autonomy (r (150) = +0.72, p < .01) and satisfaction of the need for competence (r (150) = +0.62, p < .01), while it is moderately positively correlated with the satisfaction of the need for relatedness (r (150) = +0.42, p < .01).

Hence, the hypothesis was confirmed that the highest degree of correlation was determined between the degree of satisfaction of the need for autonomy and job satisfaction, followed by the satisfaction of the need for competence and job satisfaction, while the lowest, albeit moderately high, was the correlation between the satisfaction of the need for relatedness and job satisfaction. These results point to the importance of satisfaction of psychological needs for the overall job satisfaction – the more satisfied they are, the more likely employees will be satisfied with their job and vice versa, if they are satisfied to a lesser extent, the greater the possibility that job satisfaction will be lower.

Table 2: Illustration of job satisfaction through intrinsic and extrinsic factors and fulfillment of basic psychological needs

	Job satisfaction	Job satisfaction – intrinsic factors	Job satisfaction – extrinsic factors	Fulfillment of psychological needs
Job satisfaction	1	.963**	.950**	.732**
Job satisfaction – intrinsic factors		1	.838**	.710**
Job satisfaction –extrinsic factors			1	.667**
Fulfillment of psychological needs				1

**Correlation significant at the level 0.01 (2-tailed).

Table 3: Illustration of job satisfaction through subscales – basic psychological needs

	Job satisfaction	Intrinsic satisfaction	Extrinsic satisfaction	Need satisfaction autonomy	Need satisfaction competence	Need satisfaction relatedness
Job satisfaction	1	.963**	.950**	.775**	.679**	.479**
Intrinsic satisfaction		1	.838**	.755**	.678**	.447**
Extrinsic satisfaction			1	.723**	.617**	.422**
Need satisfaction – autonomy				1	.726**	.591**
Need satisfaction – competence					1	.610**
Need satisfaction – relatedness						1

**Correlation significant at the level 0.01 (2-tailed).

H2: Perceived support for employee autonomy is related to job satisfaction – the higher the perceived support for employee autonomy, the more satisfied they are with their job.

A very high positive correlation was found between the variables of overall job satisfaction and work climate (r (150) = +0.82, p < .01) given in Table 4, which shows that the growth of the perceived support for employee autonomy also drives the increase in the degree of job satisfaction. Extrinsic job satisfaction is very highly correlated with work climate (r (150) = +0.82, p < .01), as well as intrinsic job satisfaction (r (150) = +0.76, p < .01). Hence, work climate, i.e., perceived support for employee autonomy is very highly correlated with extrinsic and intrinsic satisfaction, as well as overall job satisfaction.

H3: Job satisfaction differs depending on the content of the job, i.e., among employees in different positions.

One-factor analysis of variance (ANOVA) was employed to investigate the influence of job position on job satisfaction. The obtained results illustrated in Table 5 show that there is a difference among employees F (3,146) = 3.71, p < 0.05, while the subsequent Bonferroni test revealed differences between managers and waiters, as well as between managers and hotel housekeeping and technical maintenance staff. Managers (AS = 3.97) and receptionists (AS = 3.94) are significantly more satisfied with their jobs than workers in maintenance service (AS = 3.39) and waiters (AS = 3.42).

H4: There is a difference in job satisfaction depending on the type of job – employees in managerial positions are more satisfied with their jobs compared to other employees.

In Table 6, the results of one-factor analysis of variance (ANOVA) show that there is a difference F (3,146) = 3.71, p < 0.05 in the degree of job satisfaction among respondents in different job positions. A subsequent Bonferroni test revealed a statistically significant difference between managers and hotel housekeeping and technical maintenance staff. Managers (AS = 3.97) and receptionists

Table 4: Illustration of the relationship between perceived autonomy support and job satisfaction

	Job satisfaction	Job satisfaction – intrinsic factors	Job satisfaction – extrinsic factors	Work climate – autonomy support
Job satisfaction	1	.963**	.950**	.823**
Job satisfaction – intrinsic factors		1	.838**	.765**
Job satisfaction – extrinsic factors			1	.821**
Work climate – autonomy support				1

** Correlation significant at the level 0.01 (2-tailed).

Table 5: Illustration of the influence of job position on job satisfaction

ANOVA

		Sum of squares	df	Mean square	F	Sig.
Job satisfaction	Between groups	8.311	3	2.770	3.714	.013
	Within groups	108.916	146	.746		
	Total	117.227	149			

				N	Mean	Std. deviation
Job satisfaction	Receptionist			32	3.9356	.66628
	Waiter			13	3.4223	.69318
	Hotel housekeeping and technical maintenance staff			21	3.3890	1.18963
	Managers			84	3.9729	.85787
	Total			150	3.8355	.88699
	Groups	**Mean value**	**SD**	**F**	**df**	**p**
Job satisfaction	Receptionist	3.94	0.66	3.714	3	0.013*
	Waiters	3.42	0.69		146	
	Hotel housekeeping and technical maintenance staff	3.39	1.19			
	Managers	3.97	0.86			

* Correlation significant at the level 0.05 (2-tailed).

(AS = 3.94) are significantly more satisfied with their job compared to hotel housekeeping and technical maintenance staff (AS = 3.39).

Conclusion

In accordance with the postulates underlying self-determination theory that served as the basis of this paper, it was established that satisfaction of basic psychological needs and a conducive work environment have a positive effect on the outcomes of work.

In the context of basic psychological needs, the results of the research showed that the highest degree of correlation was determined between the degree of fulfillment of the need for autonomy and job satisfaction, then between the fulfillment of the need for competence and job satisfaction, while the lowest, albeit moderately high, was the correlation between the fulfillment of the need for relatedness and job satisfaction. These results indicate the importance of fulfillment of psychological needs for the overall job satisfaction – the more fulfilled they are, the more likely employees will be satisfied with their job and vice versa; if they are fulfilled to a lesser extent, the greater the possibility that job satisfaction will be lower. The hypothesis that there are differences in the degree of job satisfaction depending on the type of job was corroborated. Work assignments that encourage freedom of speech, creativity and variety enable greater fulfillment of basic psychological needs contributing thereby to greater job satisfaction. Given that similar differences were found also in the degree of fulfilment of basic psychological needs for autonomy, competence and relatedness, we can infer that certain types of jobs enable a greater degree of satisfaction of certain psychological needs, thus affecting overall job satisfaction (although general job satisfaction includes extrinsic and intrinsic factors). It is surprising that the level of job satisfaction among receptionists is almost equal to that of managers, bearing in mind that some of the extrinsic factors are more satisfied among managers than among receptionists. A possible explanation is that a high degree of job satisfaction in this group of employees stems at least partly from a higher degree of satisfaction of psychological needs.

In addition to the importance of fulfillment of basic psychological needs, it was determined that also the work climate created by autonomy-supportive management structures has a favorable effect on job satisfaction. Furthermore, where there is no support for autonomy, where employees feel an increased pressure from the management, where there is no respect for their opinions, initiative, creative potential, resulting in them feeling unfree and constrained, there is a greater possibility of being less satisfied with the job.

Job satisfaction is a complex and multidimensional phenomenon influenced by a combination of factors within the work environment and individual psychological structure. Understanding the interplay between basic psychological needs and work climate is crucial for determining the source of satisfaction with the job. In line with the results of this research, the recommendations for the Serbian hospitality industry involve improvement of facets of job that lead to a greater employee satisfaction contributing thereby to a greater work efficiency and a higher employee retention rate. In that sense, the following is proposed:

- Encouraging employee autonomy in performing tasks,
- Encouraging the development of skills and competencies,

Table 6: Illustration of job satisfaction in relation to the respondent's job position

		Sum of squares	df	Mean square	F	Sig.
MSQ- Job satisfaction	Between groups	8.311	3	2.770	3.714	.013
	Within groups	108.916	146	.746		
	Total	117.227	149			

		N	Mean	Std. deviation
MSQ- Job satisfaction	Receptionists	32	3.9356	.66628
	Waiters	13	3.4223	.69318
	Hotel housekeeping and technical maintenance staff	21	3.3890	1.18963
	Managers	84	3.9729	.85787
	Total	150	3.8355	.88699

- Creating a work environment that fosters team spirit, cooperation and mutual support,
- Open and transparent communication,
- Acknowledging and rewarding the achievements of employees. A sense of accomplishment contributes to a sense of competence and satisfaction.

These recommendations will aid hotel managers in creating an environment that supports employee satisfaction, increases their motivation and productivity, and contributes to better business results of hotel companies.

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THE ROLE AND IMPORTANCE OF PROGRAMMING LANGUAGES IN THE APPLICATION OF ERP SOLUTIONS

Uloga i značaj programskih jezika u primeni ERP rešenja

Abstract

ERP software solutions are important for every company because they significantly improve and simplify company operations through a system based on well-organized data and software modules. There are a large number of ERP solutions on the market in the form of commercial or open-source software. The paper focuses on the largest and most represented ERP software solutions, whose most significant features are presented in an overview. As these are software solutions that, by their nature, must be written in some programming language, the paper analyzes the programming languages that the presented ERP systems most use. The choice of programming language is very important when creating any new ERP solution because it often directs the system development and defines the framework of possible tasks that can be performed in it. Apart from the primary programming languages for each considered ERP system, other programming languages are also listed which they support at least in some of their segments. This approach in the paper can be useful to look at the existing situation in the field of relations between ERP software and programming languages, but also to provide a basis for the creation of some future ERP solutions viewed through the needs of the systems themselves and the capabilities of programming languages.

Keywords: *ERP systems, programming languages, business operations, software in business*

Sažetak

Softverska ERP rešenja značajna su za poslovanje svake firme jer se na taj način kroz jedan uređen sistem, zasnovan na dobro organizovanim podacima i softverskim modulima, može značajno unaprediti i pojednostaviti funkcionisanje preduzeća. Na tržištu postoji veliki broj ERP rešenja koja pripadaju komercijalnom ili otvorenom softveru. U radu je fokus na najvećim i najzastupljenijim ERP softverima koji su na pregledan način predstavljeni kroz svoje najznačajnije osobine. Kako se radi o softveru koji po prirodi stvari mora da bude napisan u nekom programskom jeziku, u radu su analizirani programski jezici koji se najviše koriste za prikazane ERP sisteme. Odabir programskog jezika je značajan pri kreiranju svakog novog ERP rešenja jer to često usmerava pravac razvoja sistema i definiše okvir mogućih zadataka koji u njemu mogu da se izvrše. Osim primarnih programskih jezika, za svaki razmatrani ERP sistem navedeni su i drugi programski jezici za koje oni bar u nekim svojim segmentima imaju podršku. Ovakav pristup u radu može biti koristan da se sa jedne strane sagleda postojeća situacija na polju odnosa između ERP softvera i programskih jezika, ali i da se da osnova za kreiranja nekih budućih ERP rešenja, imajući u vidu potrebe samih sistema i mogućnosti programskih jezika.

Ključne reči: *ERP sistemi, programski jezici, poslovanje preduzeća, softver u poslovanju*

Introduction

The accelerated digital transformation of business systems has brought major changes in the way companies operate. In order for business processes to adapt to a dynamic environment, companies need to implement some kind of application solution, such as ERP (Enterprise Resource Planning) software solutions.

ERP is a type of software that is used to manage the day-to-day business activities of a company, such as procurement, project management, risk management, accounting and business compliance of all business units. A complete ERP package includes the management of the entire company performance, as well as various modules that help plan, calculate, forecast and report on the company's financial results. ERP software connects a large number of business processes and enables fast data flow between them. Among other things, by collecting company data from different business segments, ERP systems eliminate duplication and enable data integrity.

Today, ERP software solutions play a key role in a large number of companies of all sizes in all industries. Depending on the needs of the organization, a large number of business segments, such as the overall architecture and its elements, need to be considered. These segments can include consistency, security, availability, scalability, legal segments, as well as company's organization and processes.

Regardless of the company size, ERP solutions are an indispensable part of business. Which ERP solution an organization will decide on depends on numerous factors and assessments. Different ERP solutions have their own advantages and disadvantages, which, depending on the company needs, can more or less affect its business.

ERP software consists of a large number of elements, modules, functions and layers. In order to ensure safe operation, different ERP solutions use different programming languages. The choice of programming language depends on several factors. Depending on the needs when developing an ERP software solution, it is necessary to consider various external factors, economic sector, as well as the legal issues of the country where the company is located.

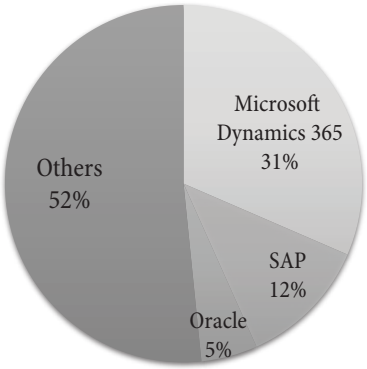
Internal factors, on the other hand, include team organization, internal processes and information flow. It is also necessary to take into account the needs of the company, such as the necessary support and tools for using different modules, organization of business activities, special communication with different stakeholders, as well as communication between company's business units. There is no limit to which programming language to use to develop ERP software; however, some languages stand out. For the development itself, it is possible to use one or several integrated languages for different parts of the ERP software, depending on what is being developed in the software (front-end, back-end, business logic, security, etc.).

ERP solutions

In order to reveal the importance and use of programming languages, it is necessary to describe some ERP solutions. We use four ERP solutions as an example, three of which occupy almost half of the market share [26], and the fourth solution is an open-source solution, which by its nature is different from commercial solutions and for that reason may be more interesting to test differences in the use of programming languages in commercial ERP solutions and open-source ERP solutions.

Figure 1 shows the distribution of software platforms on the market. The most popular ERP solutions are shown, while the option "others" includes a large number of ERP solutions by smaller manufacturers. Among other things, there are open-source ERP solutions such as Odoo. The information on the market share of Odoo ERP solutions

Figure 1: Distribution of software platforms



Source: Software connect [26]

is relative because this solution is not commercial, so the data on its use in companies is not relevant enough.

See more about the design of ERP systems and their development trends in [3]. The research agenda of ERP systems and expectations of how they will develop in the future is presented in more detail in [4]. See more about the analysis of the future needs of the ERP system in terms of database models in [5]. An analysis of the possible advantages and limitations of the ERP system is given in [25]. A comparative analysis of several cloud-based ERP software, such as SAP, Oracle and Microsoft solutions, is given in [7]. A more detailed description of ERP system architecture and the comparison of several systems is given in [2].

Artificial intelligence can be applied in ERP systems. A detailed bibliometric analysis of 837 publications connecting artificial intelligence and ERP systems is presented in [1]. The connection of the ERP system with blockchain technologies and accounting information systems is described in [8]. See more about the application of modern ERP systems in the era of digital transformation in [11]. The implementation of the ERP system and its challenges regarding planning, management and administration are the subject of [14].

ERP software is also studied at faculties, most often at master's studies, but there are also faculties such as the Faculty of Economics of the University of Belgrade, where this subject is covered as part of the ERP software course in undergraduate studies since 2020/21. A detailed analysis of the necessary skills for students studying ERP software is given in [6]. A detailed overview of literature on educational practices related to ERP software is given in [28].

Microsoft Dynamics 365

Dynamics 365 is an ERP software developed by Microsoft in 2016 by merging the existing ERP software Dynamics AX with the customer relationship management application Dynamics CRM. In this way, a powerful portfolio of modular SaaS (Software-as-a-Service) applications was created, designed to help companies effectively manage their main business processes. This software combines ERP and CRM software components along with artificial-intelligence-based tools. It fully encompasses internal and external business flows, fully integrating organizational data, processes and business logic. Read how students can be trained to work in the Microsoft Dynamics system in [29].

Dynamics 365 offers smart integrated tools that effectively connect processes, prioritize operations and convert prospects into customers. It consists of a large number of modules, which improve the company's operations in different ways. It mainly focuses on finance, sales, marketing, customer management, project management and talent management. Each of the modules is adapted to the specific needs of the company.

Users of Dynamics 365 services have the option of point-and-click creation of their own applications, which reduces the required programming knowledge to a minimum. The ERP software is built on the Microsoft Azure cloud platform, which provides additional security for its users. As this ERP software is managed through a web browser, all tools can be accessed from anywhere. For this reason, there is a great focus on security of access and privacy of the data itself. Microsoft does not use the data and has no access to it, as it belongs to the company.

A great advantage of Dynamics 365 ERP software is the ability to combine it with other Microsoft applications. In this way, users get a comprehensive overview of all transactions, records and information about relevant business activities. Companies that rely heavily on Office 365 suite applications can further improve the user experience due to full integration with ERP and CRM systems.

SAP

SAP is a widely used ERP software, developed in Germany in 1972. The original name of this software was System Analysis Program Development (German: SystemAnalyse Programmentwicklung), but over time it got its final name, Systems Applications and Products. This ERP system creates a centralized system that allows access and sharing of business data within every part of the organization, which is later used for various business analyses. In this way, the entire business is unified

and centralized, creating a better and more organized working environment for employees. In 2019, SAP was used in over 404,000 business systems worldwide, and the company itself was ranked 12th among the world's largest technology companies [19].

SAP ERP software contains over a hundred modules that cover every business aspect. The number of modules can vary significantly depending on the software version that the company owns, individual business requirements as well as industry requirements. The focus is primarily on serving large companies, but over the years, solutions have been developed for smaller companies. One of the biggest advantages of the SAP system compared to other systems is its flexibility in terms of serving companies of all sizes. SAP Business One can improve the operations of small businesses, while medium-sized enterprises can take advantage of SAP Business ByDesign.

Another advantage of the SAP solution is the shorter implementation time. Although it is among the most expensive ERP solutions, it is considered that the speed of implementation and the effect it has on business efficiency make the investment return period significantly shorter compared to the use of other systems. In addition, SAP is extremely flexible and requires relatively few business changes. In order to improve business, the development team of this ERP solution constantly makes improvements and fully adapts to all market changes. The best market practices are applied to reduce costs and increase the user's comparative advantage.

One of the most important components of the SAP ERP solution is the SAP S/4 HANA solution, which is based on the SAP HANA relational database. The HANA database enables the storage of huge amounts of data. It is possible to save files whose size reaches 16 TB per file [17]. SAP S/4 HANA is suitable for real-time data analysis and processing, with a simple and intuitive interface. All data is fully protected because the database can only be accessed with authorization, the files themselves are encrypted and it is impossible to access them from the outside. In addition, the SAP HANA database is available as a service on the cloud platform. If a company wants to avoid building and maintaining infrastructure, this can be an excellent option for storing information.

Oracle NetSuite

NetSuite is an organization that has developed a cloud-based business management assistance platform. This is one of the fastest growing ERP solutions with over 34,000 users [20] from various industries. The organization was founded in 1998 under the name NetLedger. Over the years, a large number of applications have been developed to help companies organize business, understand business results, and analyze business results as a whole.

NetSuite covers all business parts, including accounting, procurement, logistics and inventory. In addition to the basic modules, it is possible to choose applications for marketing, CRM and human resources, which includes applications for personnel records and payroll. All modules are specially adapted to the needs of each individual company and all data is stored in a single database. For this reason, information from all business flows is available in real time, which greatly facilitates business analysis and timely business decisions.

NetSuite uses a SaaS (Software-as-a-service) business model, which means that users pay a subscription fee to have access to all technologies. Companies are thus freed from the responsibility of purchasing infrastructure and worrying about software security and functionality. By eliminating the costs of software maintenance and improvement, the budget is relieved, leaving space for the development of other business components.

Although it is one of the first ERP systems, there are components that set NetSuite apart from other software solutions. First, NetSuite unifies the entire business on one platform. This means that finance, procurement, production, human resources, marketing and sales are located in one place in one database. Therefore, it is not necessary to develop separate software solutions for managing business processes. This significantly increases efficiency because workers register in one place and have access to every relevant business aspect. Second, a centralized system with a single database eliminates the need for third-party software that could be unreliable. Third, NetSuite is fully adapted to cloud operations. Many ERP systems do not have their own cloud system, which increases the risk of data loss, slows down upgrades and prevents scalability.

NetSuite Cloud enables smooth growth and meets all user requirements with a guarantee of data protection. Fourth, NetSuite provides a whole range of analytical tools that can give the company a completely new perspective of its operations. Finally, NetSuite is an extremely flexible platform. It can improve business operations regardless of the industry. The platform can be adapted to the specific needs of each company.

Odoo ERP

Apart from commercial ERP software, there are also ERP software solutions that are more or less free and open source. Their common feature is that they can be adapted, supplemented and developed according to the company's needs. There are a large number of open-source ERP systems, but they occupy a relatively small market share. Sixteen most frequently selected open-source ERP systems can be seen in [18]. Odoo is among them.

The Odoo ERP system is enterprise resource planning software used to manage business processes. Odoo ensures the entire integration of business activities on a single platform using Odoo applications. The Odoo ERP solution is an open-source software, which sets it apart from other popular and commercial ERP solutions. The Odoo system covers almost the entire business and is mostly applied in accounting, subscriptions, planning, business consolidation, invoicing, inventory management, human resources management, marketing, CRM, as well as a system for dynamic site content management (Content Management System). On their website [21] they claim to have 7 million users.

It used to be called OpenERP, so it appears in literature under this name as well. The presentation of this system is given in [9]. A comparative study of this ERP system and its technologies in relation to others is given in [12]. A thorough comparison between ERP software Odoo and Microsoft Dynamics NAV is given in [10].

Odoo is available in 2 versions: the *Enterprise edition*, which works on a subscription basis, as well as the *Community version*, which is completely free. Both versions are mainly aimed at small and medium-sized companies, because this ERP software still cannot compete with expensive ERP systems such as SAP and Oracle. Odoo stands out among small companies dealing with distribution, production, marketing and accounting. The price of the Odoo ERP system depends on the number of users and the number of required Odoo applications.

The main advantage of this system is the price. Odoo implies a large number of applications that can cover the entire business, at significantly lower prices for system installation and maintenance. Small businesses are often unable to afford even the cheapest versions of well-known ERP systems. For this reason, Odoo offers a free version, which can be found on the official website, or on GitHub. In addition, the whole system is very flexible, offering easy integration with many third-party software solutions and applications. Also, the official website offers extensive training on the standard functions of the ERP system, while training on the use of other ERP software is significantly more expensive. Odoo can function on a cloud platform or locally, depending on the company's needs. Finally, Odoo has a wide user base, which means that almost any problem can be solved easily.

It is important to mention the shortcomings of Odoo software. First, the setup of the system itself is very complex. It is possible to encounter a whole range of problems when trying to integrate independently. Second, the Enterprise version has a number of hidden costs. If the company opts for only one additional application, it has to allocate a significantly higher amount than the standard annual subscription. This means that businesses in the growth phase may encounter additional unplanned expenses, which can create further budgeting problems. Third, due to the limited number of servers, it is often not possible to reach the necessary support, and users are left with insufficiently broadly defined documentation.

However, it is important to note that most open-source ERP systems represent a much more affordable and better solution for small businesses that do not have enough resources to implement an expensive system. Odoo adapts and automates a large number of processes, which can significantly improve business. This system can represent a unique solution to a large number of problems small and medium-sized enterprises face.

Application of programming languages in ERP solutions

ERP software solutions are very complex systems that increase the effectiveness of the entire business. Many organizations have recognized the potential of implementing an ERP solution and it is believed that over 70% of large businesses use some type of ERP software. Additionally, the global market for these systems is estimated to be worth $74.2 billion in 2023 [13]. For this reason, the provision of ERP system services is one of the most profitable sectors of application software.

ERP software solutions are very complex computer systems that automate the most important business processes of a company. They are made up of a large number of modules that are adapted to the specific needs of each business unit. These systems are fully centralized, so information needed for various business aspects can be downloaded from a common database. Therefore, building and using these systems require detailed planning and the use of one or more programming languages.

Some of the well-known programming languages that are often found in the structure of an ERP system are Java, PHP, SQL, Python, Ruby, JavaScript, C++, C#, etc. In addition, a number of programming languages have been developed to support the development and maintenance of such systems, such as ABAP, X++, SuiteScript and AL. ERP systems must be carefully adapted to all company needs, so a combination of several programming languages is often used to achieve the desired results. There are several reasons for this:

- Building a multi-layered system: Many ERP systems are multi-layered, so different languages are used to build the user interface, database, business logic, program logic and for various analyses and reports. For example, JavaScript combined with HTML can often be used in building interface, Python and Java are used to implement business logic, while SQL and PHP are used to communicate with the database.
- User interface development of mobile and web applications: If the target is accessed via the Android operating system using various applications, then the Kotlin programming language can be used to develop applications on the Android operating system, which is compatible with a wide range of existing Java libraries and tools. Kotlin is a modern programming language originally used for Android application development but is increasingly used in general software development as well. Also, ERP platforms that are developed in Java can be extended or updated using Kotlin without having to replace the entire code.
- Special analytical tools: ERP systems give very powerful analytical options to their users. In order to make the best business decisions, programming languages R and MATLAB are often used for statistical and numerical calculations within various modules.
- Integration with other systems: It is often necessary to integrate ERP modules with various third-party services such as banking, trade, transport and special systems. It may happen that the ERP system is written in one programming language, and the external systems in a completely different one, so in that case it is necessary to use an additional programming language for successful integration.
- Integration with old systems: In cases where a new ERP solution is developed over existing systems, it is necessary to use a greater number of programming languages in order to maintain full compatibility and functionality of the entire system.

This practice requires a high level of planning, the ability to manage projects, as well as a great knowledge of the entire system. If these conditions are met, the use of multiple layers of programming languages can improve business efficiency, system application flexibility, as well as the implementation of additional tools that can subsequently bring a competitive advantage to the company.

In the case of the 16 open-source ERP systems shown in [18], the most represented programming languages are Java (used by 6 systems), Python (4) and PHP (4).

Programming languages in the MS Dynamics 365 environment

Dynamics 365 supports several programming languages depending on the development and integration needs

of different modules and applications, including C, C#, HTML, JavaScript, X++, SQL, FetchXML, and ASP.NET. One of the key features of the Dynamics 365 ERP system is adaptability to different business needs, and the choice of programming language itself depends on different application needs and modules within the system. By combining different programming languages and technologies, it allows for continuous development of existing solutions and successful integration with other systems.

The most commonly used programming language for developing applications in the field of finance and business within the Dynamics 365 software is X++. X++ is used to write business logic, create custom solutions, and integrate third-party solutions. It is an object-oriented programming language for building applications and working with data, which is used in enterprise resource planning programming and database applications. It provides the ability to use the system class for a wide range of areas of system programming, such as classes, tables, user interface, file import and export, form and report manipulation, etc. This programming language runs all the elements in this Microsoft environment, such as classes, forms, queries, data types, and the like. X++ is an object-oriented language that is very similar to C# or Java programming language. Some of the main features of the X++ language are the ability to work with relational tables in Microsoft Dynamics 365. This is so because this language uses keywords that mostly match the common keywords in the standard SQL language. Also, this language is extremely efficient in terms of saving memory space. X++ has mechanisms for discarding objects that are no longer referenced, so that their memory space can be reused.

When developing CRM applications, the most commonly used programming languages are C#, JavaScript and SQL. C# is a widespread object-oriented language that is used in many services provided by Microsoft. When building CRM applications within the Dynamics 365 ERP system, C# has several roles. First, it is important to note the development of plugins, i.e. special code components that react to special events or orders within the CRM system. Second, C# can support the X++ language for writing business logic, enabling the implementation of complex operations and integrations. Finally, it is used when automating business processes and specialized actions. JavaScript plays an important role in customizing the behavior and functionality of various forms in Dynamics 365. In addition, this language is used to set various events that are triggered during interaction with the system itself, such as pressing a certain button, loading and saving processes, changing field values and the like. JavaScript provides developers with a range of system and user experience customization options, which can be significant for attracting new users. SQL (Structured Query Language) plays a key role in the development of the Dynamics 365 CRM system. It is used to store and manage various business data, as well as to create various analyses and reports. The Microsoft Dynamics 365 CRM system supports all types of queries as a standard SQL language because it uses the Microsoft SQL server to store and manage data.

Business Central is one of the solutions of Microsoft Dynamics 365 and is used in business management in small and medium-sized enterprises, to automate and simplify business processes. Within this solution, the AL (Application Language) programming language is used to manipulate data (input, download, change) in the database, and it is also used to control the execution of application objects (application segments, reports, etc.). Using the AL language, business rules can be created to ensure the process of storing meaningful data in the database in line with the way clients do business. Code written in the AL language can be part of triggers on database objects such as tables, fields, reports, records, queries, and the like. Unlike other languages, AL is tailored to the development of Dynamics 365 Business Central only.

Microsoft has developed the Dynamics 365 for Phones Android application that provides access to system data and functionality. This Android app provides sellers, agents and supervisors with tools to manage their data and update records and status when online or offline. The Kotlin programming language is used to develop Android applications.

Programming languages in the SAP environment

SAP makes it possible to use different programming languages, offering great flexibility when developing and adapting

the system to the business. SAP has multiple development environments that implement programming languages in different ways to enable building, customizing, extending, and integrating SAP applications. It is fully compatible with programming languages such as Java, C, C++, SQL, Python, JavaScript. However, in order to provide a secure environment for developing and modifying applications, the ABAP programming language was developed.

ABAP (Advanced Business Application Programming) is a programming language specifically designed for the development of business applications and tools within SAP solutions and represents the development base of the entire range of SAP products. This programming language can be used in many SAP services, such as SAP ERP, SAP Business Suite and SAP S/4 HANA. ABAP enables the construction and customization of specialized modules for materials management, financial accounting, asset management, sales and other modules available. The SAP NetWeaver development environment allows users to upgrade existing applications using the ABAP programming language. Application Server ABAP (AS ABAP) is also in this development environment. It is a variant of the application server that serves as a development environment for SAP applications and consists of three layers: presentation layer, application layer and database layer. This ensures independence of ABAP applications from hardware, operating system and database. Authors' experiences in training IT students in the ABAP programming language at Victoria University in Australia is given in [15].

SQL (Structured Query Language) is a standardized language for communicating with relational databases. The SAP HANA database supports a large number of SQL items for data entry, system administration and manipulation of existing data. As SAP has a fully centralized system, SQL is a key tool for almost all modules and applications and is essential for the creation of various business reports and the analysis of specific financial results of the company. In addition, the SQL programming language is a key tool for customizing and possibly expanding the SAP system. SQL is easily combined with ABAP items and thus facilitates the development of business applications. During system integration, it is often necessary to communicate between the old system and the new one, and the SQL language is used for data synchronization. Due to its relational structure, but also its simplicity, the SAP HANA database is primarily focused on the use of the SQL language, i.e. its improved version of SAP HANA SQL.

Although ABAP is the primary programming language for developing and building an SAP software solution, other programming languages are also of great importance. Java plays an important role in designing specific business applications. The SAP Application Server (AS) Java system, like the ABAP programming language, is located in the SAP NetWeaver development environment. This environment consists of three layers: Java Enterprise Runtime, AS Java System Components and Applications. Java provides platform independence, object-oriented programming capabilities, and a wide range of libraries, which can help when building very complex applications. Java plays a role in the development of programs on the Java Enterprise Editon 5 platform, which is used especially for the development of large-scale applications in the SAP ERP system. In addition, Java is often used when building web-based user interfaces and enables data exchange between SAP and other solutions. Finally, SAP GUI for Java is client software that allows users to access the SAP system from a Java environment.

In addition to the mentioned programming languages, which play a primary role in the development of various modules, SAP provides a platform for the implementation of other programming languages. Python is widely applied and is used to connect to the SAP database, apply artificial intelligence to extract different entities from textual data using the Business Entity Recognition service. It is also used to automate repetitive tasks, which can significantly reduce user errors and save time. C and C++ can be used to integrate applications written in those languages with ABAP codes. Various functions written in C/C++ are also available, which can enhance existing applications. Finally, HTML and JavaScript can be used to create SAP GUI applications that use JavaScript libraries. However, the application of all these programming languages must be done with care and caution because they can affect the stability and security of the system.

SAP also developed an Android application that provides access to business data, reports and system

functionalities, for which the Kotlin programming language was used.

Programming languages in the Oracle NetSuite environment

NetSuite is one of the most well-known cloud-based ERP solutions that provides support to organizations in conducting business, increasing efficiency, directing business decisions and analyzing results. A large number of tools have been developed that specialize in different aspects of business such as accounting, finance, e-commerce and the like. However, as the needs of organizations become more complex, NetSuite enables the application of different programming languages in order to fully adapt the services to the different business logics of individual companies. The primary programming language for the development of this ERP solution is SuiteScript.

SuiteScript is a NetSuite platform built with the help of the JavaScript programming language whose primary role is the automation and customization of business processes. However, the possibilities are much wider than that. This script programming language allows users to manipulate business and user information with the help of user events such as web requests, value changes within various fields, form submit and pre-scheduled events. SuiteScript consists of several key components that provide a high degree of flexibility to users. *Suitelet* is an upgrade to the standard SuiteScript that allows you to create a customized user experience using the HTML language. *Portlet* allows upgrading the existing dashboard to display relevant information to users. Integration of RSS, HTML, as well as maps, blogs and applications for sending messages is possible. *Scheduled SuiteScript* enables the automation of business processes with the help of scheduled actions that can be triggered at a predetermined time using JavaScript extensions. *User Event SuiteScript* component is used to validate required data and implement business logic with the help of user events. A defined set of rules is triggered when users interact with the system such as opening, modifying and saving records. *Client SuiteScript* is an upgrade that supports custom calculations and various alerts based on user inputs or interactions. If the full potential of these components is used, it is possible to create completely customized software for any business.

NetSuite provides a wide range of capabilities to build reliable and scalable integrations that extend core capabilities. This means that in addition to using SuiteScript, there is a platform that supports programming in several well-known programming languages. Users have the ability to integrate existing or new applications written in Java, PHP, C# and Ruby. SuiteTalk API is an integrated web service that enables communication with external systems and integration of applications written in different programming languages. A set of SOAP (Simple Object Access Protocol) protocols is provided that serve to exchange structured data with more complex applications written in JavaScript, Java and Python using XML (eXtensible Markup Language) of the protocol. In addition, it is possible to work with the REST (Representational State Transfer) API, which is based on principles that support the scalability and simplicity of applications. The REST API enables the exchange of data between different systems using HTTP methods (GET, POST, PUT, DELETE). This ensures smooth integration of external systems within the NetSuite ERP system, thereby removing potential limitations during migration or implementation of this ERP software solution.

Access to the NetSuite solution is also enabled through the Android application. This route allows access to key business functions such as finance, sales, inventory management and human resources. In order to enable this approach, the Kotlin programming language was used to create the Android application.

Programming languages in the Odoo solution

Odoo ERP is an open-source software used by a large number of companies for business automation, management and analysis. Most of this software is written in the Python programming language and therefore uses the versatility and simplicity of this language to automate and customize business processes. The programming language Python is a general-purpose language which according to the TIOBE Programming Community Index [27] is the most popular programming language, so many open-source

ERP software solutions use Python as a development environment.

Python provides tools for improving existing as well as developing new components within the system. This programming language allows for input and extensive analysis of business processes, which also includes a visual overview of data, which can significantly facilitate the understanding of statistical information and the monitoring of generated invoices, reports and project results. Odoo Python also helps employees within the organization. Almost the entire HR module is written in this programming language, and with it, employees receive tasks, receive salary calculations and determine the remaining number of days off. Effective monitoring of projects is also enabled with a number of tools and modules that take care of accounting items, accounts, inventory and marketing. Users have the ability to develop their own automated actions with just a few lines of code. Odoo Python uses various packages to develop ERP systems. The Python-docutils package is used to load business documentation in more useful formats such as XML and HTML. On the other hand, the Python-simplejson package is tasked with encoding and decoding JSON files. Also, the Python-dateutil package provides a powerful extension for more complex date operations.

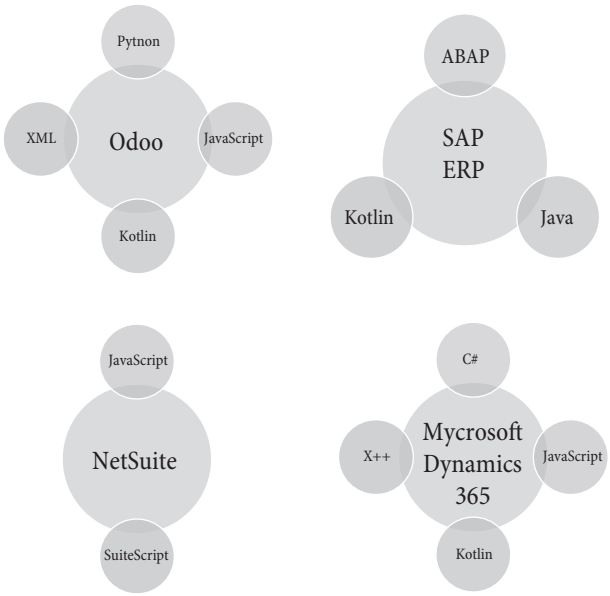
Odoo ERP system is closely related to the PostgreSQL database system and uses it as a standard DBMS system. PostgreSQL is an extremely powerful open-source database management system. It was developed in 1986 as part of the POSTGRES project at the University of California. PostgreSQL is a relational database and provides a number of tools and options to help developers build applications, manage data, and protect data. The Odoo ERP system uses the Python library psycopg2, which is specifically designed to communicate with data storage programs. As these systems are separate, users can expect a high level of service in both aspects. Companies get a very efficient solution for managing various business processes, as well as for storing the necessary data. The PostgreSQL database allows for a large number of upgrades that can take data analysis to a whole new level. This can help businesses make later business decisions. Among the 16 displayed open-source ERP solutions, [20] most often used PostgreSQL (10 systems) and MySQL (7) as database management systems.

In addition to the Python programming language, the Odoo system takes advantage of other languages to develop various modules and to communicate with external systems. JavaScript plays an important role when building user interfaces in combination with HTML and CSS. A special Javascript platform has been built which has three main roles:

- The web client: Javascript is used when building single-page private web applications that are used to view and modify business data
- The website: Odoo provides the possibility of building websites that should provide the necessary information to all stakeholders such as customers and potential collaborators. This is the public part of the Odoo ERP system.
- The point of sale: Odoo supports the development of a one-page web sales point that supports efficient electronic commerce.

Odoo supports the integration of other programming languages such as XML for defining data structures, QWeb for creating formatted and styled reports, HTML and CSS for the front-end part of the application. Integration with applications written in the most well-known object-

Figure 2: Display of the relations between ERP solutions and the programming languages they use



Source: Authors

oriented languages is enabled, but the primary focus is still on developing solutions in the Python environment.

Since Odoo has an app available for Android systems, it uses the Kotlin programming language. Every application in the Odoo database is available from one source applications, which allows for maintenance and monitoring, record keeping, sales, etc.

Since the ERP solutions selected in this paper use several different programming languages for different purposes, Figure 2 gives a clearer overview. The lines on the graph define which ERP solution uses which programming language, where, due to the large number of languages, the bold line represents the connection between the ERP solution and its primary language.

Conclusion

ERP software solutions are increasingly used and have become an indispensable part of every company's business. The paper presents some of the most popular ERP solutions on the global market. Microsoft Dynamics 365, SAP ERP, Oracle NetSuite and Odoo, as an open-source software solution, are presented. The specifics of each of these systems are highlighted from the point of view of their application in business operations, as well as from the point of view of differences in platforms, database management systems, modules, and the most commonly used applications. Special attention is paid to the programming languages used in these ERP solutions. Each of them has a primary programming language, but due to the need to work with large amounts of diverse data and software, at least in some parts they support other programming languages, which is shown in more detail in Figure 2. The importance of programming languages in ERP systems is large because the speed of further development and the possibility of applying new software solutions is mostly based on the strength and ability of the programming language to realize it.

Development teams tasked with building enterprise resource planning software opt for different programming languages depending on the needs of the business systems. Depending on the choice of ERP solution, organizations have complex tools for analysis and efficient management of business processes, thus the choice of programming language can make a big difference when implementing and developing the system. It is important to note that most ERP solutions are not limited to only selected languages. Platforms for the implementation of other programming languages have been developed, which enables easier integration of ERP solutions with various business processes, as well as the application of specific tools and applications written in lesser-known programming languages.

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ECONOMIC FEASIBILITY OF SMALL-SCALE BIODIESEL PRODUCTION IN SERBIA

Analiza ekonomske opravdanosti proizvodnje biodizela u pogonima malog kapaciteta

Abstract

This paper examines the economic feasibility of producing biodiesel in a small-scale production plant with an annual capacity of 1,000 tons. Based on average raw material prices (rapeseed oil, sunflower oil, soybean or sunflower seeds) in the period 2017-2021, the production cost of biodiesel ranges from 101 to 114 RSD per litre, depending on the raw material used. Using oilseeds as raw materials instead of vegetable oils results in lower unit cost of biodiesel, due to revenue from oil cakes, but requires extra investment in oil presses and silos, which significantly increases investment costs. Moreover, the economic advantage of using oilseeds as raw materials is lost even with a small drop (by 5% in the case of soybean) in the selling price or sales volume of the oil cake. Manufacturing biodiesel for producers' own fuel needs is economically feasible as the unit cost of biodiesel was 25-34% lower than the retail price of Eurodiesel in the observed period. However, at the estimated production costs, the retail price of biodiesel, which would also include sales costs, excise duties and value-added tax, cannot be lower than the retail price of Eurodiesel. Assuming the complete exemption of biodiesel from excise, it could become price-competitive with fossil diesel in the domestic fuel market.

Keywords: *biodiesel, cost of production, oilseeds, Serbia*

Sažetak

U radu se ispituje ekonomska opravdanost proizvodnje biodizela u pogonu godišnjeg kapaciteta od 1.000 tona biodizela. Pri prosečnim cenama polaznih sirovina (ulje uljane repice ili suncokreta, seme suncokreta ili soje) u periodu 2017-2021. cena koštanja biodizela se kreće u rasponu od 101 RSD/l do 114 RSD/l u zavisnosti od sirovine. Niže cene koštanja se postižu kada je umesto ulja polazna sirovina seme uljarica (zbog prihoda od prodaje uljanih pogača), međutim presovanje ulja zahteva dodatna ulaganja u nabavku opreme i silosa. Pored toga, prednost semena kao polazne sirovine gubi se već pri manjem padu (npr. za 5% u slučaju soje) prodajne cene ili stepena valorizacije uljane pogače. Proizvodnja biodizela za vlastite potrebe je ekonomski opravdana jer je u posmatranom periodu cena koštanja biodizela bila 25-34% niža od maloprodajne cene evrodizela. Međutim, maloprodajna cena biodizela, koja bi uključivala pored cene koštanja i troškove prodaje i državne namete u vidu akcize i poreza na dodatnu vrednost (PDV), ne može biti niža od maloprodajne cene evrodizela. Pod pretpostavkom potpunog oslobađanja biodizela od akciza biodizel bi mogao biti cenovno konkurentan fosilnom dizelu na domaćem tržištu goriva.

Ključne reči: *biodizel, troškovi proizvodnje, uljarice, Srbija*

Introduction

Biodiesel is a liquid fuel primarily produced from crude or used vegetable oils and animal fats [7]. It can be used in certain diesel engines with minimal or no modifications required for the engine or its equipment [23]. The main advantage of biodiesel over fossil diesel is that it is derived from renewable and locally available raw materials. Recognizing the vital role of renewable energy sources in achieving Serbia's strategic objectives, the National Assembly approved the Energy Sector Development Strategy in 2015, which aims to increase the utilization of biofuels in the transport sector and achieve a 10% share in final consumption by 2020. To meet this goal, the National Action Plan for the Use of Renewable Energy Sources in Serbia set a target of introducing approximately 255,000 tons of biodiesel into the market, with the majority expected to be imported (60%) and the remainder produced domestically (40%, or about 100,000 tons). Serbia has modern industrial capacities to produce around 130,000 tons of biodiesel annually [7], however, the strategic goals were not achieved, and biodiesel production has decreased in recent years to very small quantities produced by small-capacity facilities. The literature suggests that the primary obstacles to larger biodiesel production in Serbia are the high cost of raw materials, relatively low prices of fossil fuels, and lack of state incentives [23].

Previous studies examining the economic feasibility of biodiesel production in Serbia have primarily focused on large (100,000 tons of biodiesel per year)]6] and medium-sized (5,000-20,000 tons) industrial plants [10], [13], with little attention paid to small-scale facilities (1,000-5,000 tons). While it is generally acknowledged that the unit cost of biodiesel increases as production capacity decreases [14], small-scale facilities possess certain advantages over large-scale industrial facilities. These advantages include lower investment and fixed costs, the ability to quickly adjust production volumes to market conditions, and greater tolerance for variations in raw material quality. As a result, some small-scale facilities have been able to maintain production, albeit at reduced capacities, during periods of market volatility. Hence, small-scale biodiesel production may have considerable potential in Serbia, particularly regarding its adaptability to the dynamic market environment.

The aim of this research is to assess the production costs and competitiveness of biodiesel produced in small-scale biodiesel plants in Serbia. This topic is particularly relevant in light of a recent government decision mandating a share of biofuels in transport fuels sold domestically between 2022 and 2024, which ensures a steady market demand for biodiesel. Hence, it is interesting to investigate whether small-scale biodiesel producers have the potential to become profitable suppliers to the domestic fuel market.

Method and data sources

As part of the economic analysis, the feasibility of producing biodiesel in a plant with an annual capacity of 1,000 tons was examined. Biodiesel production is carried out by batch process using alkaline transesterification of triglycerides of vegetable oils [24]. Four possible production scenarios were considered, depending on the type of raw material used (rapeseed and sunflower oil, sunflower and soybean seeds). Table 1 presents the basic characteristics of each

Table 1: An overview of the main material flows associated with the four scenarios of biodiesel production depending on raw material (in tons per year)

Type of raw material	Scenario A	Scenario B	Scenario C	Scenario D
	Rapeseed oil	Sunflower oil	Sunflower seed	Soybean seed
INPUTS				
Raw material	1026	1026	3058 [d]	7297 [e]
Methanol	118 [b]	118 [b]	118 [b]	118 [b]
OUTPUTS				
Biodiesel	1000 [a]	1000 [a]	1000 [a]	1000 [a]
Crude glycerol	139 [c]	139 [c]	139 [c]	139 [c]
Oil cake	0	0	1977 [f]	6062 [f]

Assumptions:
[a] The assumed biodiesel yield is 0.98 kg per 1 kg of oil, and the losses in the mass of the oil feedstock due to sediments are assumed to be 0.5% in Scenarios A and B, and 6% in scenarios C and D [5, 19];
[b] The calculation is based on the assumed stoichiometric oil to methanol molar ratio of 1:3;
[c] Determined from the mass balance;
[d] The average oil and water content of sunflower seed is 41% and 7%, respectively [18], and the assumed crude oil yield, including sediments, is 0.36 kg per kg of seed [18]. Total losses in seed mass during storage, handling, and cleaning are assumed to be 2% [8];
[e] The average oil and water content of soybean is 21% and 11%, respectively, and the assumed crude oil yield, including sediments, is 0.15 kg per kg of seed [17]. Total losses in seed mass during storage, handling, cleaning and processing are assumed to be 2% [8];
[f] The yield of oilseed cake was calculated using a mass balance approach, which took into account the blending of the separated sediments with the oilcakes, as well as a minor loss in mass of soybean oil cakes due to water evaporation.

scenario with the main material flows calculated based on the average yields of biodiesel achieved in similar biodiesel plants and the typical oil content in oilseeds produced in Serbia.

Assessment of investment costs

The investment required for fixed assets was estimated based on the defined specifications for necessary buildings, equipment, and other assets needed for production and business operations, as well as their respective purchase prices. The costs of acquiring equipment used for oil transesterification were estimated using data obtained from domestic manufacturers and suppliers. The investment cost for buildings and storage capacities, such as grain silos and oil tanks, was estimated by the authors based on available price lists from domestic companies. The transesterification plant is expected to operate for 300 days per year, and the tank capacities are designed to store biodiesel, oil, and methanol for up to 14 days and glycerol for up to 30 days. Biodiesel and oil are stored in steel tanks with individual capacities of 60 m^3, while methanol is stored in a tank with a capacity of 6 m^3. Raw glycerol is stored in rigid IBC plastic tanks with a capacity of 1,000 litres. A building with an area of 60 m^2 is required to accommodate the transesterification plant, excluding tanks.

Scenarios C and D require investments in oil pressing equipment and grain silos, in addition to the transesterification plant and storage tanks defined previously. For these scenarios, it was assumed that oil pressing is carried out continuously (24 hours a day) for 300 days per year, processing 10.0 tons of cleaned sunflower seed and 23.8 tons of cleaned soybean seed daily. To process 417 kg of sunflower seed in one hour, a press with a processing capacity of 500 kg of grain per hour and an installed power of 22 kW is required. For soybeans, approximately 993 kg of seeds need to be processed in one hour, requiring the purchase of two extruders with an individual capacity of 500 kg of grain per hour (55 kW each) and two presses with a capacity of 500 kg per hour (22 kW each). The grain storage silo's capacity is determined to provide autonomy for about 21 days, with two and three silo cells with an individual capacity of about 300 m^3 being sufficient for sunflower and soybean storage, respectively, considering the typical bulk density of sunflower (400 kg/m^3 [1, p. 306]) and soybeans (720 kg/m^3 [1, p. 306]). The presses, extruders, and auxiliary equipment's (grain cleaners, receiving hoppers, screw conveyors, elevators, pumps, coolers for extruded mass, tanks for oil reception and settling) technical specifications and purchase prices are obtained from domestic manufacturers and suppliers of oil extraction equipment. The cost of the grain silos, which includes all expenses associated with acquiring the silos and auxiliary equipment, as well as the value of construction works, is estimated by the authors based on data provided by a domestic silo construction company. In addition to the silo itself, the total cost covers the expenses associated with constructing foundations and a grain pit, as well as the purchase of necessary conveyors and elevators for filling and emptying the silos. In scenarios C and D, additional space is required to accommodate oil pressing equipment (presses, extruders, auxiliary equipment) with a total estimated area of 60 m^2 and 150 m^2, respectively. The oilseed cake left after oil has been extracted from oilseeds is stored on a floor in a designated closed area. The required area is estimated at 73 m^2 for sunflower cake and 143 m^2 for soybean cake, assuming a bulk density of sunflower and soybean cake of 420 kg/m^3 [20] and 660 kg/m^3 [2], respectively, and that the cake is stored up to a height of 3 m for a maximum of 14 days.

Assessment of production costs

The main direct costs that arise in the production of biodiesel are costs related to the use of fixed assets (depreciation, insurance, and maintenance costs), interest payments, labor expenses, costs of raw materials and auxiliary materials (chemicals), and energy expenses. Depreciation costs are calculated using the proportional method, and depreciation rates are determined based on the expected useful life of individual groups of fixed assets (see Table 2). The costs of equipment and building insurance are determined by multiplying their purchase price with standard insurance rates. The yearly maintenance and repair expenses are calculated as a percentage of the purchase price of the

corresponding assets using standard values suggested by equipment manufacturers or suppliers (see Table 2).

Table 2: Overview of rates used to estimate annual depreciation, maintenance, and insurance costs

Fixed assets	Depreciation rate	Maintenance costs (a)	Insurance costs (a)
Equipment for transesterification	10%	4%	1%
Oil presses and extruders	10%	20%	1%
Auxiliary equipment (in oil pressing plant)	10%	10%	1%
Buildings	2.5%	1%	0.5%
Storage tanks	5%	2%	0.5%
Grain silos	3.3%	2%	0.5%
Other fixed assets (e.g. design)	20%	-	-

Note: [a] Relative to the acquisition value of the fixed asset.

The study assumes that the investment is fully financed by borrowed funds, specifically a bank loan that will be repaid in ten equal annual instalments with an annual interest rate of 7.6%. Annual interest costs are calculated using the proportional interest calculation method. The costs of raw materials, which may be either grain or oil depending on the context, are calculated as the product of the required quantity and the procurement cost. In the domestic market, oilseed prices can fluctuate widely depending on the period and region, so this study uses average annual purchase prices available from the Statistical Office of the Republic of Serbia (SORS) database. Since data on the price of crude sunflower and rapeseed oil in the domestic market is not available, this study uses average export prices as an approximation [21]. This study assumes that the procurement cost of raw vegetable oils is equal to export prices because export prices already include transportation costs, loading and unloading costs, and other handling costs (Regulation on Customs Procedure, Official Gazette of the Republic of Serbia, no. 8/2017). The procurement cost of oilseeds in Serbia is calculated by adding procurement-related expenses, such as transportation and handling costs, to their respective purchase price. Handling costs increase the purchase price of oilseeds by an average of 7%, according to Ćurović [4]. Transportation costs are estimated at 6 euros per ton of grain, based on data obtained from carriers. This assumes that the grain is transported by trucks with a capacity of 25 tons of grain and a distance of 30-50 km in one direction.

The costs of auxiliary materials, such as methanol, potassium hydroxide, and sulfuric acid, are determined based on the consumption norms established during the multi-year operation of similar facilities and their prices on the domestic market in 2021 (Table 4). By measuring the energy consumption in a similar transesterification plant with a yearly capacity of 1,000 tons of biodiesel, it was determined that the specific electricity consumption is approximately 60 kWh per ton of oil. The electricity consumption in the oil pressing plant is estimated based on the total installed power of the equipment, which is 26.4 kWh in scenario C and 166.1 kWh in scenario D, assuming an average load factor of 70%. To estimate the electricity consumption for filling and emptying silos, it is assumed that silo filling is done 14 times a year using a chain conveyor and elevator with a total power of 15 kW, and that 8 hours are required to fill all of the silo cells. Silo emptying is carried out continuously during the operation of the press/extruder, i.e., 7,200 hours per year, using a 2.2 kW screw conveyor with an average motor load of 70%. To account for other energy consumers, such as room lighting, the total energy consumption is multiplied by a correction factor of 1.10.

Labor costs have been calculated based on the gross annual salaries of the employees. The production process is highly automated, requiring only one operator/technician

Table 3: Prices of raw materials and by-products (excluding VAT) in the period 2017-2021 (EUR/t)

Raw material	2017	2018	2019	2020	2021	Average price (2017-2021)	Average annual growth rate
Rapeseed oil [a]	764	678	730	764	1153	818	13%
Sunflower oil [a]	744	638	626	732	933	735	7%
Sunflower seed [b]	275	228	239	277	443	292	15%
Soybean seed [b]	368	297	291	340	569	373	15%
Sunflower cake [a]	399	409	342	365	505	404	12%
Soybean cake [a]	153	161	173	188	237	182	8%

Explanation: [a] Average export price; [b] Average purchase price of oilseed grains in Serbia.
Source: Based on data from the Statistical Office of the Republic of Serbia.

and one or two additional workers per 8-hour shift in scenarios A and B, and scenarios C and D, respectively. This results in a total of 5 employees for scenarios A and B, and 9 employees for scenarios C and D. The average monthly gross salaries for the operator and workers in the plant have been set at 900 euros and 650 euros, respectively. These figures are in line with the average salaries for similar qualifications in the agriculture and processing industries in 2021 [22]. The costs of laboratory analyses are estimated at 26,000 euros per year, assuming that the quality of oil and biodiesel is analyzed every other week at a cost of 500 euros per analysis.

The cost of biodiesel production is determined by subtracting the revenue from the sale of by-products from the total production costs. In the transesterification process, glycerol is obtained as a by-product, in addition to biodiesel as the main product. In the case of oilseed as the starting material, oil cake is also obtained, in addition to glycerol. The amount of revenue from the sale of by-products is obtained by multiplying the sold quantities with the corresponding unit sales prices. The study assumes that the obtained oil cake can be fully realized on the market at sales prices that are at the level of average export prices (Table 3). While pure glycerol has significant value as a product [6], the crude glycerol generated by the examined process contains numerous impurities, including water, salts, soaps, traces of alcohol, and glycerides [3]. Currently, there is no market for crude glycerol in Serbia. Consequently, small producers are compelled to store the produced quantities on their premises until a suitable disposal method or an interested buyer can be found. However, the costs of storing and disposing of crude glycerol were not considered in the study.

Results and discussion

Production cost of biodiesel

The investment required for a plant with an annual capacity of 1,000 tons of biodiesel varies significantly depending on whether the starting raw material is oil or oilseeds. In scenarios A and B, where crude oil is assumed as the starting raw material, the total investment cost is around 140,000 euros. In these scenarios, storage tanks for oil and biodiesel constitute the largest contributor to total investment costs, accounting for 37% of the total investment. Investments in transesterification equipment rank second in terms of importance, accounting for 35% of the total investment, while buildings and associated infrastructure account for about 19% of total investments.

In scenarios C and D, where oilseeds are the starting raw material, total investment costs are significantly higher due to additional investments in equipment for oil pressing and storage of seeds and cakes. The investment required for sunflower oil pressing equipment (press and auxiliary equipment) is estimated at 35,500 euros, while for soybeans, it is 114,500 euros. The higher investment in scenario D is attributed to the larger amount of seeds that need to be processed per unit of time (due to the lower oil content in soybeans compared to sunflower seeds), which necessitates the purchase of two presses and the need to extrude soybeans before pressing.

The first three scenarios have similar total annual production costs, ranging from 1 to 1.3 million euros, while scenario D incurs costs of around 3.4 million euros (Table 6). The costs of raw materials are the dominant factor in the total production costs of biodiesel, which is consistent with previous research findings [10], [13], [14],

Table 4: Specific consumption of chemicals and energy and their procurement cost

Input	Specific consumption		Price, exc. VAT
	Unit	Value	
Methanol (99.8%)	kg/kg oil	0.116	0.65 EUR/kg
Potassium hydroxide (KOH, min. 88%)	kg/kg oil	0.027	3.2 EUR/kg
Sulfuric acid (H_2SO_4, 96-98%)	g/kg oil	0.2	0.95 EUR/kg
Electricity (total)	kWh/t biodiesel	67 (A); 67 (B); 231 (C); 1021 (D) *	0.103 EUR/kWh
in the transesterification plant	kWh/t oil	66 (A-D) *	
in the oil pressing facility	kWh/t grain	49 (C); 129 (D) *	
filling and emptying of silos	MWh/year	≈14.1 (C and D) *	

Explanation: * Letters denote individual scenarios

[15], [16]. Depending on the type of raw material used, the share of these costs ranges from 73%, for sunflower seed, to 86%, for soybean (Table 5). The costs of auxiliary materials (i.e., chemicals used in the transesterification process) are the second most significant cost contributor to the total production costs. Their share is the lowest in scenario D, at around 5%, while in the other scenarios, it ranges from 13% to 16%. Based on the 2021 prices of chemicals, the specific costs of auxiliary materials amount to 0.17 euros per kg of biodiesel.

Energy costs have a minor share in total costs in scenarios where oil is used as the starting raw material. However, in scenarios where seeds are used as the starting raw material, energy costs can constitute a significant share, primarily due to the energy requirements of the press and extruder. The specific electricity consumption for transesterification of oil into biodiesel is 60 kWh/t of oil, which is significantly higher compared to modern industrial-scale plants where more affordable energy sources are utilized for heating and other technological procedures. For instance, in a plant with an annual capacity of 100,000 t, the specific electricity consumption is around 12 kWh/t of biodiesel [16], while it amounts to roughly 42 kWh/t of biodiesel in a plant with a capacity of 10,000 t [14]. The specific electricity consumption in the oil pressing plant is estimated to be approximately 44 kWh per ton of sunflower seed or approximately 117 kWh per ton of soybean, which is in line with literature data. According to Havrysh et al. [11], the specific electricity consumption for sunflower oil production in industrial plants in Ukraine ranges from 96.6 kWh to 198 kWh per ton of sunflower oil, which translates to 38.6-79.2 kWh per ton of seed assuming an oil yield of 0.4 kg per kg of grain. Meanwhile, Helgeson and Schaffner [12] estimated that small-capacity plants consume 45-106 kWh electricity per ton of sunflower seed, depending on the oil press' capacity. Fridrihsone et al. [9], based on primary data from small-scale producers of rapeseed oil, estimated the specific electricity consumption at 45 kWh per ton of seed. Kukić [17] conducted experimental research on an industrial extruder and oil press with a capacity of roughly 900 kg of grain per hour and found that the specific electricity consumption ranges from 90 kWh to 130 kWh per ton of soybean, depending on the oil and water content of the seed and settings on the extruder and press.

The labor costs contribute around 4-6% to the total costs in scenarios A, B, and C, while their share in scenario D is around 2%. Other costs, such as costs related to the use of fixed assets and interest costs, contribute to the total costs to a small extent, cumulatively accounting for approximately 4-6% of total costs.

When assessing the competitiveness of multiple products, the unit cost is a significant factor in justifying the economic feasibility of production. Based on the average prices of raw materials and by-products from 2017 to 2021 (as shown in Table 3), the unit cost of biodiesel

Table 5: Investment in a biodiesel production plant depending on the considered scenarios and the starting raw material (in EUR)

Fixed assets	Scenario A	Scenario B	Scenario C	Scenario D
Oil pressing	0	0	119,500	216,500
Presses and extruders	0	0	22,000	88,000
Grain silos	0	0	84,000	102,000
Auxiliary equipment for oil pressing	0	0	13,500	26,500
Biodiesel production	101,700	101,700	101,700	101,700
Process equipment	42,000	42,000	42,000	42,000
Energy equipment	7,500	7,500	7,500	7,500
Tanks	52,200	52,200	52,200	52,200
Buildings	27,000	27,000	86,850	158,850
Building for transesterification plant	27,000	27,000	27,000	27,000
Building for oil pressing plant and oil cakes			59,850	131,850
Other expenses	11,583	11,583	27,725	42,935
Design and engineering (2%)	2,574	2,574	6,161	9,541
Test run costs (2%)	2,574	2,574	6,161	9,541
Unexpected expenses (5%)	6,435	6,435	15,403	23,853
Total	140,283	140,283	335,775	519,985

produced in a plant with an annual capacity of 1,000 tons ranges from 0.98 EUR to 1.11 EUR per kg (101 RSD/L to 114 RSD/L), depending on the raw material used (Table 7). The lowest unit cost is achieved by producing biodiesel from sunflower seeds, mainly due to the significant revenue generated from the sale of oil cakes. On the other hand, the least economically favorable option is the production of biodiesel from crude rapeseed oil due to the relatively high procurement costs of the raw material.

The sensitivity analysis revealed that the unit cost of biodiesel is most influenced by changes in the purchase price of raw materials (Figure 1). This was expected as raw material costs make up a significant proportion of the total production costs. The unit cost of biodiesel produced from oilseeds is more sensitive to changes in the purchase price of raw material than the unit cost of biodiesel produced from crude vegetable oil. For example, if the purchase price of raw materials increases by 10% compared to the expected value (average prices during the period of 2017-2021), the unit cost of biodiesel produced from soybean grain will rise by 30%, whereas the unit cost of biodiesel produced from sunflower oil will only rise by 7%. The sensitivity analysis results also demonstrate that the unit cost of biodiesel based on oilseed grain, especially soybean, is highly sensitive to the revenue generated from the sale of oil cake. A small decrease of 10% in the

Table 6: Total production costs of 1,000 tons of biodiesel using average prices of raw materials and by-products in the period 2017-2021 (in EUR)

Cost category	Scenario A	Scenario B	Scenario C	Scenario D
Purchase value of raw materials	838,899	753,488	974,880	2,955,170
Quantity (t/year)	1,026	1,026	3,058	7,297
Price (EUR/t)	818	735	319	405
Other materials	166,122	166,122	175,214	175,214
Methanol	77,323	77,323	81,555	81,555
KOH	88,604	88,604	93,453	93,453
H2SO4	195	195	206	206
Electricity	6,937	6,937	23,770	105,171
Oil pressing and silos	0	0	16,833	98,235
Biodiesel production facility	6,937	6,937	6,937	6,937
Labor costs	45,600	45,600	80,400	80,400
Technician/operator	10,800	10,800	10,800	10,800
Plant workers	31,200	31,200	62,400	62,400
Administration (outsourced)	3,600	3,600	7,200	7,200
Costs related to the use of fixed assets	14,737	14,737	32,492	59,768
Depreciation costs	10,552	10,552	20,102	31,638
Maintenance costs	3,294	3,294	10,724	25,584
Insurance costs	891	891	1,666	2,546
Interest costs	10,662	10,662	25,519	39,519
Laboratory testing costs	26,000	26,000	26,000	26,000
TOTAL	1,108,957	1,023,545	1,338,275	3,441,242

Table 7: Unit cost of biodiesel (calculated with average prices of raw materials and by-products in the period 2017-2021)

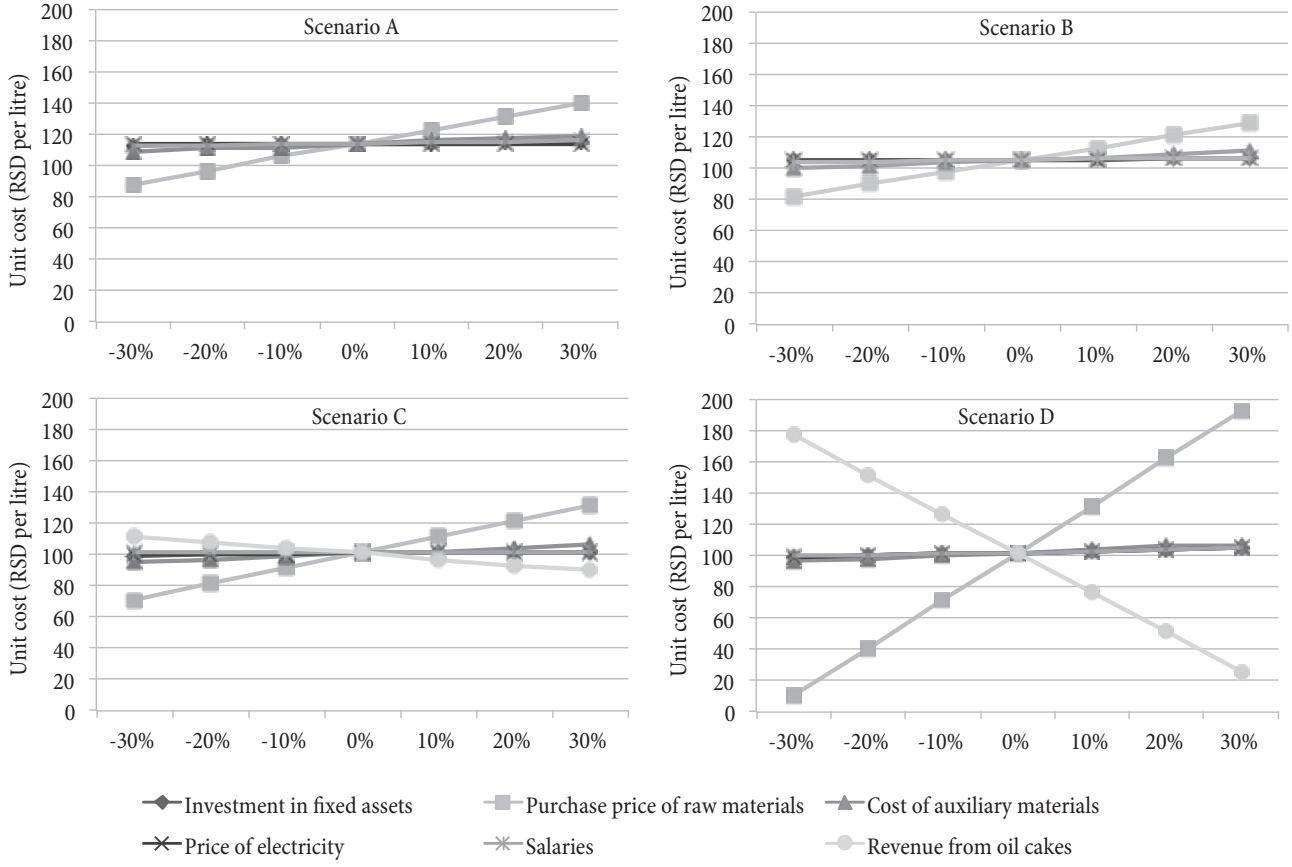
		Scenario A	Scenario B	Scenario C	Scenario D
A	Total production costs	1,108,957	1,023,545	1,338,275	3,441,242
B	Revenue from by-products	0	0	360,541	2,450,286
	Glycerol	0	0	0	0
	Oilseed cake	0	0	360,541	2,450,286
C	Production costs reduced by the value of by-products (C=A-B)	1,108,957	1,023,545	977,733	990,956
D	Unit cost of biodiesel				
	EUR/kg	1.11	1.02	0.98	0.99
	EUR/L	0.98	0.90	0.86	0.87
	RSD/L	114	105	101	102

selling price of oil cake or sales volume would cause the unit cost of soybean biodiesel to increase by 25% (from 102 RSD/L to 127 RSD/L), making it significantly higher than the unit cost of biodiesel produced from rapeseed oil. Furthermore, it can be observed that the unit cost is relatively insensitive to changes in investment costs, salaries, as well as fluctuations in the prices of electricity and chemicals used in the transesterification process (Figure 1).

Price competitiveness of biodiesel

The question arises whether investing in biodiesel production at the calculated cost is justified. The answer depends on the production goal, whether it is to meet producers' own fuel needs or to sell biodiesel on the market. Producing biodiesel for one's own needs can be economically justified, as the cost is 25-34% lower than the average retail price of diesel (152 RSD/L during 2017-2021). Agricultural farms and enterprises can save significantly on fuel costs if they use biodiesel from their own production instead of fossil diesel as fuel. However, an annual production of one million kg of biodiesel (1.13 million litres) significantly exceeds the needs of most domestic economic entities whose primary activity is agricultural production. Considering that around 120 litres of diesel fuel per hectare are used in crop production [10], this amount is sufficient for processing about 8,500 hectares. It is estimated that fewer than ten economic entities in Serbia manage areas larger than 8,500 hectares. Therefore, to increase investments in biodiesel production, the investors need assurance that the produced quantities of biodiesel (partially or entirely) can be sold on the market. A prerequisite for successful market penetration is the price competitiveness of biodiesel in the fuel market, that is, biodiesel can be offered at lower retail prices than fossil diesel. Market research conducted in 2008 showed that potential consumers are interested in buying pure biodiesel (B100) if its retail price is 8-10% lower than the price of corresponding fossil diesel [23]. They justified this price difference with higher biodiesel consumption, higher vehicle maintenance costs if biodiesel is used (e.g., more frequent oil filter replacement), but also with

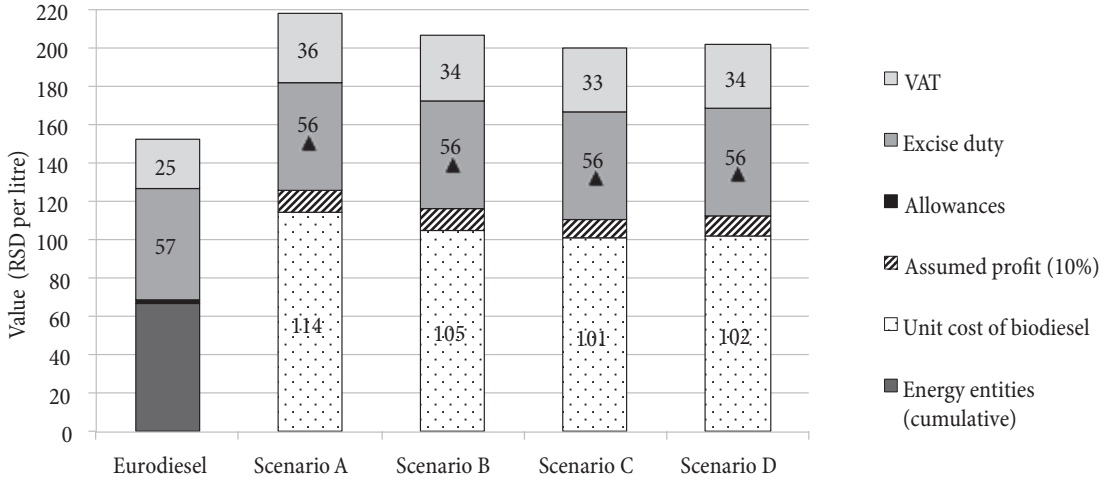
Figure 1: Sensitivity of biodiesel's unit cost to changes in the values of individual input parameters



customer distrust of a new product on the market. Based on the average retail price of diesel during the observed period, the acceptable market price of biodiesel would be around 137 RSD/L. Although the unit cost of biodiesel is significantly lower than 137 RSD/L, it is important to note that the unit cost of biodiesel does not include the producer's profit, taxes and expenses associated with the selling of biodiesel. In addition to a 20% value-added tax (VAT), biofuels in the Republic of Serbia are subject to an excise duty, as per the Law on Excise Duties. From 2017 to 2021, the average excise duty for biofuels was 56 RSD/L. Taking into account the projected 10% profit, as well as the excise duty and VAT, the retail price of biodiesel can vary between 200 RSD/L to 218 RSD/L, depending on the raw material used in production (as shown in Figure 2). The retail price of biodiesel determined by the total cost method not only exceeds the acceptable market price of biodiesel but also surpasses the retail price of fossil diesel. Moreover, to ensure the profitability of production, the retail price needs to be even higher, as it must cover other expenses such as distribution costs, quality control costs, and the reduction in revenue due to discounts granted to fuel distributors, which was between 9-13 RSD/L in 2022 for Eurodiesel. It is evident that the retail price of biodiesel that would guarantee a profit for the producer cannot compete with the price of fossil diesel in the domestic fuel market. The same conclusion can be drawn by observing the prices in individual years, as the lowest acceptable retail price of biodiesel from the producers' perspective has always been higher than the price of Eurodiesel, except for soy biodiesel in 2018 (as shown in Table 8).

The competitiveness of biodiesel depends on several factors, including the procurement cost of raw materials, the retail price of fossil diesel, and the amount of state levies in the form of taxes. From 2017 to 2021, the purchase prices of raw materials increased at an average annual rate of 7% for sunflower oil and 15% for sunflower and soy (Table 3). In the same period, there was a significant increase in the price of rapeseed oil (13% on average annually), and in 2021 it was 24% higher than the price

Figure 2: Formation of retail price of biodiesel by the total cost method depending on the starting raw material (RSD/L)



Note: The triangle indicates the retail price without excise on biodiesel

Table 8: Unit cost (UC) and the lowest acceptable retail price of biodiesel for its producers (RP) depending on the raw material in the observed period from 2017 to 2021 (RSD/L)

Fuel		2017		2018		2019		2020		2021	
		RP	UC	RP	UC	RP	UC	RP	UC	RP	UC
Eurodiesel		143	-	152	-	161	-	142	-	162	-
Biodiesel	Scenario A	212	112	199	100	207	106	212	108	267	150
	Scenario B	210	110	193	96	193	95	208	105	236	126
	Scenario C	202	104	177	84	180	85	194	94	255	140
	Scenario D	203	105	116	38	167	75	200	100	259	196

of crude sunflower oil, mainly due to the rising demand for rapeseed oil in the European Union for the needs of the biodiesel industry. Over the same five-year period, the retail price of Eurodiesel also increased (as shown in Table 8), but at a lower average annual rate of only 4%. If this trend continues, domestically produced biodiesel cannot compete in the fuel market without appropriate state incentives. One effective measure proposed by Tešić et al. [23] to encourage the domestic biodiesel industry is the partial or complete exemption of biodiesel from excise duties. The results suggest that state tax and excise policy measures significantly influence the retail price of biodiesel. Over the observed five-year period, excise duties and value-added tax accounted for 42-45% of the retail price of biodiesel, depending on the raw material. If biodiesel were entirely exempt from excise duties, the retail price would range from 133 RSD/L to 151 RSD/L, depending on the raw material, and would be lower than the retail price of fossil diesel, as illustrated in Figure 2.

Conclusions

Based on the average market prices of raw materials between 2017 and 2021, the estimated production cost of biodiesel in a plant with an annual capacity of 1,000 tons varies from 101 to 114 RSD per litre, depending on the type of raw material utilized. Lower costs can be achieved by using oilseeds instead of oil as the starting material, mainly due to significant revenues from the sale of oil cake. However, producing biodiesel from oilseeds requires investment in an oil extraction plant and storage facilities for seeds and oil cakes, which significantly increases investment costs. Moreover, the unit cost of biodiesel from oilseeds is very sensitive to changes in the price of oil cake or sales volume. Investing in biodiesel production is economically justified if the primary goal is to satisfy producers' own fuel needs since the cost of biodiesel during the observed period is significantly lower than the retail price of Eurodiesel. However, at these production costs, it is not possible to achieve a retail price that would guarantee profit for the producers and compete with the price of fossil diesel on the domestic fuel market. This is because the retail price, in addition to the production costs, must also include accumulation, excise, VAT, and often other expenses. Considering these components, the retail price of biodiesel produced in small-capacity plants cannot be lower than the retail price of Eurodiesel, making its sale impossible.

The competitiveness of biodiesel is primarily determined by three factors: the retail price of fossil diesel, the amount of state levies in the form of excise and VAT, and the unit cost of biodiesel, which largely depends on the price of the input raw material. During the observed five-year period, the purchase prices of raw materials, such as oilseeds and vegetable oils, have increased at a faster rate than the retail price of Eurodiesel. If this trend continues, small-scale domestic biodiesel producers cannot produce biodiesel at competitive prices without state incentives. One such measure that could increase biodiesel's competitiveness in the domestic fuel market is complete exemption from excise, which amounted to about 58 RSD/L in 2022.

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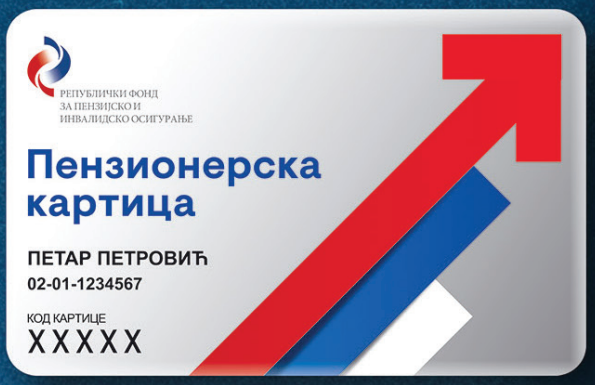

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