

FAKULTET ZA EKONOMIJU I INŽENJERSKI MENADŽMENT U NOVOM SADU

Ekonomija

teorija i praksa

Economics

Theory and Practice



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ORIGINALNI NAUČNI RADOVI

THE RELATIONSHIP BETWEEN LEISURE, INCOME AND HAPPINESS: COMPARING THE LABOR-LEISURE TRADE-OFF AND LEISURE SATISFACTION THEORIES

Fadilah Muhamad Ichsan¹

Abstract: *This study compares two competing theories that explain the relationship among income, leisure, and happiness: the labor–leisure trade-off from microeconomics, which predicts a negative correlation between income and leisure time, and the leisure satisfaction theory from psychology, which predicts a positive correlation between leisure time and happiness. Using 2023 data from the UK Office for National Statistics, the study analyzes aggregated averages for five age groups through linear regression and Pearson’s correlation in R software. The results reveal stronger positive correlations between leisure time and happiness (r up to 0.96) than negative correlations between income and leisure time (r up to -0.615), supporting the leisure satisfaction theory over the labor–leisure trade-off model. Although the small sample size and data aggregation limit the generalizability of findings, the results underscore the greater importance of leisure for well-being compared with income alone and highlight the need to integrate economic and psychological perspectives in research on subjective well-being.*

Keywords: *leisure; income; happiness; labor–leisure trade-off; leisure satisfaction theory*

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INTRODUCTION

The relationship between labor and leisure has been a central issue in microeconomics, especially through the labor-leisure trade-off framework, which posits a negative correlation between income and leisure time (Malakhov, 2019). Since time is a limited resource, there are only 24 hours in a day, allocating more time to leisure necessarily reduces time available for labor, and vice versa. Consequently, individuals who prioritize leisure generally earn less income than if they worked longer hours.

According to the labor-leisure trade-off theory, the opportunity cost of leisure increases as income grows, since each hour not worked foregoes higher potential earnings (Steinsson, 2024; Wolff & Resnick, 2012). This leads to a downward-sloping relationship between leisure and income. However, some recent studies suggest that as wages rise, individuals may actually choose more leisure over additional income, indicating a shift in preferences toward life satisfaction over income maximization (Malakhov, 2019).

From a psychological perspective, leisure satisfaction theory suggests that leisure has a direct positive effect on happiness by enabling relaxation, enjoyment, social connections, personal growth, and stress recovery (Choe & Baek, 2023; Nawijn & Veenhoven, 2013). Leisure time allows individuals to disconnect from work-related stress, improving subjective well-being. This perspective contrasts sharply with the economic model's assumption that leisure mainly represents forgone income.

This paper aims to investigate which of these two competing perspectives better explains the relationship among leisure, income, and happiness, by comparing the strength of their respective correlations.

CURRENT STATE OF KNOWLEDGE

A study by van Hoorn (2008) from the Nijmegen Center for Economics analyzed data on more than 100,000 individuals across 40 countries, examining income, leisure, and happiness using secondary data from the Groningen Growth and Development Center (GDP per capita and annual leisure) and the World Values Survey for happiness. The results indicated that while higher income generally correlates with higher reported happiness, this relationship weakens when leisure time is included in the analysis, suggesting leisure itself is a key contributor to well-being.

Importantly, van Hoorn (2008) also found that income and leisure can be positively correlated at the country level: in societies where people earn

more, they often have more leisure time, possibly because higher earnings afford the ability to reduce working hours. However, the presence of leisure modifies the income-happiness relationship, demonstrating that money alone does not guarantee higher happiness without sufficient time for leisure.

Kahneman and Deaton (2010) provided further nuance by distinguishing between life evaluation (how satisfied someone is overall) and emotional well-being (moment-to-moment feelings of happiness). Their regression analysis of survey data from all 50 U.S. states (collected through daily phone interviews) revealed that while life evaluation continues to improve with income beyond \$75,000 annually, emotional well-being plateaus. This “satiation point” indicates that after a certain income level, additional earnings do not significantly increase happiness. They also applied Weber’s Law to explain why the perceived significance of income changes depends on one’s starting income level.

In a South Korean context, Bae (2022) explored the link between income, leisure activities (specifically sports), and happiness, surveying over 10,000 people aged 15 and older. Findings showed that people engaging in sports-based leisure reported higher happiness levels than those involved in non-sport leisure activities. Moreover, individuals with higher income levels derived greater happiness from their sports participation, suggesting an interaction between financial means and the enjoyment of leisure activities.

While each of these studies offers important insights, they vary in scope, theory, data type, and methodology. Table 1 summarizes these differences:

Table 1. Breakdown of past research on the issue of labor, leisure, and happiness

Publication	Van Hoorn (2008)	Kahneman & Deaton (2010)	Bae (2022)
Scope	Multi-country	Single country (USA)	Single country (Korea)
Theory	Income-leisure trade-off, diminishing marginal utility	Satiation point, Weber’s Law	Leisure-happiness relationship
Data	Secondary	Primary	Primary
Method	Multilevel modeling	Regression analysis	ANOVA, t-test

This body of literature illustrates that while income can influence happiness, leisure plays a crucial mediating role, and the relationship is shaped by cultural, economic, and methodological contexts.

THEORETICAL FRAMEWORK

This study draws on two key theories to analyze the relationships among income, leisure, and happiness: the labor-leisure trade-off and the leisure satisfaction theory.

The **labor-leisure trade-off** is a foundational concept in microeconomics, proposing that individuals allocate their limited time between labor (income-generating activities) and leisure (non-work activities) to maximize utility (Malakhov, 2019; Steinsson, 2024). The theory predicts a negative correlation between income and leisure because time spent on leisure reduces time available for paid labor, thereby lowering income. As wages rise, the opportunity cost of leisure increases, creating an incentive for individuals to substitute leisure with work (Steinsson, 2024; Wolff & Resnick, 2012). This trade-off is captured by substitution and income effects, which explain shifts in individuals' preferences when wages change: higher wages make working more rewarding compared to leisure, encouraging people to work longer hours.

Despite its usefulness, the labor-leisure trade-off theory has limitations. It oversimplifies decision-making by assuming people always act rationally and have full freedom to choose between work and leisure, ignoring real-life constraints such as job availability, skills mismatches, or social norms (Steinsson, 2024). Moreover, it does not adequately account for external influences like labor regulations, retirement policies, or mandatory vacation laws, all of which can significantly shape the actual balance between labor and leisure (Weiss, 2009).

In contrast, the **leisure satisfaction theory**, grounded in psychology, argues that leisure contributes positively to happiness by offering autonomy, personal benefits, and social advantages (Liu & Da, 2019; Wang & Wong, 2014). Leisure enables individuals to exercise freedom of choice, engage in activities aligned with personal interests, and recover from work-related stress, all of which enhance subjective well-being (Nawijn & Veenhoven, 2013). Additionally, leisure often facilitates social connections and the formation of supportive relationships, which further contribute to happiness (Liu & Da, 2019).

Nevertheless, leisure satisfaction theory also has weaknesses. It emphasizes the **quality** of leisure experiences over their **quantity**, highlighting that simply having free time does not guarantee happiness unless the activities are personally meaningful or culturally acceptable (Nawijn & Veenhoven, 2013). Furthermore, financial constraints can undermine the positive effects of leisure if individuals overspend on leisure activities, leading to long-term stress (Wang & Wong, 2014). Finally, certain leisure activities, such as excessive internet use, may even reduce well-being (Nawijn & Veenhoven, 2013).

Table 2 summarizes key differences between these theories:

Table 2. Difference between Labor-Leisure Trade-Off and Leisure Satisfaction Theory

Theory	Labor-Leisure Trade-Off	Leisure Satisfaction Theory
Common variable	Leisure	Leisure
Unique variable	Income	Happiness
Correlation direction	Negative (income↔leisure)	Positive (leisure↔happiness)
Study area	Microeconomics	Psychology

By comparing these theories, this paper aims to identify which better explains the observed relationships in the data.

RESEARCH QUESTIONS AND HYPOTHESES

This paper investigates the relationships among income, leisure time, working time, and happiness through two sets of research questions derived from the labor-leisure trade-off and leisure satisfaction theories.

For the labor-leisure trade-off, the verificatory research questions are:

- 1. RQ1: Is there a negative correlation between income and leisure time?
- 2. RQ2: Is there a positive correlation between income and working hours?

For the leisure satisfaction theory, the verificatory research questions are:

- 3. RQ3: Is there a positive correlation between leisure time and reported happiness?
- 4. RQ4: Is there a negative correlation between working time and reported happiness?

To compare the two theories directly, an additional exploratory question is posed:

5. RQ5: Which correlations are stronger: the negative correlation between income and leisure time or the positive correlation between leisure time and happiness?

The corresponding hypotheses for the verificatory questions are:

1. H1: There is a negative correlation between income and leisure time.
2. H2: There is a positive correlation between income and working time.
3. H3: There is a positive correlation between leisure time and reported happiness.
4. H4: There is a negative correlation between working time and reported happiness.

To assess these hypotheses, this paper uses a p-value threshold of **0.05** as the standard for statistical significance. However, given the small sample size (five age groups), p-values above 0.05 will be interpreted with caution, and their significance will be considered in conjunction with theoretical consistency and effect size (Pearson's coefficient), as recommended by Kwak (2023) and Wasserstein, Schirm, & Lazar (2019).

The fifth research question, being exploratory in nature, does not have a formal hypothesis and will be answered by comparing the absolute strengths of the observed correlations.

METHODOLOGY

This study investigates the correlations among income, leisure time, working time, and reported happiness. Analyses were conducted using **linear regression** and **Pearson's correlation coefficient** in R software, enabling assessment of the direction, strength, and statistical significance of each relationship.

For regression analysis, the `lm()` function was used to model each pair of variables, providing slope coefficients and p-values. A positive slope indicates a positive correlation, while a negative slope indicates a negative correlation. P-values were interpreted using a conventional threshold of **0.05**, but given the small sample size (five age groups), p-values slightly above 0.05 were considered with caution, as recommended by Kwak (2023) and Wasserstein, Schirm, & Lazar (2019). This approach recognizes that rigid thresholds may not always reflect the practical significance of results, especially when sample sizes are limited.

Scatterplots with fitted regression lines were created using the `plot()` and `abline()` functions to visualize the correlations. Pearson's correlation coefficients were calculated using `cor.test(method="Pearson")`, providing a measure of association strength on a scale from -1 (perfect negative correlation) to 1 (perfect positive correlation).

1. Data sources

All variables were derived from UK Office for National Statistics (ONS) datasets from 2023 (ONS, 2024):

- Income: Median weekly pay by age group, from the "Employment and Labor Market" section.
- Leisure and Working Time: Average daily minutes spent on activities from the "Time Use in the UK" dataset, categorized into working time (working at or away from home) and leisure time (personal care, entertainment/socializing, exercise).
- Happiness: Self-reported happiness scores by age group from the "Quarterly Personal Well-Being" dataset.

2. Age group harmonization

To enable correlation analyses, age groups were standardized across datasets into five ranges: 25-34, 35-44, 45-54, 55-64, and 65-74. Original data for broader or narrower age groups were interpolated by averaging across overlapping single-year ages. While necessary for consistency, this harmonization introduces some imprecision in reflecting the exact distributions within each age group.

3. Interpretation of statistical significance

This study uses a conventional threshold of $p < 0.05$ to assess statistical significance. However, due to the small sample size ($n=5$), strict adherence to this threshold may not fully capture the reliability of results. Therefore, p-values slightly above 0.05 are interpreted cautiously, in conjunction with theoretical expectations and the magnitude of Pearson's coefficients, rather than imposing an alternative fixed threshold. This nuanced approach aligns with recommendations by Kwak (2023) and Wasserstein, Schirm, & Lazar (2019).

4. Limitations and standard deviations

As the analyses rely on aggregated average values for five age groups, individual-level data are not available. This prevents calculation of standard deviations for each variable or correlation, which is a limitation of the secondary data source. While these constraints limit the

generalizability of the findings, they do not undermine the study's ability to explore the central research question: which theoretical model better explains the relationship among income, leisure, and happiness.

RESULTS AND DISCUSSIONS

This section presents the correlations among income, leisure time, working time, and happiness, interpreted in the context of the theoretical frameworks. Table 3 shows the slopes, p-values, and Pearson coefficients for each pair of variables.

Table 3. Slope, p-value, and Pearson coefficient of all correlations

Correlation	Slope	p-value	Pearson coefficient
Income↔Personal care (leisure)	-1.34	0.396	-0.495
Income↔Entertainment (leisure)	-0.43	0.388	-0.503
Income↔Exercise (leisure)	-5.19	0.270	-0.615
Income↔Working away	0.45	0.263	0.621
Income↔Working from home	0.81	0.389	0.502
Personal care (leisure)↔Happiness	0.012	0.010	0.960
Entertainment(leisure)↔Happiness	0.003	0.103	0.802
Exercise(leisure)↔Happiness	0.033	0.053	0.874
Working away↔Happiness	-0.003	0.036	-0.902
Working from home↔Happiness	-0.007	0.036	-0.903

1. Significance and interpretation

Three correlations have p-values below the conventional 0.05 threshold: leisure-happiness (personal care), and both working time-happiness pairs. This indicates strong evidence for positive associations between leisure (personal care) and happiness, and negative associations between working time and happiness. While other correlations did not reach $p < 0.05$, their direction matches theoretical expectations: income negatively correlated with leisure, and leisure positively correlated with happiness.

Given the small sample size, these p-values are interpreted cautiously alongside effect sizes (Pearson's coefficients). Notably, correlations between leisure and happiness consistently showed stronger associations (Pearson's r up to 0.96) than income-leisure correlations (r up to -0.615), indicating that leisure satisfaction theory better explains the observed patterns.

2. Answering the hypotheses

Per the results, these are the answers to the hypotheses:

- H1: Income is negatively correlated with leisure time. This hypothesis is supported by the result, where all leisure categories showed negative slopes and r values.
- H2: Income is positively correlated with working time (working from home and working away). This hypothesis is supported by the result, with positive slopes and r values.
- H3: Leisure time is positively correlated with happiness. This hypothesis is supported by the result, with positive slopes and strong r values.
- H4: Working time (working from home and working away) is negatively correlated with happiness. This hypothesis is supported by the result, with negative slopes and strong r values.

3. Comparing correlations

To address the exploratory question, whether income-leisure or leisure-happiness correlation is stronger, Table 4 ranks the absolute values of Pearson's coefficients.

Table 4. Rank of correlation strengths

Rank	Variables	Pearson coefficient (in absolute value)
1	Personal care (leisure)↔Happiness	0.960
2	Working from home↔Happiness	0.903
3	Working away↔Happiness	0.902
4	Exercise(leisure)↔Happiness	0.874
5	Entertainment(leisure)↔Happiness	0.802
6	Income↔Working away	0.621
7	Income↔Exercise (leisure)	0.615
8	Income↔Entertainment (leisure)	0.503
9	Income↔Working from home	0.502
10	Income↔Personal care (leisure)	0.495

Correlations involving happiness and leisure time ($r > 0.8$) are substantially stronger than those involving income and leisure time ($r < 0.62$). This supports the conclusion that **leisure satisfaction theory better explains the relationship among leisure, income, and**

happiness than the labor-leisure trade-off theory, consistent with findings by Nawijn and Veenhoven (2013) and Choe and Baek (2023).

4. How the identified limitations impacted the results

While these results align with theoretical expectations, the small sample size limits statistical power. Additionally, the use of aggregated age-group averages prevents detailed exploration of variability within each group. Nonetheless, the direction and strength of observed correlations provide meaningful insights into how leisure and income relate to happiness.

CONCLUSION

This study examined the relationships among income, leisure, and happiness by comparing the predictions of two theories: the microeconomic labor-leisure trade-off, which proposes a negative relationship between income and leisure time, and the psychological leisure satisfaction theory, which posits a positive relationship between leisure and happiness. Using 2023 data from the UK Office for National Statistics, linear regression and Pearson correlation analyses revealed that the correlations between leisure and happiness were consistently stronger than those between income and leisure.

These findings support the hypotheses derived from both theories, confirming the existence of negative correlations between income and leisure time, positive correlations between leisure time and happiness, and negative correlations between working time and happiness. Importantly, the exploratory analysis showed that leisure satisfaction theory better explains the observed data, as correlations between leisure and happiness were significantly stronger than those involving income.

While limitations, such as reliance on aggregated data and a small sample size, restrict the generalizability of these results, this study demonstrates the importance of considering leisure as a key determinant of well-being. By highlighting the stronger role of leisure in promoting happiness compared to income alone, this research underscores the value of integrating economic and psychological perspectives when studying subjective well-being.

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ODNOS IZMEĐU SLOBODNOG VREMENA, PRIHODA I SREĆE: POREĐENJE TEORIJE RAZMENE RADA I SLOBODNOG VREMENA I TEORIJE ZADOVOLJSTVA SLOBODNIM VREMENOM

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Sažetak: Ova studija upoređuje dve teorijske perspektive koje nastoje da objasne odnos između prihoda, slobodnog vremena i subjektivnog blagostanja. Prva, mikroekonomska teorija razmene rada i slobodnog vremena, pretpostavlja negativnu korelaciju između nivoa prihoda i količine slobodnog vremena. Druga, psihološka teorija zadovoljstva slobodnim vremenom, polazi od pretpostavke da između slobodnog vremena i sreće postoji pozitivna povezanost. Na osnovu podataka Kancelarije za nacionalnu statistiku Ujedinjenog Kraljevstva za 2023. godinu, sprovedena je analiza agregiranih prosečnih vrednosti za pet starosnih grupa korišćenjem linearne regresije i Pirsonovog koeficijenta korelacije u softveru R. Rezultati ukazuju na snažniju pozitivnu povezanost između slobodnog vremena i sreće (r do 0,96) nego na negativnu povezanost između prihoda i slobodnog vremena (r do -0,615), čime se pruža veća empirijska podrška teoriji zadovoljstva slobodnim vremenom u odnosu na model razmene rada i slobodnog vremena. Iako ograničena veličina uzorka i agregacija podataka smanjuju mogućnost generalizacije rezultata, nalazi sugerišu da slobodno vreme ima značajniji uticaj

na subjektivno blagostanje od samog nivoa prihoda. Ovi rezultati ističu potrebu za integracijom ekonomskih i psiholoških pristupa u istraživanjima determinanti sreće i kvaliteta života.

Ključne reči: slobodno vreme, prihod, sreća, razmena rada i slobodnog vremena, teorija zadovoljstva slobodnim vremenom.

THE IMPACT OF CORPORATE SOCIAL RESPONSIBILITY ON LOYALTY IN THE HOTEL SECTOR

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Abstract: *The growing awareness of the broader social community about the importance of socially responsible activities has led to socially responsible behavior of organizations becoming not just a desirable choice, but an expected one. As a multidimensional concept, Corporate Social Responsibility (CSR) is most often observed within the context of its effects, one of the most significant being its influence on consumer behavior—specifically, their intentions to revisit the hotel and/or share positive experiences with others. Therefore, the aim of this paper is to examine the direct impact of CSR on customer loyalty, and then to explore the mediating effects of key factors identified in the literature that shape users' perceptions of hotel services: service quality, corporate image, corporate reputation, and satisfaction, on the relationship between CSR and customer loyalty in the hotel industry. The research results indicate that CSR has a significant, positive, and direct effect on customer loyalty, which is mediated by service quality, corporate image,*

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corporate reputation, and satisfaction, with service quality emerging as the strongest interaction factor.

Keywords: *Corporate Social Responsibility, consumer loyalty, service quality, customer satisfaction, corporate image, corporate reputation.*

INTRODUCTION

Corporate Social Responsibility (CSR) is a concept that continuously attracts attention in scientific and professional circles, as there is still no consensus regarding the meaning of the concept itself, its motives for implementation, potential effects, and the areas in which it is applied (Kotler & Lee, 2005). It is a specific business philosophy adopted either voluntarily as a strategic commitment or through obligations imposed by institutional frameworks or by the broader social community. In the broadest sense, CSR is “the responsibility of companies for their impact on society” (European Commission, 2011). The importance of the CSR concept stems from its multidimensionality, as it involves the company itself, multiple stakeholders, the entire economy, and the social community (Porter & Kramer, 2006). As one of the most cited CSR concepts, the model that includes four components is often referenced in domestic and foreign literature: economic responsibility, legal responsibility, ethical responsibility, and discretionary/philanthropic responsibility. Economic and legal responsibilities are demanded by society, while ethical and discretionary/philanthropic responsibilities are expected by society.

Applying the CSR concept as a marketing tool can lead to a positive corporate image and reputation (Martinez et al., 2014), especially as consumers and investors increasingly direct their consumption and investment decisions toward socially responsible companies. In this context, consumer loyalty can also be viewed as a key indicator of whether corporate activities and goals are perceived positively or accepted in line with expectations.

Analyzing the effects of CSR implementation in the hotel sector, among numerous tangible and intangible benefits, Wong & Kim (2020) highlight the following as most significant: improved hotel image or brand, reduced guest dissatisfaction due to price increases, increased loyalty to the hotel, improved efficiency, and reduced operational costs. Accordingly, hotel managers particularly aim to incorporate CSR into business strategies to

not only address financial and non-financial performance interests (Kim & Kim, 2016) but also to minimize negative impacts of business activities on the environment, cultural setting, and social community. Viewing socially responsible behavior as an element of corporate strategies, numerous researchers have examined the relationship between CSR and consumer loyalty (Adebayo & Ogunshola, 2017; Afridi et al., 2018; Latif et al., 2020), concluding that CSR has a positive influence on consumer loyalty. This is especially significant in conditions of increased consumer awareness regarding socially responsible corporate behavior. However, there is limited research examining mediating effects of key factors, primarily those related to shaping consumer perceptions regarding services, such as quality, image, reputation, etc. Especially, such studies are lacking in the hospitality industry.

Studying these effects in hospitality is important for two reasons: firstly, because of the growing awareness among modern tourists about environmental preservation and socially responsible behavior of hotels; secondly, because tourists increasingly value experiences that include authenticity. Therefore, perceptions of quality, image, and reputation of hotels become critical factors in choosing destinations and hotels, as well as in recommending their experiences to others. Starting from the defined research problem, the subject of this study is the influence of social responsibility on consumer loyalty in the hotel sector in the Republic of Serbia. Since perceptions of CSR activities can additionally influence many other factors such as perceived service quality, consumer satisfaction, corporate image, and reputation (Latif et al., 2020), which individually can significantly affect consumer loyalty, the primary aim of this research is to examine the mediating effects of these factors on the impact of CSR on customer loyalty.

LITERATURE REVIEW

Despite numerous efforts to create a clear and unbiased definition of social responsibility, there remain various approaches and aspects to the concept, often reflecting the perspective of the author or organization examining it. One of the earliest attempts at theoretical conceptualization of social responsibility is attributed to Bowen, who believed that owners of capital and organizational managers have “an obligation to implement policies, make decisions, or carry out actions that are desirable in terms of fulfilling the goals of our society” (Bowen, 1998). However, this conceptualization as an obligation is challenged by contemporary

approaches emphasizing the voluntary nature of socially responsible business conduct. Being socially responsible does not only mean complying with legal obligations but also going beyond mere legal adherence by investing more in human capital, the environment, and stakeholder relationships (European Commission, 2001). In this broader sense, social responsibility generally refers to organizations' behavior that extends beyond their legal duties towards society and the environment (Zlatanović & Mulej, 2015).

Because of its multidimensionality, the concept of social responsibility is increasingly analyzed within the context of sustainable development (Moon, 2007; Kolk & Van Tulder, 2010; Ebner & Baumgartner, 2006), its impact on financial performance and the significant benefits it can bring, summarized by Vlastelica-Bakić et al. (2012) as: fostering positive attitudes toward the organization (McWilliams & Siegel, 2001), products and services (Sen & Bhattacharya, 2001), brand loyalty (He & Lai, 2014), development of competitive advantages (Porter & Kramer, 2006), cost and risk reduction (Kotler & Lee, 2005), attracting investors, and ultimately, building long-term value. Additionally, research indicates that CSR produces other positive outcomes such as consumer satisfaction and loyalty (Marinković et al., 2019), employee satisfaction, motivation, emotional commitment, reduced turnover intentions, and improved work performance (Kunz, 2020).

Various marketing studies confirm a positive impact of consumers' perceptions of socially responsible business practices on their loyalty. The application of CSR allows consumers to identify companies based on positive perceptions they create about them (Sen & Bhattacharya, 2001), and their willingness to recommend companies that pay more attention to social issues can influence increased loyalty of existing customers or attract new ones (Ofluog̃lu & Atilgan, 2014). Kim and Kim (2016) emphasize that companies' CSR efforts generate positive effects such as favorable product/service evaluations, repurchase intentions, increased trust, and enhanced loyalty. When CSR activities are noticed and well accepted by consumers, this leads through positive evaluations of the company and their relationship with it to greater loyalty (McCain et al., 2019). Notably, in the hotel industry, there are positive relationships between customer perceptions of corporate social responsibility initiatives and their loyalty (Kim & Kim, 2016). Based on all the above, the following hypothesis can be proposed:

H1: Customer perceptions of CSR in hotel services have a significant and positive impact on consumer loyalty.

However, some research has not found a direct link between CSR and customer loyalty (García de los Salmones et al., 2005). This suggests that the impact may be moderated by certain factors that influence this relationship. Since empirical studies indicate that service quality, corporate image, and corporate reputation significantly influence customer expectations in hotels, it can be hypothesized that these factors play a mediating role in this relationship. Because satisfaction - based on comprehensive prior hotel service experiences - is a key determinant of customer attitudes and behavioral intentions, it is also plausible that satisfaction has a significant moderating effect on the CSR - loyalty link. Accordingly, the following hypotheses are formulated:

H2: Service quality influences the relationship between customer perceptions of CSR and customer loyalty in hotel services.

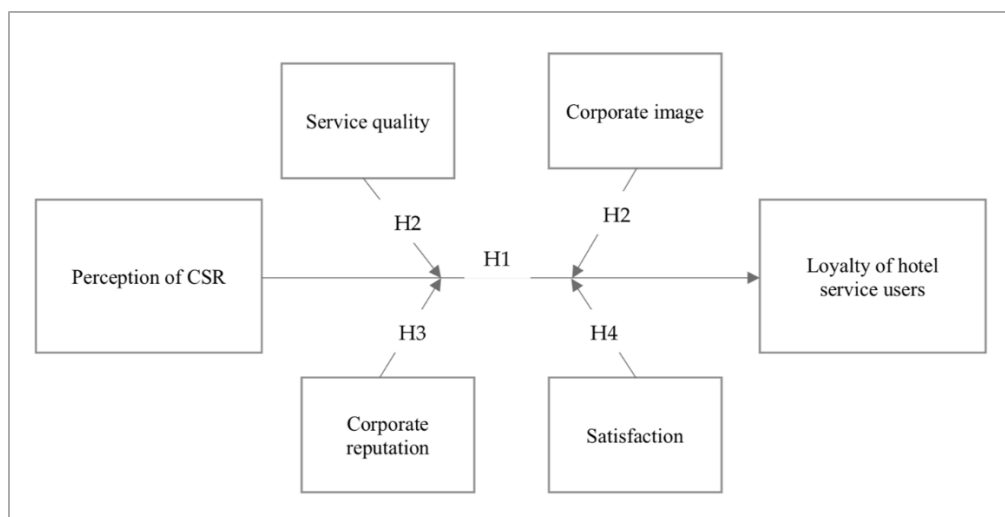
H3: Corporate image influences the relationship between customer perceptions of CSR and customer loyalty in hotel services.

H4: Corporate reputation influences the relationship between customer perceptions of CSR and customer loyalty in hotel services.

H5: Customer satisfaction influences the relationship between customer perceptions of CSR and customer loyalty in hotel services.

The research model can be visually summarized as follows:

Figure 1. Research Model



Source: Authors

RESEARCH METHODOLOGY

The research was conducted on a sample of 52 hotel service users. The sample of respondents was segmented by gender, age, and frequency of hotel use. Among the 52 respondents, 39 were female (75%), and 13 were male (25%). The largest number of respondents, 28, were aged between 41 and 50 years (53.8%), and 29 indicated that they use accommodation services occasionally throughout the year (55.8%). The obtained results are presented in Table 1.

Table 1. Sample structure (total of 52 respondents)

Gender	Freq- uency	%	Age	Frequency	%	Frequency of use	Frequency	%
male	13	25	< 20	2	3.8	once a month	14	26.9
female	39	75	21-30	4	7.7	several times a month	6	11.5
			31-40	12	23.1	occasionall y during the year	29	55.8
			41-50	28	53.8	once a year	3	5.8
			> 50	6	11.5			
	52	100		52	100		52	100

Source: Authors

Data were collected during 2022 using a structured questionnaire developed based on relevant claims from the analyzed literature. Specifically, the items in the questionnaire were defined by reviewing theoretical and empirical studies related to perceptions of CSR (Radivojevic et al., 2022), service quality (Latif et al., 2020), consumer satisfaction (Saad Andaleeb & Conway, 2006), corporate image (Latif et al., 2020), corporate reputation (Özkan et al., 2019), and consumer loyalty (Josimovic et al., 2025a). Respondents' statements were measured on a 5-point Likert scale (1 – strongly disagree; 5 – strongly agree). The questionnaire is presented in Table 2.

Table 2. Questionnaire

User perceptions of social responsibility (CSR) - Cronbach' alpha = 0.903
The hotel you last visited:
CSR1: supports cultural and social events and projects.
CSR2: strives to contribute to the development of the local economy.
CSR3: is dedicated to the establishment of ethical principles.
CSR4: shows responsibility for environmental protection.
CSR5: strives to comply with regulations related to the welfare of its clients.
CSR6: correctly applies health and safety rules and regulations.
CSR7: offers environmentally friendly products and services.
CSR8: continuously improves the quality of its products and services.
CSR9: strives to make products and services available to all guests.
CSR10: ensures that employees respect professional standards.
CSR11: shows a good attitude towards employees.
CSR12: offers a pleasant working environment.
Service quality (SQ) - Cronbach' alpha = 0.807
SQ1 The physical environment of the hotel is very good.
SQ2 The hotel staff is professional and dedicated.
SQ3 A good organization of the hotel makes it possible to respond to guests' requests in a timely and quality manner.
SQ4 My interaction with the hotel staff was excellent.
SQ5 The hotel staff provides complete information about the hotel's products/services.
User satisfaction (SAT) - Cronbach' alpha = 0.958
SAT1 The hotel offer is in line with my needs
SAT2 I would be a hotel guest again.
SAT3 I would recommend the hotel to others.
SAT4 Hotel provides excellent service.
SAT5 Hotel provides the service I expect
SAT6 Compared to other hotels, this hotel is good or better.
SAT7 I think that the decision to choose this hotel was correct.
SAT8 Overall, my experience with the hotel was positive.
Corporate image (CI) - Cronbach' alpha = 0.861
CI1 I have always had good impressions of this hotel.
CI2 In my opinion, this hotel has a good image.
CI3 I believe that the image of this hotel is better than its competitors.
CI4 I think the quality of service provided by the hotel is adequate.

CI5 The hotel staff is very friendly.
CI6 The appearance of the hotel is attractive.
CI7 The area around the hotel is clean.
CI8 Hotel is located in a beautiful area.
CI9 The prices in the hotel are correct.
CI10 I feel that I am getting the expected value for my money
Corporate reputation (CR) - Cronbach' alpha = 0.916
CR1 This hotel is well managed.
CR2 This hotel has good employees.
CR3 This hotel is oriented towards the needs of the guests.
CR4: The hotel is well designed.
CR5: I heard good comments about this hotel.
CR6: The hotel has a good reputation.
CR7: A hotel's reputation is based on offering good products and services.
CR8: The hotel has a better reputation than its competitors.
Customer loyalty (LOY) - Cronbach' alpha = 0.942
LOY1 I would recommend friends and relatives to visit this hotel.
LOY2 I would book this hotel again.
LOY3 I would pass on positive comments about this hotel to other people.
LOY4 I think this hotel was my best choice.
LOY5 Whenever I have the chance, I would extend my stay at this hotel.

Before testing the validity of the questionnaire as a measurement instrument, an analysis of the frequency and quality of the data was conducted. The results showed that the data were not normally distributed. For this reason, a transformation was applied using the Box-Cox transformation. The same sample was used for testing the questionnaire's validity. Since the first step in this process involves assessing the adequacy of the sample, the Kaiser-Meyer-Olkin (KMO) test was first performed (0.830), followed by Bartlett's test of sphericity on the entire sample ($\chi^2 = 1128$, $p < 0.001$). The KMO test result clearly indicates a strong correlation among factors, while Bartlett's test of sphericity suggests that the correlation matrix is appropriate for factor analysis. Therefore, the results of both tests confirm the adequacy of the sample for further analysis.

The results of the exploratory factor analysis indicate that factors are grouped according to expectations, noting that Promax rotation was used, which is common in social research. Since all factors had factor loadings greater than 0.5, they were retained for further analysis. Also, no items had cross-loadings greater than 0.3. Internal consistency among items was tested using Cronbach's alpha coefficient. The values ranged from a minimum of 0.807 for SQ (service quality), indicating acceptable internal consistency, to a maximum of 0.958 for SAT (satisfaction), indicating excellent internal consistency. The convergent and discriminant validity of the questionnaire was tested using confirmatory factor analysis. The results of the confirmatory factor analysis are presented in Table A1, while the goodness-of-fit indices are shown in Table 3. Since different indices provide various perspectives and insights into the data structure, indices from different groups were used in the study. All indices show satisfactory values.

Table 3. Fit indexes

Comparative Fit Index (CFI)	0.898
Tucker-Levis Index (TLI)	0.889
Bentler-Bonett normalized fit index (NNFI)	0.889
Relative non-central index (RNI)	0.898
Root Mean Square Error (RMSEA)	0.028
Standardized root means square error (SRMR)	0.037

Source: Authors

All factor loadings shown in Table A1 are statistically significant. It is a common practice to eliminate from the questionnaire all items with factor loadings below 0.4; however, Josimović et al. (2025) suggest that only items with factor loadings greater than 0.5 should be used in further analysis. Besides factor loadings, the average extracted variance (AVE) is also a good indicator of the convergent validity of the questionnaire, and in the case of all subscales, it exceeds the critical value of 0.5 (Parrey et al., 2019). The composite reliability index was used to assess the consistency of the questionnaire. The results of this index are also presented in Table A1 and indicate satisfactory values. Discriminant validity of the scales was tested based on the Fornell-Larcker criterion. The squared root of AVE for each latent factor was compared with the correlations between the constructs, as shown in Table 5. It is important to note that the squared

root of AVE for each latent factor is displayed along the main diagonal. The results confirmed discriminant validity, as the correlations between each latent factor were lower than the square root of their respective AVE.

Table 4. Table 5. Results of the discriminant analysis

	CSR	SQ	SAT	QI	QR	LOY
CSR	0.782					
SQ	.656**	0.793				
SAT	.577**	.454**	0.781			
QI	.662**	.690**	.568**	0.8		
QR	.756**	.687**	.457**	.789**	0.860	
LOY	.595**	.432**	.716**	.665**	.698**	0.810

Source: Authors

Since the questionnaire met the conditions for convergent and discriminant validity of the measurement instrument, as well as reliability, it can be concluded that it is suitable for further analysis. In other words, in the continuation of the study, the validity of the hypotheses was tested using structural equation modeling (SEM). SEM was employed to determine the validity of the proposed research model and the relationships among variables within that model. The study used a covariance-based SEM model.

RESULTS OF THE RESEARCH AND DISCUSSION OF THE FINDINGS

As previously emphasized, the validity testing of the research model was conducted using structural equation modeling (SEM) to evaluate the proposed hypotheses. The first step in model validation, as well as in assessing the validity of the measurement component, involves examining the fit indices; this step was initiated accordingly. The same indices used in the measurement model component yielded good values, indicating that the testing of the proposed hypotheses could proceed. The results of applying the SEM model are presented in Table 5.

Table 5. SEM model results

Latent factor	Coefficient	St. error	Z-test	p-value	Results
LOY - CSR	0.324	0.009	2.571	0.010	H1 is accepted
LOY – (CSR*SQ)	0.143	0.013	11.000	0.000	H2 is accepted
LOY – (CSR*SAT)	0.089	0.019	4.684	0.000	H3 is accepted
LOY – (CSR*IC)	0.106	0.011	9.636	0.000	H4 is accepted
LOY – (CSR*SR)	0.121	0.015	8.067	0.000	H5 is accepted
Fit index: CFI = 0.898; TLI = 0.889; RNI = 0.898; RMSEA = 0.027; SRMR = 0.038					

Source: Author's calculations

As illustrated in Table 5, the values of all coefficients are statistically significant at the 0.05% confidence level, which is standard in this type of research. The obtained results indicate the following:

1. CSR has a strong and statistically significant positive impact on customer loyalty in hotel services. This finding suggests that modern hotel customers are aware of the importance of sustainable business practices and value such behavior. From a theoretical standpoint, this aligns with the stimulus-response theory, which validates CSR as a stimulus that influences and shapes consumer behavior. In other words, CSR can be used as a stimulus that affects hotel choice and subsequently influences users' intentions to revisit the same hotel. Furthermore, CSR acts as an effective stimulus impacting both the cognitive and affective components in the customer, leading to a range of positive effects that establish a deeper relationship between the customer and the hotel. According to social exchange theory, this created bond will influence customers' intentions to maintain the relationship to protect their interests (Josimovic et al., 2024). This, in turn, manifests in discretionary behaviors by customers and their efforts to justify potential service shortcomings by the hotel (Josimovic et al., 2025b). It is well known that in such situations, hotel customers feel a moral obligation to support the hotel and justify any service failures, thus maintaining the reciprocity of the relationship and mutual benefit.
2. Service quality, satisfaction, corporate image, and corporate reputation moderate the relationship between CSR and customer loyalty. This result is expected and significant for two reasons. First, perceptions and emotions triggered by CSR can be adjusted through these factors. Second, the consequences of failing to implement CSR can be mitigated by acting upon these factors. From the perspective of expectation theory, the finding indicates that customers' expectations regarding hotel services are formed

based on these factors, which also serve as antecedents to CSR. For hotel management, this implies that deficiencies in these factors cannot be compensated solely through CSR implementation; however, shortcomings in the execution of CSR-related behaviors can be alleviated by influencing these factors. An additional implication is that CSR cannot be the primary factor directly affecting customer loyalty to hotels despite its strong overall impact. Therefore, hotel management should not focus solely on one factor but should consider an integrated approach, recognizing the influence and interaction of all these factors in shaping customer loyalty.

CONCLUSION

The increasing awareness of the importance of socially responsible behavior conditions broader societal expectations for organizations to align their operations with social and ethical standards. When dedication to social causes is recognized, it can lead to improvements in reputation and corporate image. On the other hand, customers, as key promoters of a company, can significantly influence the development of a sustainable image. Given the belief that companies actively engaged in CSR activities may achieve better results than those that are not, it follows that investing in strategic corporate social responsibility and caring for the interests of all stakeholders can bring substantial advantages to businesses, including a high reputation, a good image, and satisfied and loyal consumers.

By analyzing the concept of socially responsible business, the work provides insight into how applying this concept individually can influence consumer loyalty, as well as modeling the effects of key factors that shape the perceptions of hotel service users. Although the study's sample consisted of users of hotel services in the Republic of Serbia, the examined influences and the significance of the modeling effect can serve as a basis for analysis in other service sectors. Comparing these results can lead to general conclusions about CSR's impact on user behavior across different services. Additionally, the results should inform hotel managers on how perceptions of socially responsible behavior can determine the behavior of potential and existing guests. Since market survival depends not only on attracting new customers but also on expanding the base of loyal guests, it is essential to understand the potential effects of planning and implementing socially responsible activities. As social responsibility influences consumer loyalty through both direct and indirect paths, it cannot be driven solely by promotional purposes. The way hotel guests perceive CSR will significantly influence their perception of service

quality, satisfaction, and their impression of the company's image and reputation. Ultimately, how CSR activities shape guest satisfaction, as well as the hotel's image and reputation, will condition their intention to revisit or whether they consider the hotel the best choice worth recommending and leaving positive comments.

However, like any study, this work may have certain limitations. The first limitation pertains to the sample size, which included 52 hotel service users. The second limitation arises from the questionnaire method used for data collection and primarily from the subjectivity of respondents. The restriction also lies in the fact that the empirical study was conducted among consumers, one of many key stakeholders, and it only covered certain aspects (dimensions) of social responsibility. In response to these limitations, further research opportunities can be identified. Initially, considering the potential number of hotel guests, future studies should include a larger number of respondents to ensure more relevant conclusions and more comprehensive recommendations for decision-makers. Additionally, to examine whether visiting a hotel significantly influences respondents' attitudes, subsequent research should compare attitudes before and after visiting a particular hotel.

Since the CSR concept is oriented toward the broader community and involves respecting the interests of a large number of stakeholders, future research should investigate how socially responsible activities influence the attitudes and behaviors of employees in the hotel industry or whether they can also affect the hotel's reputation, as evaluated by media or other organizations within the wider social community. Furthermore, considering the results of numerous studies exploring the benefits of implementing the CSR concept, future research can specify this aspect for the hotel industry. This would provide a more realistic picture of the expected benefits and effects, thereby enabling the formulation of clear recommendations for improving operations in this field so that the benefits of CSR in broader contexts become more meaningful and purposeful.

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Appendix

Table 1. Results of Exploratory factor analysis

Latent factor	Item	Factor loadings	St. error	z test	p	AVE	CR
CRS	Q1	0.764	0.024	2.571	0.010	0.611	0.95
	Q2	0.782	0.024	32.583	0.000		
	Q3	0.709	0.024	29.542	0.000		
	Q4	0.732	0.024	30.500	0.000		
	Q5	0.829	0.022	37.682	0.000		
	Q6	0.822	0.021	39.143	0.000		
	Q7	0.709	0.028	25.321	0.000		
	Q8	0.776	0.028	27.714	0.000		
	Q9	0.824	0.032	25.750	0.000		
	Q10	0.842	0.022	38.273	0.000		
	Q11	0.765	0.043	17.791	0.000		
	Q12	0.814	0.024	33.917	0.000		
SQ	Q13	0.773	0.031	24.935	0.000	0.63	0.89
	Q14	0.821	0.033	24.879	0.000		
	Q15	0.751	0.031	24.226	0.000		
	Q16	0.763	0.028	27.250	0.000		
	Q17	0.848	0.032	26.500	0.000		
SAT	Q18	0.773	0.029	26.655	0.000	0.61	0.93
	Q19	0.823	0.033	24.939	0.000		
	Q20	0.696	0.028	24.857	0.000		
	Q21	0.737	0.031	23.774	0.000		
	Q22	0.735	0.031	23.710	0.000		
	Q23	0.892	0.031	28.774	0.000		
	Q24	0.769	0.028	27.464	0.000		
	Q25	0.803	0.032	25.094	0.000		
CI	Q26	0.771	0.035	22.029	0.000	0.64	0.93
	Q27	0.728	0.033	22.061	0.000		
	Q28	0.737	0.035	21.057	0.000		
	Q29	0.727	0.035	20.771	0.000		

Latent factor	Item	Factor loadings	St. error	z test	p	AVE	CR
	Q30	0.948	0.016	59.250	0.000		
	Q31	0.823	0.016	51.438	0.000		
	Q32	0.598	0.016	37.375	0.000		
	Q33	0.809	0.016	50.563	0.000		
	Q34	0.888	0.032	27.750	0.000		
	Q35	0.877	0.034	25.794	0.000		
CR	Q36	0.872	0.018	48.444	0.000	0.73	0.96
	Q37	0.908	0.023	39.478	0.000		
	Q38	0.873	0.019	45.947	0.000		
	Q39	0.785	0.018	43.611	0.000		
	Q40	0.861	0.006	143.500	0.000		
	Q41	0.802	0.017	47.176	0.000		
	Q42	0.871	0.034	25.618	0.000		
	Q43	0.868	0.033	26.303	0.000		
LOY	Q44	0.948	0.016	59.250	0.000	0.65	0.91
	Q45	0.762	0.019	40.105	0.000		
	Q46	0.801	0.021	38.143	0.000		
	Q47	0.763	0.026	29.346	0.000		
	Q48	0.746	0.031	24.065	0.000		

Source: Authors

UTICAJ KORPORATIVNE DRUŠTVENE ODGOVORNOSTI NA LOJALNOST U HOTELSKOM SEKTORU

Biljana Popović

Nikola Radivojević

Vinko Burnać

Sažetak: *Rastuća svest šire društvene zajednice o značaju društveno odgovornih aktivnosti uticala je da društveno odgovorno ponašanje organizacija više ne bude stvar poželjnog, već podrazumevanog izbora. Kao višedimenzionalan koncept, društvena korporativna odgovornost (CSR) se najčešće posmatra u kontekstu efekata koje implicira, pri čemu se kao jedan od najbitnijih efekata ističe uticaj na ponašanje potrošača, odnosno na njihove namere da ponovo posete hotel i/ili da svoja pozitivna iskustva prenesu drugima. Otuda, cilj rada jeste da se ispita direktan uticaj CSR na lojalnost potrošača značajan, a potom istraži modelirajući efekte, u literaturi identifikovanih kao ključnih faktora koji oblikuju percepciju korisnika hotelskih usluga: kvalitet usluge, korporativni imidž, korporativnu reputaciju i satisfakciju, na odnos između CSR i lojalnost korisnika hotelskih usluga. Rezultati istraživanja pokazuju da CSR ima značajan, pozitivan i direktan uticaj na lojalnost korisnika hotelskih usluga, na koji modelirajuće deluju kvalitet usluge, korporativni imidž, korporativnu reputaciju i satisfakciju, pri čemu kao najjači interakcijski faktor se javlja kvalitet usluge.*

Ključne reči: *korporativna društvena odgovornost, lojalnost potrošača, kvalitet usluge, satisfakcija potrošača, korporativni imidž, korporativna reputacija.*

PREGLEDNI RADOVI

PROPISI U OBLASTI SAOBRAĆAJA

Mitrić Vidoje¹

Sažetak: Osnovni cilj ovog istraživanja jeste analiza propisa u oblasti saobraćaja sa posebnim osvrtom na drumski saobraćaj, kako bi se sagledala njihova uloga u unapređenju bezbednosti, efikasnosti i održivosti saobraćajnog sistema. Drumski saobraćaj predstavlja jedan od najvažnijih segmenata transportnog sistema, te su zakonski okviri i regulative ključni za njegovo funkcionisanje. Propisi u ovoj oblasti obuhvataju zakone, pravilnike i standarde koji definišu tehničke uslove za vozila, regulaciju saobraćaja na putevima, prava i obaveze učesnika u saobraćaju, kao i mere za sprečavanje i sankcionisanje prekršaja. Poseban akcenat stavljen je na Zakon o bezbednosti saobraćaja na putevima, koji predstavlja osnovni pravni okvir za regulisanje ove oblasti. Ovo istraživanje ima za cilj da ukaže na značaj usklađivanja domaćih propisa sa međunarodnim standardima, kao i na potrebu kontinuiranog prilagođavanja zakonskog okvira kako bi se odgovorilo na izazove savremenog saobraćaja. Takođe, analiziraće se efekti primene propisa na smanjenje saobraćajnih nezgoda i unapređenje kvaliteta drumskog saobraćaja.

Ključne reči: propisi, drumski saobraćaj, bezbednost, zakon, infrastruktura.

UVOD

Regulisanje saobraćaja na putevima ima dugu istoriju, koja prati razvoj civilizacije i potrebu za organizovanjem kretanja ljudi i robe. Još u antičkom Rimu postojala su pravila koja su uređivala kretanje na glavnim

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putevima, dok su u srednjem veku nastale prve takse i regulative za održavanje drumskih infrastruktura. Razvojem industrijske revolucije i pojavom motornih vozila krajem 19. i početkom 20. veka, potrebe za zakonskim regulisanjem saobraćaja postale su sve značajnije. Jedan od prvih koraka u modernom regulisanju saobraćaja bio je uvođenje saobraćajnih znakova i pravila za vozače, kako bi se smanjio broj nesreća i omogućilo efikasno korišćenje puteva. Prvi zakon o saobraćaju donet je u Velikoj Britaniji 1865. godine, poznat kao „Red Flag Act”, kojim su postavljena ograničenja za motorna vozila i obavezna pratnja pešaka sa crvenom zastavicom ispred vozila. Ubrzo su i druge zemlje počele da uvode slične propise prilagođene svojim potrebama.

Na području današnje Srbije, prvi ozbiljni propisi o saobraćaju doneti su u Kraljevini Jugoslaviji tokom 20-ih i 30-ih godina prošlog veka, kada su uvedena pravila za tehnički pregled vozila, vozačke dozvole i osnovna regulacija saobraćaja. Nakon Drugog svetskog rata, sa razvojem motorizacije, doneta su nova zakonska rešenja koja su pratila ubrzani rast broja vozila i modernizaciju puteva.

Danas, propisi u oblasti saobraćaja obuhvataju širok spektar zakona, pravilnika i standarda, čiji je osnovni cilj unapređenje bezbednosti, efikasnosti i održivosti transportnog sistema. U Republici Srbiji ključni zakonski okvir čini Zakon o bezbednosti saobraćaja na putevima, koji je donet 2009. godine, sa značajnim izmenama i dopunama od 2018. godine, a definiše prava i obaveze svih učesnika u saobraćaju, tehničke standarde za vozila i mere za sprečavanje saobraćajnih nesreća. Pored toga, ovaj zakon pruža osnovu za kontinuirano unapređenje infrastrukture i podsticanje inovacija u oblasti transporta.

Razmatranje propisa u oblasti saobraćaja omogućava dublje razumevanje njihovog značaja za društvo, posebno u kontekstu očuvanja ljudskih života, zaštite životne sredine i podrške ekonomskom razvoju. U tom smislu, uloga modernih tehnologija i digitalizacije u saobraćaju postaje sve značajnija, jer doprinosi efikasnijem upravljanju saobraćajem i smanjenju negativnih uticaja na životnu sredinu. Upravo zbog toga je važno analizirati dosadašnji razvoj i aktuelne trendove u ovoj oblasti kako bi se predložila rešenja za buduće izazove.

PRAVNI OKVIR ZA DRUMSKI SAOBRAĆAJ U SRBIJI

Saobraćajno pravo predstavlja skup pravnih normi kojima se regulišu odnosi između subjekata u saobraćaju. Ovo je najkonkretnija, praktična

definicija saobraćajnog prava (Lipovac, 2008). Pravni okvir za drumski saobraćaj u Republici Srbiji definiše zakone, pravilnike i standarde koji regulišu sve aspekte bezbednosti, efikasnosti i održivosti saobraćaja. U Srbiji je ova problematika tradicionalno bila u nadležnosti policije, a tek je po donošenju poslednjeg ZOBS-a nadležnost prenet na civilnu Vladinu Agenciju (Božanić, Dedović, Božović, 2021).

Ključni zakon u ovoj oblasti je Zakon o bezbednosti saobraćaja na putevima (Sl. glasnik RS, 110/2018), koji predstavlja temeljni pravni akt. Njime se definišu prava i obaveze svih učesnika u saobraćaju, tehnički uslovi za vozila, pravila kretanja na putevima, kao i mere za sprečavanje i sankcionisanje prekršaja. Ovaj zakon postavlja osnovne principe upravljanja drumskim saobraćajem u Srbiji. Učesnici u saobraćaju dužni su da se ponašaju u skladu sa propisanim pravilima radi očuvanja bezbednosti i reda na putevima. Regulativa takođe propisuje obavezne tehničke preglede vozila, uslove za registraciju i standarde koji se odnose na ispravnost sistema za kočenje, osvetljenje i emisiju gasova. Uz to, zakon uvodi niz bezbednosnih mera, poput obaveznog korišćenja sigurnosnih pojaseva, ograničenja brzine, pravila o alkoholu i psihoaktivnim supstancama, kao i uslova za prevoz dece.

Pored osnovnog zakona, pravni okvir obuhvata pravilnike i podzakonske akte koji detaljnije regulišu specifične aspekte drumskog saobraćaja. Na primer, Pravilnik o saobraćajnoj signalizaciji usvojen je i objavljen u Sl. glasniku RS, 85/2015, dok je Pravilnik o tehničkim pregledima vozila potvrđen u Sl. glasniku RS, 72/2017. Takođe, Pravilnik o prevozu opasnih materija, koji je donet radi osiguranja sigurnog transporta opasnih supstanci, objavljen je u Sl. glasniku RS, 95/2016, a Pravilnik o obuci vozača, koji detaljno propisuje uslove i kriterijume za sticanje vozačke dozvole, važi od objavljivanja u Sl. glasniku RS, 67/2017 („Zvanični akti Ministarstva unutrašnjih poslova, Zakon o bezbednosti saobraćaja na putevima, 2018, 8).

Srbija je u obavezi da svoje zakonodavstvo usklađuje sa regulativama Evropske unije, što podrazumeva prilagođavanje domaćih propisa međunarodnim standardima. To uključuje uvođenje emisijskih normi EURO 6, implementaciju novih bezbednosnih tehnologija poput sistema za automatsko kočenje i asistenciju vozaču, kao i digitalnih tahografa za praćenje radnog vremena vozača. Značajan korak u ovom procesu je i usklađivanje sa EU standardima, što je potvrđeno rešenjima Ministarstva građevinarstva, saobraćaja i infrastrukture iz 2020. godine. „Usklađivanje sa EU regulativama predstavlja ključni korak ka modernizaciji saobraćajnog sistema”, (Ministarstvo građevinarstva, saobraćaja i infrastrukture, 2020).

Implementacija i nadzor sprovođenja propisa povereni su Ministarstvu unutrašnjih poslova, Ministarstvu građevinarstva, saobraćaja i infrastrukture, kao i Agenciji za bezbednost saobraćaja. Dok saobraćajna policija kontroliše saobraćaj i izdaje vozačke dozvole, Agencija promoviše edukaciju i organizuje kampanje o značaju bezbednosti na putevima. Prema izveštaju Agencije za bezbednost saobraćaja iz 2019. godine, značajna unapređenja ostvarena su u urbanim sredinama, dok ruralna područja još uvek zahtevaju dodatne mere i ulaganja. "Prema izveštaju Agencije za bezbednost saobraćaja (2019), ostvareni su značajni napreci u urbanim sredinama, dok ruralne oblasti zahtevaju dodatne mere," (Agencija za bezbednost saobraćaja, 2019).

Iako pravni okvir u Srbiji pokriva većinu aspekata drumskog saobraćaja, njegovo sprovođenje u praksi suočava se sa izazovima. Ograničeni kapaciteti inspeksijskih službi i nedovoljna edukacija učesnika u saobraćaju, posebno mladih vozača, predstavljaju probleme. Pored toga, loše održavanje infrastrukture, naročito u ruralnim područjima, dodatno otežava primenu zakona. Zato je kontinuirano unapređenje zakonodavstva, praćeno ciljnim infrastrukturnim investicijama, imperativ za dalji razvoj. "Kontinuirano unapređenje zakonodavstva i infrastrukturne investicije ključni su za smanjenje broja saobraćajnih nezgoda," (Ministarstvo unutrašnjih poslova, 2021).

Pravni okvir za drumski saobraćaj u Srbiji čini osnovu za održavanje reda i bezbednosti na putevima. Njegovo kontinuirano unapređenje i usklađivanje sa međunarodnim standardima ključni su za smanjenje broja saobraćajnih nezgoda i obezbeđivanje efikasnijeg transportnog sistema.

BEZBEDNOST U DRUMSKOM SAOBRAĆAJU

Bezbednost drumskog saobraćaja je jedna od naučnih disciplina koja primenom naučne metodologije prati, izučava i objašnjava pojavne oblike, (fenomenologiju), uzroke, uslove i druge faktore zbog kojih nastaju pojave koje ugrožavaju ljude i imovinu u saobraćaju, a posebno saobraćajne nezgode (etiologija) i strategiju i taktiku sprečavanja saobraćajnih nezgoda i drugih negativnih pojava u saobraćaju, pri čemu se pored sopstvenih rezultata, koristi i rezultatima drugih naučnih disciplina (Tojagić, 2020).

Na sticanje neophodnih znanja, veština i stavova za bezbedno učešće vozača u drumskom saobraćaju najveći i najneposredniji uticaj svakako imaju saobraćajna kultura u društvu i motivisanost samog vozača za vožnju (Bogojević, 2022).

Savremena tehnologija, uključujući algoritme mašinskog učenja i analizu velikih podataka, igra značajnu ulogu u razvoju sistema bezbednosti. Uvođenje pametne infrastrukture, kao što su povezani semafori i komunikacioni sistemi između vozila, može dodatno poboljšati bezbednost. Ovi sistemi omogućavaju koordinaciju između učesnika u saobraćaju, minimizirajući rizik od sudara (Miladinović, Milošević, Ilić, 2025).

Bezbednost u drumskom saobraćaju predstavlja jedan od ključnih aspekata saobraćajne politike Republike Srbije. Ova oblast je regulisana Zakonom o bezbednosti saobraćaja na putevima, kao i nizom pravilnika i strategija koje definišu mere za unapređenje bezbednosti.

Prema podacima Agencije za bezbednost saobraćaja, u 2023. godini u Srbiji je zabeleženo 34.826 saobraćajnih nezgoda, što predstavlja povećanje od 3,2% u odnosu na 2022. godinu. „Ukupno 34.826 nezgoda u 2023. godini jasno ukazuje na potrebu za hitnijim merama bezbednosne kontrole," (Agencija za bezbednost saobraćaja, 2023). Broj poginulih u saobraćajnim nesrećama iznosio je 502 osobe – smanjenje u odnosu na 553 smrtna slučaja prethodne godine – dok je broj teže povređenih učesnika porastao za 5% u odnosu na prethodnu godinu.

Nepropisna brzina je identifikovana kao ključni faktor u 66% saobraćajnih nezgoda sa smrtnim ishodom. „Ministarstvo unutrašnjih poslova navodi: '66% smrtonosnih nezgoda je direktno povezano sa prekoračenjem brzine, što predstavlja ozbiljan izazov za implementaciju mera kontrole,'" (Ministarstvo unutrašnjih poslova, 2023). Takođe, nekorišćenje sigurnosnog pojasa ostaje jedan od najčešćih prekršaja, što dodatno povećava rizik od ozbiljnih povreda.

Srbija je potpisnica međunarodnih saobraćajnih konvencija, kao što su Bečka konvencija o drumskom saobraćaju i Evropski sporazum o glavnim međunarodnim drumskim pravcima (AGR). „Usklađivanje sa normama EU u oblasti tehničke ispravnosti vozila, emisije gasova i radnih uslova profesionalnih vozača ključno je za unapređenje saobraćajne bezbednosti u Srbiji," (Stojanović, B., „Pravna regulativa i evropski standardi u saobraćaju", 2023). Ova usklađenost omogućava primenu naprednih tehnoloških rešenja koja doprinose smanjenju broja nezgoda.

Iako pravni okvir u Srbiji pokriva većinu aspekata drumskog saobraćaja, njegovo sprovođenje u praksi suočava se sa značajnim izazovima. Ograničeni kapaciteti inspeksijskih službi i nedovoljna edukacija učesnika, posebno mladih vozača, predstavljaju ozbiljne probleme. „Prema izveštaju

Ministarstva unutrašnjih poslova, 38% svih saobraćajnih nezgoda izazvano je nepropisnom brzinom, dok su alkohol i psihoaktivne supstance faktori u 27% slučajeva sa smrtnim ishodom," (Ministarstvo unutrašnjih poslova, 2023). Ovi podaci jasno ukazuju na potrebu za jačanjem mera kontrole, uključujući povećanje broja saobraćajnih inspektora i modernizaciju sistema za detekciju prekršaja putem naprednih tehnologija.

Prema izveštaju Ministarstva građevinarstva, saobraćaja i infrastrukture, investicije u putnu infrastrukturu u 2023. godini povećane su za 12% u cilju unapređenja bezbednosti, naročito u ruralnim područjima. „Nove investicije u infrastrukturu predstavljaju temelj za dugoročno unapređenje bezbednosti na putevima," (Ministarstvo građevinarstva, saobraćaja i infrastrukture, 2023).

Bezbednost u drumskom saobraćaju ostaje prioritet za Republiku Srbiju. Kontinuirano unapređenje zakonskog okvira, ulaganje u infrastrukturu, primena naprednih tehnologija i ciljane edukacije učesnika u saobraćaju ključni su za smanjenje broja saobraćajnih nezgoda i zaštitu života građana. „Efikasna primena zakonskih mera, praćena stalnim ulaganjem u savremene tehnologije, neophodna je za postizanje značajnog smanjenja saobraćajnih nesreća," (Evropska komisija, 2023).

USAGLAŠAVANJE DOMAĆIH PROPISA SA MEĐUNARODNIM STANDARDIMA

Usaglašavanje domaćih propisa sa međunarodnim standardima u oblasti drumskog saobraćaja predstavlja ključnu komponentu u procesu unapređenja saobraćajne bezbednosti i efikasnosti saobraćajnog sistema u Srbiji. U okviru istraživačkog rada, cilj je analizirati kako se srpski propisi o drumskom saobraćaju usklađuju sa međunarodnim zakonodavstvom i standardima, kao i identifikovati izazove i prednosti ovog procesa. Poseban fokus stavlja se na analizu dosadašnjih napora u harmonizaciji domaćih zakona sa zahtevima Evropske unije, ali i na identifikaciju oblasti u kojima postoji prostor za dodatno unapređenje.

Srpska legislativa u oblasti drumskog saobraćaja, iako dobro razvijena, mora da bude u skladu sa globalnim i evropskim normama kako bi se omogućilo nesmetano funkcionisanje saobraćajnog sistema, unapredila bezbednost i smanjio broj saobraćajnih nezgoda. Evropska unija, kao najvažniji međunarodni partner Srbije, postavila je visoke standarde u pogledu bezbednosti saobraćaja, emisije gasova, bezbednosti vozila i

prava učesnika u saobraćaju. Proces usklađivanja domaćih propisa sa zakonodavstvom EU postavlja konkretne zadatke za reformu postojećih pravnih akata, kao i za implementaciju novih tehnologija i metoda u saobraćaju.

Jedan od ključnih aspekata usklađivanja je zakonska harmonizacija sa evropskim normama. To podrazumeva promene i dopune Zakona o bezbednosti saobraćaja na putevima, kao i drugih povezanih zakona i pravilnika, u skladu sa regulativama Evropske unije. Na primer, usklađivanje sa pravilima o emisijama iz vozila, kao i sa standardima za tehničke preglede i registraciju vozila, omogućava Srbiji da se približi EU standardima i smanji štetne posledice po životnu sredinu. Pored toga, harmonizacija zakonodavstva otvara mogućnosti za razvoj modernijih sistema za nadzor i kontrolu saobraćaja, što dodatno doprinosi povećanju efikasnosti i smanjenju broja nesreća.

Takođe, usaglašavanje sa normama za saobraćajnu signalizaciju i bezbednost vozila predstavlja važan korak ka većem usklađivanju sa međunarodnim standardima. Evropski pravilnici, kao što su regulative o sigurnosti vozila, obaveznoj upotrebi sigurnosnih pojaseva, kao i o sistemima za automatsko kočenje, postavljaju jasne zahteve koje treba implementirati kroz domaće zakone i pravilnike.

Obuka vozača i edukacija učesnika u saobraćaju takođe se mora uskladiti sa međunarodnim praksama. Evropska unija propisuje standarde za obuku vozača, posebno kroz obavezne kurseve za vozače profesionalaca i obaveznu edukaciju o bezbednosti saobraćaja. Srbija je potpisnica nekoliko važnih međunarodnih konferencija i sporazuma, uključujući Bečku konvenciju o saobraćajnim znacima i signalizaciji (1968), Ženevsku konvenciju o drumskom saobraćaju (1949), kao i AETR sporazum o radnom vremenu vozača i korišćenju tahografa. Ovi sporazumi ne samo da definišu pravila za bezbedno kretanje u međunarodnom saobraćaju, već predstavljaju ključne temelje za usklađivanje sa globalnim standardima. Poseban značaj ima Bečka konvencija, koja osigurava univerzalno prepoznavanje saobraćajnih znakova i signalizacije, čime se olakšava komunikacija i povećava bezbednost na putevima širom sveta. AETR sporazum, s druge strane, doprinosi zaštiti radnih prava vozača i povećava efikasnost transportnog sistema kroz regulisanje radnih sati. U tom kontekstu, fokus će biti na analizi postojećih obrazovnih programa u Srbiji, kao i na načinima njihovog prilagođavanja zahtevima međunarodnih konvencija, sa ciljem unapređenja kvaliteta obuke i usklađenosti sa globalnim standardima.

Izazovi u procesu usklađivanja uključuju prepreke u implementaciji novih tehnologija, kao što su digitalni tahografi i sistemi za praćenje saobraćaja. Takođe, postojanje različitih pristupa u zakonodavstvu, tehničkim standardima i obuci može otežati harmonizaciju, zbog čega je važno razviti jasnu strategiju za postepeno uvođenje novih standarda. Uvođenje ovih standarda zahteva ne samo tehničku adaptaciju već koordinaciju između različitih sektora kako bi se osigurala što šira primena i efikasnost u praksi.

IZAZOVI I PREPORUKE ZA UNAPREĐENJE PROPISA U OBLASTI DRUMSKOG SAOBRAĆAJA

Iako postoje jasni zakoni i pravilnici u oblasti drumskog saobraćaja u Srbiji, suočavamo se sa brojnim izazovima u implementaciji i sprovođenju tih propisa. Jedan od ključnih problema jeste nepoštovanje saobraćajnih pravila od strane učesnika u saobraćaju, što se manifestuje kroz česta prekoračenja brzine, vožnju pod uticajem alkohola, nepravilno parkiranje i druge prekršaje koji ugrožavaju bezbednost. Takođe, neadekvatno održavanje infrastrukture u ruralnim i urbanim područjima, sa oštećenim putevima i nedostatkom adekvatne signalizacije, dodatno povećava rizik od saobraćajnih nezgoda. Pored toga, nedovoljna edukacija vozača, naročito mladih, o pravilima saobraćaja, bezbednosnim merama i odgovornom ponašanju na putevima, predstavlja još jedan ozbiljan izazov.

Problemi u oblasti tehničke ispravnosti vozila takođe nisu zanemarljivi. Mnogi vozači ne poštuju obavezu redovnih tehničkih pregleda, što znači da na putevima često imamo vozila koja nisu tehnički ispravna. Takođe, nepostojanje efikasnog sistema za proveru ispravnosti vozila u realnom vremenu, kao i neadekvatna kontrola vozila pre nego što se registruju ili učestvuju u saobraćaju, predstavlja značajan problem za bezbednost na putevima.

Prema statističkim podacima Agencije za bezbednost saobraćaja, u Republici Srbiji je tokom 2022. godine u saobraćajnim nezgodama poginulo 535 osoba, dok je u 2021. godini taj broj iznosio 521. Broj poginulih na putevima poslednjih godina varira, ali se ukazuje na trend rasta povreda i nezgoda sa teškim posledicama, pri čemu neispravna vozila i nesavesno ponašanje vozača značajno doprinose ovim negativnim ishodima.

Predlozi za poboljšanje bezbednosti i efikasnosti

Da bi se unapredila bezbednost i efikasnost u drumskom saobraćaju, potrebno je fokusirati se na nekoliko ključnih oblasti:

Poboljšanje infrastrukture – investiranje u modernizaciju i održavanje puteva, naročito u ruralnim i slabije razvijenim područjima, ključno je za smanjenje rizika. To uključuje obnovu puteva, postavljanje savremene saobraćajne signalizacije, kao i instalaciju svetlosnih sistema na kritičnim lokacijama.

Unapređenje tehničkih pregleda – razvoj sistema za praćenje tehničke ispravnosti vozila u realnom vremenu i strožije kontrole vozila pre registracije.

Stroža kontrola i sankcionisanje – korišćenje savremenih tehnologija, kao što su kamere za merenje brzine, digitalni tahografi i sistemi za detekciju alkohola, može doprineti efikasnijem praćenju saobraćajnih prekršaja. Takođe, jačanje uloge saobraćajnih inspekcija i policije u prepoznavanju i sankcionisanju prekršaja, sa strožim kaznama za vožnju pod uticajem alkohola i prekoračenje brzine, može pomoći u smanjenju broja nezgoda.

Edukacija vozača i šira javna kampanja – organizovanje redovnih kampanja za podizanje svesti o bezbednosti saobraćaja i odgovornom ponašanju na putevima od ključne je važnosti. Obuka vozača, naročito mladih, i njihovo obrazovanje o sigurnosti saobraćaja, pravilima vožnje i pravilnoj upotrebi sigurnosnih pojaseva trebalo bi da postane obavezni deo vozačkih ispita. Takođe, važno je ulagati u obuke za profesionalne vozače, kako bi se minimizirali rizici u transportu. Modernizacija tehničkih pregleda i kontrole vozila – uvođenje savremenih tehnologija za proveru tehničke ispravnosti vozila, kao što su digitalni sistemi za detekciju nesreća i neispravnosti vozila, može doprineti povećanju sigurnosti. Takođe, redovni tehnički pregledi, obavezna registracija vozila na osnovu savremenih ekoloških i bezbednosnih standarda, kao i uvođenje strožih kontrola ispravnosti vozila pre nego što se upuste u saobraćaj, mogu značajno smanjiti broj vozila koja predstavljaju pretnju za bezbednost. Usmeravanje na preventivne mere – uvođenje preventivnih programa, kao što su sigurnosni kursevi za vozače, obavezne edukacije o upotrebi sigurnosnih pojaseva i preventivne provere stanja vozila, može imati dugoročne pozitivne efekte na smanjenje broja nezgoda. Takođe, važno je obezbediti povoljne uslove za razvoj alternativnih vidova prevoza, kao što su biciklističke staze i pešačke zone, kako bi se smanjila gužva na putevima i omogućila sigurna kretanja za sve učesnike. Usaglašavanje sa

međunarodnim standardima – postepenim usklađivanjem domaćih propisa sa zakonodavstvom Evropske unije, kao i međunarodnim normama, Srbija bi mogla da poboljša kvalitet saobraćaja smanji broj saobraćajnih nesreća i poveća sigurnost na putevima. Uvođenje novih tehnologija, kao što su automatski sistemi za kočenje, digitalni tahografi, i proširena upotreba sistema za nadzor saobraćaja, može doprineti većoj efikasnosti i bezbednosti u saobraćaju.

ZAKLJUČAK

Istraživanje usklađivanja domaćih propisa u oblasti drumskog saobraćaja sa međunarodnim standardima, kao i analiza izazova i preporuka za unapređenje bezbednosti i efikasnosti, ukazuju na potrebu za sveobuhvatnom reformom i implementacijom savremenih rešenja. Iako Republika Srbija već ima razvijen pravni okvir za regulaciju drumskog saobraćaja, postoje značajni izazovi u oblasti implementacije propisa, poštovanja saobraćajnih pravila, održavanja infrastrukture i edukacije vozača. Ovi problemi mogu dovesti do povećanog broja saobraćajnih nezgoda i ugrožavanja bezbednosti učesnika u saobraćaju.

Usmeravanje na preventivne mere, uvođenje novih tehnologija i usklađivanje sa međunarodnim standardima, posebno sa standardima Evropske unije, predstavlja temelj za postizanje visoke bezbednosti u drumskom saobraćaju. Implementacijom ovih preporuka, Srbija može značajno poboljšati efikasnost saobraćajnog sistema i smanjiti rizik od saobraćajnih nezgoda, čime bi doprinosila sigurnosti svih učesnika u saobraćaju i postizanju dugoročne održivosti saobraćajnog sistema.

Ključne preporuke uključuju modernizaciju puteva i postavljanje savremene signalizacije radi smanjenja rizika od nezgoda, kao i razvoj inteligentne infrastrukture sa senzorima i kamerama za praćenje saobraćaja. Edukacija vozača, naročito mladih, treba da postane prioritet kroz obavezne kurseve i kampanje koje promovišu odgovorno ponašanje u saobraćaju.

Pored toga, neophodno je uvođenje strožih kaznenih mera za prekršaje, automatizovanih sistema nadzora, te nasumičnih tehničkih pregleda vozila kako bi se osigurala njihova ispravnost. Usmeravanje na preventivne mere, poput identifikacije rizičnih zona i podsticanja odgovornog ponašanja vozača, može doprineti smanjenju broja nezgoda.

Primena novih tehnologija, poput sistema asistencije vozaču i digitalnih rešenja za kontrolu, zajedno sa usklađivanjem sa evropskim standardima, ključna je za dugoročno unapređenje saobraćaja. Ove mere ne samo da bi

značajno poboljšale bezbednost, već bi i povećale efikasnost i održivost transportnog sistema u Srbiji.

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TRAFFIC REGULATIONS

Vidoje Mitrić

Abstract: *The main goal of this research is to analyze regulations in the field of traffic, with a special focus on road traffic, in order to understand their role in improving the safety, efficiency, and sustainability of the traffic system. Road traffic represents one of the most important segments of the transport system, and therefore legal frameworks and regulations are essential for its functioning. Regulations in this area include laws, rulebooks, and standards that define technical requirements for vehicles, traffic regulation on roads, the rights and obligations of traffic participants, as well as measures for preventing and sanctioning violations. Special emphasis is placed on the Law on Road Traffic Safety, which represents the fundamental legal framework for regulating this field. The aim of this research is to highlight the importance of harmonizing national regulations with international standards, as well as the need for continuous adaptation of the legal framework to respond to the challenges of modern traffic. The effects of the implementation of these regulations on reducing traffic accidents and improving the quality of road traffic will also be analyzed.*

Keywords: *regulations, road traffic, safety, law, infrastructure.*

GREEN BOND MARKET-RELATED DYNAMIC CORRELATIONS AND VOLATILITY SPILLOVERS: SYSTEMATIC LITERATURE REVIEW

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Jolović Ivana³

Abstract: *Given the green bond universe's expansion, grasping the evolvement of empirical investigations on green bond market-related dynamic correlations and volatility spillovers is paramount. The research aims to generate a systematic literature review considering these investigations' evidence, delineate dominant green bond-correlated markets and volatility transmissions, ascertain prevalent econometric models employed, and unveil recurring patterns in research findings. To attain the research aim, the academic literature databases' – Web of Science, Scopus, and Google Scholar – collections were scrutinized, and the PRISMA systematic literature review methodology's recommended phases – identification, screening, eligibility, and inclusion – were followed. Articles' selection criteria included the article's content validity, relevance to the research question, evidence robustness, and recency of publication. Finally, the research was built on the latest (2019-2024 period) empirical knowledge, extracted from a total of 30*

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pertinent articles published in 18 reputable academic journals. The research findings documented a solid knowledge foundation and spawned recommendations valuable for both academic and non-academic actors.

Keywords: *green bonds, dynamic correlation, volatility spillover, systematic literature review.*

INTRODUCTORY CONSIDERATIONS

Green bonds herald the economy's and the environment's reconciliation – these bonds' aptitude to comply with both economic and environmental goals positions them not only as a financing mechanism of the moment, but of the future. Namely, issuers' strategic intents to tackle the challenges of environmental preservation “one bond at a time”, by financing or re-financing, partially or fully, new or existing green projects, as well as investors' portfolio hedging aspirations, coupled with growing climate awareness, led to the green bond universe's amplification – as per the latest reported figures, green bonds 2024 issuance volume (688 billion U.S. dollars) outpaced that of 2023 (588 billion U.S. dollars) by 17%, and matched its 2021's record-high issuance volume (594 billion U.S. dollars) (Skandinaviska Enskilda Banken, 2025; Statista, 2024). The expectations are that these bonds' issuance volume will continue to reach new highs (Ferrer, Shahzad & Soriano, 2021; Han & Li, 2022; Joksimović & Stoimenov, 2024; Jolović & Jolović, 2021; Mensi, Naeem, Vo & Kang, 2022; Park, Park & Ryu, 2020) and attain an impressive value of 1.02 trillion U.S. dollars by 2030 (TechSci Research, 2025).

Nevertheless, as the mounting body of research (Elsayed, Naifar, Nasreen & Tiwari, 2022; Jolović, Sinoi & Focaracci, 2025; Liu, Liu, Da, Zhang & Guan, 2021) documents, even a market of this magnitude cannot be independent, nor immune to cross-market volatility spillovers. Understanding green bond market connectedness and movements with various markets is, therefore, of paramount importance. Since the academic community placed a strong emphasis on this issue in the past several years, the central question posed by this research is: “What are the specificities and findings of current (2019-2024 period) empirical literature on green bond market-related dynamic correlations and volatility spillovers?”. In alignment with the research question posed, the aim of the research is, finally, articulated as the development of a systematic literature review that provides insight into dominant green

bond-correlated markets and volatility transmissions, prevalent econometric models used, and recurring patterns observed in the research findings.

RESEARCH METHODOLOGY

Following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) methodology's recommended phases – identification, screening, eligibility, and inclusion (Moher, Liberati, Tetzlaff & Altman, 2009) – academic literature databases, including Web of Science, Scopus, and Google Scholar, were searched in pursuit of articles addressing the research's central question. In this endeavour, the combinations of the following keywords were employed: “green bond(s)”, “green bond(s) market(s)”, “dynamic correlation(s)”, “dynamic connectedness”, “volatility”, “volatility spillover(s)”, “financial market(s)”, “hedging”. Onward, the selection criterion – recency of article's publication – was applied, considering the research's contemporaneity aspiration (2019-2024 interval), as well as aspiration of embracing recent global instability events' (COVID-19 crisis, Brexit, Russia-Ukraine war, etc.) escalations. Furthermore, critical selection criteria – article's content validity, relevance to the research question, and evidence robustness – were applied. Articles that failed to meet the aforementioned criteria, along with linguistically incomprehensible/repetitive/unavailable ones, were declared redundant and excluded from further research. Finally, after the filtering processes' completion, the research encompassed a total of 30 pertinent, high-quality and readily accessible academic articles that empirically discussed the research's central topic. The aforementioned articles were extracted from 18 reputable academic journals of the following publishers: AIMS Press, Elsevier, Emerald Publishing, MDPI, Springer, Taylor & Francis, and Wiley.

THE MAIN FINDINGS OF THE SYSTEMATIC LITERATURE REVIEW

The main findings of the systematic review of the empirical literature on green bond market-related dynamic correlations and volatility spillovers, spanning the years 2019 –2024, are outlined below:

1. Reboredo (2019) performed an extensive study considering the setting of the global market, utilising Copula models on daily data (October 14, 2014 –August 31, 2017), with the aspiration to

investigate co-movements in the “green bond market–financial markets” (corporate bond market, treasury bond market, stock market, energy commodity market) relation (Reboredo, 2019). In finer detail, as stated by Reboredo (2019, p. 38): *“We examine co-movement between the green bond and financial markets, finding that the green bond market couples with corporate and treasury bond markets and weakly co-moves with stock and energy commodity markets. We also find that green bonds have negligible diversification benefits for investors in corporate and treasury markets, whereas diversification benefits are sizeable for investors in stock and energy markets. We further confirm that green bonds are affected by substantial price spillovers from corporate and treasury fixed-income markets and that large price swings in stock and energy markets have a negligible impact on green bond prices.”* (Reboredo, 2019, p. 38);

2. Park et al. (2020) executed a comprehensive study considering the setting of the global market, utilising Baba-Engle-Kraft-Kroner (BEKK) model, as well as Dynamic Conditional Correlation-Generalised Autoregressive Conditional Heteroscedasticity (DCC-GARCH) model on daily data (January 1, 2010 –January 1, 2020), with the aspiration to analyse the volatility dynamics and spillovers between the equity and green bond markets (Park et al., 2020). In finer detail, as stated by Park et al. (2020, p. 10): *“We test whether green bonds exhibit asymmetric volatility and confirm that although green bonds do exhibit asymmetrical volatility, they have the unique characteristic that their volatility is sensitive to positive shocks, unlike other financial instruments. We also analyze the association between the green bond and equity markets and confirm that the two markets have some volatility spillover effects but that neither responds significantly to negative shocks in the other market.”* (Park et al., 2020, p. 10);
3. Reboredo & Ugolini (2020) conducted a broad study considering the setting of the global market, utilising Structural Vector Autoregressive (SVAR) model on daily data (October 14, 2014 –June 25, 2019), with the aspiration to examine price connectedness between the green bond and financial markets (fixed-income markets (treasury bond market, corporate bond market, high-yield corporate bond market), currency market, stock market, energy commodity market) (Reboredo & Ugolini, 2020). As stated by Reboredo & Ugolini (2020, p. 25): *“Our empirical findings reveal that the green bond market is closely linked to the fixed-income and currency markets, receiving sizeable price spillovers from those markets and transmitting negligible reverse effects. We also show that, in*

contrast, the green bond market is weakly tied to the stock, energy and high-yield corporate bond markets.” (Reboredo & Ugolini, 2020, p. 25);

4. Reboredo, Ugolini & Aiube (2020) undertook an extensive study considering the setting of the European Union (EU) and the United States (U.S.) markets, utilising Wavelet-based methods, as well as Vector Autoregressive (VAR) models on daily data (October 12, 2014 –December 20, 2018), with the aspiration to explore co-movement and network price connectedness between the green bond and different asset classes markets (energy market, financial markets (fixed-income markets (treasury bond market, corporate bond market, high-yield corporate bond market), stock market)) over a few investment horizons (Reboredo et al., 2020). As stated by Reboredo et al. (2020, p. 1): *“Our empirical evidence reveals strong connectedness between green bonds and treasury and corporate bonds in the short and long run and in both the EU and the USA, with green bonds receiving sizeable spillovers from treasury and corporate bond prices and transmitting negligible effects. Likewise, we find that green bonds are weakly connected with high-yield corporate bond, stock and energy assets over different time scales.”* (Reboredo et al., 2020, p. 1);
5. Ferrer et al. (2021) performed a comprehensive study considering the setting of the global market, utilising 2018’s Baruník and Křehlík (BK-18) method on daily data (October 14, 2014 –December 19, 2019), with the aspiration to investigate time-frequency connectedness between the green bond and financial markets (treasury bond market, corporate bond market, equity market, currency market), as well as energy market (crude oil market) (Ferrer et al., 2021). As stated by Ferrer et al. (2021, p. 1): *“The empirical results indicate that connectedness between the global green bond market and the conventional financial and energy markets mainly occurs at shorter time horizons, suggesting that shocks are rapidly transmitted across markets with an effect lasting less than a week. A strong connectedness in return and volatility is found between green bonds and Treasury and investment-grade corporate bonds, principally because of the numerous characteristics they share. This finding implies that green fixed-income securities are not a different asset class, but they closely mirror the performance of government and high-quality corporate bonds. In contrast, there is a quite limited connectedness between the green bond market and the general stock market, the renewable energy equity sector and the crude oil market regardless of the time horizon considered.”* (Ferrer et al., 2021, p. 1);

6. Le, Abakah & Tiwari (2021) executed an extensive study considering the setting of the U.S. market, utilising 2012's Diebold and Yilmaz (DY-12) time-domain spillover index model, as well as BK-18 frequency-domain spillover method on daily data (November 28, 2018 –June 29, 2020), with the aspiration to examine the time- and frequency-domains connectedness and spillover among the fintech, green bond, and cryptocurrency markets (Le et al., 2021). As stated by Le et al. (2021, p. 1): *"The results of DY suggest that, first, the total connectedness of 21st century technology assets and traditional common stocks is very high, and hence in the turbulent economy, there is a high probability of contemporaneous losses. Second, Bitcoin, MSCIW, MSCI US, and KFTX are net contributors of volatility shocks whereas US dollar, oil, gold, VIX, green bond and green bond select are net receivers. Therefore, Fintech and common equities are not good hedging instruments in the same portfolio. Third, the short-term witnesses higher volatility transmission than the long-term. That is, holding assets for a long-term is likely to mitigate risks whereas trading financial assets in the short-term can increase risk because of higher volatility. Fourth, the traditional assets, gold and oil, as well as modern assets, green bonds, are useful as good hedgers compared with other assets because shock transmissions from them to Fintech, KFTX are below 0.1% and, more importantly, the total volatility spillover of all assets in the sample is moderately average, accounting for 44.39%."* (Le et al., 2021, p. 1);
7. Liu et al. (2021) conducted a broad study considering the setting of the global market, utilising binary Copula models, as well as Conditional Value-at-Risk (CoVaR) methods on daily data (July 5, 2011 –February 24, 2020), with the aspiration to investigate the dynamic dependency structure and risk spillover among the green bond market and six clean energy markets (Liu et al., 2021). As stated by Liu et al. (2021, p. 1): *"Our empirical analysis shows that there is positive time-varying average and tail dependence between GBs and CE stock markets. Moreover, extreme downward or upward movements in the CE stock market have a spillover effect on the GB market, and vice versa. Furthermore, the risk spillover between these markets is asymmetric."* (Liu et al., 2021, p. 1);
8. Naeem, Adekoya & Oliyide (2021) undertook a thorough study considering the setting of the global market, utilising 2014's Diebold and Yilmaz (DY-14) method, as well as BK-18 method on daily data (December 1, 2008 –December 31, 2020), with the aspiration to examine the asymmetric connectedness between the green bond and

commodity markets (gold market, silver market, crude oil market, natural gas market, wheat market, corn market) in the time- and frequency-domains (Naeem, Adekoya & Oliyide, 2021). As stated by Naeem, Adekoya & Oliyide (2021, p. 1): *“Findings reveal the evidence of asymmetric spillovers among the assets across time and different frequency cycles. While the spillover is stronger for commodities within the same class, gold and silver have the strongest connectedness with green bonds regardless of the periods. However, crude oil observes a strong connection with green bonds in the long-run. Additionally, the asymmetric spillover results show that positive returns spillover is stronger in the short-run, while negative returns spillover substantially holds in both periods but is more pronounced in the short-run.”* (Naeem, Adekoya & Oliyide, 2021, p. 1);

9. Naeem, Nguyen, Nepal, Ngo & Taghizadeh-Hesary (2021) performed an extensive study considering the setting of the global market, utilising Cross-Quantilogram (CQ) approach on daily data (December 1, 2008 –December 31, 2019), with the aspiration to investigate the asymmetric behaviour of green bonds in correlation to commodity markets (energy market, metals (precious and industrial) market, agriculture commodities market) (Naeem, Nguyen, Nepal, Ngo & Taghizadeh-Hesary, 2021). As stated by Naeem, Nguyen, Nepal, Ngo & Taghizadeh-Hesary (2021, p. 1): *“The empirical evidence highlights the asymmetric behaviors of green bonds in response to diverse groups of commodities. Further, the hedging and diversification benefit of including green bonds to commodity portfolio is revealed. Defined by the uncorrelation or negative correlation with commodities in the periods of high volatility, we found the strongest hedging benefit of green bonds against the fluctuation of natural gas, some industrial metals, and agricultural commodities.”* (Naeem, Nguyen, Nepal, Ngo & Taghizadeh-Hesary, 2021, p. 1);
- 10 Nguyen, Naeem, Balli, Balli & Vo (2021) executed a comprehensive study considering the setting of the global market, utilising Rolling Window Wavelet Correlation (RWWC) approach, as well as Wavelet Coherence approach on daily data (December 1, 2008 –December 1, 2019), with the aspiration to examine the interrelationship between the green bond and other asset markets (stock market, commodity market, clean energy market, conventional bond market) (Nguyen et al., 2021). As stated by Nguyen et al. (2021, p. 1): *“We find strong evidence that most correlation emerged and reached a peak in the aftermath of GFC 2007-2009. While comovement among stocks,*

commodities, and clean energy is found relatively high, the diversification benefit of green bonds is significantly revealed due to its low or negative correlation with stocks and commodities.” (Nguyen et al., 2021, p. 1);

- 11 Pham (2021) conducted an extensive study considering the setting of the global market, utilising DY-14 method, BK-18 method, as well as CQ approach on daily data (August 1, 2014 –August 1, 2020), with the aspiration to investigate the frequency connectedness and cross-quantile dependence between the green bond and green equity markets (Pham, 2021). As stated by Pham (2021, p. 1): *“Our empirical results suggest that after controlling for movements in the general stock, energy and fixed-income markets, the dependence between green bond and green equity during normal market conditions is relatively small. On the other hand, green bond and green equity are more connected during extreme market movements, where they boom and bust together. We also find that across all market conditions, the spillover effects between green bond and green equity are short-lived, as the degree of connectedness dissipates in the medium- and long-term investment horizons.” (Pham, 2021, p. 1);*
- 12 Elsayed et al. (2022) undertook a broad study considering the setting of the global market, utilising Multivariate Wavelet approach, Ensemble Empirical Mode Decomposition (EEMD) method, as well as DY-12 method on daily data (September 30, 2014 –June 30, 2020), with the aspiration to inspect the interdependence between the green bond and financial markets (treasury market, corporate bond market, stock market, energy market, clean energy market) in the time- and frequency-domains (Elsayed et al., 2022). As stated by Elsayed et al. (2022, p. 1): *“The findings of wavelet multiple correlations indicate that the benefits of diversification opportunities are more evident in the short run. The evidence of wavelet multiple cross-correlations reveals that green bonds and financial markets are highly integrated in the long run. The results of the static connectedness framework explain that the direction and magnitude of spillover behave differently across markets. The world stock market is the net spillover transmitter, while the corporate bond market is the net spillover receiver among the selected markets. The green bond market is receiving more but transmitted less volatility in the present study. The evidence on dynamic connectedness measured by the rolling window approach shows that the interconnection between green bonds and financial markets is volatile over time.” (Elsayed et al., 2022, p. 1);*

- 13 Gyamerah, Bright & Akwaa-Sekyi (2022) performed a thorough study considering the setting of the global market, utilising Unrestricted Trivariate VAR-BEKK-GARCH model on daily data (November 2, 2011 –August 31, 2021), with the aspiration to explore the mean and volatility spillover between the green bond's price and the renewable energy stock's price (Gyamerah et al., 2022). As stated by Gyamerah et al. (2022, p. 310): *"The results from the VAR-BEKK-GARCH model indicate that there exists a unidirectional Granger causality from renewable energy stock prices to green bond prices. While the price of green bonds is positively influenced by its own lagged values and the lagged values of renewable energy stock prices, only the past price value of renewable energy stocks has a positive effect on the current price value. We identified a uni-directional volatility spillover from renewable energy stock prices to green bond prices. However, there was no shock spillover from both sides of the market."* (Gyamerah et al., 2022, p. 310);
- 14 Mensi et al. (2022) executed a comprehensive study considering the setting of the Group of Seven (G7) countries' (Canada, France, Germany, Italy, Japan, United Kingdom (UK), U.S.) markets, utilising BK-18 method, as well as Wavelet Coherence approach on daily data (January 1, 2014 –May 11, 2021), with the aspiration to explore the dynamic and frequency spillovers between the green bond, West Texas Intermediate (WTI) oil and G7 stock markets (Mensi et al., 2022). As stated by Mensi et al. (2022, p. 331): *"The results show that the spillovers is dynamic and crisis-sensitive. Furthermore, adding GBs and oil futures to stock portfolio reduces the spillover size during turmoil periods. The short-term spillovers (up to five trading days) represent the largest proportion of the total spillovers. A significant jump in spillovers is observed in the early of COVID-19 outbreak (March–April 2020). Interestingly, Canada, France, Germany, Italy, and UK are the net transmitters of spillovers, whereas Japan and GBs are the net recipients of the spillovers, irrespective of time horizons. Oil and US stock market shift from net contributors in short term to net receipts in medium and long terms. Wavelet coherence analysis reveals significant co-movements between G7 stock markets and both oil and GBs. The co-movements are more pronounced in both medium and long terms and during COVID-19 spread where both oil and GBs lead stock markets. GBs provide higher diversification benefits to G7 investors than oil in the short-term. The hedging is expensive at the long term for GBs and intermediate term for WTI oil. Finally, the hedge effectiveness of crude oil is higher than GBs, irrespective of time horizons."* (Mensi et al., 2022, p. 331);

- 15 Rao, Gupta, Sharma, Mahendru & Agrawal (2022) conducted an extensive study considering the setting of the global market, utilising Time-Varying Parameter-Vector Autoregressive (TVP-VAR) model, as well as Quantile Regression approach on daily data (August 1, 2011 – July 1, 2021), with the aspiration to examine the nexus and the connectedness between the green bond market and the cryptocurrency and commodity markets, before, throughout, and after the COVID-19 era (Rao et al., 2022). As stated by Rao et al. (2022, p. 725): *“Findings show that these markets are strongly linked, which will only expand in the post-pandemic future. Before the pandemic, the MSCI World and Emerging Markets indices contributed the most shocks to the remaining market variables. Green bond index shows a greater correlation and shock transmission with gold. Bitcoin can no longer be used as a good hedging instrument.”* (Rao et al., 2022, p. 725);
- 16 Yadav, Tandon, Singh, Shore & Gaur (2022) undertook an extensive study considering the setting of the global market, utilising DCC model, DY-12 method, as well as BK-18 method on daily data (October 3, 2016 – February 23, 2021), with the aspiration to investigate the dynamic linkages of the green bond market with the energy and cryptocurrency markets (Yadav et al., 2022). As stated by Yadav et al. (2022, p. 1): *“The DCC reveals no dynamic linkages of volatility from the green bond to the energy and crypto market in the short run. Referring to Diebold and Yilmaz (2012), it dictates that the green bond (RSPGB) is a net receiver while the energy market (RIGW) and cryptocurrency (RETHET) are the largest and least contributors to the transmission of the volatility. Additionally, the Baruník and Křehlík (2018) model confirmed that the magnitude of the total spillover is high in more prolonged than shorter periods, suggesting reduced diversification opportunities.”* (Yadav et al., 2022, p. 1);
- 17 Dai, Zhang & Yin (2023) performed a thorough study considering the setting of the Chinese market, utilising Quantile Regression model, as well as TVP-VAR model on daily data (April 21, 2010 – March 25, 2022), with the aspiration to investigate the extreme spillover effects considering the high carbon emission stock, green bond and WTI crude oil markets (Dai et al., 2023). As stated by Dai et al. (2023, p. 1): *“The results display a static total spillover index of approximately 49% at the conditional mean and conditional median estimates; while about 83% under the left tail and right tail estimates. The quantile-based spillover model is better than the mean-based one, because the former better captures the risk contagion mechanism under extreme market*

conditions. In addition, under extreme market conditions, green bond and WTI crude oil are net receivers of systemic shocks, while the remaining markets analyzed are net transmitters. The connectedness is time-varying in all cases, but the tail is less volatile. The analysis of relative tail dependence suggests the existence of asymmetric behavior, which implies different spillover effects in bullish and bearish markets.” (Dai et al., 2023, p. 1);

- 18 Mensi, Vo, Ko & Kang (2023) executed an extensive study considering the setting of the U.S. market, utilising DY-12 method, BK-18 method, TVP-VAR model, as well as Quantile-on-Quantile Regression method on daily data (January 3, 2011 –September 9, 2022), with the aspiration to explore the frequency dynamic spillovers in return and volatility, as well as the hedging ability of green bonds, gold, silver, Brent crude oil, the U.S. dollar index, and the volatility index (VIX) against the downside U.S. stock prices, prior to the inception and throughout the COVID-19 era, and in the short- and long-term (Mensi et al., 2023). As stated by Mensi et al. (2023, p. 558): *“We show that the short-term volatility spillovers dominate their long-term counterparts. Green Bond is net transmitters of spillovers in the system at the short term and net receivers at the long term. S&P500 and silver (USDx and oil) are net transmitters (receivers) of short- and long-term spillovers. Gold and VIX are net receivers of short-term spillovers and net transmitters of long-term spillovers. COVID-19 crisis has more effects on the short-term spillover, which reaches its highest level early 2020. COVID-19 and time horizons lead the direction and the magnitude of spillovers. The Quantile-on-Quantile regression analysis shows significant nonlinear relationships between markets under study. More interestingly, we show that green bonds and gold are safe haven assets for US equity investors during COVID-19. On the other hand, a mixed portfolio offers higher diversification benefits. Finally, hedging effectiveness is dependent on COVID-19 and time horizon.” (Mensi et al., 2023, p. 558);*
- 19 Peng, Ding, Zhou & Zhu (2023) conducted a thorough study considering the setting of the Chinese market, utilising VAR model, DCC-GARCH model, as well as Copula-CoVaR model on daily data (May 9, 2016 – May 6, 2022), with the aspiration to investigate the spillover effect between the green bond market and the traditional bond markets (corporate bond market, enterprise bond market, conventional bond market) (Peng et al., 2023). As stated by Peng et al. (2023, p. 538): *“The research findings of this paper are as follows: (1) There are three*

spillover effects of mean value, volatility and extreme risk among the green bond market, corporate bond market, enterprise bond market and conventional bond market. (2) From the perspective of mean spillover between markets, only the mean spillover between the conventional bond market and the green bond market is bidirectional, and there is the profoundest impact of spillover from the green bond market to the conventional bond market. (3) As far as the volatility spillover between markets is concerned, the volatility spillover between the three traditional bond market and the green bond markets are all positive. The volatility spillover between the conventional bond market and the green bond market is the largest, which is particularly obvious in the first half of 2018 and the first half of 2020. (4) In terms of inter-market extreme risk spillover, the risk spillover between the green bond market and the traditional bond market is positive. The green bond market contributes more to the risk spillover of the enterprise bond market, and it has a time-varying risk spillover effect on the traditional bond market.” (Peng et al., 2023, p. 538);

20 Tang, Aruga & Hu (2023) undertook an extensive study considering the setting of the U.S. market, utilising Bayesian Dynamic Conditional Correlation-Multivariate Generalised Autoregressive Conditional Heteroscedasticity (DCC-MGARCH) model, as well as BK-18 method on daily data (June 30, 2014 –October 18, 2021), with the aspiration to investigate the dynamic correlation and volatility spillover between the green bond, clean energy, and fossil fuel markets (Tang et al., 2023). As stated by Tang et al. (2023, p. 1): *“Three findings arose from our results: First, the green bond market has a weak negative correlation with the fossil fuel (WTI oil, Brent oil, natural gas, heating oil, and gasoline) and clean energy markets, which means that green bonds play a critical hedging role against fossil fuel and clean energy. Second, the green bond and clean energy are net volatility receivers from WTI crude oil and heating oil for the short term, indicating that investors and policymakers need to pay attention to the WTI oil volatility spillover risk when promoting green bonds and clean energy. Third, the correlation and volatility spillover from WTI crude oil to green bonds and clean energy is stronger than that of Brent oil, which implies that investors and policymakers need to consider the price movements of WTI crude oil more than Brent oil when investing in the green bond market.”* (Tang et al., 2023, p. 1);

21 Umar, Abrar, Hadhri & Sokolova (2023) performed an extensive study considering the setting of the global market, utilising Network

Dynamic Connectedness framework on daily data (May 1, 2009 – March 1, 2022), with the aspiration to analyse the influence of oil price shocks on conventional bonds, Islamic bonds (sukuks) and green bonds (Umar et al., 2023). As stated by Umar et al. (2023, p. 1): *“We document a sizable connectedness between oil price shocks and the three fixed income market segments namely conventional bonds, sukuks and green bonds. Among the oil shocks, we find that demand and risk shocks are the main transmitters of spillover, whereas conventional bonds appear to be an influential transmitter of spillover among the fixed income segments.”* (Umar et al., 2023, p. 1);

- 22 Yadav, Pandey, Taghizadeh-Hesary, Arya & Mishra (2023) executed a thorough study considering the setting of the global market, utilising DCC-GARCH model on daily data (October 1, 2015 –February 24, 2022), with the aspiration to explore volatility spillovers among the green bond market and the renewable energy and cryptocurrency markets (Yadav et al., 2023). As stated by Yadav et al. (2023, p. 928): *“The results reveal the presence of spillovers from green bonds to renewable energy and the cryptocurrency market in the long run.”* (Yadav et al., 2023, p. 928);
- 23 Zhang & Umair (2023) conducted an extensive study considering the setting of the global market, utilising VAR model, as well as TVP-VAR model on daily data (January 1, 2010 –December 31, 2020), with the aspiration to explore dynamic spillover effects between the green bond, renewable energy stock and carbon markets (Zhang & Umair, 2023). As stated by Zhang & Umair (2023, p. 77605): *“The results reveal significant dynamic spillover effects between green bonds and renewable energy stocks, as well as between carbon markets and renewable energy stocks. Additionally, the findings suggest a complementary relationship between green bonds and carbon markets.”* (Zhang & Umair, 2023, p. 77605);
- 24 Chen, Shi & Hou (2024) undertook a comprehensive study considering the setting of the Chinese market, utilising TVP-VAR model, BK-18 frequency connectedness method, as well as Network Visualization techniques on daily data (January 4, 2012 –December 31, 2022), with the aspiration to investigate the dynamic evolution and volatility spillovers between the green bond and conventional financial markets (conventional bond market, stock market, commodity market, foreign exchange market) (Chen et al., 2024). As stated by Chen et al. (2024, p. 1): *“The empirical findings are as follows: firstly, there is a significant*

volatility spillover effect between the green bond market and other traditional financial markets, with the spillover effect showing clear time-varying characteristics. The total spillover effects among all markets increase notably during extreme market conditions. Secondly, the green bond market primarily acts as a net risk spillover transmitter in most periods. Thirdly, compared to the stock, foreign exchange, and commodity markets, the green bond market has a more significant spillover effect on the traditional fixed-income market. Finally, the volatility spillover effect of the green bond market on other markets exhibits a time-frequency evolution, predominantly driven by short-term factors. However, as market maturity increases, the influencing factors of the spillover effect gradually shift from short-term to medium and long-term factors.” (Chen et al., 2024, p. 1);

- 25 Gao & Liu (2024) performed a thorough study considering the setting of the global market, utilising DY-14 method, BK-18 method, as well as Glosten-Jagannathan-Runkle-Generalised Autoregressive Conditional Heteroscedasticity (GJR-GARCH) model on daily data, with the aspiration to analyse the time and frequency return and volatility spillover relation between the rare earth market and the oil, clean energy, gold, base metals, green bond, Environmental, Social and Governance (ESG), and agricultural markets (Gao & Liu, 2024). As stated by Gao & Liu (2024, p. 1): *“The empirical results suggest that the rare earth metals (REM) market is a net spillover receiver from the base metal, clean energy, and ESG markets, which are the top three net risk emitters. The network connectedness results shed light on the connections and strengths at different time horizons throughout the sample. The regression results indicate that financial condition and investor sentiment play the most significant roles in driving connectedness and have different effects at different frequencies. Furthermore, severe financial stress may increase short-term risk spillover, which indicates that investors sell out risky assets in stressful times. However, financial stress decreases long-term spillover, which implies that it damages the long-term operation of the financial market.”* (Gao & Liu, 2024, p. 1);
- 26 Joof, Adaoglu & Taspinar (2024) executed an extensive study considering the setting of the global market, utilising DY-12 method, TVP-VAR model, as well as DCC-GARCH model on daily data (2012 – 2022), with the aspiration to investigate the volatility spillovers and the hedging between the green bond, clean energy stock, and fossil fuel markets (Joof et al., 2024). As stated by Joof et al. (2024, p. 1): *“The*

dynamic volatility spillovers reach their peak points during the onset period of COVID-19 pandemic, the Russia-Ukraine crisis/war, the oil price plunge, and the negative oil price in descending order of magnitude, respectively. Furthermore, the results show that during the turmoils not caused by the fossil fuel markets, crude oil and coal are better instruments for hedging due to their negative correlations with green bonds and clean energy stocks. However, during turmoils caused by fossil fuel markets, the hedging and the diversification power of crude oil against green bonds and clean energy stocks is weaker as the dynamic correlations become more positive.” (Joof et al., 2024, p. 1);

- 27 Mensi, Selmi, Al-Kharusi, Belghouthi & Kang (2024) conducted a broad study considering the setting of the U.S. market, utilising DY-12 method, as well as Quantile Connectedness approach on daily data (April 1, 2013 –April 4, 2023), with the aspiration to explore the spillovers among the green bond market and the non-green bond (10-year U.S. treasuries) and energy markets (WTI crude oil market, heating oil market, natural gas market, petrol market) amidst the bear and bull market conditions (Mensi et al., 2024). As stated by Mensi et al. (2024, p. 1): *“The main results show a strong time-varying connectedness between focal asset classes during major crisis periods, including the oil price crash, the China-US trade conflict, the coronavirus crisis and the war between Russia and Ukraine. The network analysis reveals that WTI, heating oil and green bonds act as net transmitters of risk, while the other asset classes serve as net receivers of spillovers. In extreme conditions, spillovers between energy commodities, green bonds and non-green bonds are asymmetric, given that they are not equal in the upper and lower quantiles. Green bonds offer greater diversification benefits when coupled with WTI, heating oil, gasoline, and natural gas, though with varying portfolio weights.”* (Mensi et al., 2024, p. 1);
- 28 Umar, Hadhri, Abakah, Usman & Umar (2024) undertook a thorough study considering the setting of the developed markets worldwide (Australia, Canada, Denmark, EU, Hong Kong, Japan, New Zealand, Norway, Switzerland, Sweden, UK, U.S.), utilising DY-14 Generalised VAR framework on daily data (December 1, 2008 –June 1, 2022), with the aspiration to inspect the spillover effects among oil price shocks and green bonds issued in 12 aforementioned economies (Umar et al., 2024). As stated by Umar et al. (2024, p. 1): *“Our results show the dominance of the US and the European green bond markets as the main contributors to return and volatility spillovers among international green bonds, respectively. The degree of connectedness among markets*

varies over time with a more pronounced effect on returns during turbulent periods. Oil shocks exhibit a relatively low degree of connectedness with green bonds implying potential diversification attributes. This result is, particularly, supported in the case of green bond markets of USA, Euro, Denmark and Hong-Kong.” (Umar et al., 2024, p. 1);

- 29 Wu & Qin (2024) performed an extensive study considering the setting of the Chinese market, utilising Asymmetric DCC-GARCH model on daily data, with the aspiration to analyse asymmetric dynamic volatility spillovers between the new energy, ESG, green bond and carbon markets (Wu & Qin, 2024). As stated by Wu & Qin (2024, p. 1): *“Our results show that (i) the persistence of asymmetric volatility shock transmission between new energy and ESG stock markets is about 40 days, which is higher than that of carbon or green bond markets; (ii) bad total volatility spillovers dominate good total volatility spillovers after the COVID-19 outbreak; (iii) for both good and bad volatility, ESG and green bond markets are mainly net transmitters, while new energy and carbon markets are mainly net receivers; and (iv) the bad volatility spillovers to new energy and ESG stock markets from other markets in the green finance system are higher than good volatility spillovers. However, the good volatility spillovers to carbon and green bond markets from other markets are higher than bad volatility spillovers.” (Wu & Qin, 2024, p. 1);*
- 30 Yousaf, Mensi, Vo & Kang (2024) executed a comprehensive study considering the setting of the global market, utilising BK-18 method, DCC-GARCH model, BEKK-GJR-GARCH model, as well as Wavelet Coherence analysis on daily data, with the aspiration to explore dynamic frequency spillovers, co-movements and volatility transmission between crude oil and green bond yields (Yousaf et al., 2024). As stated by Yousaf et al. (2024, p. 1): *“The results of BK-18 show that the spillover between green bonds is higher in short-term horizons than in intermediate- and long-term horizons. Furthermore, Industrial and Securitized ABS bonds are weakly connected with other green bonds. The findings of BEKK-GJR-GARCH model shows the negative unidirectional volatility spillover from oil to Global GB markets, indicating the hedging ability of green bonds against the oil. The dynamic conditional correlations are negative between oil and Industrial and Securitized ABS over sample period, suggesting them as strong hedge and safe haven against the oil. The Wavelet Coherence analysis reveals that the connectedness is weak between crude oil and green bonds in most of the short and long run.” (Yousaf et al., 2024, p. 1).*

CONCLUDING CONSIDERATIONS

Research findings divulged that erratic markets represent suitable ground for volatility spillovers, i.e., transmissions of shocks across various markets – several studies (Chen et al., 2024; Elsayed et al., 2022; Ferrer et al., 2021; Nguyen et al., 2021; Peng et al., 2023; Reboredo, 2019; Reboredo & Ugolini, 2020; Reboredo et al., 2020; Umar et al., 2023) provided evidence on dynamic connectedness and transmissions of shocks on relation green bond market–conventional bond market; dozen studies (Chen et al., 2024; Dai et al., 2023; Elsayed et al., 2022; Ferrer et al., 2021; Mensi et al., 2022; Mensi et al., 2023; Nguyen et al., 2021; Park et al., 2020; Pham, 2021; Reboredo, 2019; Reboredo & Ugolini, 2020; Reboredo et al., 2020) evidence on green bond market–stock market dynamic connectedness and volatility spillovers; a good many of authors (Chen et al., 2024; Dai et al., 2023; Ferrer et al., 2021; Gao & Liu, 2024; Joof et al., 2024; Mensi et al., 2022; Mensi et al., 2023; Naeem, Adekoya & Oliyide, 2021; Naeem, Nguyen, Nepal, Ngo & Taghizadeh-Hesary, 2021; Nguyen et al., 2021; Rao et al., 2022; Reboredo et al., 2020; Tang et al., 2023; Umar et al., 2023; Umar et al., 2024; Yousaf et al., 2024) evidence on green bond market–commodity market dynamic connectedness and volatility spillovers; a plethora of authors (Elsayed et al., 2022; Gao & Liu, 2024; Gyamerah et al., 2022; Joof et al., 2024; Liu et al., 2021; Mensi et al., 2024; Naeem, Adekoya & Oliyide, 2021; Naeem, Nguyen, Nepal, Ngo & Taghizadeh-Hesary, 2021; Nguyen et al., 2021; Reboredo, 2019; Reboredo & Ugolini, 2020; Tang et al., 2023; Wu & Qin, 2024; Yadav et al., 2022; Yadav et al., 2023; Zhang & Umair, 2023) evidence on green bond market–energy market dynamic connectedness and volatility spillovers; a number of authors (Chen et al., 2024; Ferrer et al., 2021; Mensi et al., 2023; Reboredo & Ugolini, 2020; Reboredo et al., 2020) evidence on green bond market–foreign exchange market dynamic connectedness and volatility spillovers; whilst a handful of studies (Le et al., 2021; Rao et al., 2022; Yadav et al., 2022; Yadav et al., 2023) supplied evidence on dynamic connectedness and spread of volatility shocks on relation green bond market–fintech/cryptocurrency market.

Furthermore, research produced the following conclusions: commodity market and energy market demonstrate dominance in the realm of connectedness and transmissions of volatility attained with green bond market; green bond market predominantly holds the position of net volatility receiver; Diebold and Yilmaz (DY) and Baruník and Křehlík (BK) methods, as well as Generalised Autoregressive Conditional

Heteroscedasticity (GARCH) family models, are detected as the most attractive econometric modelling choices; a number of authors of the examined articles are united in the stance that green bonds can serve as an ultimate portfolio hedge. Additionally, spatially and temporally viewed, the following conclusions arose: the majority of the articles address global green bond market-related dynamic correlations and volatility spillovers; academia's curiosity surrounding this topic intensifies in the years drawing closer to 2024 (the growth in articles' corpus volume related to this topic can be attributed to the green bond phenomenon's topicality, as well as to the sharp volatility spillover events triggered by the recent public health-endangering and geopolitical events, such as COVID-19, Brexit, Russia-Ukraine war, etc.).

Contribution to the latest knowledge could be recognised in the innovative scrutiny of the research itself, since a systematic literature review on this niche topic has not been carried out to the best of the authors' knowledge. Recommendations for academic actors include guidance regarding further investigations of the scarce topic of green bond market-fintech/cryptocurrency market dynamic connectedness and volatility spillovers, due to lacking/contradicting findings of the examined articles; whilst recommendations for non-academic actors (investors, portfolio managers, policymakers, etc.) include recognition of hedging evidence (regarding green bonds' inclusion into investment portfolios) provided in 14 scrutinised studies (Elsayed et al., 2022; Joof et al., 2024; Le et al., 2021; Mensi et al., 2022; Mensi et al., 2023; Naeem, Adekoya & Oliyide, 2021; Naeem, Nguyen, Nepal, Ngo & Taghizadeh-Hesary, 2021; Nguyen et al., 2021; Pham, 2021; Reboredo et al., 2020; Tang et al., 2023; Yadav et al., 2022; Yousaf et al., 2024; Zhang & Umair, 2023). Ultimately, research limitations can be found in the main empirical research part's exclusivity of conference articles, master's/PhD theses, institutional/industry reports, etc., that is, in reliance on only peer-reviewed articles published in academic journals.

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DINAMIČKE KORELACIJE I PRELIVANJA VOLATILNOSTI U KONTEKSTU TRŽIŠTA ZELENIH OBVEZNICA: SISTEMATSKI PREGLED LITERATURE

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Sažetak: Usled ekspanzije univerzuma zelenih obveznica, razumevanje evolucije empirijskih studija o dinamičkim korelacijama i prelivanjima volatilnosti u kontekstu tržišta zelenih obveznica od izuzetne je važnosti. Istraživanje ima za cilj da generiše sistematski pregled literature uvažavajući dokaze pomenutih studija, istakne dominantno korelisana tržišta i transmisije volatilnosti u kontekstu zelenih obveznica, detektuje preovlađujuće ekonometrijske modele, te identifikuje repetitivnost u istraživačkim nalazima. Zarad dostizanja cilja istraživanja, kolekcije baza koje integrišu akademsku literaturu – Web of Science, Scopus i Google Scholar – pažljivo su pregledane, a preporučene faze PRISMA metodologije za sistematski pregled literature – identifikacija, skrining, ocena podobnosti i uključivanje – uvažene. Kriterijumi za odabir članaka uključivali su: validnost sadržaja članka, relevantnost za postavljeno istraživačko pitanje, robusnost dokaza i datum objave. Konačno, istraživanje je izgrađeno na najnovijim (interval od 2019-2024. godine) empirijskim saznanjima, ekstrahovanim iz 30 relevantnih članaka objavljenih u 18 renomiranih akademskih časopisa. Rezultati istraživanja dokumentovali su solidnu bazu znanja, te iznedrili preporuke dragocene kako za akademske, tako i za neakademske aktere.

Ključne reči: zelene obveznice, dinamička korelacija, prelivanje volatilnosti, sistematski pregled literature.

CIRKULARNA EKONOMIJA KAO PRISTUP ODRŽIVOSTI I NJEN UTICAJ NA ŽIVOTNU SREDINU

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Sažetak: Koncept cirkularne ekonomije (CE) postao je ključni okvir za postizanje održivosti kroz efikasno korišćenje resursa, minimizaciju otpada i recirkulaciju materijala. Ovo istraživanje predstavlja sistematski pregled literature koji obuhvata naučne radove objavljene u periodu 2015–2025. godine, sa ciljem da se ispita na koji način prakse cirkularne ekonomije utiču na životnu sredinu. Analiza je fokusirana na najčešće korišćene metodološke pristupe, uključujući analizu životnog ciklusa (LCA), analizu tokova materijala (MFA) i procenu ugljeničnog otiska, kao i na indikatore koji se primenjuju na mikro, mezo i makro nivou. Rezultati ukazuju na nedostatak metodološke standardizacije i ograničenu povezanost između ekoloških, ekonomskih i društvenih dimenzija održivosti. Iako CE pokazuje potencijal za smanjenje potrošnje materijala i energije, uporedivost rezultata ostaje ograničena zbog heterogenosti pokazatelja. Ovaj rad doprinosi postojećoj literaturi identifikovanjem ključnih metodoloških praznina i predlaže uključivanje digitalnih

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tehnologija, transparentnosti podataka i usklađenih politika kao prioriteta budućih istraživanja i implementacije.

Ključne reči: cirkularna ekonomija, održivost, uticaj na životnu sredinu, analiza životnog ciklusa.

UVOD

Koncept cirkularne ekonomije (Circular Economy - CE) je stekao značajnu pažnju u akademskim i industrijskim krugovima, kao okvir za održivo upravljanje resursima. Prakse cirkularne ekonomije doprinose održivosti smanjenjem emisija ugljenika i potrošnje vode. CE strategije kao što su ponovna upotreba, ponovna proizvodnja i valorizacija otpada značajno smanjuju opterećenje životne sredine povezano sa tradicionalnim linearnim proizvodnim sistemima. Cirkularna ekonomija pruža vredan okvir za smanjenje uticaja na životnu sredinu, ali je treba posmatrati kao komponentu šire strategije održivosti, a ne kao samostalno rešenje. Razumevanje nijansiranog odnosa između CE i održivosti je ključno za oblikovanje efikasnih politika i poslovnih modela koji pokreću značajne promene životne sredine (Geissdoerfer et al., 2017). Cirkularna ekonomija predstavlja promenu paradigme u ekonomskim i ekološkim sistemima, sa ciljem da se uravnoteži industrijski razvoj sa očuvanjem resursa i smanjenjem otpada. Principi CE su sledeći: unapređenje i očuvanje prirodnih resursa kroz upravljanje i obnavljanje prirodnog kapitala, optimalno korišćenje materijala i resursa radi maksimiziranja vrednosti i eliminisanje negativnih eksternalija iz ekonomskog sistema i načina života kako bi se podstakla efikasnost sistema (Cayzer et al., 2017; Ghazanfari, 2023; Jackson et al., 2014).

Ovi principi primenjuju se na različitim nivoima, od pojedinačnih kompanija do nacionalnih politika. Dok je cirkularna ekonomija postala popularna na globalnom nivou, obim i pristup njenoj implementaciji značajno variraju u različitim regionima (Ghisellini et al., 2016). Cirkularni model zahteva kulturnu promenu i promenu ponašanja među potrošačima i industrijama, obezbeđujući da održivost postane osnovni princip u obrascima proizvodnje i potrošnje (Ghisellini et al., 2016). Rastuća tranzicija ka cirkularnoj ekonomiji iziskuje snažne alate za merenje za procenu njenih ekoloških, ekonomskih i društvenih koristi. Fokus istraživanja o cirkularnoj ekonomiji je najvećim delom na optimizaciji lanca snabdevanja, dok je životna sredina na drugom mestu (Adami & Schiavon, 2021). Takođe, dok postoje brojni indikatori cirkularne ekonomije, ne postoji univerzalno prihvaćen okvir za njihov

izbor i efektivnu primenu. Mnogi indikatori se fokusiraju na efikasnost protoka materijala i stope recikliranja, dok manje njih razmatra šire uticaje na održivost, kao što su ekonomska održivost i socijalna jednakost (Saidani et al., 2019a). Osnovni cilj cirkularne ekonomije je ostvarivanje profita i privredni rast, dok je sa druge strane osnova cirkularne ekonomije koncept 6R i to su (Ministarstvo zaštite životne sredine - Republika Srbija, 2019; Radić Milanović, 2024):

- Rethink - Ponovno razmatranje poslovnih modela kako bi se smanjio otpad i napravile uštede;
- Refuse - Odbijanje upotrebe svega onoga što nije neophodno;
- Reduce - Smanjenje potrošnje energije i materijala;
- Reuse - Ponovna upotreba proizvoda tako što se ispravan proizvod koji više nekom ne treba, ne baca, već daje ili prodaje nekome kome treba;
- Repair - Popravka komponenata i delova tako da se produži životni vek proizvoda;
- Recycle - Reciklaža i ponovno vraćanje materijala i sirovina u tokove proizvodnje.



Slika I Grafički prikaz cirkularne ekonomije kroz koncept 6R (Ministarstvo zaštite životne sredine - Republika Srbija, 2019; Radić Milanović, 2024)

Pored brojnih teorijskih definicija, različiti autori ističu potrebu za kvantifikacijom efekata CE kako bi se omogućilo objektivno poređenje sa

tradicionalnim modelima. Elia, Gnoni i Tornese (2017) naglašavaju značaj razvoja indeksa koji omogućavaju evaluaciju nivoa cirkularnosti proizvoda i procesa, dok Morseletto (2020) ukazuje na važnost definisanja globalnih ciljeva i merljivih pokazatelja za praćenje napretka (Elia et al., 2017) (Morseletto, 2020). U ovom radu postavlja se ključno istraživačko pitanje: U kojoj meri prakse cirkularne ekonomije doprinose ekološkoj održivosti i na koji način se njihovi efekti mogu konzistentno meriti na različitim nivoima?

METODOLOGIJA

Ovo istraživanje je zasnovano na pregledu literature o metodologijama merenja cirkularne ekonomije i njenog uticaja na životnu sredinu. Pretraga je sprovedena u akademskim bazama podataka Scopus i Google Scholar, obuhvatajući radove objavljene u periodu 2015–2025. godine. Ključne reči korišćene u pretrazi uključivale su: *circular economy*, *environmental impact*, *sustainability metrics* i *waste reduction*. U početnoj fazi identifikovano je 112 radova, od kojih je 76 ispunilo osnovne kriterijume relevantnosti (naslov, apstrakt i ključne reči). Nakon detaljnog pregleda sadržaja, 40 radova je uključeno u finalnu analizu. Proces selekcije radova sproveden je prema preporukama PRISMA okvira (Preferred Reporting Items for Systematic Reviews and Meta-Analyses), kao što je prikazano u sličnim pregledima (Geissdoerfer et al., 2017). Kriterijumi uključivanja obuhvatali su:

- empirijska istraživanja koja mere ekološke efekte praksi cirkularne ekonomije,
- radove koji koriste kvantitativne ili mešovite metode (LCA, MFA, carbon footprint),
- publikacije dostupne na engleskom jeziku i sa punim tekstom.

Metodološki pristup obuhvatao je:

- identifikaciju ključnih indikatora koji se koriste za procenu uticaja CE na životnu sredinu na mikro, mezo i makro nivou;
- komparativnu analizu okvira evaluacije (LCA, MFA, carbon footprint);
- procenu izazova u merenju, uključujući nedoslednost podataka i nedostatak standardizacije;
- analizu potencijalnih rešenja, poput digitalnih alata i interdisciplinarne saradnje.

Kriterijumi isključenja odnosili su se na teorijske radove bez empirijske validacije, nerecenzirane izvore i publikacije van navedenog vremenskog okvira. Potencijalna ograničenja metodologije uključuju fokus na dve baze podataka, što može dovesti do izostavljanja dela relevantnih istraživanja, kao i činjenicu da različiti autori koriste različite terminologije i metrike (Araujo Galvão et al., 2018).

CIRKULARNA EKONOMIJA I ODRŽIVOST

Ekonomska održivost zahteva inovativne pristupe u globalnoj konkurenciji, fokusirajući se na efikasnije korišćenje resursa i povećanje produktivnosti, uz istovremeno smanjenje negativnog uticaja na životnu sredinu. Ekološka održivost naglašava važnost očuvanja prirodnih resursa i sticanja znanja koje omogućava njihovo vrednovanje i unapređenje. Socijalna održivost ističe da razvoj može biti smatran održivim samo ako je pravedan i zadovoljava potrebe većine svetske populacije (Vićentijević, 2023). Iako se CE često povezuje sa održivošću, odnos između ova dva koncepta ostaje dvosmislen. Održivost je širok okvir koji obuhvata ekološke, ekonomske i socijalne dimenzije, koji se često nazivaju trostruki krajnji rezultat. Nasuprot tome, CE se prvenstveno fokusira na efikasnost resursa, smanjenje otpada i sisteme zatvorene petlje (Geissdoerfer et al., 2017). Održivost je koncept otvorenog tipa koji nastoji da uravnoteži ekološko, ekonomsko i društveno blagostanje, dok CE posebno ima za cilj smanjenje unosa resursa i minimiziranje otpada. Takođe, održivost integriše dugoročna ekonomska i društvena razmatranja, dok se CE prvenstveno bavi optimizacijom protoka materijala i energije. Međutim, istraživanja pokazuju da sama implementacija cirkularnih modela ne garantuje automatski sveobuhvatnu održivost, jer se ekonomske i društvene dimenzije često zanemaruju u odnosu na ekološku komponentu (Walzberg et al., 2021). Dok održivost ima za cilj da podjednako koristi društvu, privredi i životnoj sredini, CE prvenstveno koristi ekonomskim akterima i industriji, uz indirektnu prednost za životnu sredinu (Geissdoerfer et al., 2017). Istraživanja pokazuju da preduzeća često posmatraju cirkularnu ekonomiju kao sredstvo za postizanje ekoloških ciljeva, dok je njen doprinos ekonomskim i socijalnim aspektima i dalje nedovoljno jasan (Walker et al., 2022). Pored toga, postoji potreba za razvojem metodoloških alata koji mogu preciznije kvantifikovati društvene koristi cirkularnih praksi (Walker et al., 2021). Za razvoj cirkularne ekonomije neophodno je da države usvoje dugoročne strateške politike i mere koje podstiču privrednike na ekološki i ekonomski održivo

poslovanje. Te politike treba da precizno definišu uslove za održivi razvoj, kao i da postave jasne ciljeve i prioritete (Banić, 2019). Da bi se postigla istinska održivost, politike cirkularne ekonomije moraju integrisati socijalne indikatore i dugoročne ciljeve, čime bi se obezbedilo da koristi od cirkularnih procesa budu raspodeljene na celo društvo, a ne samo na industrijske aktere (Walker et al., 2021; Walzberg et al., 2021).

PREGLED INDIKATORA CIRKULARNE EKONOMIJE PO NIVOIMA

Više autora razvilo je specifične alate i indikatore za merenje stepena cirkularnosti, pri čemu se pristupi razlikuju u zavisnosti od analize (mikro, mezo ili makro nivo). Alamerew & Brissaud (2019) razvili su alat za procenu strategija na kraju životnog ciklusa proizvoda, dok je Ellen MacArthur Foundation (2019) ponudila standardizovane „Circularity Indicators” koji omogućavaju poređenje performansi između različitih industrija (Alamerew & Brissaud, 2019; Foundation; & Granta and Life Design, 2019). U cilju bolje sistematizacije načina na koje se meri doprinos cirkularne ekonomije (CE) održivosti, sprovedena je klasifikacija postojećih indikatora prema nivou njihove primene – mikro (pojedinačni proizvodi i preduzeća), mezo (industrijski klasteri i lanci snabdevanja) i makro (nacionalni/regionalni nivoi). Ova podela omogućava uporedivost različitih pristupa i identifikaciju ključnih prednosti i ograničenja svake grupe indikatora. U *Tabeli 1* prikazan je pregled najčešće korišćenih indikatora u relevantnoj literaturi, uključujući metodološke osnove, prednosti i izazove u njihovoj primeni.

Važno je naglasiti da većina postojećih indikatora meri samo određene aspekte cirkularnosti, poput reciklaže, dok zanemaruju šire sistemske promene, kao i potrebu za razvojem sveobuhvatnijih indikatora koji obuhvataju celokupan životni ciklus proizvoda i sistemske promene (Moraga et al., 2019). Određena istraživanja naglašavaju važnost razvoja novih sistema indikatora za merenje i upravljanje cirkularnom ekonomijom, prilagođenih specifičnim nacionalnim uslovima, kao i potrebu za razvojem standardizovanih metoda za praćenje napretka ka cirkularnoj ekonomiji (Geng et al., 2013)(McDonald & Burgoyne, 2019). Jasno je da i dalje postoji visok stepen heterogenosti među postojećim metrikama, što otežava njihovu uporedivost. Autori sugerišu razvoj jedinstvenog seta pokazatelja koji bi obuhvatio ekološke, ekonomske i društvene dimenzije održivosti (Parchomenko et al., 2019).

Tabela I Pregled indikatora cirkularne ekonomije

Nivo	Indikatori	Opis/metodologija	Prednosti	Ograničenja
Mikro (ISO 14040:2006. Environmental Management — Life Cycle Assessment — Principles and Framework; Saidani et al., 2019b)	- MCI (Material Circularity Indicator) - LCA (Procena životnog ciklusa) - R-Score (Reuse, Repair, etc.)- Product-level CE score	- MCI meri koliko je materijal cirkularan unutar proizvoda - LCA kvantifikuje ekološki uticaj proizvoda tokom celog životnog ciklusa - R-Score ocenjuje primenu 6R strategija	- Fokus na konkretne proizvode ili firme - Visoka preciznost	- Zavisi od dostupnosti podataka - Teško poredivi rezultati među industrijama
Mezo (Bringezu & Moriguchi, 2018; Chertow, 2007)	- MFA (Material Flow Analysis) - Eco-Industrial Park metrics - Symbiosis Index	- Analizira tokove materijala u industrijskim zonama i između organizacija	- Prikazuje sistemsku povezanost među firmama - Pomaže optimizaciji resursa	- Kompleksna implementacija - Ograničen broj studija
Makro (European Commission. (2018). Monitoring Framework for the Circular Economy; Eurostat. (2023). Circular Economy – Overview)	- CE Monitoring Framework (EU)- Recycling rate- Resource productivity - Domestic Material Consumption (DMC) - Circular Jobs Indicator	- Nacionalni i regionalni indikatori zasnovani na statistici	- Pogodni za formiranje politika - Poredivi među državama	- Nizak nivo detalja - Spora ažuriranja podataka

Izvor: Autori

BENEFITI CIRKULARNE EKONOMIJE ZA ŽIVOTNU SREDINU

Najuticajniji koncepti koji su oblikovali CE uključuju „eko-efikasnost”, industrijsku ekologiju i viziju „intersistemskih ekosistema.” Idealizovane verzije CE predviđaju zatvorene cikluse materijala i energije, 100% korišćenje obnovljivih izvora i eliminaciju otpada, ali takav sistem nije realan s obzirom na to da se većina svetske energije i dalje proizvodi iz neobnovljivih izvora (Korhonen et al., 2018a). Kritičkim pristupom konceptu CE, autori definišu CE kao ekonomski sistem koji maksimizira uslugu proizvedenu kroz materijalne i energetske tokove u društvu,

koristeći kružne tokove materijala i obnovljive izvore energije. CE treba da ograniči eksploataciju resursa na nivo koji priroda može da podnese, uz očuvanje prirodnih ciklusa materijala, energije i hranljivih materija (Korhonen et al., 2018a). U praksi, CE uključuje primere poput recikliranja biomaterijala, ponovne upotrebe u ekosistemima i integrisanja kroz biološke procese. Takođe - umesto individualne potrošnje, naglasak se stavlja na zajedničko korišćenje resursa, čime se smanjuje potreba za novim materijalima i energijom. Ciljevi CE su ekološki (smanjenje potrošnje sirovina i energije, otpada i emisija), ekonomski (smanjenje troškova resursa i upravljanja otpadom, otvaranje novih poslovnih prilika) i društveni (zapošljavanje, participativno donošenje odluka). Da bi CE postala stvarnost, potrebno je uspostaviti sisteme koji podstiču međusektorsku i međusobno povezanu saradnju među organizacijama (Korhonen et al., 2018a). Od izuzetne važnosti je prelazak na modele koji oponašaju prirodne cikluse, gde se resursi kontinuirano recikliraju i ponovo koriste, smanjujući otpad i negativan uticaj na životnu sredinu (Esposito et al., 2018). Bez jasnih finansijskih prednosti, usvajanje CE može se suočiti sa otporom preduzeća koja daju prednost kratkoročnoj profitabilnosti. Jedno od rešenja bi mogao biti integrisani CE okvir koji usklađuje koristi za životnu sredinu, efikasnost resursa i stvaranje ekonomske vrednosti. Takođe, vlade bi trebalo da olakšaju usvajanje CE kroz zakone, finansijske podsticaje i infrastrukturnu podršku, dok preduzeća treba da iskoriste digitalne tehnologije, optimizaciju lanca snabdevanja i nove poslovne modele kako bi pokrenula održive industrijske prakse (Lieder & Rashid, 2016).

Uspeh implementacije CE zavisi od standardizovanih metrika, ekonomskih podsticaja i međusektorske saradnje. Buduća istraživanja bi trebalo da se fokusiraju na razvoj holističkih okvira za procenu CE, integraciju digitalnih alata za praćenje i promovisanje cirkularnih poslovnih modela koji poboljšavaju i održivost i profitabilnost. Samo kroz sistematske strategije implementacije, cirkularna ekonomija može preći sa koncepta na praktičnu realnost velikih razmera u proizvodnom sektoru (Lieder & Rashid, 2016). Cirkularna ekonomija (CE) se pojavila kao moćan koncept koji obuhvata problem upravljanja otpadom i resursima, nudeći strukturirani pristup produženju produktivnosti resursa i smanjenju uticaja na životnu sredinu. Iako mnoge strategije grupisane pod CE – kao što su ponovna upotreba, reciklaža i ponovna proizvodnja – nisu nove, sam koncept služi kao okvir koji ujedinjuje i preoblikuje ove strategije na način koji promoviše sistemске promene. Prebacivanjem okusa sa odlaganja otpada na produženje životnog veka resursa, CE pruža

diskurzivni prostor gde politika preduzeća, industrija i akademska zajednica mogu da sarađuju kako bi razvili održiva rešenja (Blomsma & Brennan, 2017). Cirkularna ekonomija još uvek prolazi kroz teorijsko i praktično usavršavanje. Odsustvo standardizovanih definicija i alata za merenje stvara izazove za procenu njenog stvarnog uticaja na održivost. Pored toga, dok je industrijska ekologija igrala ključnu ulogu u razvoju CE, potrebna je veća integracija perspektiva društvenih nauka da bi se razumeli bihevioralni, ekonomski i institucionalni faktori koji utiču na usvajanje ovog koncepta (Blomsma & Brennan, 2017). Na globalnom nivou, primena cirkularne ekonomije može smanjiti pritisak na prirodne resurse, omogućiti sigurniju nabavku sirovina, povećati konkurentsku prednost, stimulisati inovacije i podstaći privredni rast (Knežević et al., 2022). Empirijske studije pokazuju da primena CE strategija može doprineti smanjenju potrošnje energije i emisija, ali stvarni efekti zavise od konteksta implementacije i sektorskih specifičnosti (Rossi et al., 2020). Uz tehničke inovacije treba razvijati i mehanizme za angažovanje zaposlenih i praćenje učinka, jer ljudski faktor ima presudan uticaj na uspeh cirkularnih inicijativa (Veleva et al., 2017).

DISKUSIJA

Prelazak na cirkularnu ekonomiju (CE) je široko prepoznat kao ključna strategija za postizanje održivosti životne sredine. CE doprinosi ciljevima održivog razvoja, posebno odgovornoj potrošnji i proizvodnji, putem efikasnijeg korišćenja resursa (Ferraz & Pyka, 2023). Dok je CE konceptualno zasnovan na principima smanjenja, ponovne upotrebe i recikliranja, odsustvo standardizovanog okvira za procenu njegovog uticaja na životnu sredinu ostaje ključni izazov. Ključne metodologije kao što su procena životnog ciklusa (LCA), analiza protoka materijala (MFA) i analiza ugljeničnog otiska pružaju vredan uvid u doprinose CE efikasnosti resursa, smanjenju emisija i minimiziranju otpada. Međutim, nedoslednosti u njihovoj primeni u različitim industrijama i geografskim regionima ometaju uporedivost (Kirchherr et al., 2017). Štaviše, mnoge studije daju prednost ekonomskim koristima u odnosu na ekološke performanse, pokazujući nedostatak u holističkim procenama održivosti. Glavni nalaz iz literature je potreba za integrisanim i standardizovanim skupom indikatora za sveobuhvatnu procenu uticaja CE na životnu sredinu. Tranzicija ka cirkularnoj ekonomiji nije izolovan proces – ona se odvija paralelno sa digitalizacijom, automatizacijom i demografskim promenama, poput starenja populacije. Ovi međusobno povezani faktori

imaju značajan uticaj na tržište rada, često otežavajući njihovo posmatranje pojedinačno. Očekuje se da će njihov zajednički efekat dovesti do sve izraženijeg jaza između potrebnih i dostupnih veština, ukoliko ne dođe do adekvatnih prilagođavanja u obrazovnom sistemu i programima stručnog usavršavanja (Mitrović & Jandrić, 2020). Buduća istraživanja bi trebalo da se usredsrede na razvoj univerzalno prihvaćenih metrika koje su u skladu sa ciljevima održivosti, uključujući društvene i ekonomske dimenzije pored ekoloških razmatranja. Pored toga, uloga digitalnih tehnologija, kao što su blockchain i veštačka inteligencija, u poboljšanju tačnosti merenja CE zahteva dalje istraživanje. Uprkos potencijalu, nekoliko izazova ometa široko usvajanje CE. To uključuje nedostatak standardizovanih metrika za procenu koristi za životnu sredinu, ekonomske prepreke za primenu cirkularnih poslovnih modela i potrebu za većom saradnjom između industrije i potrošača (Ghisellini et al., 2016). Pored toga, iako se CE pokazala efikasnim pristupom u upravljanju otpadom, integracija u šire ekonomske sisteme ostaje u ranim fazama, često se suočavajući sa otporom zbog visokih početnih troškova i regulatornih praznina (Ghisellini et al., 2016). Određene kulturne barijere (nedostatak svesti i interesovanja potrošača), organizacione barijere (otpor promenama unutar kompanija) i regulatorne barijere (nedostatak podržavajuće politike) takođe su zastupljene u literaturi (Kirchherr et al., 2018)(Korhonen et al., 2018b). Autori sugerišu da je za uspešnu tranziciju ka cirkularnoj ekonomiji potrebna koordinisana akcija svih zainteresovanih strana.

Efikasnost CE u isporuci ekoloških koristi zavisi od rigoroznosti implementacije i procene (Kirchherr et al., 2017). Brza integracija novih tehnologija u privredu, kako u okviru digitalizacije, tako i u procesu prelaska na cirkularnu ekonomiju, naglašava značaj osnovnih digitalnih veština, uz neophodnost usvajanja koncepta celoživotnog učenja i stalnog stručnog usavršavanja. Pored toga, produžen radni vek dodatno podstiče razvoj obrazovnih modela usmerenih na kontinuirano usavršavanje, omogućavajući radnicima da tokom celog radnog veka prilagođavaju i unapređuju svoja znanja i veštine (Mitrović & Jandrić, 2020). Prelazak sa linearnog na cirkularni model zahteva kulturnu promenu i promenu ponašanja među potrošačima i industrijama, obezbeđujući da održivost postane osnovni princip u obrascima proizvodnje i potrošnje (Ghisellini et al., 2016). Saradnja među zemljama regiona postaje posebno važna u okviru različitih inicijativa koje koriste digitalnu ekonomiju kao alat za prelazak na cirkularnu ekonomiju - novi model poslovanja i održivog ekonomskog razvoja (Glušćević, M., Kaluđerović, 2019). Koncept

cirkularne ekonomije često se fokusira na tehničke aspekte reciklaže i ponovne upotrebe, zanemarujući dublje društvene promene potrebne za održivost. Za istinsku transformaciju potrebna je promena potrošačkih navika i smanjenje ukupne potrošnje resursa (Hobson & Lynch, 2016).

ZAKLJUČAK

Cirkularna ekonomija ima potencijal da značajno doprinese održivosti kroz efikasnije korišćenje resursa, smanjenje otpada i unapređenje ekoloških performansi proizvodnih sistema. Međutim, analiza literature pokazuje da postoje velike razlike u pristupima merenju ovih koristi, kao i nedostatak standardizovanih i uporedivih indikatora. Identifikovani su ključni izazovi, uključujući fragmentiranost metodologija, ograničenu primenu integrisanih okvira i poteškoće u dostupnosti kvalitetnih podataka. Iako su mnogi indikatori razvijeni na mikro, mezo i makro nivou, njihova praktična upotreba i međusobna usklađenost ostaju ograničene. Postoji jasna potreba za razvojem harmonizovanog sistema za praćenje efekata cirkularne ekonomije, koji bi omogućio transparentniju evaluaciju njenog doprinosa održivosti. Budući pravci istraživanja treba da obuhvate razvoj univerzalnih indikatora, bolju integraciju digitalnih alata za praćenje resursa, kao i jačanje saradnje između sektora, industrija i politika. Dok CE nudi obećavajući put ka održivijoj budućnosti, uspeh zavisi od sistematske podrške, inovacija u poslovnim modelima i sveobuhvatne procene uticaja na životnu sredinu. Tranzicija je počela, ali postizanje potpuno cirkularne ekonomije će zahtevati dugoročnu posvećenost i interdisciplinarnu saradnju. Transformacija ka cirkularnom modelu zahteva ne samo tehnička rešenja, već i promenu kulturnih obrazaca, regulatornu podršku i dugoročnu stratešku posvećenost svih aktera društva.

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CIRCULAR ECONOMY AS AN APPROACH TO SUSTAINABILITY AND ITS IMPACT ON THE ENVIRONMENT

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Abstract: *The concept of circular economy (CE) has become a key framework for achieving sustainability through the efficient use of resources, waste minimization, and material recirculation. This study presents a systematic literature review encompassing scientific papers published between 2015 and 2025, with the aim of examining how circular economy practices affect the environment. The analysis focuses on the most frequently applied methodological approaches, including Life Cycle Assessment (LCA), Material Flow Analysis (MFA), and carbon footprint assessment, as well as on indicators applied at the micro, meso, and macro levels. The results indicate a lack of methodological standardization and a limited connection between the environmental, economic, and social dimensions of sustainability. Although the circular economy shows potential for reducing material and energy consumption, the comparability of results remains limited due to the heterogeneity of indicators. This paper contributes to the existing literature by identifying key methodological gaps and proposing the inclusion of digital technologies, data transparency, and harmonized policies as priorities for future research and implementation.*

Keywords: *circular economy; sustainability; environmental impact; life cycle assessment.*

STRUČNÍ RAD

CHALLENGES OF PANEL DATA SERIES APPLICATION IN RESEARCH OF VARIOUS ECONOMIC PHENOMENA

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Abstract: *In recent decades, in addition to time series data and comparative data, panel data has been intensively used in empirical research. The application of these data series facilitates the implementation of analyses that could not otherwise be carried out using individual time series or comparative data. One of the key advantages of the panel data model in researching numerous economic phenomena and other aspects of social reality is that it provides the maximum amount of information from a limited number of observations per observation unit in a given time period while minimizing the number of degrees of freedom. Greater data variability contributes to greater efficiency of estimates and a reduction of multicollinearity, and given that these models enable the observation of variations by observation units (individual effects) and by time periods (time effects), the analysis of structure and changes in structure over time can be performed simultaneously. In addition, panel models provide greater informativeness as a result of an increased sample size and a higher number of degrees of freedom.*

Keywords: *panel data, panel series, panel data models, research, economic phenomena.*

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INTRODUCTION

According to the available scientific and expert literature, the first panel data collection and the implementation of a panel study, which dealt with the income dynamics, was carried out in the sixties of the last century in the USA - *Panel Study of Income Dynamics - PSID* (Sarafidis & Wansbeek, 2021). Since then, the popularity and application of the methodology in the field of panel data analysis has been constantly increasing with the development of a large number of new models, methods and research tests.

Panel series represent a combination of time series data and comparative data as they simultaneously provide temporal and spatial dimensions (Gujarati, 2009). These data represent a special form of composite data where the same cross-sectional unit (for example country, company, etc.) is observed over time (Gujarati, 2004). In the aforementioned context, cross-section data refer to a set of observation values that a variable has in different time periods, and are therefore collected at regular time intervals (e.g. daily, weekly, monthly, quarterly, annually, etc.), while comparative data (Pooling time series) are data of one or more variables that were collected at the same moment in time (e.g. household consumption by country during one year).

The research problem of this paper is oriented towards the challenges and possibilities of applying panel data series in the research of various aspects of economic reality. The subject of the research involves the analysis of the advantages and limitations of the panel data application, as well as the consideration of types and models of panel data which are implementing in empirical research. The aim of this research study refers to finding out what needs to be done in cases where research cannot be conducted using only time series or cross-sectional data. Also, the research aim includes determining the most common areas of application of panel data series and indicating the effectiveness of their application in solving the previously mentioned problem.

The scientific and expert literature is very rich in research studies that apply panel data series. In Europe, the application of panel studies began at the end of the eighties of the last century. Initially, Hujer & Schneider (1989) published the results of a socio-economic panel research in Germany, shortly after that the results of a study dealing with labor mobility in Sweden (Bjorklund, 1989) appeared, and then Alessie, Kapteyn & Melenberg (1989) published the results of a household consumption research in the Netherlands.

At the end of the eighties and during the nineties of the last century, panel models were increasingly applied in numerous scientific researches, mainly in the field of social sciences, such as political sciences (Beck & Katz, 1995), sociological sciences (England, Farkas, Kilbourne & Dou, 1988), and economic sciences (Brown, Keim, Kleidon & Marsh, 1983; Boehmer & Megginson, 1990; Erdem, 1996; Keane, 1997) etc.

In the Republic of Serbia, the first studies based on panel data series were economic studies dealing with foreign trade (Dragutinović Mitrović, 2005). More frequent application has been noted over the last decade, in research on factors of business success of enterprises in the Republic of Serbia (Knežević, 2015), then research on foreign direct investments and competitiveness of European developing countries (Stankov, 2017), the difference in earnings and the impact on employment (Ognjenović, 2018) and relationship between competitiveness and corruption (Radulović, 2018). In recent years, the application of panel data series has also been noted in sociological research on household consumption in Serbia (Hanić & Bugarčić, 2021), as well as the connection between investment in education and some macroeconomic elements (Lepojević & Janković-Milić, 2024).

POSSIBILITIES AND LIMITATIONS OF PANEL DATA APPLICATION

Due to the numerous advantages of panel series, over time there has been an intensification of their application in various fields of empirical research. Among the most significant advantages, according to Hsiao (2003) and Klevorick (1989), the following should be highlighted:

- Controlling individual heterogeneity.

One of the basic assumptions on which panel series are based is that the unit of observation (company, country, etc.) is a heterogeneous category. In the case of time series data and comparative data, there is no possibility of heterogeneity control, so the research results may be biased.

- More information, greater variability, a higher number of degrees of freedom and greater efficiency of panel data with lower collinearity between variables.

The problem of multicollinearity is often present in time series. In the case of the panel series application, the spatial dimension is included, which adds additional variability of the data, so the probability of multicollinearity is significantly reduced.

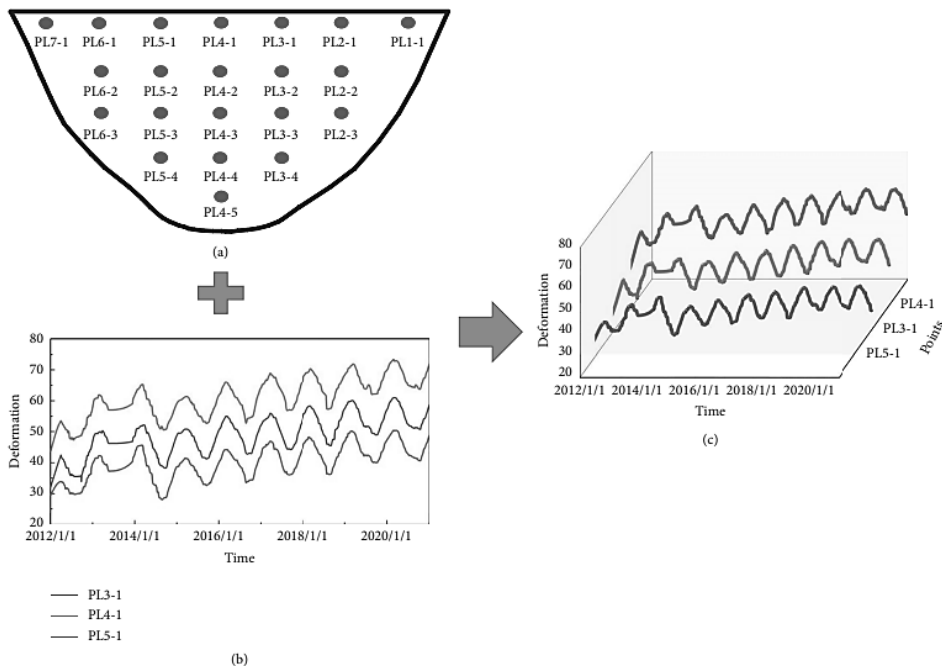
- More successful research into the dynamics of adaptation.

By using panel data, trends such as periodic unemployment, job changes, residential mobility, income volatility, etc. can be studied much better compared to the use of time series data and comparative data. With panels, it is possible to connect certain experiences and behaviors of the subject at one point in time with other experiences and behaviors of the same subject at another point in time.

- More effectively identifying and measuring effects that cannot otherwise be identified using only comparative data or only time series data.

The research problem can arise if there are large differences in the values of the observation units being compared, making such a comparison meaningless. The above-mentioned can be avoided with panel series because their application ensures the observation of differences in data related to the same unit of observation.

Illustration 1. Panel data scheme



Note. Cross-sectional data (a) + Time-series data (b) = Panel data (c)

Source: Cheng, L., Chen, J., Ma, C., Yang, J., Xu, X., & Yuan, S. (2023). Multipoint Deformation Safety Monitoring Model for Concrete Arch Dams Based on Bayesian Model Selection and Averaging. *Structural Control and Health Monitoring*, 2023(1), 5042882.

One of the important advantages of using this data is related to the dynamism of information and empirical results, which is achieved by using comprehensive panel data modeling instead of single-point modeling. In this way, the validity and accuracy of the model are increased.

Cheng et al. (2003) point out another advantage and state that two-dimensional panel data includes time series and cross-sectional information, as shown in Illustration 1 (c). Cross-sectional data indicate the locations of the observation points (a), and time series data reflect the time effects of the prototype observation data (b).

Ajmani (2009) states that another significant advantage of using panel series is reflected in the increase in sample size, i.e. increasing the number of observations. If N represents the number of observation units, and T the number of time periods, the research will include NT observations.

In addition to the evident advantages, by applying the panel series analysis, the authors of empirical studies also encounter certain problems and face the following limitations of this data:

- Data collection and design issues.

According to Bailer (1989), it is a comprehensive problem that combines the problem of coverage (complete data on the population of interest is missing), the problem of non-response (due to the lack of cooperation of the respondent or errors made by the interviewer), the problem of recall (the respondent does not remember the answer exactly), and problems related to the nature of the interview (frequency of interviews, interval between interviews, reference period, etc.).

- Measurement errors.

When conducting research, errors can arise due to incorrect understanding of questions, insufficient or incomplete recall of content, intentional provision of incorrect answers, inadequacy of available information, errors in recording information, interviewer influence, etc. (Kalton, Kasprzyk & McMillen, 1989).

- Selection problems (self-selection, non-response and attrition).

For example, if labor force employment is investigated, a problem arises when certain individuals refuse employment because, for example, they are not satisfied with the offered wage (self-selection). The problem can also arise if the respondent is not available and fails to give an answer, or when they refuse to give an answer during the survey (non-response). Non-response can represent a very serious problem in this case, which

persists not only in the current, but also in all subsequent research cycles. Attrition usually increases when moving from one round of data collection to another, but over time the growth rate becomes lower.

- Time series dimension.

Since typical micro-panels include annual data and thus cover a short time period for each individual subject, the short dimension of the time series can be a problem. If, in this case, the number of time units were to increase, it could lead to the emergence of new problems related, for example, to data spillage or difficulty in computational processes.

- Dependency of comparative data.

This problem can affect the research results and lead to the occurrence of errors in inference. Most often, with macro panels of countries or regions, where very long time series are used, the possibility of comparative data dependence is not taken into account.

Researchers must be aware of the mentioned limitations and shortcomings of panel data. It is unreasonable to expect that the application of panel data will solve all the problems that normally arise when using comparative data and time series data (Baltagi, 2005).

TYPES AND MODELS OF PANEL DATA IN EMPIRICAL RESEARCH

Types of panel data

Since panel studies in recent decades have begun to be intensively applied in the research of various social phenomena, there are more and more theoretical and empirical studies in the scientific literature that talk about their types and ways of grouping. According to one of the criteria, panel data can be viewed as balanced and unbalanced. In the case of balanced panel data, each comparative observation unit has the same number of time series observations, that is, the time series are of the same length. In these circumstances, there are no problems caused by a lack of data. Gujarati (2004) points out that if the number of observations differs from one subject to another in the panel, then it is an unbalanced panel where data for certain observation units are missing in some time periods, and modified classical estimation methods must be applied.

If a large number of units N is observed in a short time period T , this is referred to as classical panels, while longitudinal panels analyze a small number of observation units in a large number of time periods.

The difference between macro panels and micro panels is found in the size of the observation unit. Namely, macro panel data refer to countries, regions, industrial branches and the like, while the analysis of certain companies, individuals, etc., is considered micro panel research.

Depending on how the problem of missing research data is solved, panel data can be viewed as rotating and pseudo panels. Biørn (1981) points out that this problem can be solved by replacing, i.e., "rotating," the group of units whose data are missing in a given period with an equal number of new units for which data are available, in order to maintain the same number of observation units throughout the entire research period. In this way, a new series of rotating panel data would be obtained. Baltagi (1995) states that for models based on rotational panel series, there are well-developed estimation and testing methods. Since it is not always feasible to ensure sample consistency from period to period in terms of the presence of exactly the same observation units, groups of observation units and their average values can be used instead of individual data for estimating panel models. These series are therefore called pseudo-panel series.

Models of panel data

Panel data models can be viewed as linear and non-linear models. Linear panel models can be static (estimation and testing are carried out under the conditions of violation of the initial assumptions) and dynamic models, as well as non-stationary panels (unit root tests and cointegration).

The general form of the panel data regression model can be presented as:

$$y_{it} = \beta_{1it} + \sum_{k=2}^K \beta_{kit} x_{kit} + u_{it}$$

where:

y_{it} – the value of the dependent variable for the i observation unit in period t ;

x_{kit} – the value of the k independent variable for the i observation unit in period t ;

$x_{1it} = 1$, for each i and t ;

β_{1it} – unknown regression parameters, which in the general form of the panel data model are variable by observation units and time periods, i.e., they are not constant as in classical regression analysis;

u_{it} – random error with arithmetic mean equal to zero and constant common variance for each i and t .

The model includes both structural and temporal dimensions, which raises the question of modeling the structural and temporal dependence of the selected variables in the model. The general specification of the linear panel data model implies that for each observation unit there is a different response of the dependent variable to variations in the independent variables and that this response differs for each time period. Therefore, the regression parameter of each observation unit is specific to each time period. Such a model cannot be estimated because the number of regression parameters exceeds the number of data points in the sample. To estimate the model, assumptions are introduced regarding the properties of the model regressors, the characteristics of the random error, the statistical dependence between the regressors and the random error, and the degree of variability of the regression parameters.

Depending on the degree of variability of the regression parameters, the following situations may occur:

- all regression parameters in the model are constant;
- the intercepts differ by observation units, while the regression parameters for the independent variables are constant;
- regression parameters with independent variables are variable by observation units and time periods.

If the intercepts vary while the regression parameters are constant, a distinction is made between models with individual effects (the intercept varies only by observation units) and models with both individual and time effects (the free member varies across both observation units and time periods).

When the coefficients vary for each i and each t , there is a total of NT intercepts and $k-1$ slope coefficients for each i as well as for each t . Since it is impossible to estimate such a model, it is necessary to introduce various restrictions.

One restriction can be based on the assumption that all regression parameters are constant; in that case, a single parameter β_1 and a single slope parameter β_k would be estimated for the entire sample, meaning that all observation units react in the same way. Such a model is called the **model with constant regression parameters (Pooled-effects Model)**.

The second restriction, which is most commonly applied to classical panels where N is large and T is small, is based on the assumption that the intercepts β_1 vary, while the parameters of the regressors remain constant. A model in which the intercepts β_1 vary only across observation

units is called the **individual effects model**, while a model in which the intercepts β_1 vary across both observation units and time periods is called the **individual and time effects model**. Furthermore, the individual and time effects can be treated as fixed parameters, in which case we refer to the **Fixed-effects Model**, or they can be treated as stochastic variables, in which case we are talking about the **Random-effects Model**.

CONCLUSION

It is concluded that panel data series contain data on a large number of the same observation units at a given number of specific points in time or time periods, and each observation simultaneously contains both a spatial and a temporal dimension. This allows all relevant information from the sample to be used in the estimation of regression parameters (Matyas & Sevestre, 1996). Panel series are becoming very popular and are increasingly used in the quantification of economic relations because they are by nature disaggregated by observation units, as well as because they combine information on both the structure and dynamics of the observed phenomenon (Dragutinović Mitrović, 2002).

In cases where research cannot be conducted using only time series or cross-sectional data, panel data series offer an efficient solution. Among the key advantages of applying panel models are the successful control of observation unit heterogeneity, the reduced possibility of multicollinearity problems, more efficient research into adjustment dynamics, as well as the identification and measurement of effects that cannot otherwise be identified using only cross-sectional or only time series data. Certainly, one of the most significant advantages of using panel data series lies in the increase in sample size, i.e., the increase in the number of observations.

In the study of macroeconomic phenomena, panel models are most commonly applied in research on international trade, foreign trade exchange, exchange rates, and other socio-economic phenomena. At the micro level, these models are most often used in research on GDP or unemployment trends across different countries, as well as in dynamic studies of income distribution among different categories of the population or company stock prices.

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26. Ognjenović, K. Đ. (2018). *Analiza razlika u zaradama i višestrukog izbora zaposlenja primenom parametarskih i poluparametarskih ekonometrijskih metoda panela* (Doctoral dissertation). University of Belgrade.
27. Radulović, M. (2018). The influence of national competitiveness on the perception of corruption in the countries of the European Union: Panel Vec Model. *Business Economy*, 13(1), 73-92. PROVERITI REFERENCU
28. Sarafidis, V., & Wansbeek, T. (2021). Celebrating 40 years of panel data analysis: Past, present and future. *Journal of Econometrics*, 220(2), 215-226. <https://doi.org/10.1016/j.jeconom.2020.06.001>

29. Stankov, B. (2017). *Panel analysis of foreign direct investment and competitiveness in emerging and developing European countries* (Doctoral dissertation). University Business Academy, Faculty of Economics and Engineering Management Novi Sad.

IZAZOVI PRIMENE PANEL SERIJA PODATAKA U ISTRAŽIVANJIMA RAZLIČITIH EKONOMSKIH POJAVA

Biljana Stankov

Milijana Roganović

Sažetak: *Poslednjih decenija se u empirijskim istraživanjima, pored podataka vremenskih serija i uporednih podataka, intenzivno koriste i panel podaci. Primena ovih serija podataka olakšava sprovođenje analiza koje se inače ne bi mogle realizovati pojedinačnim korišćenjem vremenskih serija ili uporednih podataka. Jedna od ključnih prednosti modela panel podataka u istraživanjima brojnih ekonomskih pojava i drugih aspekata društvene stvarnosti, je ta što i pored ograničenog broja opservacija sa jedne strane i minimum broja stepeni slobode možemo dobiti maksimum informacija u datom periodu. Porast efikasnosti ocena i smanjenje multikolinearnosti nastaje zahvaljujući većoj varijabilnosti podataka. Pored navedenog, modeli panel podataka beleže još jednu značajnu prednost koja se ogleda u objedinjavanju individualnih i vremenskih efekata. Varijacije određene pojave se mogu posmatrati po jedinicama posmatranja, ali i po periodima, pa se pored analize strukture može izvršiti i analiza promena u strukturi tokom vremena. Zahvaljujući rastu veličine istraživačkog uzorka i broja stepeni slobode, panel modeli obezbeđuju i veću informativnost.*

Ključne reči: *panel podaci, panel serije, modeli panel podataka, istraživanje, ekonomske pojave.*

UPUTSTVO AUTORIMA ZA PISANJE I PRIPREMANJE RUKOPISA

Ekonomija – teorija i praksa predstavlja časopis međunarodne orijentacije koji ima za cilj objavljivanje radova iz svih oblasti ekonomije i privrednog poslovanja. Časopis objavljuje radove na srpskom i na engleskom jeziku. Časopis *Ekonomija – teorija i praksa* otvoren je za sva argumentovana mišljenja i ideologije. Empirijska istraživanja i teorijske analize problema u svim oblastima ekonomije od podjednakog su značaja i biće objavljeni, ukoliko po mišljenju recenzenata i urednika zadovoljavaju kriterije časopisa u pogledu relevantnosti i profesionalnog nivoa.

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Osnovni format za knjige

Autor, S. I. (godina izdavanja). *Naslov dela*, Mesto izdavanja, Izdavač

Jedan autor

Carić, S. (2007). *Bankarski poslovi i hartije od vrednosti*, Novi Sad, Privredna akademija

Jedan autor, novo izdanje

Vunjak, M. N. (2008). *Finansijski menadžment: Poslovne finansije* (7. izd.). Subotica, Proleter A.D. Bečej, Ekonomski fakultet

Dva autora

Soleša, D., Carić, M. (2016). *Informacione i komunikacione tehnologije*, Novi Sad: Univerzitet Privredna Akademija, Fakultet za ekonomiju i inženjerski menadžment.

Tridošest autora

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Bez autora

Publication Manual of the American Psychological Association (Fourth Edition). (1994). Washington, D.C., American Psychological Association

Bez autora, ima samo urednika, editora, ed.

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Momirović, K., Bala, G. i Hošek, A. (2002). Taksonomska struktura nekih simptoma aberantnog ponašanja dece od 4 do 7 godina. U: K. Momirović i D. Popović (ur.), *Psihopatija i kriminal* (str. 125-142). Leposavić, Univerzitet u Prištini, Centar za multidisciplinarna istraživanja Fakulteta za fizičku kulturu.

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Članak u časopisu, dva autora

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Carić, S. (2007). *Bankarski poslovi i hartije od vrednosti*, Novi Sad, Privredna akademija

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Vunjak, M. N. (2008). *Finansijski menadžment: Poslovne finansije* (7th edition). Subotica, Proleter A.D. Bečej, Ekonomski fakultet

Two authors

Soleša, D., Carić, M. (2016). *Informacione i komunikacione tehnologije*, Novi Sad: Univerzitet Privredna Akademija, Fakultet za ekonomiju i inženjerski menadžment.

Three to six authors

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Without author

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Author's last name initial, year, title of the paper, name of symposium, page numbers, place of publishing, publisher.

Soleša, D., Černetič M., Gerlič I., (2007). *New Media in Education*, Selected topics, University of Novi Sad - Faculty of Education in Sombor, Faculty for Organizational Sciences in Kranj and University of Maribor - Faculty of Education Maribor, pg. 219

If you use an Internet source (Title/Heading of the web-page, date of using the source, web-site)

1. Ministarstvo za nauku i tehnološki razvoj (2010, January 20), Lista časopisa za društvene nauke, Taken from http://www.nauka.gov.rs/cir/index.php?option=com_content&task=view&id=930&Itemid
2. Ekonomija u Wikipediji (2010, February 02), Taken from: <http://bs.wikipedia.org/wiki/Ekonomija>

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Quotations

If a source is quoted word by word, it is necessary to give the author's name, year of publishing and page from which the quotation was taken (using "p.")

The quote is introduced by giving the author's last name, followed by the year of publishing in brackets.

According to Mirković (2001), "primena skladišta..." (p. 201) or Mirković (2001) believes that "primena skladišta..." (p. 201).

If the introducing phrase does not mention the author's name, the author's last name should be put at the end of the quotation, followed by the year of publishing and page number in brackets.

Summary or paraphrase

According to Vunjak (2008), the elasticity of financial management ischeaper additional capital, (p. 32).

The elasticity of financial management ischeaper additional capital (Vunjak, 2008, p. 32)

One author

Babović (2009) compares the structures of approaches...

Two authors

Both last names have to be supplied

In another research (Babović and Lazić, 2008) it is concluded that...

In the English text (conjunction *and*) is marked as "&"

Three to five authors

When mentioned for the first time, all the authors' names need to be supplied. In repeated quoting, the last name of the first author is supplied, followed by "et al."

(Babović, Veselinović, Carić, Đorđević i Ćirić, 2011)

Six or more authors

In the introductory phrase, there has to be the last name of the first author, or in brackets

Carić et al. (2010) claim that...

...is not relevant (Carić et al., 2011)

When more than one work by the same author are mentioned:

(Bandin, 2005, 2007)

When more than one work by the same author were published the same year, they are marked with letters a, b, c etc.

(Bandin, 2006a, 2006b, 2006c)

If you haven't read the original work, you should give the name of the author which referred you to the mentioned source:

Bergson's research (mentioned by Mirković and Boškov, 2006).

Pages are always supplied in quotations:

(Mirković, 2006, p. 12)

When quoting parts

(Carić, 2008, ch. 3)

(Carić, 2008, p. 231–258)

Unnamed author

If a work has not been authorized, that source is mentioned by the introducing phrase, or with the first one or two words put in brackets.

Titles of books and reports are given in italic, while titles of articles and chapters are given under quotation marks.

A similar poll has been conducted in a number of organizations with database managers employed full-time ("Limiting database access". 2005).

FOOTNOTES

Sometimes it is necessary to supply additional comments or explanations for certain issues mentioned in the text. This is done in the form of footnotes, which can be directly related to the topic or simply give some additional technical information.

Footnotes are marked with exponent in Arabic numbers at the end of the sentence.

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