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BARRIERS TO GREEN TECHNOLOGY IMPLEMENTATION: DOES SIZE MATTER?

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Abstract. *This paper investigates whether enterprise size determines the degree and dynamics of green technology adoption among processing enterprises in the Republic of Serbia. The research was conducted from September to December 2024 on a sample of 256 enterprises of different sizes. Empirical findings confirm that enterprise size is associated with the number of implemented green technologies, with larger enterprises leading the way in the green transition. Institutional barriers, particularly regulatory challenges, become significantly more pronounced among large enterprises. However, the relationship between enterprise size and perceived administrative burden largely disappears after accounting for the number of green technologies implemented. Similarly, the association between enterprise size and regulatory challenges is substantially reduced, suggesting that the greater institutional burden reported by large enterprises is partly related to their greater engagement with green technologies rather than to firm size per se. On the other hand, securing financial resources represents a dominant issue within the micro-enterprise segment. The obtained results provide an empirical basis for designing differentiated support measures to facilitate the green transition of domestic processingprocessing enterprises.*

Key words: *green technologies, processingprocessing enterprises, barriers*

JEL Classification: Q50, Q55

1. INTRODUCTION

Rising greenhouse gas emissions and accelerating depletion of natural resources have pushed sustainable production to the top of the industrial policy agenda (Tongsoongnern & Shing Lee, 2022;), and green technologies have emerged as an instrument for reducing

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environmental impacts and improving resource efficiency. The transition toward green technologies has become an increasingly important strategic and policy priority for processingprocessing sector. Yet implementation of green technologies remains far from straightforward, as enterprises face a range of financial, technological, organizational, administrative, and regulatory barriers and the nature and intensity of these barriers may differ considerably across enterprises depending on their characteristics and available resources (Durrani et al., 2024; La Hiz & Bolivar-Ramos, 2021).

Among these characteristics, enterprise size stands out as a factor that may shape both the capacity to implement green technologies and the barriers encountered during the implementation process (Appiah et al., 2025). Larger enterprises typically have greater access to financial, human, and technological resources, while smaller enterprises may face stronger constraints related to access to finance, knowledge, expertise, and appropriate technical solutions (Rodrigues & Franco, 2023; Hakam & Hakam, 2024). At the same time, larger enterprises may experience greater exposure to administrative and regulatory requirements (Maniu, Costache & Dumitrascu, 2021), not necessarily because of their size per se, but because their broader engagement with green technologies may bring them into contact with regulatory requirements more frequently.

Against this background, this study examines whether enterprise size is associated with the type and intensity of barriers perceived by Serbian processing enterprises in the implementation of green technologies. In particular, the study investigates whether larger enterprises are more likely to report administrative and regulatory barriers, while smaller enterprises are more likely to face financial constraints. It further examines whether the observed relationship between enterprise size and institutional barriers can be explained by differences in the number of green technologies implemented.

2. LITERATURE REVIEW

The transition toward green technologies has emerged as one of the challenges for contemporary industrial firms, driven by mounting regulatory pressures, resource scarcity, and market expectations aligned with sustainable development goals (Darnall et al., 2009; Younis & Sundarakani, 2020). Although the adoption of green technologies is becoming recognized more as a strategic imperative, the obstacles encountered during this process often depend on organizational scale and available resources. Firm size is among factors frequently highlighted as affecting both the intensity and the type of barriers (Wildnerova et al., 2024), although empirical findings across global economies yield divergent results.

A substantial body of literature support the evidence that larger firms are better positioned to adopt environmental practices. Larger firms typically implement more environmental practices and outperform SMEs in climate performance (Caputo et al., 2024). This commonly happens due to better access to financial, human, and technical resources (Andries & Stephan, 2019; Darnall et al., 2009), ability to exploit economies of scale in resource-intensive activities (Dzeraviaha, 2022; Chowdhury & Shumon, 2019), and increased stakeholder pressures associated with greater organizational visibility (Younis & Sundarakani, 2020). Credit constraints in emerging markets systematically hold back corporate investment in green technologies, and the removal of financial frictions alone could reduce industrial CO2 emissions by approximately 4.5% (De Haas et al., 2025). Complementary evidence from China shows that financing constraints are relevant to enterprises' discretionary efforts in green technology innovation (Zhang et al., 2021; Nguyen & Vu, 2024), further highlighting

the importance of financial conditions for firms' environmental investment decisions. Organizational scale moderates the relationship between stakeholder pressures and the adoption of circular economy models, suggesting that size conditions not only the capacity to act, but also the responsiveness to external sustainability demands (Ahmadov et al., 2024; Cassells & Lewis, 2011). This resource-differentiated position leads to differences in the types of green practices firms adopt according to their size: large firms tend to employ resource-intensive environmental practices, such as green product design and green production, to achieve environmental, cost, and business performance benefits; conversely, small firms often adopt resource-light practices, including green logistics and green packaging, gaining only environmental and cost benefits (Wong et al., 2020; Yacob et al., 2019).

In contrast, certain studies within the European context challenge the assumption that firm size predetermines the magnitude of the barrier burden. Evidence from Slovak processing firms indicates that enterprise size and prior experience do not statistically significantly affect the perceived intensity of barriers; instead, the intrinsic costs of eco-innovation represent the most significant challenge affecting all enterprises uniformly (Klement et al., 2023). These findings shift the analytical focus to strategic action and collaboration as key determinants of eco-innovation success. Technological gaps, financial constraints, and regulatory hurdles burden all actors, even though larger organizations possess greater resources while smaller ones exhibit superior agility (Khan et al., 2025).

Research focusing specifically on developing and emerging economies provides consistent evidence that the lack of financial resources acts as a primary barrier to green technology adoption across the enterprise size spectrum. High initial investment costs and constrained access to capital represent the most frequent obstacle for green technology adoption, particularly for small and medium-sized enterprises, while implementation is further hindered by knowledge gaps, regulatory complexities, and organizational inertia (Baharom, 2025; Batrancea et al., 2022). Similarly, Bandyopadhyay and Kashyap (2025) examine the role of green financing in supporting solar micro, small, and medium-sized enterprises in India, highlighting the relevance of access to finance for sustainable enterprise development. Matarirano and Chireka (2026) further examine sustainability practices among South African SMEs, focusing on awareness, climate change readiness, green finance readiness, and barriers to implementation. More importantly, when observing the entire corporate spectrum, the literature notes a distinct differentiation in the types of barriers encountered at different organizational scales. Business obstacles vary significantly by firm size; the SME segment is primarily burdened by challenges such as access to finance, business licensing, and tax rates, whereas large firms face difficulties centred around labour regulations, administrative complexity, and political instability (Ali & Singh, 2024; Troise et al., 2023). Evidence from heavy industry also demonstrates the relevance of examining environmental investment decisions beyond the SME sector. Panjaitan et al. (2023), for example, investigate management decisions concerning the adoption of emissions-reduction measures in Indonesian heavy industry. This shifting focus from financial pressures in smaller firms to administrative challenges in large enterprises provides a crucial parallel to our study. Divergent literature findings establish the foundation for this research in the Republic of Serbia, aiming to analyse the underlying dynamics of these differences within the domestic context. While descriptive data indicate that financial constraints predominantly affect the micro-enterprise segment and administrative barriers become more pronounced among large enterprises, the objective of this paper is to test whether this administrative burden is uniquely associated with firm size, or if it results

from the fact that larger firms implement a higher number of green technologies, thereby coming into contact with legal regulations more frequently.

3. DATA AND METHODOLOGY

This study examines whether enterprise size influences the perception of barriers to green technology implementation among Serbian processingprocessing firms. We employ a cross-sectional survey design with a bivariate hypothesis to test and compare perceived barriers related to the firm size.

3.1. Sample

To examine how Serbian processingprocessing firms perceive barriers to green technology implementation, we targeted four climate-relevant processingprocessing sectors: wood and paper, metal products and machinery, food and beverages, and rubber and plastics. We purposively selected these sectors, as they are resource-intensive, contribute substantially to Serbia's industrial carbon footprint, and face strong regulatory and stakeholder pressures associated with the country's EU accession.

Firms were identified through publicly available records from the national SME registry and contacted using a convenience-based approach to maximize participation. Although not random, this strategy provided balanced coverage across the four target sectors. Data were collected between September and December 2024, yielding 256 valid responses. One respondent per firm took part, typically the owner or a senior manager responsible for operational and sustainability decisions. Targeting decision-makers was important, as their perceptions directly shape how barriers are perceived and addressed within the firm. We use a mixed-mode protocol: over 65% of responses were obtained through telephone interviews, and the remainder through an online questionnaire. Participation was voluntary, we obtained informed consent for each respondent and confidentiality was assured.

The sample composition is as follows: metal products and machinery (29.3%), wood and paper (23.8%), food and beverages (23.8%), and rubber and plastics (23.0%). Most firms were small (40.1%) or medium-sized (34.6%), while micro (19.1%) and large enterprises (6.2%) were less represented. The average firm age was 19.38 years (SD = 9.61, range: 0.80–49.90).

Table 1 Descriptive statistic

Variable	Category	n (%)	
Enterprise size	Micro (<10 employees)	49	(19.1)
	Small (10–49 employees)	102	(40.1)
	Medium (50–249 employees)	89	(34.6)
	Large (≥250 employees)	16	(6.2)
Sector	Metal products and machinery	75	(29.3)
	Wood and paper	61	(23.8)
	Food and beverages	61	(23.8)
	Rubber and plastics	59	(23.0)
Firm age (years)	Mean (SD)	19.38	(9.61)
	Range	0.80–49.92	

Source: Authors' calculation

3.2. Variables

We measured perceived barriers to green technology implementation through ten binary indicators (0 = not implemented, 1 = implemented), capturing different obstacles identified in the SME green-transition literature: lack of financial resources, lack of knowledge and expertise, inability to find adequately qualified staff, inability to find appropriate technical solutions, complicated administration, regulatory challenges, lack of demand from clients, perceived non-profitability, high initial costs, and a residual "no challenges or obstacles" category. Respondents could choose multiple barriers, as obstacles to the green transition in processingprocessing firms often occur simultaneously. Enterprise size is a four-level ordinal variable obtained directly from the Serbian Business Registers Agency (Agencija za privredne registre, APR) and coded as 1 = micro, 2 = small, 3 = medium, 4 = large.

3.3. Analytical approach

The analysis proceeded in two main stages. First, we used Pearson chi-square tests of independence to examine whether the proportion of firms reporting each barrier differs significantly across the four size categories. We reported Cramér's V as a measure of effect size. Where expected cell counts were below five — a known concern given the smaller large-firm subgroup (n = 16) — results were verified using exact tests with Monte Carlo simulation (10,000 replicates). Second, because enterprise size is an ordered categorical variable, we applied linear-by-linear association tests to detect monotonic increases or decreases in barrier reporting across the sizes.

To examine differences in green technology implementation across size groups, we used the Kruskal-Wallis H test, with the H statistic distributed as chi-square with $k - 1$ degrees of freedom. We also used the Spearman rank correlation to assess the strength and direction of the relationship between size and the number of implemented technologies. Finally, we computed partial correlations to assess whether the relationship between enterprise size and barrier reporting is weakened when controlling for the number of green technologies implemented (with a two-tailed significance threshold of $p < 05$). All analyses were conducted in IBM SPSS Statistics.

4. RESULTS

Table 2 reports the percentage of firms reporting each barrier, both overall and by enterprise size. The most frequently reported obstacle to green technology implementation was a lack of financial resources, reported by 60.2% of firms. Complicated and demanding administration ranked second (36.7%), followed by high initial costs (28.5%) and regulatory challenges (28.1%). About one quarter of firms reported difficulty in finding adequately qualified staff (25.8%), and approximately one fifth pointed to a lack of in-house knowledge and expertise (21.5%). Less frequently reported barriers included an inability to find appropriate technical and technological solutions (15.6%), lack of demand from clients (11.3%), and perceived non-profitability (6.2%). Only 8.6% of firms reported facing no obstacles to green technology implementation. On average, firms reported 2.33 distinct barriers (SD = 1.67) out of nine items, indicating that obstacles to the green transition tend to co-occur rather than appearing in isolation.

Table 2 Endorsement of perceived barriers to green technology implementation by enterprise size (% within size group)

Barrier	Total (N = 256)	Micro (n = 49)	Small (n = 102)	Medium (n = 89)	Large (n = 16)
Lack of financial resources	60.2	71.4	55.9	61.8	43.8
Lack of knowledge and expertise	21.5	20.4	22.5	19.1	31.2
Cannot find adequate staff	25.8	30.6	26.5	24.7	12.5
Cannot find appropriate technical solutions	15.6	14.3	8.8	24.7	12.5
Complicated administration	36.7	24.5	37.3	42.7	37.5
Regulatory challenges	28.1	20.4	16.7	40.4	56.2
Lack of demand from clients	11.3	6.1	9.8	13.5	25.0
Not profitable	6.2	6.1	2.9	6.7	25.0
High initial costs	28.5	30.6	20.6	34.8	37.5
No challenges or obstacles	8.2	6.1	12.7	4.5	6.2

Note: Values are percentages of firms within each size group endorsing the barrier. Respondents could endorse multiple barriers.
Source: Authors' calculation

Table 3 reports the chi-square tests of independence and the linear-by-linear association tests of trend across the sizes. Three barriers had statistically significant differences across enterprise size. Regulatory challenges showed the strongest and most clearly directional pattern. It rose from 20.4% among micro firms and 16.7% among small firms to 40.4% among medium-sized firms and 56.2% among large firms, $\chi^2(3) = 21.02$, $p < .001$, Cramér's $V = .287$. The linear-by-linear association test confirmed a strongly significant monotonic increase with size, $\chi^2 (1) = 15.29$, $p < .001$. This represents the largest effect observed in the analysis and indicates that the perceived burden of regulatory compliance increases substantially as firms grow.

Perceived non-profitability also varied significantly across size groups, $\chi^2(3) = 11.54$, $p = .009$, $V = .212$. While reporting remained low among micro, small, and medium-sized firms (between 2.9% and 6.7%), it rose sharply to 25.0% among large firms. The linear-by-linear test was likewise significant, $\chi^2 (1) = 3.95$, $p = .047$, supporting a monotonic increase with size.

The third significant difference is related to the inability to find appropriate technical and technological solutions, $\chi^2 (3) = 9.35$, $p = .025$, $V = .191$. This pattern, however, was non-monotonic: endorsement was lowest among small firms (8.8%), highest among medium-sized firms (24.7%), and intermediate among micro (14.3%) and large firms (12.5%). Accordingly, the linear-by-linear test was not significant, $\chi^2 (1) = 2.50$, $p = .114$, indicating that this difference cannot be characterised as a simple size gradient.

In addition to these three findings, lack of demand from clients/consumers showed a significant monotonic trend across size despite a non-significant test ($\chi^2 (3) = 4.95$, $p = .176$; linear-by-linear $\chi^2 (1) = 4.27$, $p = .039$). Reporting increased gradually from 6.1% in micro firms to 25.0% in large firms, suggesting a weak but directionally consistent relationship between firm size and perceived demand-side constraints.

The remaining barriers, lack of knowledge and expertise, inability to find adequate staff, complicated administration, and high initial costs did not reach statistical significance and did not differ significantly across size categories. Lack of financial resources, while the most frequently endorsed barrier overall, displayed the strongest descriptive size gradient in the opposite direction: 71.4% of micro firms reported financial constraints, falling progressively to 43.8% among large firms. The omnibus and trend tests, however,

did not reach significance (χ^2 (3) = 5.27, p = .153; linear-by-linear χ^2 (1) = 1.98, p = .159), most likely reflecting the limited statistical power of the small large-firm subgroup (n = 16).

Table 3 Chi-square tests of independence and linear-by-linear association tests for perceived barriers by enterprise size

Barrier	χ^2 (df = 3)	P	Cramér's V	L-by-L χ^2 (df = 1)	p (trend)
Lack of financial resources	5.27	0.153	0.144	1.98	0.159
Lack of knowledge and expertise	1.31	0.728	0.071	0.08	0.783
Cannot find adequate staff	2.15	0.542	0.092	1.64	0.201
Cannot find appropriate technical solutions	9.35	0.025*	0.191	2.50	0.114
Complicated administration	4.54	0.209	0.133	3.15	0.076
Regulatory challenges	21.02	0.001***	0.287	15.29	0.001***
Lack of demand from clients	4.95	0.176	0.139	4.27	0.039*
Not profitable	11.54	0.009**	0.212	3.95	0.047*
High initial costs	5.63	0.131	0.148	1.50	0.221
No challenges or obstacles	4.78	0.188	0.137	0.61	0.433

Note: χ^2 = Pearson chi-square test of independence; L-by-L = Linear-by-Linear Association test (Mantel-Haenszel test for trend). Cramér's V is reported as a measure of effect size.
* p < .05; ** p < .01; *** p < .001.
Source: Authors' calculation

4.1. The role of green technology implementation

To examine whether the observed size-related differences in barrier perception are linked to firms' actual engagement with green technology, we examined the number of green technologies implemented per firm. Implementation was measured as the count of distinct technologies adopted out of nine surveyed. The number of implemented technologies averaged 3.03 (SD = 1.78, range = 0–8), with 96.1% of firms reporting at least one adopted technology.

A Kruskal-Wallis test confirmed that the number of green technologies implemented differed significantly across enterprise size groups, H (3) = 36.18, p < .001. Implementation rose monotonically with firm size, from a mean of 2.06 technologies among micro firms and 2.71 among small firms to 3.62 among medium-sized firms and 4.81 among large firms. A Spearman rank correlation confirmed the strength and direction of this relationship (r = .375, p < .001). Larger firms implement more green technology than their smaller counterparts.

Firms were than grouped into three implementation levels (low: 0–1 technologies, n = 42; mid: 2–3, n = 134; high: 4 or more, n = 80), and the proportion reporting each barrier was compared across groups (Table 4). Reporting regulatory challenges rose from 7.1% in the low-implementation group to 25.4% in the mid-implementation group and 43.8% in the high-implementation group, χ^2 (2) = 19.31, p < .001. A similar pattern emerged for complicated administration, with endorsement increasing from 21.4% to 33.6% to 50.0% across the three groups, χ^2 (2) = 10.87, p = .004. Other barriers did not differ significantly across implementation levels.

To assess whether implementation level helps account for the relationship between enterprise size and barrier perception, partial correlations were computed between size and each barrier, controlling for the number of green technologies implemented. For regulatory challenges, the correlation with size was reduced from r = .245 (p < .001) to r = .146 (p =

.019), indicating partial mediation: implementation level accounts for a meaningful share, but not all, of the size-related increase in regulatory burden. For complicated administration, the relationship was reduced from r = .111 (p = .076) to r = .037 (p = .556), indicating that the apparent size effect is largely explained by differences in implementation activity. These findings suggest that the regulatory and administrative obstacles reported by larger firms partly reflect their greater engagement with green technology adoption. Firms encounter such barriers more visibly because they are actively implementing green technologies, rather than because of size per se.

Table 4 Endorsement of perceived barriers by green technology implementation level (% within group)

Barrier	Low (0–1 tech.) (n = 42)	Mid (2–3 tech.) (n = 134)	High (≥4 tech.) (n = 80)	χ^2 (df = 2)	P
Lack of financial resources	59.5	61.9	57.5	0.42	0.810
Lack of knowledge and expertise	14.3	26.1	16.2	4.33	0.119
Cannot find adequate staff	28.6	26.1	23.8	0.35	0.84
Cannot find appropriate technical solutions	11.9	17.2	15.0	0.71	0.703
Complicated administration	21.4	33.6	50.0	10.87	0.004**
Regulatory challenges	7.1	25.4	43.8	19.31	0.001***
Lack of demand from clients	14.3	7.5	16.3	4.29	0.117
Not profitable	4.8	6.7	6.3	0.21	0.901
High initial costs	26.2	24.6	36.3	3.45	0.178
No challenges or obstacles	9.5	11.2	3.8	3.59	0.166

Note: Implementation level based on the number of green technologies adopted by the firm out of nine surveyed (energy efficiency, renewable energy, waste management, green products/services, air emissions reduction, water emissions reduction, soil emissions reduction, water consumption optimisation, supply chain optimisation). Values are percentages of firms within each implementation group endorsing the barrier.

* p < .05; ** p < .01; *** p < .001.

Source: Authors' calculation

4.2. Robustness of the chi-square assumption

Because the large-firm subgroup is comparatively small, several cross-tabulations contained expected cell counts below five, formally violating the assumption of the Pearson chi-square test. The barriers most affected were perceived non-profitability (minimum expected frequency = 1.00) and lack of demand (1.81). To verify the robustness of the significant results, we re-ran each test using exact methods with Monte Carlo simulation (2,000 sampled tables, 99% confidence interval). The substantive conclusions remained unchanged: the differences for regulatory challenges and perceived non-profitability remained statistically significant under exact testing. As an additional sensitivity check, we re-ran the analyses combining medium-sized and large firms into a single category. The results were consistent with the main findings, regulatory challenges remained highly significant (χ^2 (2) = 19.34, p < .001), although the size-specific effect for perceived non-profitability was diluted by the merger, confirming that this finding is driven specifically by the distinct position of large firms in the sample.

5. DISCUSSION

The findings of this study provide empirical support for a size-differentiated model of green technology adoption barriers among Serbian processingprocessing firms. The most frequently reported obstacle across the entire sample was the lack of financial resources, endorsed by 60.2% of firms, consistent within the broader international evidence on developing and transition economies (Baharom, 2025). Importantly, the descriptive gradient reveals that financial pressure is most acute among micro enterprises (71.4%), declining steadily toward large firms (43.8%). Although this difference did not reach statistical significance, the direction and magnitude of the descriptive pattern is consistent with the theoretical expectation that resource endowment scales with firm size (Andries & Stephan, 2019; Darnall et al., 2009). This descriptive pattern is consistent with research highlighting the relevance of financing constraints for green technology innovation in China (Zhang et al., 2021) and the role of green financing in supporting solar MSMEs in India (Bandyopadhyay & Kashyap, 2025). Evidence from Indonesian heavy industry and South African SMEs further illustrates the relevance of examining sustainability-related barriers across different enterprise contexts (Panjaitan et al., 2023; Matarirano & Chireka, 2026). This expectation is well grounded in the literature: larger firms typically implement more environmental practices and outperform SMEs in overall climate performance (Caputo et al., 2024), in part because they are better positioned to exploit economies of scale in resource-intensive activities (Dzeraviaha, 2022).

Micro enterprises in Serbia face a compounded disadvantage: they are least likely to have adopted green technologies, yet financial barriers prevent them from initiating the process. Unlike larger firms that are already implementing green technologies, micro firms face a prior obstacle, mobilizing the initial capital to begin. This suggests that financial support instruments, such as subsidized green credit lines or targeted grant schemes, would have the highest marginal impact in the micro-enterprise segment consistent with De Haas et al. (2024).

Regulatory challenges showed the strongest and most clearly monotonic size-related pattern in the entire analysis ($\chi^2(3) = 21.02$, $p < .001$, Cramér's V = .287), rising from 20.4% among micro firms to 56.2% among large firms. This result is consistent with Ali and Singh (2024) finding, that large firms in developing economies are disproportionately exposed to administrative complexity and labour regulation burdens, and with the broader observation that organizational visibility amplifies stakeholder and regulatory pressure (Younis & Sundarakani, 2020). However, when controlling for the number of green technologies implemented, the correlation between enterprise size and perceived regulatory burden was reduced from $r = .245$ to $r = .146$. For complicated administration, the relationship was reduced even more, from $r = .111$ ($p = .076$) to $r = .037$ ($p = .556$), representing the size effect statistically negligible after controlling for implementation activity and indicating that a substantial share of the institutional barrier burden reported by large firms is not a direct function of their organizational scale per se, but rather a consequence of their greater engagement with green technologies.

This finding is conceptually important and represents a contribution to the existing literature. The prevailing framing treats administrative barriers to sustainability as either a general burden (Klement et al., 2023; Banwo et al., 2017) or a size-differentiated one (Ali & Singh, 2024; Basit et al., 2024). Our research findings interpret the administrative barrier to a significant degree, as an exposure effect. Large firms face more intrusive regulation not because they are large, but because they encounter more regulation. As smaller firms progress along the green transition path and implement more green technologies, they too most likely will be exposed to institutional friction at increasing rates.

Perceived non-profitability showed statistically significant jump among large enterprises, with 25.0% reporting it as a barrier compared to only 2.9–6.7% across smaller size groups. One plausible explanation is that micro and small firms have implemented relatively few green technologies on average and are therefore possibly not yet positioned to observe or meaningfully assess the commercial returns of those investments. At early stages of adoption, the question of profitability is largely hypothetical as firms have not accumulated sufficient experience with green technologies to form a reliable judgment about their market impact. Large firms, by contrast, have implemented a substantially broader portfolio of green technologies and can assess profitability. However, domestic demand for green products remains limited, and the overall market infrastructure for capitalising on green credentials is still at an early stage of development. This interpretation carries important policy implications. The micro-enterprise financial barrier calls for supply-side instruments, subsidized credit, grants, and risk-sharing mechanisms that lower the cost of entry into the green transition. The large-firm profitability barrier calls for demand-side instruments: green public procurement policies, sustainability reporting, and preferential market access conditions for firms meeting environmental standards in the context of Serbia's EU accession process. The non-profitability finding among large firms may mask a divergence within that segment between exporters, who can monetise green investment through international market access, and domestically-oriented producers, for whom the profitability case remains structurally weak until domestic demand conditions mature.

Similarly, the monotonic increase in perceived lack of demand from clients across firm size categories (6.1% among micro firms, rising to 25.0% among large firms) suggests that market-side pull signals operate differently across firm segments. Large firms more deeply integrated into supply chains and more exposed to international market expectations, may be more acutely aware of the gap between current demand signals and the investment required for further green transformation.

Overall result also adds nuance to the Slovak evidence (Klement et al., 2023) suggesting that barriers are broadly uniform across size categories: in the Serbian context, financial barriers are indeed widely shared, but institutional barriers are not, they cluster around the most active adopters, who happen to be the largest firms.

6. CONCLUSION

This study examined whether enterprise size shapes the perception of barriers to green technology adoption among Serbian processing firms, using a cross-sectional survey of 256 firms across four climate-relevant processing sectors. The findings confirm that size is a meaningful differentiator, but in a more nuanced way than a straightforward resource-based account would predict.

Enterprise size directly conditions the number of green technologies implemented, with larger firms leading the transition. The mean number of adopted technologies rises monotonically from 2.06 among micro firms to 4.81 among large firms, a pattern confirmed by both the Kruskal-Wallis test and the Spearman rank correlation. This implementation gradient, in turn, structures the barrier landscape in ways that cannot be reduced to size alone. Financial constraints emerge as the most pervasive obstacle overall, reported by 60.2% of firms, and are most acute among micro enterprises, the segment least able to mobilise the capital needed to begin the green transition. Regulatory challenges and

administrative burden, by contrast, increase monotonically with firm size, peaking at 56.2% and 37.5% among large enterprises, respectively. The apparent size-differentiation of institutional barriers is, however, substantially explained by differences in implementation depth, when the number of adopted technologies is controlled for, the correlation between size and regulatory burden weakens meaningfully, and the size effect on administrative burden becomes statistically negligible. The institutional friction experienced by large firms reflects their greater engagement with green technology, not their organizational scale per se.

The findings collectively support the interpretation that financial and institutional barriers operate through fundamentally different mechanisms and at different stages of the adoption lifecycle. Financial constraints function as a gateway barrier as they determine whether a firm can begin the green transition at all, and their persistence across all implementation levels confirms that they are not resolved by the act of adopting technologies. Institutional barriers, particularly regulatory complexity and administrative burden, are better understood as participation barriers: they intensify as firms move deeper into the green technology portfolio, and their apparent concentration among large enterprises reflects engagement with the transition rather than size per se. Policy interventions that treat these two barrier types as equivalent, or that apply uniform support instruments across the enterprise size spectrum, would therefore be structurally misaligned with the reality facing Serbian processing firms. Effective policy design requires a differentiated approach, one that deploys financial instruments to enable entry among micro and small enterprises, while addressing the regulatory and administrative environment that burdens the most active adopters regardless of their scale.

Several limitations of this study should be acknowledged. Because firms were reached through publicly available databases and Chamber of Commerce networks, the sample is not fully representative of the broader Serbian processing population, particularly firms outside the four selected sectors. The non-random nature of the sample also introduces a possibility of self-selection bias, as firms more engaged with sustainability issues may have been more likely to participate. The comparatively small, large-firm subgroup (n = 16) limits statistical power for that category, and some findings concerning large enterprises should be interpreted with appropriate caution. Finally, the cross-sectional design precludes causal inference: the observed relationship between implementation depth and institutional barrier perception is consistent with an exposure mechanism, but longitudinal data would be needed to establish its direction with confidence. Despite these limitations, the sample covers the full enterprise size spectrum across four climate-relevant processing sectors, and the use of partial correlations to disentangle the roles of size and implementation activity represents a methodological contribution that future research could build upon.

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PREPREKE ZA UVOĐENJE ZELENIH TEHNOLOGIJA: DA LI VELIČINA PREDUZEĆA IMA UTICAJA?

Rad analizira da li veličina preduzeća utiče na stepen i dinamiku uvođenja zelenih tehnologija u prerađivačkom sektoru Republike Srbije. Istraživanje je sprovedeno od septembra da decembra 2024. godine, na uzorku od 256 preduzeća različitih veličina. Empirijski nalazi potvrđuju da veličina preduzeća neposredno uslovljava broj uvedenih zelenih tehnologija, pri čemu veća preduzeća prednjače u procesu zelene tranzicije. Institucionalne prepreke, poput složenih administrativnih procedura i usklađivanja sa zakonskim propisima, značajno su izraženije kod velikih preduzeća. Ovakvo stanje ne proizilazi neposredno iz njihove veličine, već predstavlja posledicu primene većeg broja tehnologija od strane ovih preduzeća, usled čega se češće i susreću sa regulatornim zahtevima. Sa druge strane, obezbeđivanje finansijskih sredstava predstavlja dominantan izazov kada su u pitanju mikro preduzeća. Dobijeni rezultati predstavljaju potencijalnu empirijsku osnovu za kreiranje ciljanih mera podrške koje bi doprinele unapređenju procesa zelene tranzicije u domaćim preduzećima iz prerađivačke delatnosti.

Ključne reči: *zelene tehnologije, prerađivački sektor, prepreke*