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Behavioral and Institutional Approaches to Optimizing the Battery Take-Back System in the Czech Republic

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Abstract: Optimizing battery take-back systems is a critical component of the circular economy, yet efficiency remains limited by various systemic barriers. This paper identifies these barriers in the Czech Republic through the lens of behavioral and institutional economics. The main objective is to propose theoretically grounded measures to increase the overall efficiency of the collection system. The research framework integrates concepts from behavioral economics—specifically heuristics and choice architecture—and institutional economics, focusing on transaction costs and the role of formal and informal rules. Utilizing a systematic literature review and a comparative case study analysis involving the Czech Republic, Germany, and Sweden, the study identifies a significant "saturation paradox" where infrastructural growth does not yield proportional increases in collection rates. The findings suggest that focusing on behavioral nudges and reducing non-monetary transaction costs, such as information search costs, is more effective than mere physical expansion of the network. The results offer a strategic basis for policymakers to design more effective environmental regulations and collection systems tailored to the specific institutional context of post-communist economies.

Keywords: battery recycling; behavioral economics; institutional economics; nudge; Czech Republic; circular economy

JEL Classification: Q53; D91; D23

1. Introduction

The transition toward a circular economy has become a fundamental pillar of sustainable development, necessitating efficient systems for resource recovery and waste management (Zhan et al., 2024). Within this framework, the management of hazardous waste, particularly used batteries, represents a critical challenge due to its environmental risks and the strategic value of recovered materials (Zanoletti et al., 2024).

This issue is particularly pressing in light of the evolving legislative landscape of the European Union. The European Green Deal and the subsequent Circular Economy Action Plan (European Commission, 2020) have set ambitious targets for waste reduction and material recovery. Most notably, the recently adopted Regulation (EU) 2023/1542 concerning batteries and waste batteries introduces stricter collection targets (45% by 2023, rising to 63% by 2027) and mandates the implementation of a 'battery passport' to ensure traceability. This

regulation represents a paradigm shift from voluntary compliance to mandatory life-cycle management. However, as noted by Ghisellini et al. (2016), top-down legislative measures often fail if they do not account for the local institutional and behavioral realities of the implementation phase.

Despite the existence of robust legislative frameworks established by the European Union, empirical evidence suggests that the actual efficiency of take-back systems often falls short of theoretical expectations (Schultz, 2014). In the Czech Republic, this discrepancy points to the existence of systemic barriers that traditional economic models may fail to fully capture.

Current research in environmental economics increasingly emphasizes the necessity of integrating behavioral and institutional perspectives to understand these inefficiencies. As identified by Shogren et al. (2021), the success of environmental policy is heavily dependent on the alignment of institutional rules with human psychology. This study builds upon the foundational concepts of behavioral economics, specifically the role of "nudging" and cognitive biases in consumer decision-making (Thaler & Sunstein, 2021). Simultaneously, it draws on New Institutional Economics to analyze how transaction costs and formal rules shape the incentives within the collection system (North, 1990). Recent studies demonstrate that even minor increases in information search costs can significantly deter recycling participation (Wang et al., 2019).

The objective of this paper is to identify the primary behavioral and institutional barriers affecting the battery take-back system in the Czech Republic and to propose optimization measures. Specifically, the research addresses the following question: How do institutional constraints, particularly transaction costs, and behavioral factors, such as cognitive heuristics, influence the effectiveness of waste collection from the perspective of Czech consumers? By synthesizing these two theoretical streams—institutional and behavioral economics, the paper aims to provide actionable insights for both policymakers and collection scheme operators to enhance the efficiency of the circular economy.

2. Methodology

The methodological approach was designed to ensure rigor and replicability. The first phase consisted of a systematic literature review conducted in accordance with the guidelines proposed by Snyder (2019) for integrative reviews. This approach allows for the synthesis of literature on mature topics (transaction costs) with emerging fields (behavioral nudging). The review covered peer-reviewed articles from the Web of Science and Scopus databases published between 2010 and 2024, selected based on their applicability to the specific institutional context of the Czech Republic.

The second phase employed a qualitative case study design, focusing on the Czech Republic as a critical case (Yin, 2018). This method is particularly suitable for investigating contemporary phenomena within their real-life context, specifically when the boundaries between the phenomenon (recycling behavior) and context (institutional rules) are not clearly evident. The empirical analysis synthesized secondary data from the ECOBAT annual reports and the Ministry of the Environment with a legislative analysis of Act No. 542/2020 Coll., on

End-of-Life Products, and the strategic framework of the Regulation (EU) 2023/1542 concerning batteries and waste batteries. Furthermore, a comparative analysis of international best practices from Germany, Sweden, and the Netherlands was conducted to benchmark the Czech system against high-performing European models.

To guide the research and address the identified efficiency gap, two central hypotheses were formulated:

Hypothesis 1 (H1): The current inefficiency of the battery take-back system in the Czech Republic is primarily caused by high non-monetary transaction costs (specifically information search costs), rather than a lack of physical infrastructure.

Hypothesis 2 (H2): Behavioral biases, specifically the status quo bias and the availability heuristic, significantly reduce consumer participation in recycling, regardless of the density of the collection network.

3. Results

The analysis of the battery take-back system in the Czech Republic reveals a significant structural paradox. While the infrastructure for collection has seen extensive growth, the actual performance metrics indicate a period of prolonged stagnation.

3.1. Infrastructure Saturation and Performance Gap

Quantitative assessment of the collection network confirms that physical availability has reached a saturation point. As of 2023, the Czech Republic maintains over 20,500 collection points (ECOBAT, 2024), theoretically providing access to 90% of the population within a short walking distance. However, a longitudinal comparison reveals that the collection rate has fluctuated between 45% and 48% over the last five years. The development of collection rates in relation to the expanding infrastructure, as well as the increasing gap towards the mandatory EU targets, is illustrated in Figure 1.

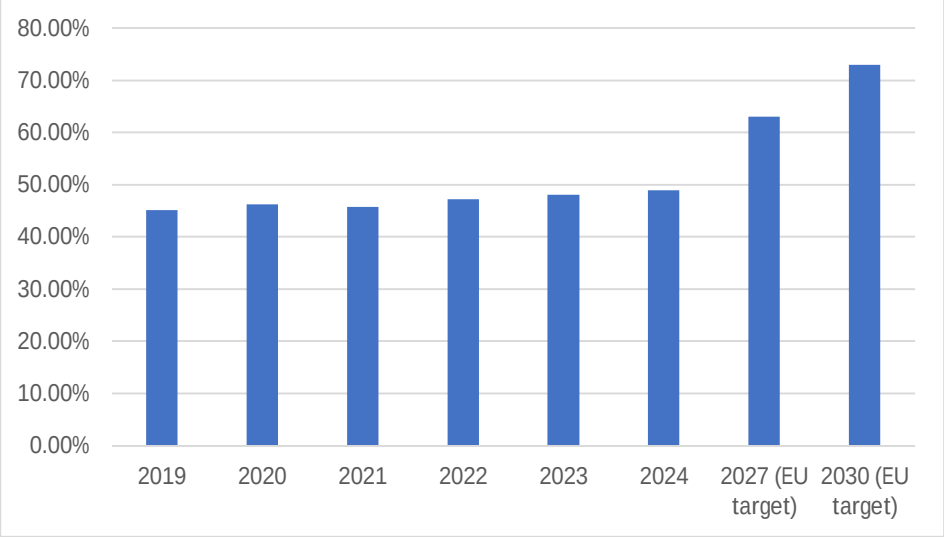

Figure 1. Collection rates of portable batteries in the Czech Republic (2019–2024) and future EU targets for 2027 and 2030

This statistical discrepancy provides the primary empirical evidence for Hypothesis 1 (H1). Since a 15% increase in the density of collection points did not yield a proportional increase in efficiency, it is evident that physical distance is no longer the primary limiting factor. The barrier has shifted from physical access to information search costs. Applying North's (1990) institutional framework, we identify that the "cost" of participation is not defined by meters to the bin, but by the cognitive effort required to identify the correct disposal method and verify sorting rules under the Act No. 542/2020 Coll., on End-of-Life Products.

3.2. Comparative Analysis of International Models

To contextualize the Czech results, the study benchmarked the local system against high-performing European models (Germany and Sweden). This comparison highlights the role of informal institutions and different regulatory approaches. The institutional configurations and behavioral drivers vary significantly across the examined countries, as summarized in Table 1.

Table 1. Institutional comparison of battery take-back systems

Country	Key Mechanism	Performance Level	Primary Driver
Czech Republic	Physical Infrastructure	Stagnating (~49%)	Information search costs
Germany	Retail Integration	High (>50%)	Institutional convenience
Sweden	Normative Influence	High (>55%)	Social trust & moral duty

The comparison illustrates that while the Czech Republic relies primarily on the density of its physical infrastructure, the higher efficiency in the benchmarked countries is driven by lower transaction costs or stronger social norms.

The German Model (Institutional Efficiency): G Germany achieves superior collection rates by integrating collection points directly into the "natural pathways" of consumers (OECD, 2018). By placing highly visible bins at retail exits and high-traffic areas, the system reduces transaction costs to near-zero. This minimizes the cognitive load on the consumer, as the act of disposal is integrated into the act of daily shopping, a strategy consistent with the principles of choice architecture (Thaler & Sunstein, 2021).

The Swedish Model (Normative Influence): Sweden demonstrates that high social trust and established environmental norms can effectively compensate for logistical complexity (Lundgren, 2020; Naturvårdsverket, 2023). In this model, recycling is internalized as a social duty. This normative pressure serves as an informal institution that reduces the need for external behavioral nudges, as the population exhibits high intrinsic motivation to comply with environmental regulations (Schultz, 2014).

In contrast, the Czech Republic is currently situated in an 'institutional trap' (North, 1990). It lacks the extreme retail visibility and logistical convenience of the German model, while also lacking the deeply rooted normative pressure found in Sweden. Consequently, further expansion of the physical network in the Czech Republic may yield diminishing returns (ECOBAT, 2024), unless fundamental behavioral and institutional frictions—specifically search costs and habit persistence—are addressed.

3.3. Identification of Behavioral Barriers

The persistence of batteries in municipal solid waste (approx. 50% of sold volume) confirms the dominance of cognitive biases, validating Hypothesis 2 (H2). Two specific biases were identified as critical:

Status Quo Bias: Consumers default to the easiest available option, due to habit persistence. Without a disruptive trigger, the intention to recycle is overridden by routine.

Availability Heuristic: Because collection containers in the Czech Republic are often placed in low-visibility zones (e.g., inside administrative buildings or behind store counters), they do not trigger the mental "reminder" at the moment of disposal.

The analysis suggests that current information campaigns are often ineffective because they appeal to conscious, rational decision-making. However, the act of disposal is largely governed by automatic habits and routine. As described by Kahneman (2011), without a disruptive cue to break this routine, the cognitive effort required to recycle overrides the intention to do so.

4. Discussion

The findings of this research reveal a fundamental discrepancy between infrastructural supply and behavioral response within the Czech battery take-back system. While the collection network has expanded to over 20,500 points (ECOBAT, 2024), the stagnation of collection rates at approximately 45–48% suggests that the system has reached its marginal utility in terms of physical expansion. This aligns with the "saturation paradox" observed by Wang et al. (2019), indicating that the limiting factor is no longer the "hardware" (infrastructure) but the "software" (institutional rules and consumer psychology).

4.1. The Institutional Efficiency Gap and Transaction Costs

The validation of Hypothesis 1 (H1) demonstrates that the Czech system is currently hindered by high non-monetary transaction costs. Although Act No. 542/2020 Coll. provided a solid legal foundation for Extended Producer Responsibility (EPR), it inadvertently placed a significant cognitive burden on the end-user. As theorized by North (1990), if the information search costs (identifying where and how to sort) exceed the perceived utility of the action, rational actors will default to non-participation. In the Czech Republic, the lack of a unified digital interface and the low visual prominence of collection points in retail spaces maintain these transaction costs at an inhibitive level.

From an economic perspective, this study demonstrates that further extensive expansion of the physical network exhibits diminishing marginal utility. For both firms and the state, it is financially more efficient to allocate resources toward digital integration and unified information platforms that reduce information search costs, rather than investing in further densification of a network that has already reached its saturation point. This shift from quantitative to qualitative optimization can lead to significant savings in the total logistics costs of the take-back system.

4.2. Behavioral Inertia: Habit vs. Conscious Deliberation

The persistent presence of batteries in municipal solid waste provides strong evidence for Hypothesis 2 (H2) regarding behavioral biases. The core failure of current communication strategies is their reliance on conscious, rational decision-making. Educational campaigns assume that consumers make an active choice to recycle. However, as Kahneman (2011) points out, routine waste disposal is largely an automatic, habitual activity. The status quo bias acts as a powerful deterrent; without a disruptive "nudge" in the physical environment, the consumer defaults to the easiest path—the general waste bin. The Czech system currently lacks effective "choice architecture" to trigger an impulse at the moment of disposal. Our findings suggest that unless collection bins are moved from hidden corners to "natural decision pathways" (e.g., apartment exits), the gap between the intention to recycle and the actual behavior will remain.

Instead of costly rational educational campaigns, operators should focus on 'visual disruption' of consumer routines. Implementing aesthetically distinct and visually prominent containers in residential zones serves as a low-cost behavioral trigger that effectively overcomes the status quo bias more efficiently than traditional information appeals.

4.3. Cultural Context and Social Norms

A critical nuance is the role of cultural friction. Comparing the Czech Republic to the Swedish model highlights a difference in informal institutions. Sweden's success is built on high social trust where recycling is a moral obligation. As noted by Kaasa et al. (2014), post-communist societies often exhibit lower levels of institutional trust, meaning consumers are less likely to respond to "moral suasion" alone. This implies that for the Czech Republic to meet the ambitious targets of Regulation (EU) 2023/1542 (63% by 2027), it must focus more on environmental design and digital convenience than on traditional normative appeals.

4.4. Practical Implications and Future Research

From the perspective of the Circular Economy, the current focus is disproportionately shifted toward end-of-pipe collection. As argued by Kirchherr et al. (2017), a true circular transition requires higher-order strategies (Reduce, Reuse). While the new Battery Passport will reduce information asymmetry, the physical "last mile" of collection will still fail if behavioral triggers are missing. Future research should employ field experiments (A/B testing) to quantify the exact impact of visual nudges and social feedback on actual collection volumes in Czech residential areas.

For collective system operators and retailers, the research suggests that success lies not in merely increasing the number of collection points, but in their strategic placement within the consumer's 'natural decision-making paths. A key managerial recommendation is to relocate collection boxes from less visible areas—such as behind counters or in administrative zones—directly to store exits or near parking payment machines, thereby reducing non-monetary transaction costs for consumers to near zero.

5. Conclusions

The objective of this paper was to identify the primary institutional and behavioral barriers hindering the efficiency of the battery take-back system in the Czech Republic. The research demonstrates that the current stagnation in collection rates is not a result of infrastructural deficiency, but rather a consequence of high transaction costs and cognitive biases. Based on the synthesis of empirical data and theoretical frameworks, the study confirms that the high density of the collection network has reached a point of diminishing returns. The primary barrier has shifted to information search costs (validating H1), where consumers face significant ambiguity regarding disposal rules under Act No. 542/2020 Coll. Simultaneously, consumer behavior is inhibited by the status quo bias (validating H2), as the lack of visual cues and environmental nudges in the physical decision-making pathway leads individuals to default to automatic habits of disposing of batteries in general waste.

To overcome these barriers and meet the ambitious targets of Regulation (EU) 2023/1542, a strategic shift from quantitative expansion to qualitative optimization is required. This paper proposes a hybrid intervention strategy that addresses both institutional and behavioral constraints. From an institutional perspective, digital integration through unified interactive platforms is essential to minimize search costs. Complementing this, the redesign of the choice architecture through highly visible, aesthetically distinct collection containers in residential common areas is necessary to break behavioral inertia.

The study provides three main practical contributions. First, for operators, it identifies the necessity of re-designing choice architecture within retail environments. Second, for policymakers, it provides evidence of the inefficiency of further physical network expansion and recommends a strategic focus on digital tools to reduce transaction costs. Third, regarding economic benefits, it proposes cost optimization through behavioral interventions, which are financially less demanding than large-scale infrastructural changes.

Future research should focus on the experimental verification of specific behavioral nudges in the Czech retail context, prioritizing field-based A/B testing to quantify the effectiveness of these interventions in real-world settings. Additionally, investigating the long-term sustainability of these behavioral changes compared to traditional awareness campaigns remains a key challenge for further study.

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Conflict of Interest: none

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