

No green without digital: rethinking the twin transition. Evidence from Lithuania

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Abstract

Purpose – This study examines what actually predicts green digital tool adoption at the population level, testing the EU twin transition framework’s assumption that environmental motivation is the primary predictor of adoption.

Design/methodology/approach – A nationally representative face-to-face survey of 1,004 Lithuanian adults measured adoption of six green digital tools alongside sociodemographic variables, digital lifestyle engagement across five domains, AI awareness, and environmental attitudes. Hierarchical regression compared the incremental explanatory power of each predictor block.

Findings – Digital lifestyle variables explain 15.6% of additional variance beyond sociodemographics (37.7%), while AI awareness adds only 0.1% and environmental attitudes add just 0.5%. Non-users and high users differ 5-to-7-fold on digital engagement metrics but only marginally on environmental attitudes (3.25 vs. 3.84 on a 5-point scale), indicating that non-adoption is better explained by digital exclusion than by environmental indifference.

Research limitations/implications – The cross-sectional design precludes causal inference. Findings are based in a single national context, and replication across other EU member states is needed.

Practical implications – Digital inclusion, particularly skills investment for older adults and rural populations, may be a more effective policy lever for expanding green digital tool adoption than environmental awareness campaigns.

Social implications – The EU twin transition risks deepening existing inequalities if green digital tools remain accessible only to the digitally included. These patterns suggest digital inclusion functions as an enabling condition for green digital participation rather than a parallel agenda.

Originality/value – This is the first population-level empirical study of green digital tool adoption across multiple tool categories simultaneously. It demonstrates that the green digital divide is empirically indistinguishable from the digital divide and shows that this weak attitude-behavior association does not strengthen among the digitally capable, indicating a capability gap rather than a motivational one.

Keywords Green digital tools, Digital divide, Twin transition, Environmental attitudes, Digital lifestyle, Sustainable technology adoption

Paper type Research article

1. Introduction

The European Union has placed the “twin transition” (i.e. the simultaneous pursuit of digital transformation and environmental sustainability) at the center of its strategic agenda. The European Green Deal Coalition (European Commission, 2021a, b, c, d), the Digital Decade Policy Programme 2030; European Parliament and Council of the European Union (2022), and the 2030 Digital Compass (European Commission, 2021a, b, c, d) all operate on a shared premise that digital technologies can serve as enablers of environmentally sustainable behavior (Muench *et al.*, 2022). Smart meters will help households reduce energy



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consumption, CO2 tracking applications will make carbon footprints visible and actionable, sharing platforms will reduce resource use, and intelligent transport systems will optimize mobility. The implicit theory of change is that citizens who care about the environment will adopt these tools, and that increasing environmental awareness will therefore increase digital green behavior.

This assumption, however, has rarely been tested empirically at the population level. While a growing body of research has examined pro-environmental behavior (Stern, 2000; Kollmuss and Agyeman, 2002; Vieira *et al.*, 2023; Miller and Rice, 2024) and digital technology adoption (Venkatesh *et al.*, 2003; van Dijk, 2020; Lythreathis *et al.*, 2022; Răileanu Szeles, 2024; Wang, 2025) as separate domains, surprisingly little work has investigated who actually uses green digital tools and why. The few studies that exist tend to focus on individual technologies in isolation. For example, smart meter acceptance (Krishnamurti *et al.*, 2012), electric vehicle app usage (Chen *et al.*, 2020), or platform economy participation (Hamari *et al.*, 2016), rather than examining green digital tool adoption as a behavioral pattern. This leaves a critical gap: we do not know whether green digital tool adoption is primarily driven by environmental motivation, by digital capability, or by some combination of the two. EU-wide surveys consistently reveal a striking gap between stated concern and personal engagement. The Special Eurobarometer 513 found that 93% of Europeans consider climate change a serious problem and 90% support making the EU climate-neutral by 2050, yet only 64% report consciously making sustainable choices in their daily lives (European Commission, 2021a, b, c, d). The present study suggests this pattern extends into the digital domain: environmental concern, however strongly held, does not straightforwardly translate into adoption of the green digital tools that the twin transition agenda depends upon.

This question has significant policy implications. If green digital tool adoption is driven by environmental values, then awareness campaigns and value-based interventions are the appropriate policy response. If, however, adoption is driven by general digital engagement (i.e. meaning that green tools are simply one expression of a broader digital lifestyle) then digital inclusion policies become the primary lever. The distinction matters especially for the EU's twin transition agenda, which currently treats digitalization and greening as complementary forces that can be advanced in parallel. If the twin transition's green digital tools are only accessible to the digitally included, the agenda risks deepening rather than bridging existing inequalities (Kovacic *et al.*, 2024).

Recent critical scholarship has questioned whether the twin transition framework adequately accounts for who benefits from the coupling of digital and environmental policy. Kovacic *et al.* (2024) argue that the twin transition discourse functions as a legitimization strategy that reduces complex environmental challenges to problems solvable by digital technology, while neglecting questions of access and equity. Similarly, the EU's own Joint Research Centre has acknowledged that the digital transition must be inclusive if it is to deliver on its green promise, noting that "making the twin transition fair and inclusive can make its acceptance easier" (Muench *et al.*, 2022, p. 12). Yet empirical evidence on who is included and excluded from the green digital transition remains scarce.

The present study addresses this gap by examining predictors of green digital tool adoption in Lithuania, an EU member state that provides a particularly informative context for this question. As a post-Soviet society that has undergone rapid but uneven digital modernization, Lithuania exhibits sharp digital divides along age, settlement, and education lines (Statistics Lithuania, 2023; European Commission, 2022). Divides that coincide with substantial variation in green digital tool usage. At the same time, previous research has documented that Lithuanian residents hold moderate environmental concern but exhibit low climate self-efficacy and tend to externalize responsibility for climate action to government and institutions (Mačiulienė *et al.*, 2025; Balžekienė and Budžytė, 2021; Telešienė *et al.*, 2021). This combination (i.e. present environmental attitudes but variable digital capacity) makes Lithuania an ideal case for disentangling the relative contributions of values and capabilities to green digital behavior.

Using a representative face-to-face survey of 1,004 Lithuanian adults, we employ hierarchical regression to systematically compare the explanatory power of sociodemographic characteristics, digital lifestyle variables, AI awareness, and environmental attitudes. **Our core finding is stark: digital lifestyle variables explain over 30 times more variance in green tool adoption than environmental attitudes ($\Delta R^2 = 0.156$ vs. 0.005).** People who use more digital services in their daily lives, who are younger, more educated, and urban-dwelling, are far more likely to use green digital tools, regardless of how concerned they are about the environment. This leads us to argue that the *green digital divide* is better understood as a manifestation of the digital divide than as a gap in environmental motivation.

Against this background, the present study addresses three research questions. RQ1: To what extent does broader digital engagement predict green digital tool adoption beyond sociodemographic characteristics? RQ2: Does AI awareness contribute to green digital tool adoption beyond general digital lifestyle? RQ3: Do environmental attitudes add explanatory power to green digital tool adoption once digital lifestyle and AI awareness are accounted for? Together these questions allow us to test whether the twin transition framework's implicit theory of change (that environmentally motivated citizens will adopt green digital tools) is supported at the population level, or whether adoption is better explained by the general digital engagement patterns documented in digital divide research.

The study contributes to three literatures. First, it provides population-level empirical evidence to the emerging critical discourse on the EU's twin transition, demonstrating that the framework's implicit theory of change may be targeting the wrong predictor. Second, it extends digital divide research by showing that green digital tools follow the same adoption patterns as other digital activities, reinforcing calls for inclusive digital policy. Third, it contributes to the environmental behavior literature by documenting a case where the well-known attitude-behavior gap is not primarily a motivational failure but a capability failure: people hold the attitudes but lack the digital means to act on them.

2. Literature review

2.1 *The twin transition and green digital tools*

The "twin transition" concept holds that digital and green transformations must advance together rather than separately. Since the European Green Deal explicitly framed digital technologies as "critical enablers" of sustainability goals, this joint agenda has become a cornerstone of EU climate and industrial policy. The European Commission's Joint Research Centre (JRC) foundational synthesis of this agenda (Muench *et al.*, 2022) describes the twin transition not merely as two concurrent trends but as an intentional coupling strategy: digital innovation is expected to enable environmental sustainability, while the green transition is expected to generate demand for digital tools. At the firm level, digital transformation has likewise been positioned as a catalyst for sustainability outcomes (Faraz *et al.*, 2025). Critically, however, Muench *et al.* (2022) themselves acknowledge that the two transitions are "not automatically aligned" and that achieving their mutual reinforcement requires a "proactive and integrative approach", a caveat that policy discourse has largely set aside. Green digital tools (i.e. technologies that enable individuals to monitor, reduce, or optimize their environmental impact through digital means) occupy a central role in this framework. These include smart energy meters that provide real-time consumption feedback (Krishnamurti *et al.*, 2012), carbon footprint calculators and tracking applications that make personal emissions visible and actionable (Hoffmann *et al.*, 2022), sharing economy platforms that reduce resource consumption through collaborative use (Hamari *et al.*, 2016), micro-mobility applications for e-scooters and bike-sharing (Si *et al.*, 2020; Chen *et al.*, 2020), intelligent transport planning tools that facilitate modal shift toward public transport (Brakewood and Watkins, 2019), and electronic ticketing systems that replace physical infrastructure while reducing paper consumption and improving service accessibility (Faber and Brakewood, 2024). These EU policy frameworks implicitly rely on citizen uptake of such

tools to achieve emissions reduction goals. Yet the behavioral drivers identified in domain-specific studies do not consistently align with the environmental framing through which policy presents these tools. The twin transition framework rests on a largely untested behavioral assumption: that environmental concern is the primary driver of green digital tool adoption. Such a logic is consistent with established theoretical models of pro-environmental behavior. Stern's (2000) value-belief-norm (VBN) theory, for instance, posits a causal chain in which environmental values activate beliefs about the consequences of environmental degradation, which in turn generate personal norms that motivate pro-environmental action. Similarly, Kollmuss and Agyeman's (2002) analysis of the attitude-behavior gap in environmental behavior identifies environmental knowledge and concern as the intended, if frequently insufficient, drivers of environmentally significant action. Applied to the green digital domain, these frameworks would predict that environmental values and perceived personal responsibility for climate change are the primary drivers of green digital tool adoption. Whether this prediction holds at the population level remains an empirical question the present study is designed to test.

A growing body of domain-specific research has examined adoption of individual green digital tools. Research on carbon footprint tracking app adoption, for instance, finds that hedonic enjoyment and perceived social benefit, rather than environmental concern, are the primary predictors of adoption intention, with the utilitarian "technology as solution" belief playing only a conditional moderating role (Hoffmann *et al.*, 2022). Similarly, the actual behavioral effects of carbon tracking tools tend to be modest and short-lived, raising questions about whether adoption alone constitutes meaningful climate action (Lasarov *et al.*, 2024). Studies of smart meter acceptance find that perceived usefulness, privacy concerns, and problem perception regarding energy issues are stronger predictors of adoption than environmental attitudes *per se* (Krishnamurti *et al.*, 2012). Research on sharing economy platform participation similarly reveals, that economic motivations and enjoyment, rather than sustainability values, are the dominant drivers of collaborative consumption, and that an attitude-behavior gap exists where environmental concern does not reliably translate into platform use (Hamari *et al.*, 2016). Studies of sustainable mobility app adoption and micro-mobility services find that perceived behavioral control, habit, and facilitating conditions are more influential than ecological motivation (Si *et al.*, 2020; Chen *et al.*, 2020). A consistent pattern emerges across these domains: the assumption that environmental values drive green digital tool adoption is, at best, partially supported by empirical evidence.

This pattern is compounded by evidence of structural inequality in access to green technologies. Research on solar PV adoption consistently shows that uptake is concentrated among higher-income, better-educated, and urban households, with disadvantaged communities systematically underrepresented regardless of their environmental concern (Lukanov and Krieger, 2019). Earlier work by Rätty and Carlsson-Kanyama (2010) similarly documented that energy consumption patterns, including adoption of more efficient technologies, are more strongly patterned by sociodemographic characteristics than by environmental attitudes. These findings suggest that the distributional consequences of the twin transition deserve at least as much attention as its technical feasibility.

Critical scholarship has further challenged the conceptual foundations of the twin transition. Kovacic *et al.* (2024) argue that EU policy discourse frames the coupling of digital and green transitions through "simplified win-win ideas, supported by digital imaginary," obscuring genuine tensions between a digital logic of unlimited technological possibility and a green logic of planetary limits. Building on this critique, Kovacic and Argüelles (2025) further argue that the twin transition reorients environmental governance itself by recasting environmental challenges as problems amenable to digital solutions, displacing attention from issues that resist digitalization (such as biodiversity loss or soil degradation) and from the material costs of digital infrastructure. On this reading, the twin transition is better understood as an industrial competitiveness strategy with environmental framing than as an environmental agenda enabled by digitalization. The assumption that citizens will adopt green digital tools

because they care about the environment is therefore not only empirically untested but potentially theoretically misconceived, a gap the present study addresses directly.

Two related conceptual currents in the broader twin transition literature warrant brief mention because they sit adjacent to, though distinct from, the citizen-level adoption question examined here. First, the literature on *digital twins*, real-time virtual replicas of physical infrastructures used to model and optimize urban energy, mobility, and water systems, locates the twin transition primarily in the technical-infrastructure domain rather than at the level of everyday citizen practice (Tzachor *et al.*, 2022). Second, the *smart citizen* literature on participatory environmental sensing, including DIY air quality monitoring and community-led pollution mapping, foregrounds active environmental knowledge production by citizens (Gabrys, 2014; Balestrini *et al.*, 2017). The present paper is concerned with a more passive form of citizen participation in the twin transition: the everyday adoption of pre-built green digital tools rather than infrastructural co-design or sensor-based environmental monitoring. We return briefly to the relationship between these strands in the discussion.

2.2 The digital divide and digital lifestyles

What each of green tool categories shares is a dual character: they are simultaneously environmental interventions and digital products, requiring both environmental motivation and digital capability from their users (Stern, 2000; Venkatesh *et al.*, 2003; van Dijk, 2020). This dual character has a direct implication for how adoption should be studied. Green digital tools are subject to the same constraints that govern digital behavior more broadly: the skills, habits, and confidence that shape whether and how extensively individuals engage with digital technologies (van Deursen and van Dijk, 2014; Hargittai and Hsieh, 2012). These capacities are unequally distributed across populations in ways that have little to do with environmental motivation (van Dijk, 2020; Robinson *et al.*, 2015). Understanding green digital tool adoption therefore requires engaging with digital divide scholarship.

Digital divide research has evolved significantly since the early focus on binary access: who has internet and who does not. Van Dijk's (2020) resources and appropriation theory identifies four successive types of access: motivational access (willingness to use digital technology), material access (physical availability), skills access (competencies for effective use), and usage access (meaningful, diverse application). Contemporary digital divide scholarship focuses primarily on the third and fourth levels, recognizing that in societies with near-universal internet connectivity, the critical divides concern quality and breadth of digital engagement rather than simple connectivity (Robinson *et al.*, 2015).

The shift from access to skills and usage as the central concern is well-documented empirically. Van Deursen and van Dijk (2014) identified six distinct internet skill types (operational, formal, information, communication, content creation, and strategic) and demonstrated that these skills are unequally distributed along sociodemographic lines even among individuals with identical material access. Hargittai and Hsieh (2012) extended this argument to usage patterns, showing that sociodemographic factors predict not only whether people use the internet but how they use it, with more advantaged groups consistently engaging in a wider range and higher complexity of online activities.

A key insight from this literature is that digital activities tend to cluster into lifestyles or repertoires rather than existing as isolated behaviors. Individuals who use e-government services, for example, also tend to use digital culture offerings, online civic participation tools, and a greater variety of devices (van Deursen and van Dijk, 2019; Robinson *et al.*, 2015). This clustering suggests that digital engagement operates as a general capacity that structures participation across specific digital activities. Ragnedda (2018) conceptualizes this capacity as "digital capital" and argues that it functions analogously to other forms of capital: it is socially distributed, reinforced by existing advantages, and converts into social and cultural capital in ways that amplify broader inequalities. Robinson *et al.* (2015) make the policy stakes of this argument explicit: because usage gaps now matter more than access gaps, interventions

targeting connectivity alone are insufficient; the determinants of digital breadth are the same sociodemographic factors that drive other forms of social stratification. The assumption that environmental motivation drives green digital tool adoption is further challenged by a substantial body of evidence on the attitude-behavior gap in environmental psychology. Meta-analyses consistently show that environmental concern is a weak and culturally variable predictor of actual behavior (Morren and Grinstein, 2016), and that even in favorable conditions, attitudes explain only a modest share of behavioral variance once structural variables are included (Bamberg and Möser, 2007). Recent cross-national evidence confirms that attitude-behavior relationships vary substantially across contexts and measures, and that efficacy and structural factors consistently outperform general environmental concern as predictors of specific actions (Miller and Rice, 2024; Vieira *et al.*, 2023). Green identity and environmental values show similarly inconsistent relationships with specific behaviors (Whitmarsh and O'Neill, 2010). Taken together, this evidence suggests that even among environmentally motivated individuals, capability constraints, including digital skills and habits, may matter more than motivation for whether green digital tools are actually adopted.

Recent scholarship confirms and extends these foundational arguments. Systematic reviews of digital divide research consistently find that education is the single strongest predictor of digital engagement, and that the majority of empirical work now focuses on the second-level divide of skills and usage rather than access (Lythreathis *et al.*, 2022; Vassilakopoulou and Hustad, 2023), and validated instruments now exist for measuring digital capability, including among older adults (Wiroonrath *et al.*, 2024). Both reviews also confirm that digital inequality closely mirrors offline social stratification, reinforcing rather than compensating for existing inequalities in education, income, and occupational status. At the European level, this pattern is empirically demonstrated by Răileanu Szeles (2024), whose typology of EU internet users based on Eurobarometer data identifies six distinct user groups with sharply differentiated sociodemographic profiles. Education and income emerge as the most consistent predictors of both the breadth and sophistication of digital engagement across member states, providing direct European evidence for the usage clustering argument central to the present study. Recent empirical work corroborates this clustering argument. Wang (2025), using latent class analysis on a large representative sample, identify four distinct digital engagement profiles based on online activity patterns, confirming that individuals cluster into coherent repertoires rather than distributing evenly along a single dimension of use. In the European context, Janssen *et al.* (2024) similarly find that digital participation across nine countries organizes into distinct dimensions shaped by broader sociocultural resources and prior digital habits. Both studies support the conclusion that digital engagement operates as an integrated general capacity rather than a set of independent behaviors, reinforcing the core digital divide argument that who uses digital tools, and how extensively, is shaped primarily by sociostructural position rather than domain-specific motivation.

A further strand of recent scholarship situates green digital tool adoption within the broader question of democratic participation in digitalized environmental governance. Kloppenburg *et al.* (2022) distinguish three dimensions through which digital technologies reshape governance: ways of seeing and knowing the environment, ways of participating and engaging in environmental decision-making, and ways of intervening and acting. They argue that the use of digital technologies does not automatically result in more inclusive or democratic governance; in fact, digitally-mediated participation can entrench technocratic framings, exclude those without the requisite digital capacities, and reduce environmental citizenship to a series of data-generating actions. Read against the present study's empirical context, this critique sharpens the policy stakes: if the green digital tools through which citizens are invited to participate in the twin transition (smart meters, e-tickets, sharing platforms, environmental tracking apps) are accessible primarily to the digitally engaged, then the "participatory turn" of EU environmental policy risks reproducing the same inequalities at the level of governance that the digital divide already produces at the level of access. The democratic implications of this asymmetry have received little systematic empirical attention.

If green digital tools follow this general pattern of digital behavior clustering, their adoption would be predicted more strongly by general digital engagement than by domain-specific environmental motivation. This represents the central hypothesis of the present study. The demographic predictors of digital engagement are well-established: age, education, income, and urbanization consistently predict both the breadth and depth of digital activity (van Dijk, 2020). In post-Soviet societies such as Lithuania and the broader Central and Eastern European region, these divides can be particularly pronounced due to the compressed timeline of digital modernization, which has created sharp generational differences between those who grew up with digital infrastructure and those who did not (Skaletsky et al., 2016).

2.3 The Lithuanian context

Lithuania provides a particularly informative setting for studying green digital tool adoption for several reasons. First, as an EU member state, Lithuania operates within the twin transition policy framework and is subject to the Digital Decade targets and Green Deal objectives. However, implementation of these frameworks at the local level has been uneven. The European Court of Auditors (2024) found that approximately 70% of Lithuanian municipalities were unaware of the EU Climate Change Adaptation Strategy, and only 16% had developed local climate adaptation plans, indicating substantial gaps between EU-level ambition and local-level implementation.

Second, Lithuania exhibits the compressed digital modernization pattern characteristic of post-Soviet societies, with rapid infrastructure development creating sharp generational and territorial divides in digital engagement. According to the DESI 2022 country report, Lithuania ranks 20th out of 27 EU member states in the human capital dimension: only 49% of the population commands basic digital skills, below the EU average of 54%, while above-basic digital skills stand at 23% compared to the EU average of 26% (European Commission, 2022). Although Lithuania has strong digital infrastructure in urban areas and performs well above the EU average in fibre broadband household coverage, it remains substantially behind in 5G deployment, and rural connectivity remains limited (European Commission, 2022). This infrastructure asymmetry is compounded by generational patterns: across the EU, the share of people aged 65–74 with at least basic digital skills is roughly half that of the 25–34 age group, a gap that is particularly pronounced in post-Soviet societies where older cohorts had no exposure to digital technologies during formative years (Eurostat, 2023). Within the Baltic states, Estonia is widely recognized as a regional digital leader, while Latvia and Lithuania lag behind, with Lithuania underperforming Estonia on most second- and third-level digital divide indicators (Fouskas et al., 2023). Importantly, Lithuania's education-based digital skills gap, at 22% points between highly and low-educated individuals, is among the smallest in the EU, suggesting that generational and territorial factors rather than educational stratification are the dominant axes of digital inequality in the Lithuanian context (Eurostat, 2023).

Third, existing research on Lithuanian environmental attitudes reveals an instructive pattern. Telešienė et al. (2021), in a nationally representative study of climate change attitudes in Lithuania, documented that the population holds moderate environmental concern but exhibits low climate self-efficacy and a strong tendency to externalize responsibility for climate action to government, EU institutions, and business rather than to individual citizens. This pattern of present-but-passive environmentalism is further corroborated by Balžekienė and Budžytė (2021), who found that while environmental values are broadly distributed across the Lithuanian population, they show weak and inconsistent relationships with specific behavioral intentions. This combination is precisely the context where one would expect digital capability rather than environmental motivation to predict whether green digital tools are adopted: if environmental concern is broadly shared but weakly linked to action, and if digital engagement is sharply stratified by age, settlement type, and prior digital experience, then the digital divide rather than the environmental attitude-behavior gap becomes the primary explanatory framework for adoption patterns.

Taken together, these theoretical perspectives converge on a testable proposition: that green digital tool adoption is better understood as a manifestation of general digital engagement than as an expression of environmental motivation. The following study examines this proposition empirically using nationally representative survey data from Lithuania.

3. Method

3.1 Survey design and sample

Data were collected through a nationally representative face-to-face survey of 1,004 Lithuanian adults (aged 18 and older), conducted in September–October 2025 by the professional survey company Baltijos Tyrimai. The measures reported here were embedded within a broader survey covering digital behavior, civic engagement, and attitudes toward technology across multiple domains. The survey employed multistage stratified random sampling. Respondents were selected using a route sampling method, with households chosen at fixed intervals along predetermined routes and individual respondents selected within households using the nearest-birthday rule, with up to three contact attempts made per household. Data were collected across 108 sampling points covering 31 urban and 36 rural locations across all ten Lithuanian counties. The sampling frame covered the non-institutionalized adult population; individuals in correctional facilities, inpatient medical institutions, and those without a fixed address were excluded. Population weights were applied in all analyses to adjust for remaining sampling discrepancies. The sample size of 1,004 yields a maximum margin of error of $\pm 3.1\%$ at the 95% confidence level.

The sample comprised 41% male and 59% female respondents. Age distribution included 16.5% aged 18–29, 29.2% aged 30–49, and the remainder aged 50 and above. By education, 5.3% had basic education, 47.1% secondary, 28.1% post-secondary, and 19.5% university education. Settlement types included rural areas (32%), small towns (25%), and major cities (43%). Regarding financial situation, 19.9% self-rated as poor, 48.2% as average, and 31.9% as good.

3.2 Measures

Dependent variable. Green digital tool adoption was measured as a count variable (range 0–6) summing binary yes/no indicators of whether respondents had ever used each of six green digital tools presented on a standardized response card (Card Q23): smart energy meters or thermostats, CO₂ and energy tracking applications, sharing and travel platforms, e-scooter and bike-sharing applications, public transport planning applications, and electronic tickets as a replacement for paper tickets. Respondents were first asked whether they were aware of each tool (Q23A) and then whether they had ever used it (Q23B); the adoption measure is based on the usage indicator. The mean was 1.29 (SD = 1.36). For descriptive purposes, respondents were also classified into four groups: non-users (0 tools, 38.2%), low users (1 tool, 24.6%), medium users (2 tools, 17.0%), and high users (3 or more tools, 20.1%).

Digital lifestyle variables. Breadth of digital engagement was measured across five domains, each computed as a count of activities within that domain. Digital culture participation (0–6 activities, M = 1.00) captured engagement with online cultural content, including visiting virtual exhibitions, watching concerts or performances online, reading e-books, browsing historical archives, visiting digital heritage platforms, and exploring folk culture online. Online civic participation (0–4, M = 0.43) measured digital civic actions such as signing online petitions, commenting on or sharing civic or political content, participating in public consultations, and reporting problems or proposing solutions to institutions. E-government service use (0–3, M = 1.03) covered use of electronic public services, including logging into government portals, submitting requests or registering for services online, and obtaining information from public institution websites. Citizen science activities (0–5, M = 0.70) included participating in surveys or research as a respondent, reading

scientific articles online, watching science documentaries, submitting observational data such as weather or health data, and using science-related websites or applications. Number of digital devices used (0–5, $M = 2.19$) counted the types of devices used in the past 12 months from a list including smartphones, desktop computers, laptops, tablets, and smart televisions. Additionally, self-rated digital skills were measured on a 5-point scale ranging from very poor to very good ($M = 3.13$). Each domain index sums behaviorally distinct activities (e.g. signing a petition and reporting a problem to an institution capture different civic actions rather than parallel indicators of the same latent construct). These indices are therefore formative rather than reflective measures, for which Cronbach's α is not strictly appropriate as a reliability statistic (Diamantopoulos and Winklhofer, 2001; Bollen and Diamantopoulos, 2017). For transparency, α was nonetheless computed across the items within each domain and is reported here: digital culture $\alpha = 0.61$, civic participation $\alpha = 0.39$, e-service use $\alpha = 0.60$, citizen science $\alpha = 0.62$, and device use $\alpha = 0.53$. The modest values are consistent with the formative interpretation: each domain is a count of behaviorally distinct activities rather than a set of parallel indicators of a single latent construct. Self-rated digital skills was a single-item indicator and consequently has no α value.

AI awareness. Respondents were asked whether they were aware of artificial intelligence using a single binary item (yes/no). A majority (61.7%) reported awareness of AI.

Environmental attitudes. Attitudes toward green and environmental digital practices were measured using eight Likert-scale items (5-point scale from strongly disagree to strongly agree). Cronbach's α was 0.819, indicating good internal consistency. The scale mean was 3.56 ($SD = 0.64$). Notable missingness existed for this scale (27.3% missing, $N = 730$ valid cases), primarily driven by respondents selecting "don't know" options on individual items. This pattern was particularly concentrated among non-users of green digital tools, among whom 42% did not complete the attitude scale.

Sociodemographic variables. The analysis included age (continuous), gender (binary), education (four categories: basic, secondary, post-secondary, university), settlement type (three categories: rural, small town, major city), and self-rated financial situation (three categories: poor, average, good), included as a control variable.

3.3 Analytical strategy

The analysis proceeded in four stages. First, descriptive statistics characterized the sample and the distribution of green digital tool adoption across the six tool categories. Second, bivariate Pearson correlations and one-way ANOVA with Welch's correction examined relationships between green tool adoption and all predictor variables, with Welch's correction applied to account for unequal group variances. Third, hierarchical multiple regression tested the incremental explanatory power of each predictor block, entered in theoretically motivated order: Block 1 comprised sociodemographic variables (age, gender, education, settlement type, and financial situation); Block 2 added digital lifestyle variables (digital skills, device use, culture use, civic use, e-service use, and science use); Block 3 added AI awareness; and Block 4 added environmental attitudes. This ordering directly addresses the three research questions: whether digital lifestyle predicts green tool adoption beyond demographics (RQ1), whether AI awareness adds predictive value beyond digital lifestyle (RQ2), and whether environmental attitudes contribute explanatory power beyond all preceding variables (RQ3). Fourth, six robustness checks assessed the stability of findings: binary logistic regression predicting any green tool use versus none, inclusion of internet use frequency as an additional predictor, unweighted model estimation, variance inflation factor diagnostics for multicollinearity, re-estimation with electronic tickets removed from the dependent variable, and a test of the interaction between environmental attitudes and digital engagement.

All analyses were conducted in jamovi version 2.5 (The jamovi project, 2024). Population weights were applied in descriptive analyses and linear regression. Logistic regression and

4. Results

Green digital tool adoption was low across the Lithuanian adult population, with respondents using an average of 1.29 out of six tools ($SD = 1.36$). More than one-third (38.2%) had not used any of the six tools, while only 20.1% used three or more. Adoption rates varied substantially across tools, revealing a clear hierarchy related to digital literacy requirements and everyday utility. Electronic tickets were the most widely adopted, used by 38.0% of respondents, followed by public transport planning apps (29.7%) and sharing and travel platforms (25.8%). Smart energy meters or thermostats had been used by 18.2% of respondents and e-scooter or bike-sharing apps by 16.6%. CO2 and energy tracking applications were the least adopted, used by only 6.5% of respondents (see Table 1). Tools integrated into routine daily transactions achieve substantially higher adoption than tools requiring deliberate environmental monitoring behavior. The six-fold difference between the most and least adopted tools suggests that the green label matters less than the functional context in which a tool is embedded: adoption follows patterns of general digital convenience rather than environmental intentionality.

To examine the predictors of adoption, bivariate Pearson correlations were computed between green tool adoption and all predictor variables. The results revealed a clear and consistent pattern. All five digital lifestyle variables correlated strongly with green tool adoption: device use ($r = 0.579$), e-service use ($r = 0.559$), digital skills ($r = 0.548$), culture use ($r = 0.526$), citizen science use ($r = 0.497$), and civic use ($r = 0.473$). Age correlated negatively ($r = -0.524$), reflecting the sharp generational gradient in digital engagement. By contrast, environmental attitudes showed the weakest correlation of any variable examined ($r = 0.324$). All correlations were significant at $p < 0.001$. The digital lifestyle variables also correlated substantially with each other ($r = 0.40$ to 0.62), consistent with the theoretical expectation that digital activities cluster into a general engagement dimension rather than constituting independent behaviors.

To further illustrate this contrast, one-way ANOVA with Welch's correction compared the four adoption groups (non-users, low, medium, and high users) across all predictor variables. Digital lifestyle variables showed steep and consistent gradients. Culture use increased from 0.33 among non-users to 2.08 among high users, citizen science use from 0.22 to 1.57, e-service use from 0.41 to 1.93, and device use from 1.31 to 3.35. Self-rated digital skills rose from 2.43 to 4.21, and mean age fell from 62.2 to 36.8. Welch's F-values for these behavioral variables ranged from 65.6 to 166.2.

Environmental attitudes, by contrast, showed a remarkably flat profile across adoption groups. Mean scores ranged from 3.25 among non-users to 3.84 among high users (a difference

Table 1. Individual green digital tool adoption rates ($N = 1,004$)

Tool	% adopted
Electronic tickets	38.0
Public transport planning apps	29.7
Sharing and travel platforms	25.8
Smart energy meters or thermostats	18.2
E-scooter and bike-sharing apps	16.6
CO2 and energy tracking apps	6.5

Note(s): Weighted data. Percentage of respondents reporting ever having used each tool. Tools ordered by adoption rate

Source(s): Authors' own work

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of less than 0.6 points on a 5-point scale), with a Welch’s F-value of 26.8, substantially lower than for any behavioral variable. Critically, non-users scored above the midpoint of the environmental attitude scale, indicating that they hold moderately positive environmental views. Their non-adoption therefore reflects not environmental indifference but an absence of the digital engagement that green tool use requires.

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4.1 Hierarchical regression

Hierarchical regression was estimated on cases with complete data across all variables ($N = 671$, weighted). Results are summarized in [Tables 2](#) and [3](#). Block 1 (sociodemographics) explained 37.7% of variance in green tool adoption ($R^2 = 0.377$). Age was the strongest predictor ($b = -0.038$, $p < 0.001$) and major city residence was also significant ($b = 0.867$,

Table 2. Hierarchical regression results: predictors of green digital tool adoption ($N = 671$)

Model	R^2	ΔR^2	p	ΔF
1: Sociodemographics	0.377	–	–	–
2: + Digital lifestyle	0.533	0.156	<0.001	36.53
3: + AI awareness	0.534	0.001	0.339	0.92
4: + Environmental attitudes	0.539	0.005	0.007	7.35

Note(s): Weighted analyses. Block 1 includes age, gender, education, settlement type, and financial situation. Block 2 includes digital skills, device use, culture use, civic use, e-service use, and science use

Source(s): Authors’ own work

Table 3. Full model coefficients: predictors of green digital tool adoption (model 4, $N = 671$)

Predictor	b	SE	t	p
<i>Block 1: Sociodemographics</i>				
Age	–0.018	0.003	–5.65	< 0.001
Gender (female vs. male)	–0.107	0.079	–1.36	0.176
Education: secondary vs. basic	0.094	0.221	0.42	0.673
Education: post-secondary vs. basic	0.204	0.231	0.88	0.377
Education: university vs. basic	0.147	0.241	0.61	0.542
Settlement: town vs. rural	0.047	0.106	0.45	0.655
Settlement: major city vs. rural	0.586	0.099	5.92	< 0.001
Financial: average vs. poor	0.109	0.121	0.90	0.368
Financial: good vs. poor	0.093	0.134	0.70	0.487

Block 2: Digital lifestyle

Digital skills	0.100	0.051	1.98	0.048
Device use	0.176	0.041	4.26	< 0.001
Culture use	0.116	0.039	2.96	0.003
Civic use	0.268	0.060	4.49	< 0.001
E-service use	0.170	0.050	3.42	< 0.001
Citizen science use	0.063	0.046	1.35	0.176

Block 3: AI awareness

AI awareness (no vs. yes)	–0.099	0.106	–0.94	0.347
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Block 4: Environmental attitudes

Environmental attitudes	0.166	0.061	2.71	0.007
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Note(s): Weighted by population weight (w_{lam3}). Significant predictors ($p < 0.05$) shown in bold. Reference categories: male, basic education, rural settlement, poor financial situation, AI aware.

Source(s): Authors’ own work

$p < 0.001$). Beyond these, higher education levels predicted adoption: respondents with post-secondary and university education adopted significantly more green tools than those with basic education ($b = 0.706$, $p = 0.007$ and $b = 0.950$, $p < 0.001$ respectively), and better financial situation was a positive predictor (good vs. poor: $b = 0.555$, $p < 0.001$). Notably, both education and financial situation lost significance once digital lifestyle variables were entered in Block 2, a pattern consistent with digital engagement accounting for much of their association, in that more educated and financially secure respondents tend to be more digitally active, although the cross-sectional design cannot establish mediation.

Adding digital lifestyle variables in Block 2 produced the largest single increment of the analysis: $\Delta R^2 = 0.156$ ($F(6, 655) = 36.53$, $p < 0.001$), bringing total explained variance to 53.3%. Significant predictors within this block were device use ($b = 0.189$, $p < 0.001$), civic use ($b = 0.285$, $p < 0.001$), e-service use ($b = 0.170$, $p < 0.001$), culture use ($b = 0.126$, $p = 0.001$), and digital skills ($b = 0.120$, $p = 0.017$). Citizen science activities was the only digital lifestyle variable that did not reach significance in Block 2 ($p = 0.096$) or in the full model ($p = 0.176$), suggesting it captures a narrower form of digital engagement than the other behavioral indicators. Block 3 (AI awareness) added virtually nothing beyond the digital lifestyle variables: $\Delta R^2 = 0.001$, $p = 0.339$. Environmental attitudes in Block 4 reached statistical significance ($\Delta R^2 = 0.005$, $p = 0.007$) but explained only 0.5 additional percentage points of variance, less than one-thirtieth of the digital lifestyle increment.

In the full model, significant predictors were age ($b = -0.018$, $p < 0.001$), major city residence ($b = 0.586$, $p < 0.001$), device use ($b = 0.176$, $p < 0.001$), civic use ($b = 0.268$, $p < 0.001$), e-service use ($b = 0.170$, $p < 0.001$), culture use ($b = 0.116$, $p = 0.003$), digital skills ($b = 0.100$, $p = 0.048$), and environmental attitudes ($b = 0.166$, $p = 0.007$). Gender, education, financial situation, AI awareness, and citizen science use were not significant in the full model.

The pattern of non-significance is theoretically interpretable rather than incidental. Education and financial situation were significant in Block 1 but lost significance in Block 2, consistent with their association being accounted for by digital engagement: more educated and financially secure respondents tend to participate more in digital culture, e-services, and device use, and once that participation is included education and income add little, although the cross-sectional data cannot confirm a mediational pathway. Gender showed a small descriptive difference but no independent effect once digital lifestyle was controlled, suggesting that earlier-documented gender gaps in green technology adoption (Råty and Carlsson-Kanyama, 2010) are largely accounted for by gendered differences in digital engagement in this sample. AI awareness, although descriptively associated with adoption, contributed no incremental variance because current-generation green digital tools (smart meters, e-tickets, sharing platforms) are not AI-dependent applications, so awareness of AI does not differentiate adopters from non-adopters at the population level. Citizen science use was the one digital lifestyle indicator that remained non-significant: as a more specialized and lower-base-rate activity ($M = 0.70$), it captures a narrower form of digital engagement that is partially redundant with the broader culture, civic, and e-service indicators with which it correlates strongly.

4.2 Robustness checks

Six robustness checks confirmed the stability of the main findings. First, variance inflation factors for all predictors ranged from 1.04 to 1.44, well below conventional thresholds, indicating no multicollinearity concerns. Second, binary logistic regression predicting any green tool use versus none replicated the main pattern: device use, culture use, e-service use, and major city residence were significant predictors, while AI awareness was nonsignificant and environmental attitudes were marginal ($p = 0.029$). Third, adding internet use frequency to the digital lifestyle block did not alter the ΔR^2 values, confirming that this variable is redundant with the other digital lifestyle indicators. Fourth, unweighted models produced the

same pattern of results ($\Delta R^2 = 0.149$ for digital lifestyle, 0.001 for AI awareness, and 0.004 for environmental attitudes), confirming that the findings do not depend on the weighting scheme. Fifth, to address potential conceptual overlap between the e-service use indicator (which includes e-government activities) and the green digital tools index (which includes electronic tickets), the hierarchical regression was re-estimated with electronic tickets removed from the dependent variable, yielding a five-tool adoption count (range 0–5). The pattern of results was if anything strengthened rather than attenuated: digital lifestyle remained the dominant predictor block with a marginally larger increment ($\Delta R^2 = 0.164$, $p < 0.001$) than in the six-tool model ($\Delta R^2 = 0.156$), AI awareness remained non-significant ($\Delta R^2 = 0.001$, $p = 0.324$), and environmental attitudes again added a small but significant increment ($\Delta R^2 = 0.005$, $p = 0.010$). The ratio of the digital lifestyle increment to the environmental attitudes increment widened slightly from 31:1 in the six-tool model to 33:1 in the five-tool model. This confirms that the headline finding does not depend on the inclusion of electronic tickets in the green tools index and is not an artifact of measurement overlap with the e-service domain; rather, the inclusion of electronic tickets, which are the most widely adopted of the six tools and the most evenly distributed across digital engagement levels, slightly attenuates the digital lifestyle effect rather than inflating it. Sixth, to test whether digital capability moderates the weak attitude-adoption association, an interaction between environmental attitudes and a composite digital-engagement index was added to the full model; it was non-significant ($b = 0.07$, $SE = 0.06$, $p = 0.22$, $\Delta R^2 = 0.001$), as was the equivalent interaction using digital skills ($p = 0.19$), indicating that environmental attitudes do not predict adoption more strongly among the digitally engaged.

5. Discussion

The central finding of this study is unambiguous: green digital tool adoption is overwhelmingly predicted by general digital engagement, not by environmental attitudes. Digital lifestyle variables explain 31 times more incremental variance than environmental attitudes ($\Delta R^2 = 0.156$ vs. 0.005), challenging the implicit theory of change embedded in the EU's twin transition framework. In practice, the green digital divide closely tracks the digital divide.

The twin transition's blind spot. The EU's twin transition agenda assumes that digital tools can enable environmentally sustainable behavior, and our findings do not dispute that smart meters, CO2 trackers, and shared mobility platforms may deliver environmental benefits for those who use them. What our findings challenge is the assumption about who uses them and why. Environmental attitudes are nearly uniform across adoption levels: non-users score 3.25 and high users score 3.84 on a 5-point scale. Non-users of green digital tools are not anti-environment; they are digitally excluded. Adoption is associated not primarily with environmental concern but with broad digital engagement. This has a direct implication for policy. Green digital tools are currently promoted through environmental messaging ("reduce your carbon footprint," "monitor your energy use") that targets a predictor explaining less than 1% of adoption variance. A more effective approach would frame these tools as part of a broader digital services ecosystem and promote their uptake through digital inclusion initiatives rather than environmental awareness campaigns.

Green Digital Tools as Digital Lifestyle. The group profile analysis reveals that green digital tool adoption is embedded in a broader pattern of general digital engagement rather than constituting a distinct behavioral category. Respondents using three or more green tools participate in six times more digital culture activities, engage with five times more e-government services, and use 2.6 times more devices than non-users. The strong intercorrelations among digital lifestyle variables ($r = 0.40$ to 0.62) confirm that these activities cluster into a coherent general engagement dimension, consistent with [van Dijk's \(2020\)](#) concept of usage access and [Ragnedda's \(2018\)](#) digital capital framework, both of

which posit that digital engagement is a general capacity shaped by sociostructural position rather than domain-specific motivation.

The individual tool adoption rates reinforce this interpretation. The six-fold difference between the most adopted tool (electronic tickets, 38.0%) and the least adopted (CO₂ tracking apps, 6.5%) does not align with a values-based account. What distinguishes these tools is not their environmental relevance but their integration into everyday digital routines. Electronic tickets, transport planning apps, and sharing platforms require the same devices, connectivity, and habitual comfort with digital interfaces as e-commerce and e-government services. CO₂ tracking apps, by contrast, require a deliberate additional step of actively monitoring one's environmental impact. The adoption gradient across tools therefore mirrors the gradient in digital engagement more broadly: routine transactional tools achieve far higher uptake than tools requiring specialist motivation or digital confidence.

Green digital tools consequently do not represent a distinct adoption pathway. They are one expression of a broader digital lifestyle that individuals either participate in extensively or not at all, and their barriers are the same barriers that constrain participation in e-government and digital culture: age, urbanization, device access, and digital skills (van Deursen and van Dijk, 2019; Lythreatis *et al.*, 2022). Research consistently finds that capability and structural constraints are more decisive than values in determining whether environmental intentions translate into action (Bamberg and Möser, 2007; Stern, 2000), and in the digital domain specifically, Hoffmann *et al.* (2022) and Lasarov *et al.* (2024) show that even among carbon footprint tracking app users, behavioral effects are modest and mediated by digital habits. This is further corroborated by Mačiulienė *et al.* (2025), who found that economic and practical motivations predicted climate adaptation actions more strongly than ecological motivations in a representative Lithuanian sample, and that 38% had taken no adaptation actions, the same proportion as non-users of green digital tools in the present study.

AI Awareness: Testing a Contemporary Assumption. The finding that AI awareness contributes virtually nothing to green digital tool adoption ($\Delta R^2 = 0.001$, $p = 0.339$) is timely given current policy enthusiasm around AI as an accelerator of both digital and green transitions. Although 62% of Lithuanian adults reported awareness of AI, this awareness does not translate into differential adoption of green digital tools, consistent with evidence that acceptance of specific AI applications is driven by perceived usefulness and trust rather than awareness alone (Aslam *et al.*, 2022). Current-generation green digital tools (smart meters, e-tickets, sharing platforms) are not AI-dependent applications, and awareness of the term alone does not distinguish who adopts them. This null result should be read narrowly: our measure is a single binary item capturing whether respondents recognise the term AI, not AI literacy in the established sense of understanding, application, and critical evaluation (Long and Magerko, 2020; Ng *et al.*, 2021). The data therefore speak only to AI awareness and cannot indicate whether AI literacy, properly measured, would relate to green digital behavior; that remains an open question for research using validated literacy instruments.

Environmental Attitudes: Present but Insufficient. Environmental attitudes were statistically significant in the full model ($p = 0.007$), and we do not claim they are irrelevant. Our contribution is to show that they are overwhelmed by digital capability as a predictor, explaining less than 1% of variance compared to 15.6% for digital lifestyle. The attitude-behavior gap literature has long sought moderators that explain when attitudes translate into action (Kollmuss and Agyeman, 2002; Bamberg and Möser, 2007; Gifford, 2011). We tested directly whether digital capability moderates this relationship by adding an interaction between environmental attitudes and a composite measure of digital engagement to the full model. The interaction was not significant ($b = 0.07$, $p = 0.22$, $\Delta R^2 = 0.001$), and an equivalent test using digital skills gave the same result ($p = 0.19$). Environmental attitudes are therefore a weak predictor of green digital tool adoption regardless of digital engagement: capability does not unlock attitudes, and the gap is structural rather than conditional. This is consistent with Stern's (2000) argument that contextual forces and facilitating conditions constrain whether values produce behavior, and with more recent cross-national evidence that

structural factors consistently outperform attitudes as predictors of specific environmental actions (Miller and Rice, 2024; Vieira *et al.*, 2023).

The pattern of missingness in the attitude data provides additional support for this interpretation. Among non-users of green digital tools, 42% did not complete the environmental attitude scale, primarily by selecting “don’t know” responses, compared to substantially lower rates among users. This suggests that the most digitally excluded individuals are not only unable to use green tools but may also be less accustomed to articulating structured positions on environmental technology, a finding consistent with Ragnedda’s (2018) argument that digital exclusion carries broader epistemic consequences beyond tool use itself.

Policy Implications. Lithuania’s combination of moderate environmental attitudes, low climate self-efficacy, and sharp digital divides along generational and territorial lines makes the pattern we document particularly visible. The mechanism we identify, in which general digital engagement rather than environmental motivation governs adoption, is not in principle specific to Lithuania, since the digital-divide processes it rests on are documented across the EU (Lythreatis *et al.*, 2022). Its strength and shape are nonetheless likely to vary with each member state’s digital-divide profile, so the extension beyond Lithuania is an expectation to be tested rather than a demonstrated result. Digital modernization across Central and Eastern Europe has been rapid but uneven, and the implementation gap between EU-level twin transition ambitions and local-level digital capacity is likely a regional rather than a purely national challenge (Fouskas *et al.*, 2023; Skaletsky *et al.*, 2016).

The policy implication is straightforward: if the aim is to expand green digital tool adoption in contexts such as Lithuania, the most effective lever these data point to is digital inclusion rather than environmental awareness, and whether the same holds across the EU is a question for cross-national replication. Concretely, this means prioritizing digital skills investment for older adults and rural populations, ensuring affordable device access, and designing green digital tools with lower digital literacy thresholds. More fundamentally, it means treating digital inclusion not as a parallel agenda to environmental policy but as a likely enabling condition for it: where citizens are excluded from the digital ecosystem in which green tools are embedded, participation in the green digital transition appears unlikely. The current twin transition framework does not sufficiently reflect this dependency, and our findings suggest it should.

6. Limitations and conclusion

Several limitations should be acknowledged. The cross-sectional design precludes causal inference: we cannot rule out that both digital engagement and green tool adoption are driven by an unmeasured third variable, and although the theoretical logic is consistent with digital engagement operating as an enabling condition, the present design cannot distinguish this from a purely correlational pattern. The dependent variable is a simple count that treats all six tools equally despite their varying complexity; future research could examine individual tools or typologies of green digital behavior. Listwise deletion due to attitude scale missingness reduced the regression sample to 671, and because missingness was concentrated among non-users, the regression may underestimate the true extent of digital exclusion. The study is based on a single national context, and while the pattern is theoretically expected to generalize across CEE member states, replication in other settings is needed. Specifically, replication of the present design across other EU member states, ideally with a harmonized cross-national survey instrument, would establish whether the digital-lifestyle-over-environmental-attitudes pattern documented here in a CEE setting also holds in member states with different digital divide profiles, different green policy histories, and different levels of digital infrastructure maturity. Such cross-national evidence would substantially strengthen the policy implications drawn here for the EU twin transition agenda. A further measurement caveat concerns the partial conceptual overlap between the e-service domain (which includes e-government

activities) and the green tools index (which includes electronic tickets), since electronic tickets function simultaneously as a routine digital transaction and as a paper-replacing green tool. This overlap could in principle inflate the observed association between digital lifestyle and green tool adoption. The robustness check reported in [Section 4.2](#), in which the regression was re-estimated with electronic tickets removed from the dependent variable, addresses this concern directly and shows that the pattern is not driven by this circularity. Future research using green behavior indicators that exclude such hybrid tools would nonetheless provide an even cleaner test. AI awareness was measured with a single binary item, which captures recognition of the term rather than AI literacy in the sense of understanding, application, and critical evaluation; the null result for AI awareness therefore does not speak to whether AI literacy, properly measured, would relate to green digital tool adoption, and future research should use validated AI literacy instruments. Finally, self-reported tool use and self-rated digital skills may be subject to social desirability and measurement bias.

These limitations notwithstanding, the study produces a clear and novel finding. Green digital tool adoption in Lithuania is predicted overwhelmingly by digital lifestyle and capability, not by environmental values. This is not a minor qualification to the twin transition framework's theory of change; it is a fundamental challenge to it. The framework assumes that environmentally motivated citizens will adopt green digital tools; our data show that adoption is instead embedded in a general pattern of digital engagement that follows the same sociodemographic gradients as all other digital activity. Non-users of green digital tools are not environmentally indifferent (they score above the midpoint on a validated environmental attitude scale) but they are digitally excluded.

Three contributions stand out. First, this study provides the first population-level empirical test of what predicts green digital tool adoption across multiple tool categories simultaneously, moving beyond single-technology studies that cannot distinguish general from domain-specific effects. Second, it demonstrates that the green digital divide is empirically indistinguishable from the digital divide, extending digital divide theory into a domain that has been theorized but not quantitatively tested at this scale. Third, it tests, and rejects, the most plausible defense of the attitudes-matter view, that attitudes translate into behavior only among the digitally capable, since the attitude-by-engagement interaction is non-significant, so the attitude-behavior gap in this domain is structural rather than conditional, contributing to a long-standing debate about why environmental concern does not reliably translate into action.

The policy implication is direct: the green digital divide appears to be a capability gap rather than a motivational one. In settings like Lithuania, expanding green digital tool adoption appears to require investment in digital inclusion (skills, device access, and lower-threshold tool design), not environmental awareness campaigns. Subject to cross-national replication, the EU's twin transition framework should treat digital inclusion as an enabling condition for green digital participation rather than a parallel agenda.

Ethics section

The study was approved by the Ethical Monitoring Board at the Citizen Science Hub, Vilnius Gediminas Technical University (approval No. CSH-2025–03). Survey data were collected by Baltijos Tyrimai, an independent market and public opinion research organization. Data collection followed established ethical guidelines in accordance with ESOMAR standards, and all participants provided informed consent prior to participation.

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