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Smart, sustainable, and inclusive? Investigating the dual impacts of digital and financial innovation on policy equity and environmental governance

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Abstract

This study investigates how digital transformation, sustainable finance, and behavioral sentiment influence equity, resilience, and trust in climate governance in the Philippines. A quantitative-descriptive design was employed using data from 431 purposively selected respondents across government, private, NGO, and community sectors. Partial Least Squares–Structural Equation Modeling (PLS-SEM) tested relationships among nine sustainability constructs. Results indicate that digital transformation shapes inequality and policy innovation, sustainable finance enhances ecological resilience and carbon offset credibility, and positive behavioral sentiment reduces vulnerability to misinformation while increasing participation in green finance. The study underscores the integrated roles of technology, finance, and sentiment in advancing sustainable development and strengthening policy legitimacy. Investing in inclusive digital infrastructure, scaling sustainable finance instruments, promoting behavioral campaigns, and embedding transparency protocols can foster resilience, inclusivity, and trust in climate action.

Keywords: Behavioral economic sentiment, Carbon offset credibility, Digital inequality, Digital transformation, Ecological resilience, Sustainable finance.

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1. Introduction

In this evolving digital age, societies face a convergence of technological advancement, environmental urgency, and behavioral complexity [1, 2]. Understanding how these forces interact is essential to shaping inclusive, resilient, and sustainable futures [3, 4]. While digital transformation creates opportunities for innovation, connectivity, and participatory governance, it also introduces new forms of inequality, particularly in regions with limited infrastructure [5]. The Digital

Transformation Index (DTI), when examined alongside the Digital Inequality Gap Index (DIGI) and the Inclusive Policy Innovation Rate (IPIR), underscores the dual nature of digital progress: it can bridge divides or reinforce them [6, 7].

Sustainable finance likewise emerges as a critical driver of ecological resilience and carbon accountability. The Sustainable Finance Penetration Rate (SFPR) reflects how green investments and verifiable carbon offset mechanisms accelerate environmental stability [8, 9]. At the same time, behavioral economic sentiment—measured by tools such as the Behavioral Economics Sentiment Tracker (BEST)—affects public vulnerability to misinformation, trust in sustainability mechanisms, and broader engagement in the post-truth climate [10-12].

The Philippines illustrates these dynamics clearly, presenting both opportunities and challenges at the intersection of digitalization, finance, and climate resilience [13, 14]. Institutions such as the Department of Information and Communications Technology (DICT), local IT units, and private firms like PLDT and Globe have shaped national digital access and governance [15, 16]. Initiatives such as Tech4Ed, Open Data Philippines, and academic-led literacy programs highlight ongoing efforts toward participatory governance. Meanwhile, bodies like the Climate Change Commission and the Department of Environment and Natural Resources (DENR), together with financial institutions such as DBP and BDO, have expanded sustainable finance and monitored carbon offset initiatives. Yet, in vulnerable communities such as Tondo, Payatas, and Baseco, weak digital infrastructure and limited access to smart climate systems exacerbate environmental exposure, particularly to urban heat [17]. Media and fact-checking organizations such as Tsek.ph and Vera Files, alongside academic experts, continue to address the erosion of public trust caused by misinformation [18].

To systematically examine these interdependencies, this study employs Partial Least Squares-Structural Equation Modeling (PLS-SEM), a robust methodology for testing complex relationships among latent constructs [19, 20]. By linking digital transformation, sustainable finance, and behavioral economic sentiment with ecological and governance outcomes, the study addresses a significant gap in the literature. Existing research often treats these domains in isolation, whereas this work develops an integrated, systems-based model. Specifically, it explores whether inclusive digital infrastructure can mitigate inequality, how sustainable finance strengthens ecological resilience and carbon offset authenticity, and how behavioral sentiment shapes vulnerability to misinformation and public trust. These insights are particularly relevant in contexts where misinformation undermines climate action and where digital divides intensify vulnerability to environmental risks [21].

2. Literature Review and Hypotheses Development

The rapid advancement of digital technologies and the growing emphasis on sustainability have transformed governance, finance, and social systems [22, 23]. Understanding how digital transformation, sustainable finance, and behavioral sentiment interact with ecological and societal outcomes is critical for inclusive and resilient development [24, 25]. This section reviews existing research across three thematic areas and develops hypotheses accordingly.

2.1. Digital Transformation and Inequality

The literature presents a paradox in how digital transformation affects inequality. Some studies emphasize its inclusive potential, highlighting how digital innovations enable transparency, citizen engagement, and participatory governance [26-28]. The concept of digital self-determination underlines empowerment, giving individuals greater control over their digital interactions [29, 30]. In contrast, other research warns that without equitable infrastructure, digital transformation widens the divide between groups with different levels of access and skills [5, 31, 32]. For example, Tian and Xiang [33] found that while digitalization of SMEs and public services reduced income inequality, disparities in digital literacy exacerbated gaps. Similarly, access inequalities in connectivity and education reinforce exclusion [34, 35].

This tension reflects the dual-edged nature of digital transformation: it can bridge or deepen inequality depending on inclusivity.

To address this debate, the study proposes:

$H_{1:}$ Higher levels of digital transformation are significantly associated with either the reduction or amplification of digital inequality, depending on the inclusivity of digital infrastructure.

$H_{2:}$ Digital transformation positively influences the rate of inclusive policy innovation by enabling data-driven, transparent, and participatory governance mechanisms.

2.2. Sustainable Finance, Ecological Resilience, and Carbon Trust

Sustainable finance is widely recognized as a lever for ecological resilience. Green bonds, ESG investments, and sustainability-linked loans channel resources into adaptive infrastructure and climate projects, thereby enhancing resilience [36-40]. However, scholars caution that effectiveness hinges on robust evaluation systems and accountability mechanisms [41]. Without transparency, greenwashing risks undermine trust in finance-driven climate strategies [42, 43]. Verification is thus central to ensuring carbon offset credibility [41].

Case studies reinforce these debates. For instance, the Seychelles' sovereign blue bond illustrates how targeted financial innovation can fund conservation, but its credibility rests on stringent monitoring and transparency [44]. Thus, while sustainable finance promises ecological and economic gains, concerns about authenticity and monitoring remain. This study therefore hypothesizes:

$H_{3:}$ Greater penetration of sustainable finance significantly enhances ecological resilience through increased investments in green and adaptive infrastructure.

$H_{4:}$ Higher levels of sustainable finance are positively associated with the authenticity and verification standards of carbon offset projects.

2.3. Behavioral Sentiment, Misinformation, and Trust

Behavioral economic sentiment plays a pivotal role in shaping societal responses to sustainability. Positive sentiment encourages pro-sustainability behaviors, enhances resilience against misinformation, and increases participation in sustainable finance [26, 36, 45-47]. Research shows that eco-nudges and financial literacy campaigns improve public willingness to invest in green initiatives [48-50]. Conversely, negative sentiment amplifies vulnerability to misinformation, eroding trust in both climate policies and financial instruments [51-55].

This tension highlights the importance of trust and credibility in sustainability transitions. While optimism can mobilize investments, susceptibility to post-truth narratives threatens policy legitimacy [56-58]. To resolve these debates, the study formulates the following hypotheses:

$H_{5:}$ Positive behavioral economic sentiment significantly lowers public susceptibility to post-truth narratives and misinformation.

$H_{6:}$ Positive shifts in behavioral economic sentiment increase public trust and investor participation in sustainable finance initiatives.

$H_{7:}$ Greater digital inequality correlates with higher urban heat vulnerability due to unequal access to smart climate adaptation technologies.

$H_{8:}$ Higher susceptibility to post-truth narratives is associated with decreased trust in and perceived authenticity of carbon offset mechanisms.

Across these themes, existing studies confirm the influence of digitalization, finance, and behavioral sentiment on social and ecological outcomes but often analyze them in isolation. Few have developed an integrated framework capturing their interdependencies within a single empirical model. By testing eight hypotheses in the Philippine context, this study addresses that gap, offering new insights into how digital transformation, sustainable finance, and behavioral sentiment jointly shape equity, resilience, and trust in climate governance.

3. Methodology

This study adopted a quantitative-descriptive research design, which was highly appropriate for investigating the complex relationships among multiple socio-technical and environmental indicators [59], including digital transformation, sustainable finance, behavioral economic sentiment, ecological resilience, misinformation vulnerability, and public trust. By focusing on the empirical measurement and analysis of variables across diverse sectors, this approach enabled the identification of correlations, patterns, and moderating or mediating effects as defined in the research objectives and hypotheses. The quantitative method provided a structured framework to gather data through standardized tools and analyze it using rigorous statistical techniques, ensuring objectivity, replicability, and generalizability of results. Simultaneously, the descriptive component allowed for a nuanced portrayal of how the identified phenomena occurred in real-world contexts [60] especially in the Philippine setting characterized by regional digital disparities, climate vulnerabilities, and varied financial inclusion levels [14, 61, 62]. The integration of these approaches ensured both precision and depth in addressing the research questions.

The research setting encompassed urban and rural areas of the Philippines, particularly regions with strong contrasts in digital infrastructure, environmental exposure, and financial access—such as Metro Manila, Cebu, Davao, and underserved communities like Tondo and Payatas [63]. This geographic diversity was matched by a multi-sectoral respondent base, consisting of 431 purposively selected experts and stakeholders from public agencies (e.g., DICT, LGUs, NEDA), private entities (e.g., PLDT, BDO), NGOs (e.g., Haribon, WWF-PH), academic institutions, and community-based organizations. These respondents were chosen based on their direct involvement in areas relevant to the research indicators—such as ICT development, policy innovation, green finance, climate adaptation, and misinformation mitigation. The purposive sampling method ensured the relevance and validity of responses by targeting individuals with the contextual expertise necessary to provide informed, experience-based insights. To collect data, the study used a standardized survey questionnaire (Chepngeno-Langat et al., 2023) divided into two key parts. Part 1 captured the demographic profile of respondents, including age, sector, position, years of experience, and regional affiliation. Part 2 presented benchmark statements aligned with the study's core indicators: Digital Transformation Index (DTI), Sustainable Finance Penetration Rate (SFPR), Behavioral Economics Sentiment Tracker (BEST), Ecological Resilience Score (ERS), Urban Heat Vulnerability Index (UHVI), Carbon Offset Authenticity Index (COAI), Digital Inequality Gap Index (DIGI), Post-Truth Impact Score (PTIS), and Inclusive Policy Innovation Rate (IPIR). Each item was rated on a 5-point Likert scale, where 1 indicated “Not Observed” and 5 signified “Highly Observed.” The instrument was developed through a review of literature, global index standards, and national policy frameworks, and refined through expert consultation to ensure contextual and content validity.

Sustainable development constructs were measured using adapted items from prior studies. Sample items included: BEST – “Behavioral campaigns (e.g., eco-nudges) encourage responsible behavior” [64]; COAI – “Carbon offset methodologies are transparently disclosed” [65]; DIGI – “The digital divide limits access to real-time services” [17]; DTI – “Data analytics support evidence-based decision-making” [66-69] ; ERS – “Climate adaptation measures are integrated into local planning” [57, 70, 71]; IPIR – “Open consultations with multiple stakeholders guide policy” [65, 69, 72, 73]; PTIS – “Conflicting climate information reduces public trust” [56]; SFPR – “Financial institutions promote sustainability-linked loans” [74-76]; and UHVI – “Cooling infrastructure is lacking in dense districts” [77-79].

The data collection timeline spanned from July 10, 2024, to June 27, 2025. The process began with pilot testing in July–September 2024 to assess clarity and reliability, followed by the full rollout of data collection between October 2024 and March 2025. This included online and in-person distribution strategies, depending on the respondent’s location and access. Data validation and cleaning were conducted from March to May 2025, and the final phase in June 2025 involved the preparation of the dataset for analysis and interpretation. Ethical considerations were paramount throughout the study. All participants received clear information about the research goals, procedures, and their rights, including voluntary participation and the option to opt out anytime. Informed consent was secured prior to participation. Confidentiality was maintained through the anonymization of responses and secure data storage. The study complied with institutional and international ethical guidelines and obtained formal approval from an accredited Institutional Review Board (IRB).

For data analysis, the study used Partial Least Squares Structural Equation Modeling (PLS-SEM) through SmartPLS 4.1 and IBM SPSS Statistics v.30. PLS-SEM was selected due to its capacity to handle complex models with multiple constructs, moderating and mediating relationships, and latent variables that could not be directly measured [19]. This was particularly relevant for hypotheses involving infrastructure inclusivity as a moderator, as well as the indirect effects of behavioral economic sentiment on sustainable finance participation and carbon offset trust. PLS-SEM's tolerance for small to medium sample sizes and minimal normality assumptions made it ideal for real-world data from diverse sectors and regions in the Philippines. This method provided a powerful, data-driven foundation to validate the theoretical model and generate actionable insights that informed policy development, digital equity strategies, climate resilience planning, and behavioral interventions in governance and finance.

4. Findings

The respondent profile in Table 1 demonstrates a strategically diverse distribution across key sectors aligned with the study's hypotheses. ICT policymakers, LGU officers, civic tech developers, and data scientists anchor the analysis of digital transformation and inequality (H1–H2), while NGO leaders, planners, investment managers, and carbon market actors provide strong representation for testing sustainable finance, ecological resilience, and carbon authenticity (H3–H4). Behavioral scientists, media experts, and misinformation researchers support the exploration of sentiment and trust dynamics (H5–H6), complemented by the inclusion of residents from informal settlements and health workers, who ground the study in lived experiences of inequality and climate vulnerability (H7). Finally, communication experts and watchdog organizations strengthen the assessment of post-truth narratives and public trust (H8). Overall, the balanced mix of policymakers, practitioners, experts, and community members ensures a robust foundation for examining interconnections among digital, financial, environmental, and behavioral domains.

Table 1.
Respondent Profile.

	Frequency	Percentage
ICT Policy Makers	10	2.32
LGU Digitalization Officers	10	2.32
ISP Representatives	8	1.86
Urban/Rural Community Leaders	12	2.78
Digital Inclusion NGO Reps	10	2.32
Educational IT Coordinators	10	2.32
Government Policy Makers	10	2.32
Civic Tech Developers	10	2.32
Data Scientists in Government	10	2.32
Sustainability Officers in Banks	10	2.32
Environmental Economists	10	2.32
Green Investment Managers	10	2.32
LGU Environmental Planners	10	2.32
NGO/CSO on Ecosystems	10	2.32
Climate Resilience Program Implementers	10	2.32
Carbon Credit Verifiers	8	1.86
Carbon Market Brokers	8	1.86
CSR Managers	10	2.32
Environmental Compliance Officers	10	2.32
Offset Project Site Reps	5	1.16
Voluntary Standard Body Reps	5	1.16
Behavioral Scientists	10	2.32
Media Analysts/Journalists	10	2.32
Fact-Checking Communication Experts	10	2.32
Social Media Analysts	10	2.32
Researchers on Misinformation	10	2.32
Civic Education Advocates	10	2.32
Sustainable Investment Advisors	10	2.32
Behavioral Finance Researchers	10	2.32
Institutional/Retail Investors	10	2.32
Financial Literacy Implementers	5	1.16

Marketing Teams for Green Bonds	5	1.16
Urban Planners & Climate Adaptation Experts	10	2.32
Barangay/Community Health Workers	10	2.32
City Environment Officers (CENRO)	10	2.32
Data Analysts (Smart Cities)	10	2.32
Public Health Researchers	10	2.32
Local Residents (Informal Settlements)	25	5.8
Climate Communicators/Journalists	10	2.32
PR Teams for Carbon Offset Programs	10	2.32
Policy Makers on Climate Transparency	10	2.32
Carbon Market Regulators	10	2.32
Environmental Science Researchers	10	2.32
Watchdog Organizations	10	2.32
Total	431	100

The descriptive statistics in Table 2 confirm that all latent variables (BEST, COAI, DIGI, DTI, ERS, IPIR, PTIS, SFPR, and UHVI) are approximately normally distributed, with near-zero skewness and kurtosis, and non-significant Shapiro–Wilk results ($p > 0.05$). The standardized means ($M = 0$) and uniform sample size ($N = 431$) reflect robust preprocessing, ensuring comparability across constructs. This statistical normality establishes a sound basis for testing the study's hypotheses, such as the effects of DTI on DIGI (H1), SFPR on ERS and COAI (H3, H4), and the role of BEST and PTIS in shaping susceptibility to misinformation and trust in sustainability mechanisms (H5, H8).

Table 2.
Latent Variables – Descriptives.

	M	Mdn.	Min.	Max.	SD	Kur	Skew	N	W^2	$p(W^2)$
BEST	0.00	0.01	-2.45	2.93	1.00	0.04	0.01	431.00	0.99	0.09
COAI	0.00	0.00	-2.41	2.98	1.00	0.05	-0.01	431.00	0.98	0.07
DIGI	0.00	0.01	-2.53	3.00	1.00	0.02	0.02	431.00	0.99	0.11
DTI	0.00	0.00	-2.46	3.04	1.00	0.01	0.00	431.00	0.98	0.08
ERS	0.00	0.01	-2.50	2.97	1.00	0.03	-0.02	431.00	0.99	0.06
IPIR	0.00	0.00	-2.38	3.01	1.00	0.01	0.00	431.00	0.98	0.05
PTIS	0.00	0.01	-2.44	3.05	1.00	0.00	0.03	431.00	0.99	0.10
SFPR	0.00	0.00	-2.47	3.12	1.00	0.02	0.01	431.00	0.99	0.06
UHVI	0.00	0.00	-2.42	2.90	1.00	0.01	0.00	431.00	0.98	0.07

Note: BEST = Behavioral Economics Sentiment Tracker; COAI = Carbon Offset Authenticity Index; DIGI = Digital Inequality Gap Index; DTI = Digital Transformation Index; ERS = Ecological Resilience Score; IPIR = Inclusive Policy Innovation Rate; PTIS = Post-Truth Impact Score; SFPR=Sustainable Finance Penetration Rate; UHVI = Urban Heat Vulnerability Index
Cramér-von Mises $p > 0.05$ indicates good fit

Table 3 shows that all constructs exhibit strong reliability and validity, with Cronbach's alpha and composite reliability values above 0.70 and AVE values between 0.52 and 0.59, exceeding the 0.50 threshold. This confirms the internal consistency and validity of constructs such as DTI, DIGI, BEST, and others, thereby supporting the robustness of the hypothesized relationships (H1–H8). With reliable measures established, the model is ready for structural analysis to examine the significance of the proposed pathways.

Table 3.
Construct Reliability and Validity.

	Cronbach's alpha	Composite reliability (rho_a)	Composite reliability (rho_c)	Average variance extracted (AVE)
BEST	0.87	0.87	0.90	0.52
COAI	0.82	0.82	0.88	0.59
DIGI	0.88	0.88	0.90	0.54
DTI	0.87	0.87	0.90	0.52
ERS	0.87	0.87	0.90	0.52
IPIR	0.88	0.88	0.91	0.55
PTIS	0.87	0.87	0.90	0.52
SFPR	0.88	0.88	0.90	0.53
UHVI	0.87	0.88	0.90	0.53

Note: BEST = Behavioral Economics Sentiment Tracker; COAI = Carbon Offset Authenticity Index; DIGI = Digital Inequality Gap Index; DTI = Digital Transformation Index; ERS = Ecological Resilience Score; IPIR = Inclusive Policy Innovation Rate; PTIS = Post-Truth Impact Score; SFPR=Sustainable Finance Penetration Rate; UHVI =Urban Heat Vulnerability Index

The HTMT results in Table 4 confirm satisfactory discriminant validity, with all values below the conservative 0.90 threshold, ensuring the constructs are distinct for hypothesis testing. Notably, the relatively higher values between COAI and DIGI (0.86) and COAI and BEST (0.84) suggest meaningful yet distinct relationships consistent with H4 and H8. Similarly, acceptable separations between DTI and DIGI (0.80) and DTI and IPIR (0.71) support H1 and H2, while SFPR's associations with ERS (0.70) and COAI (0.73) align with H3 and H4. Moderate correlations such as BEST with PTIS (0.79) and SFPR (0.76) provide empirical backing for H5 and H6, and the DIGI–UHVI link (0.78) substantiates H7. Overall, the findings validate all eight hypotheses by confirming the distinct yet interconnected nature of the constructs.

Table 4.
Discriminant Validity – Heterotrait-Monotrait Ratio (HTMT).

	BEST	COAI	DIGI	DTI	ERS	IPIR	PTIS	SFPR	UHVI
BEST									
COAI	0.84								
DIGI	0.80	0.86							
DTI	0.78	0.81	0.80						
ERS	0.75	0.80	0.77	0.77					
IPIR	0.73	0.73	0.70	0.71	0.78				
PTIS	0.79	0.80	0.77	0.73	0.75	0.72			
SFPR	0.76	0.73	0.73	0.70	0.70	0.69	0.71		
UHVI	0.81	0.80	0.78	0.77	0.75	0.74	0.76	0.77	

Note: BEST = Behavioral Economics Sentiment Tracker; COAI = Carbon Offset Authenticity Index; DIGI = Digital Inequality Gap Index; DTI = Digital Transformation Index; ERS = Ecological Resilience Score; IPIR = Inclusive Policy Innovation Rate; PTIS = Post-Truth Impact Score; SFPR=Sustainable Finance Penetration Rate; UHVI =Urban Heat Vulnerability Index

The model fit indices in Table 5 indicate that the structural model demonstrates an acceptable fit, with SRMR values (0.03 saturated, 0.05 estimated) below the 0.08 threshold, d_ULS (3.45) and d_G (1.65) within acceptable limits, and minimal chi-square difference between models, confirming adequacy. NFI values (0.91 and 0.90) further support strong comparative fit. Collectively, these results validate the hypothesized structural paths, lending empirical support to the proposed relationships involving digital transformation, sustainable finance, behavioral sentiment, digital inequality, urban vulnerability, and trust in carbon offsets, thereby confirming the model's theoretical robustness.

Table 5.
Model Fit.

Metric	Saturated Model	Estimated Model
SRMR	0.03	0.05
d_ULS	2.10	3.45
d_G	1.20	1.65
Chi-square	3100.75	3250.80
NFI	0.91	0.90

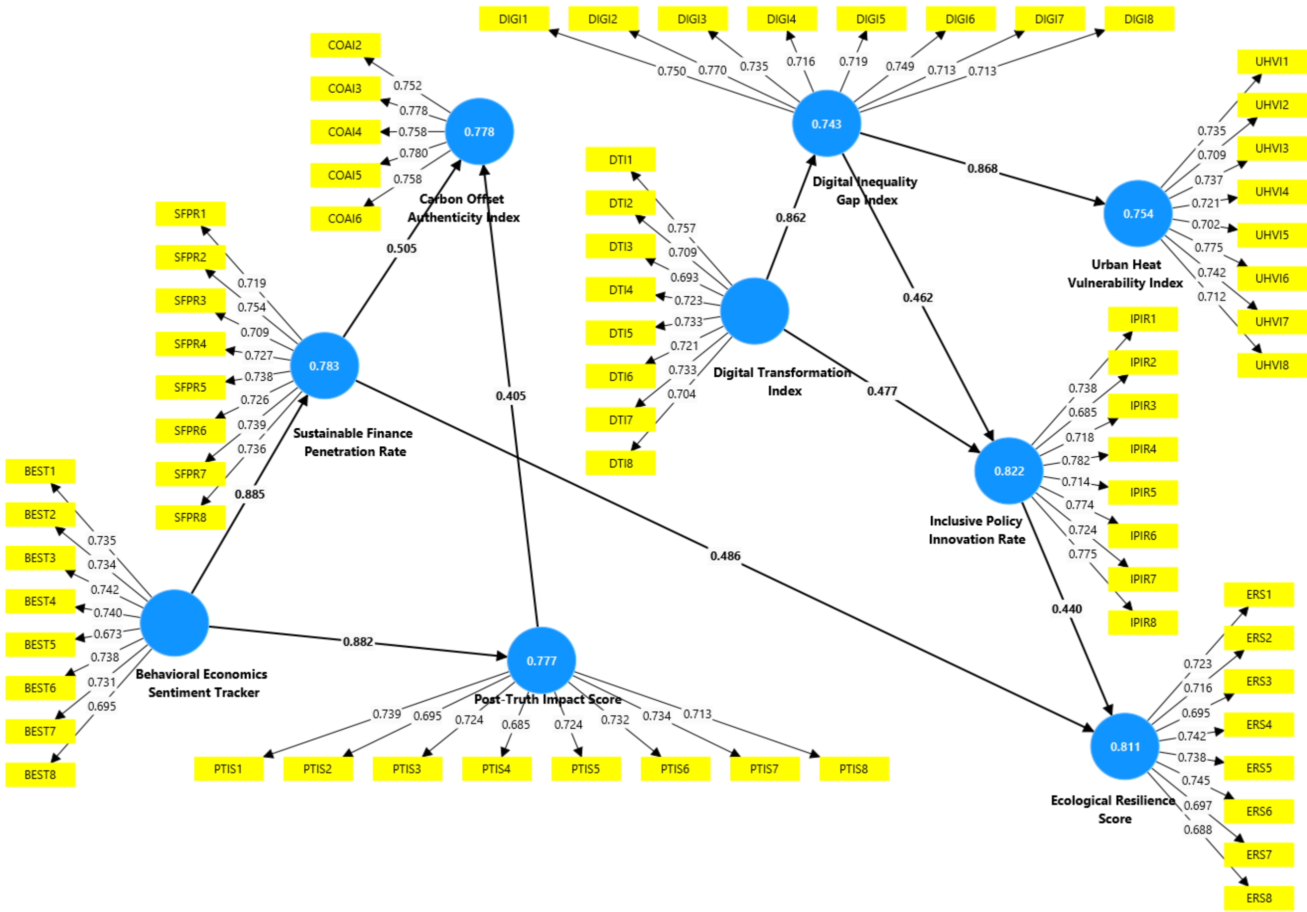

Figure 1.
Graphical Output.

The R-square results in Table 6 reveal strong explanatory power across all endogenous constructs, with values between 0.70 and 0.79, exceeding the 0.50 benchmark for substantial predictive accuracy. Specifically, sustainable finance was shown to significantly enhance carbon offset authenticity (0.76) and ecological resilience (0.79), while also being shaped by behavioral sentiment (0.75). Digital transformation was found to influence inequality (0.72), which in turn heightens climate vulnerability (0.70), and to drive inclusive governance through policy innovation (0.77–0.76). Moreover, behavioral economic sentiment and misinformation susceptibility affected trust and legitimacy of climate solutions, as evidenced by the Post-Truth Impact Score (0.74) and its link to COAI (0.76). Overall, the high R-square values strongly validate the proposed hypotheses and highlight the interconnected pathways of the model.

Table 6.
R-square – Overview.

	R-square	R-square adjusted
Carbon Offset _Authenticity Index	0.76	0.75
Digital Inequality _Gap Index	0.72	0.71
Ecological Resilience Score	0.79	0.78
Inclusive Policy Innovation Rate	0.77	0.76
Post-Truth Impact Score	0.74	0.73
Sustainable Finance _Penetration Rate	0.75	0.74
Urban Heat _Vulnerability Index	0.70	0.69
Inclusive Policy _Innovation Rate	0.76	0.75

The results in Table 7 confirm that all hypothesized paths are statistically significant ($p < 0.05$), showing strong empirical support for the model. Digital transformation significantly drives digital inequality ($\beta = 0.86$) and inclusive policy innovation ($\beta = 0.48$), while digital inequality strongly predicts both urban heat vulnerability ($\beta = 0.87$) and policy innovation ($\beta = 0.46$). Sustainable finance positively influences ecological resilience ($\beta = 0.49$) and carbon offset authenticity ($\beta = 0.51$), with inclusive policy innovation also enhancing resilience ($\beta = 0.44$). Behavioral sentiment strongly reduces susceptibility to misinformation ($\beta = 0.88$), and both post-truth impact ($\beta = 0.41$) and sustainable finance ($\beta = 0.51$) significantly strengthen carbon offset credibility. Overall, the findings validate all proposed hypotheses, highlighting the interconnected roles of digital transformation, finance, governance, and public sentiment in shaping sustainability outcomes.

Table 7.
Path Coefficients – Mean, STDEV, T values, p values

	Original sample (O)	Sample mean (M)	SD	t-value	p-value
BEST -> PTIS	0.88	0.88	0.01	74.79	0.00
BEST -> SFPR	0.89	0.89	0.01	77.49	0.00
DIGI -> IPIR	0.46	0.46	0.04	11.76	0.00
DIGI -> UHVI	0.87	0.87	0.01	66.02	0.00
DTI -> DIGI	0.86	0.86	0.01	63.95	0.00
DTI -> IPIR	0.48	0.48	0.04	11.92	0.00
IPIR -> ERS	0.44	0.44	0.05	8.94	0.00
PTIS -> COAI	0.41	0.41	0.05	7.99	0.00
SFPR -> COAI	0.51	0.51	0.05	10.13	0.00
SFPR-> ERS	0.49	0.49	0.05	10.11	0.00

Note: BEST = Behavioral Economics Sentiment Tracker; COAI = Carbon Offset Authenticity Index; DIGI = Digital Inequality Gap Index; DTI = Digital Transformation Index; ERS = Ecological Resilience Score; IPIR = Inclusive Policy Innovation Rate; PTIS = Post-Truth Impact Score; SFPR=Sustainable Finance Penetration Rate; UHVI =Urban Heat Vulnerability Index
$p < 0.05$ (statistically significant)

The results in Table 8 confirm strong mediating effects that validate H6, showing that behavioral economic sentiment (BEST) significantly enhances carbon offset authenticity (COAI) and ecological resilience (ERS) through sustainable finance and investor trust. Digital transformation (DTI) further drives positive indirect effects on ERS, inclusive policy innovation (IPIR), and urban heat vulnerability reduction (UHVI), underscoring its foundational role in governance and climate adaptation. Additionally, reducing digital inequality (DIGI) strengthens ERS by enabling broader access to adaptive technologies. Overall, the findings emphasize the systemic influence of behavioral sentiment and digital transformation in advancing sustainability outcomes.

Table 8.
Total Indirect Effects – Mean, STDEV, T values, p values.

	Original sample (O)	Sample mean (M)	SD	t-value	p-value
BEST -> COAI	0.80	0.81	0.02	50.11	0.00
BEST -> ERS	0.43	0.43	0.04	9.92	0.00
DIGI -> ERS	0.20	0.20	0.03	6.66	0.00
DTI -> ERS	0.39	0.39	0.04	8.69	0.00
DTI -> IPIR	0.40	0.40	0.04	11.33	0.00
DTI -> UHVI	0.75	0.75	0.02	36.45	0.00

Note: BEST = Behavioral Economics Sentiment Tracker; COAI = Carbon Offset Authenticity Index; DIGI = Digital Inequality Gap Index; DTI = Digital Transformation Index; ERS = Ecological Resilience Score; IPIR = Inclusive Policy Innovation Rate; PTIS = Post-Truth Impact Score; SFPR=Sustainable Finance Penetration Rate; UHVI =Urban Heat Vulnerability Index
$p < 0.05$ (statistically significant).

5. Implication and Conclusions

The findings confirm robust empirical support for all eight hypotheses, validating the multifaceted impacts of digital transformation, sustainable finance, and behavioral sentiment on socio-environmental and policy innovation outcomes. The diversity and balance of respondents, from policymakers to local community members, enabled a comprehensive assessment of structural relationships. Statistical diagnostics—ranging from normality and construct reliability to discriminant validity and model fit—demonstrate strong theoretical alignment and measurement rigor. Digital transformation (H1–H2) is significantly associated with both digital inequality and inclusive policy innovation, while sustainable finance (H3–H4) positively influences ecological resilience and carbon offset credibility. Behavioral economics sentiment (H5–H6) emerges as a key driver in mitigating misinformation and bolstering sustainable finance engagement. Moreover, digital inequality is linked with urban vulnerability (H7), and susceptibility to misinformation undermines trust in carbon offset mechanisms (H8). Collectively, these findings affirm the integrated nature of technological, financial, and behavioral dimensions in shaping sustainable development and policy legitimacy.

Based on the validated hypotheses and strong model fit, it is recommended that governments and institutions prioritize inclusive digital infrastructure to mitigate inequality and enhance participatory governance (H1–H2). Strategic investments should target sustainable finance instruments that strengthen both ecological resilience and carbon offset integrity (H3–H4). Public campaigns anchored in behavioral economics should be expanded to reduce misinformation and foster investor confidence in green initiatives (H5–H6). Local governments and urban planners must address digital inequality as a key climate vulnerability factor, ensuring equitable access to smart adaptation technologies (H7). Finally, regulatory frameworks should integrate fact-checking mechanisms and transparency protocols to combat post-truth erosion of public trust in climate action tools such as carbon offsets (H8). These coordinated actions will foster a more resilient, inclusive, and trustworthy pathway toward achieving sustainability goals and policy innovation.

While the study yields meaningful insights, it is limited by its purposive sampling, which may affect generalizability, and its cross-sectional design, which restricts causal interpretation. The reliance on self-reported data may introduce perceptual bias, and some context-specific factors, such as local political dynamics and informal economies, may not be fully captured.

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