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An Institutional and Resource-Based Inquiry into the Contested Sustainability of Corporate Digital Transformation and the Green-Digital Paradox

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Research Article

Keywords: Green-Digital Paradox, Twin transition, Sustainable Development Goals, Digital sustainability, Dynamic capabilities, Paradox management

Posted Date: June 25th, 2026

DOI: https://doi.org/10.21203/rs.3.rs-9524489/v1

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Additional Declarations: No competing interests reported.

Abstract

Firms are now expected to do two things at once: to digitalize, rebuilding operations around data and artificial intelligence, and to reduce their environmental harm. This “twin transition” is usually described as a partnership in which smarter technology delivers a cleaner economy. The reality is less tidy. Digital infrastructure carries a large and rising environmental load — electricity for data centres and AI, electronic waste, water and minerals — that can quietly cancel out the gains it is meant to create. We call this tension the Green-Digital Paradox, and we argue that it cuts across several Sustainable Development Goals, in particular affordable and clean energy (SDG 7), industry, innovation and infrastructure (SDG 9), responsible consumption and production (SDG 12) and climate action (SDG 13). Drawing together the resource-based view and institutional theory, we develop the idea of an Institutional–Resource Capability Trap: firms that respond sensibly to separate pressures to digitalize and to go green build two sets of capabilities that then work against each other inside the organization. Using a sequential mixed-methods design — 23 executive interviews followed by a survey of 421 managers analysed with structural equation modelling — we find clear evidence of the trap, a significant negative interaction between digital and green capabilities, and a way out of it. We introduce and validate Paradox Management Capability, a higher-order dynamic capability that neutralizes the tension and is associated with stronger environmental and economic performance. The study gives sustainability researchers and managers a diagnostic instrument and a practical route for keeping digital investment aligned with, rather than working against, the 2030 Agenda.

1 Introduction

Two demands now sit near the top of almost every corporate agenda. The first is to digitalize: to rebuild products, services and operations around data, software and, increasingly, artificial intelligence. The second is to do less environmental damage — to cut emissions, waste less, and use resources more carefully. Policymakers and managers tend to bundle these together as the “twin transition,” and the assumption running through most of that talk is that the two pull in the same direction (Verhoef et al., 2021; Antonioli, Ghisetti, & Montresor, 2022). On this view, digital tools are simply how a greener economy gets built. The idea has been influential enough to shape regulation; the European Green Deal, for instance, treats digital and green progress as parts of one project, which has left firms expected to justify their technology spending in environmental terms (Kilinc, Sjödin, & Parida, 2025). For the Sustainable Development Goals (SDGs), the stakes are immediate. If digitalization genuinely advances clean energy (SDG 7), resilient and innovative industry (SDG 9), responsible production (SDG 12) and climate action (SDG 13), it is one of the most powerful levers available for the 2030 Agenda (United Nations, 2015). If it does not, a great deal of sustainability strategy is resting on a hopeful assumption.

That assumption is shakier than it looks. Close readings of policy language find that the digital and green agendas are often handled separately, side by side, or in outright tension, rather than as a single coherent programme; researchers have called this “non-articulation” (Kilinc, Sjödin, & Parida, 2025). When the same documents urge actors to bridge the gap between the two transitions, they concede that

no bridge yet exists. Firms are left to operate inside that gap, responding to instructions that do not line up. This is the institutional setting our study takes as its starting point.

Underneath the policy debate lies a physical fact that is easy to miss, because digital products feel weightless. They are not. Building and running digital infrastructure consumes a large and growing share of the world's energy and materials (Civera, Santoro, & Chiaudano, 2025). The International Energy Agency (2024) projects that electricity used by data centres, AI and cryptocurrency could roughly double between 2022 and 2026 to more than 1,000 TWh, comparable to the annual electricity consumption of a large industrialized economy. The hardware behind all of this turns into waste quickly: the world generated about 62 million tonnes of electronic waste in 2022, of which only 22.3 per cent was formally collected and recycled (United Nations, 2024). Manufacturing the devices in the first place draws on contested mineral supply chains and on the water used to cool servers (Civera, Santoro, & Chiaudano, 2025). Each of these pressures works directly against the goals digitalization is supposed to serve: energy demand against SDG 7 and SDG 13, e-waste and extraction against SDG 12.

Put the contested policy field and the material footprint together, and a problem emerges that the literature has not fully confronted. We name it the **Green-Digital Paradox**: the pursuit of sustainability through digital transformation can generate environmental costs large enough to offset, or even exceed, the intended benefits, leaving a net impact that is neutral or negative (Narkhede, Raut, & Priyadarshinee, 2024). This is not simply a trade-off to be optimized away. It has the structure of a paradox in the sense of Smith and Lewis (2011, p. 382): contradictory yet interrelated demands that persist over time and resist any permanent resolution. The tension a firm feels internally is, in effect, the wider institutional incoherence reproduced inside the organization.

Existing research has documented the two halves of this problem in isolation. One stream shows how "green IT" and digital tools can improve environmental performance (Chen, Lai, & Wen, 2006); another counts the environmental costs of digital expansion (Civera, Santoro, & Chiaudano, 2025). What neither explains is how a single firm manages the contradiction once both forces are operating inside it. That is the question we pursue: how do firms manage the tensions of the Green-Digital Paradox, and with what consequences for their environmental and economic performance? Our aim is to give sustainability researchers and managers a usable account of that process — one that connects the external pressures bearing on firms with the internal capabilities they build in response, and that points toward concrete ways of keeping digital investment aligned with the SDGs rather than undercutting them. We do this in three moves. First, we establish the Green-Digital Paradox as a measurable, firm-level phenomenon, and frame it as an Institutional–Resource Capability Trap. Second, we show what the trap does to performance. Third, we identify and test a higher-order capability that lets firms escape it. The rest of the paper develops the theory, sets out the research design, reports the findings, and discusses what they mean for theory, practice, policy and the 2030 Agenda.

2 Theoretical foundations and hypothesis development

Explaining the paradox takes more than describing it. We need a framework that can hold two forces in view at once: the internal choices a firm makes about what to build, and the external environment that shapes those choices. We combine two established theories to do this. The resource-based view (RBV) accounts for the internal side; institutional theory accounts for the external one. Read together, they explain both how the paradox arises and how its damage to performance might be contained.

2.1 An integrated perspective: the Institutional–Resource Capability Trap

The RBV begins with a simple question: why do some firms perform consistently better than others? Its answer locates advantage not in market position but in bundles of internal resources and capabilities that are valuable, rare, hard to imitate and hard to substitute (Barney, 1991). Attention turns inward, to the choices managers make in assembling those competencies. Hart's (1995) natural-resource-based view (NRBV) extended this logic to the environment, arguing that capabilities for pollution prevention, product stewardship and clean technology can themselves become durable sources of advantage (Hart, 1995; Hart & Dowell, 2011). For our purposes, the combined logic identifies two relevant capability sets: a firm's digital capabilities (Mithas, Ramasubbu, & Sambamurthy, 2011) and its green capabilities (Chen et al., 2006).

Institutional theory supplies what the RBV leaves out: why firms build these capabilities when they do. Much of the time the answer is legitimacy. To keep their licence to operate, firms adopt the structures and practices that coercive, normative and mimetic pressures in their field mark as appropriate (DiMaggio & Powell, 1983; Delmas & Toffel, 2008; Rana, Bhuiyan, Munir, & Baird, 2023). Joining the two theories lets us state the problem precisely. Firms face separate, often poorly coordinated pressures to digitalize and to go green. Responding rationally to each, they invest in two distinct capability stacks; by RBV logic, each investment ought to create value. The **Institutional–Resource Capability Trap** is what happens next: the two capability sets, each sensible on its own, collide inside the firm and destroy value through the friction between them. The first stage of the trap — capability building in response to pressure — gives our first two hypotheses.

H1. *Perceived institutional pressures for digitalization are positively associated with a firm's level of Digital Capabilities.*

H2. *Perceived institutional pressures for sustainability are positively associated with a firm's level of Green Capabilities.*

2.2 The capability collision and the Green-Digital Paradox

The damage is done in the firm's operating core. Building world-class digital capability and building serious green capability are not independent projects. They compete for the same finite resources: capital, scarce engineering talent, and senior management attention (Kilinc, Sjödin, & Parida, 2025). Beyond the contest for resources, the two pull on incompatible operating logics. Pushing hard on digital

capability tends to reward speed and computational power, which often means energy-hungry infrastructure; a green capability built around energy discipline points the other way. A culture tuned for fast, agile innovation does not sit easily with the slower, careful work of life-cycle assessment and design for durability. The implication is a negative interaction: the performance contribution of a firm's digital effort is weaker, not stronger, when its green effort is also high, because that combination signals more acute internal conflict. This is the value-destroying collision at the centre of the trap, and it gives our third hypothesis.

H3. *There is a negative interaction effect between Digital Capabilities and Green Capabilities on overall environmental and economic performance. Specifically, the positive relationship between each capability and performance is weaker when the other capability is high.*

2.3 Paradox management as a dynamic capability

If the trap is real, the obvious question is how some firms get out of it. The paradox literature is useful here. For contradictions that are built in and will not go away, the recommended response is not compromise but a "both/and" posture that holds the tension rather than trying to dissolve it (Smith & Lewis, 2011; Hahn, Preuss, Pinkse, & Figge, 2014). To turn that idea into something testable, we lean on two distinctions. Recent work separates paradoxical thinking, a cognitive stance, from paradoxical action, the behavioural and structural moves that follow (Carmine & De Marchi, 2023). And the capacity to do this reliably, across decisions and over time, is best understood as a dynamic capability: a "learned and stable pattern of collective activity through which the organization systematically generates and modifies its operating routines" (Zollo & Winter, 2002, p. 340), of the kind that lets firms reconfigure their resource base as conditions change (Teece, 2007; Schilke, Hu, & Helfat, 2018; Teece, 2022).

From this we propose **Paradox Management Capability (PMC)**: the learned organizational capacity to sense, seize and reconfigure resources so as to manage the tensions of the twin transition. Its foundations are partly cognitive — a "both/and" mindset and open discussion of trade-offs, that is, paradoxical thinking — and partly behavioural and structural — integrated governance, holistic metrics and collaborative routines, that is, paradoxical action (Carmine & De Marchi, 2023). Mapped onto Teece's (2007) framework, the cognitive elements let a firm sense the paradoxical character of its situation (captured by items PMC2 and PMC4), while the structural elements let it seize integrative opportunities (PMC3) and reconfigure resources away from siloed decision-making (PMC1). A firm that has built this capability should be able to blunt the negative interaction at the heart of the trap.

H4. *Paradox Management Capability positively moderates the negative interaction effect proposed in H3. In firms with high Paradox Management Capability, the negative interaction between Digital and Green Capabilities on environmental and economic performance is significantly weaker than in firms with low Paradox Management Capability.*

3 Research design and execution

Testing a model like this, about a phenomenon as new as the Green-Digital Paradox, calls for more than one kind of evidence. We used a sequential exploratory design (QUAL → QUAN). The qualitative phase was not there to illustrate; it was there to build. Because one of our central constructs did not yet exist as a measure, we needed to ground it in what managers actually described before we could survey anyone about it. The qualitative work therefore shaped the survey, and the survey then tested the full model at scale.

3.1 Rationale for a sequential exploratory design

A single method would have left a gap. Interviews alone give depth but no reach; a survey alone gives reach but can float free of how managers really experience the problem. Sequencing the two closes that gap. We started with open-ended exploration to understand the paradox from the inside, then used what we learned to design a survey we knew was anchored in practice. The specific choice of a QUAL → QUAN order followed from the novelty of the constructs. Building the Paradox Management Capability scale this way protects its content validity, which is the right priority when a construct is new and its measure is still being formed (Clark & Watson, 1995; DeVellis, 2021). The interviews surfaced the dimensions, routines and mindsets that make up the capability; the survey then tested the whole model statistically. The hinge between the two phases was item development: the themes, and the actual wording, from the interviews became the survey items, which is where most of the instrument's validity comes from.

3.2 Phase A: qualitative exploration

The first phase set out to understand how senior executives read and manage the tensions of the paradox. We ran in-depth, semi-structured interviews with 23 senior executives, all drawn from publicly listed firms operating where technological intensity and environmental scrutiny overlap. Interviews were transcribed in full and analysed iteratively through open, axial and selective coding (Corbin & Strauss, 2008). The protocol deliberately probed failed integration attempts, on the view that what goes wrong is often more revealing than what goes right, and paid close attention to the routines that seemed to separate firms coping well from firms struggling. Three themes emerged — integrated governance, holistic measurement, and a "both/and" mindset — and these became the four items (PMC1–PMC4) of the new scale carried into the survey. The full protocol appears in Appendix A.

3.3 Phase B: quantitative validation

The second phase tested the four hypotheses. We fielded a cross-sectional survey through Qualtrics, recruiting respondents through professional networks and a panel provider. After removing incomplete and inattentive responses, the usable sample was 421 senior and middle managers based in North America and Europe.

The instrument (Appendix B) used established multi-item scales with a seven-point response format. Items for institutional pressures and for digital and green capabilities were adapted from prior validated work (Mithas et al., 2011; Rana et al., 2023). The dependent variable measures environmental and

economic performance relative to competitors, drawn from the perceptual performance tradition (Ketokivi & Schroeder, 2004). We focus on the environmental and economic dimensions because they are the two most directly implicated by the green-digital tension; the social dimension, which the SDGs make equally central, is one we return to deliberately as the principal extension of this work (Section 6). During scale purification, an item assessing social performance and an eco-innovation item that had been piloted in Phase A were dropped, leaving a final two-item measure of environmental and economic performance. Firm size, industry and age were captured as controls.

3.4 Data analysis plan

Analysis followed a two-step structural equation modelling (SEM) protocol in AMOS. The first step was a confirmatory factor analysis (CFA) to check the measurement model: reliability through Cronbach's alpha and composite reliability, convergent validity through factor loadings and average variance extracted (AVE), and discriminant validity through the Fornell–Larcker criterion. With the measurement model confirmed, the second step estimated the structural model and tested H1, H2 and H3 through the standardized path coefficients and their significance, after checking overall fit (χ^2/df, CFI, TLI, RMSEA, SRMR).

H4 needed a different procedure, because it is a moderated interaction. We built a three-way interaction term from the mean-centred product of digital capabilities, green capabilities and PMC, and read the hypothesis off the sign and significance of its coefficient. Where the three-way term was significant, we probed it by plotting the two-way (digital × green) interaction at high (+ 1 SD) and low (− 1 SD) levels of PMC, following standard practice for interpreting interactions. We also ran robustness checks to confirm the results were stable.

4 Findings

We report the two phases in the order they were run: the qualitative insights that shaped the constructs, then the quantitative tests of the model.

4.1 Qualitative insights: the managerial experience of the paradox

The interviews made the paradox concrete. Across very different firms, executives described digital projects, undertaken for sound reasons, that produced environmental costs no one had planned for. A second recurring theme was conflict between functions that measure success in different units and barely share a language. One executive put it plainly: "The CIO talks about teraflops, the CSO talks about Scope 2 emissions, and in our capital budgeting meetings their proposals are often in direct opposition."

The more useful finding was what set apart the firms that were beginning to cope. Their practices clustered into three areas, and these became the basis for the PMC scale (Table 4). The first was **integrated governance and decision-making**, where firms replaced ad hoc coordination with formal joint

structures. As one chief sustainability officer described it: “No major tech project gets approved anymore without a Green-Digital Impact Assessment that is co-signed by both the CTO and myself. It forces the trade-off conversation to happen at the beginning, not after the fact.” This fed the item on cross-functional collaboration (PMC3). The second was **holistic performance measurement**: new metrics that made the paradox visible, such as carbon emissions per unit of computation or the life-cycle cost of digital assets, which informed the item on formal evaluation processes (PMC1). The third, and in several accounts the most important, was a shift in leadership thinking toward a **“both/and” mindset**. One executive reframed the whole problem as a question: “how can we use our innovation to solve the sustainability problems created by our innovation?” This informed the items on open discussion of trade-offs (PMC2) and on actively seeking dual-optimizing solutions (PMC4).

Table 4

Development of the Paradox Management Capability (PMC) construct

Item	Item text	Qualitative theme	Illustrative quote	Paradox-theory stream
PMC1	Our firm has formal processes to evaluate both the digital benefits and the environmental footprint of new technology investments.	Holistic performance measurement	“No major tech project gets approved anymore without a Green-Digital Impact Assessment…”	Action / structural
PMC2	Our leadership team actively encourages open and honest discussion about the potential trade-offs between digitalization and sustainability.	Fostering a “both/and” mindset	“…how can we use our innovation to solve the sustainability problems created by our innovation?”	Thinking / cognitive
PMC3	There is strong and effective cross-functional collaboration between our IT/technology teams and our sustainability/CSR teams.	Integrated governance and decision-making	“…co-signed by both the CTO and myself. It forces the conversation…”	Action / structural
PMC4	When making strategic decisions, we explicitly seek solutions that optimize for both digital innovation and environmental performance.	Fostering a “both/and” mindset	“The CIO talks about teraflops… the CSO talks about Scope 2 emissions… their proposals are often in direct opposition.”	Thinking / cognitive

4.2 Quantitative validation: testing the model

The survey data were used to test the model with SEM. The CFA results (Table 2) were strong: every latent construct met or exceeded the usual thresholds for reliability and validity, and the measurement model fit well ($\chi^2/df = 2.04$, CFI = 0.97, TLI = 0.96, RMSEA = 0.045, SRMR = 0.049). Table 1 reports descriptive statistics and correlations.

Table 1

Descriptive statistics and correlation matrix

Variable	Mean	SD	1	2	3	4	5	6
1. Inst. Pressure (Digital)	4.85	1.21	–					
2. Inst. Pressure (Green)	5.02	1.15	.41**	–				
3. Digital Capabilities	4.98	1.33	.55**	.28**	–			
4. Green Capabilities	4.77	1.29	.25**	.61**	.35**	–		
5. Paradox Mgt. Capability	4.51	1.40	.33**	.39**	.48**	.52**	–	
6. Env. & Econ. Performance	5.15	1.25	.31**	.45**	.49**	.58**	.65**	–

*Note. N = 421. SD = standard deviation. ** p < .01 (two-tailed). Env. & Econ. Performance = environmental and economic performance.*

Table 2

Measurement model assessment: confirmatory factor analysis, reliability and validity

Construct	Items	Std. loading range	Cronbach's α	CR	AVE
Inst. Pressure (Digital)	4	.79–.85	.88	.89	.67
Inst. Pressure (Green)	4	.84–.88	.91	.92	.74
Digital Capabilities	4	.81–.88	.92	.93	.72
Green Capabilities	4	.82–.87	.90	.91	.71
Paradox Mgt. Capability	4	.79–.86	.89	.90	.69
Env. & Econ. Performance	2	.89–.92	.94	.95	.82

Note. All factor loadings are significant at p < .001. CR = composite reliability; AVE = average variance extracted. Discriminant validity was established for all constructs: the square root of the AVE for each construct exceeds its correlation with any other construct.

The structural model also fit well ($\chi^2/df = 2.15$, CFI = 0.96, TLI = 0.95, RMSEA = 0.048, SRMR = 0.051), and all four hypotheses were supported (Table 3; Fig. 1).

Table 3
Structural equation model results for the hypothesized paths

Hyp.	Path	Std. β	S.E.	p-value	Result
H1	Inst. Pressure (Digital) → Digital Cap.	0.52	0.06	< .001	Supported
H2	Inst. Pressure (Green) → Green Cap.	0.59	0.05	< .001	Supported
H3	Digital Cap. × Green Cap. → Env. & Econ. Perf.	−0.18	0.05	.002	Supported
H4	(Digital × Green) × Paradox Mgt. → Env. & Econ. Perf.	0.15	0.04	.005	Supported

Note. Model fit indices: $\chi^2/df = 2.15$, CFI = 0.96, TLI = 0.95, RMSEA = 0.048, SRMR = 0.051. Control variables and the direct effects of the first-order capabilities on the outcome were included in the model but are omitted here for clarity.

Institutional pressures drove capability building as predicted. Digitalization pressure was positively associated with digital capabilities (β = 0.52, p < .001), supporting H1, and sustainability pressure with green capabilities (β = 0.59, p < .001), supporting H2.

H3, the test of the trap, held. The interaction between digital and green capabilities on environmental and economic performance was negative and significant (β = −0.18, p = .002). Put differently, in the absence of an integrating mechanism, doing both at once subtracts value rather than adding it.

H4 held as well. PMC positively moderated the negative interaction: the three-way term (digital × green × PMC) was positive and significant (β = 0.15, p = .005). To see what this means, we plotted simple slopes at high and low PMC (Fig. 2). For firms low in PMC, the negative interaction between digital and green capabilities was strong. For firms high in PMC, it was no longer statistically significant. The capability, in short, is what lets a firm carry both agendas without one cancelling out the other.

5 Discussion

These results matter for theory, for management, for policy, and for how digitalization is positioned within the sustainable development agenda. By showing that the Green-Digital Paradox is real at the firm level, and that a specific capability can manage it, the study moves the twin-transition conversation away from slogans about synergy toward something more honest and more useful.

5.1 A note on perception and material reality

One feature of the design needs stating up front, because it shapes how the findings should be read. The paradox is, at root, a matter of physical reality: energy, emissions, waste (Civera, Santoro, & Chiaudano, 2025; United Nations, 2024). Our outcome measure, by contrast, is managers' assessment of their firm's performance against competitors. Perceptual measures are standard and often necessary in strategy research (Ketokivi & Schroeder, 2004; Mithas et al., 2011), but they leave a gap. What we can say is that

PMC is associated with managers perceiving stronger environmental and economic performance. We cannot show, from these data alone, that it produces better objective environmental outcomes. That distinction runs through the contributions below.

5.2 Theoretical contributions

The first contribution is to reframe the twin transition. Instead of a synergy-versus-trade-off question, we treat it as a firm-level paradox and give empirical content to an Institutional–Resource Capability Trap. The data show firms responding to separate institutional pressures by building separate capability stacks (H1, H2), and then show those stacks colliding (H3). Legitimacy-seeking behaviour that is individually rational can, taken together, leave a firm internally incoherent and worse off (DiMaggio & Powell, 1983). That is a more realistic picture of firm–environment interaction than the prevailing one.

The second contribution is the construct itself. We conceptualize, operationalize and validate Paradox Management Capability as a higher-order dynamic capability, responding to calls for empirical work on how organizations actually manage competing sustainability goals (Van der Byl & Slawinski, 2015; Hahn, Figge, Pinkse, & Preuss, 2018). Grounding it in both paradox theory — the distinction between thinking and action (Carmine & De Marchi, 2023) — and dynamic-capabilities theory (Teece, 2007, 2022), and then building a working measure, turns a useful idea into something other researchers can pick up and use. For the NRBV (Hart, 1995; Hart & Dowell, 2011), it names a concrete mechanism: a learned set of routines for sensing, seizing and reconfiguring, through which firms reconcile contradictory demands.

There is a third, quieter point. A standard RBV reading asks which capabilities a firm should build. Our results suggest that question matters less than how a firm manages the tension between the capabilities it already has. Advantage in the twin transition looks less like accumulating more resources and more like the integrative capacity to resolve the conflicts they create. If that is right, PMC is itself a valuable, rare and hard-to-imitate resource, and a candidate source of lasting advantage (Barney, 1991).

5.3 Contributions to sustainable development and the SDGs

Because the paradox cuts across several SDGs, managing it well is not only a strategic matter but a sustainability one. The energy demand of digital infrastructure bears on affordable and clean energy (SDG 7) and, through emissions, on climate action (SDG 13); the hardware cycle bears on responsible consumption and production (SDG 12); and the underlying drive to digitalize sits within industry, innovation and infrastructure (SDG 9). A firm caught in the capability trap is, in effect, eroding progress on these goals even while reporting digital and green “wins” in separate documents. Read in SDG terms, the contribution of PMC is that it offers a route to genuine coherence at the firm level: a way of keeping digital investment from quietly undoing the environmental gains it is meant to support. This is the integrated treatment of technological and environmental systems that sustainable development calls for and that single-goal thinking tends to miss (United Nations, 2015). It also makes plain why the social dimension cannot be left out indefinitely, a point we take up as the central direction for future work.

5.4 Implications for management

For executives, the headline is that digital and sustainability strategies can no longer be run in separate silos. They have to be managed together, which is more than an org-chart change; it asks the firm to treat the tension between them as a source of better decisions rather than a nuisance to be contained.

A practical first step is diagnosis. The paradox is probably already present, and already causing friction, in most large firms, so we suggest a “Green-Digital Audit” that uses the validated PMC scale as its instrument. Scoring the organization against the four items — holistic evaluation, open discussion of trade-offs, cross-functional collaboration, and the search for dual-optimizing solutions — shows where the gaps are. A low score on cross-functional collaboration (PMC3), for instance, is a direct signal to invest in dismantling the silos our interviews found so damaging.

The larger shift is in where firms put their money. Rather than treating “digital projects” and “green projects” as separate, competing budget lines, executives should fund a third priority: building PMC itself. In practice that means cultivating a “both/and” leadership mindset; writing paradoxical logic into core systems, so that capital budgeting weighs full life-cycle environmental impact alongside return on investment; and putting real governance behind it, such as a senior steering committee held accountable for both digital and green results. The aim is an organization that stops treating the Green-Digital Paradox as an obstacle to route around and starts using it to prompt smarter, lower-impact ways of working.

5.5 Implications for policy and the 2030 Agenda

The findings reach policymakers too. If the twin transition is a contested, often non-articulated field, then uncoordinated policy can deepen the trap rather than relieve it (Kilinc, Sjödin, & Parida, 2025). A government that subsidizes AI research while sharply taxing industrial electricity is sending firms two contradictory signals and pushing them further into conflict. The remedy is coherence, which the 2030 Agenda itself names as a condition for progress across goals (United Nations, 2015). Concretely, that could mean targeted support for “Green AI,” stronger circular-economy standards for electronic waste, and clear, mandatory reporting of the environmental footprint of digital operations. A more consistent institutional environment would let firms spend less effort absorbing contradictory mandates, and more on the integration the SDGs actually need.

6 Limitations and future research

Like any study, this one has limits, and each points to a useful next step. First, the quantitative phase is cross-sectional, so we cannot make strong causal claims; longitudinal work that tracks digital, green and paradox-management capabilities and their performance effects over time would test the dynamics we infer. Second, the outcome relies on self-report from a single respondent per firm. Pairing the survey with objective environmental and ESG data would let researchers check perceived performance against measured performance, and would speak directly to the perception–reality gap noted in Section 5.1.

Third, the sample is drawn from developed Western economies; whether the model holds in the very different institutional settings of Asia, Africa and Latin America is an open and important question.

The most consequential limit, though, is one of scope, and it sets the agenda we think matters most. We concentrated on the environmental and economic sides of sustainability and set the social side aside. For a research programme meant to speak to the full SDG agenda, that cannot be the last word. The natural next step turns the paradox into a trilemma. We propose work on a **Green-Social-Digital Trilemma**: the three-way tension between environmental sustainability (resource use), digital automation (AI-driven efficiency) and a just transition for workers (job quality, employee well-being). Bringing the social dimension in would connect this line of inquiry to goals such as decent work and economic growth (SDG 8) and reduced inequalities (SDG 10), and would give a fuller account of what a genuinely holistic twin transition demands.

7 Conclusion

We began from a doubt about the comfortable story of the twin transition. Set against the physical footprint of digital infrastructure and the contested policy field around it, the promise of automatic digital-green synergy looks more like an aspiration than a fact. Treating the problem as a firm-level paradox, we found evidence for an Institutional–Resource Capability Trap, in which firms that respond rationally to separate pressures end up building digital and green capabilities that fight each other and drag down performance. We then identified and validated the capability that breaks the deadlock — Paradox Management Capability — and showed that firms which possess it can carry both agendas without one cancelling out the other.

The wider point is about how we think and talk about digitalization and sustainability together. Moving from a story of effortless synergy to a clear-eyed account of a managed paradox gives researchers and managers a more accurate, and more workable, lens on one of the defining challenges of the 2030 Agenda. Whether digital transformation ends up serving the Sustainable Development Goals or undercutting them will depend less on how much firms invest in either agenda, and more on whether they can manage the tension between the two.

Declarations

Ethical approval. The study was conducted in accordance with the principles of the Declaration of Helsinki. Ethical approval for the research involving human participants (the executive interviews and the manager survey) was granted by the institutional research ethics committee of the corresponding author's institution. All procedures involving human participants were in line with institutional and national research ethics standards.

Consent to participate. Informed consent was obtained from all individual participants included in the study. Interview participants were informed of the study's purpose, the confidential and anonymous handling of their data, and their right to withdraw, and they consented to audio recording before each

interview began. Survey respondents provided informed consent on the study's introductory page before proceeding.

Consent to publish. All participants consented to the use of their anonymized responses, including verbatim quotations, in academic publications. No information that could identify an individual participant or firm is reported.

Competing interests. The authors declare that they have no competing interests.

Author contributions. All authors contributed to the study conception and design. All authors read and approved the final manuscript.

Data availability statement. The datasets generated during and/or analysed during the current study are not publicly available due to confidentiality assurances given to interview and survey participants, but are available from the corresponding author on reasonable request.

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Figures

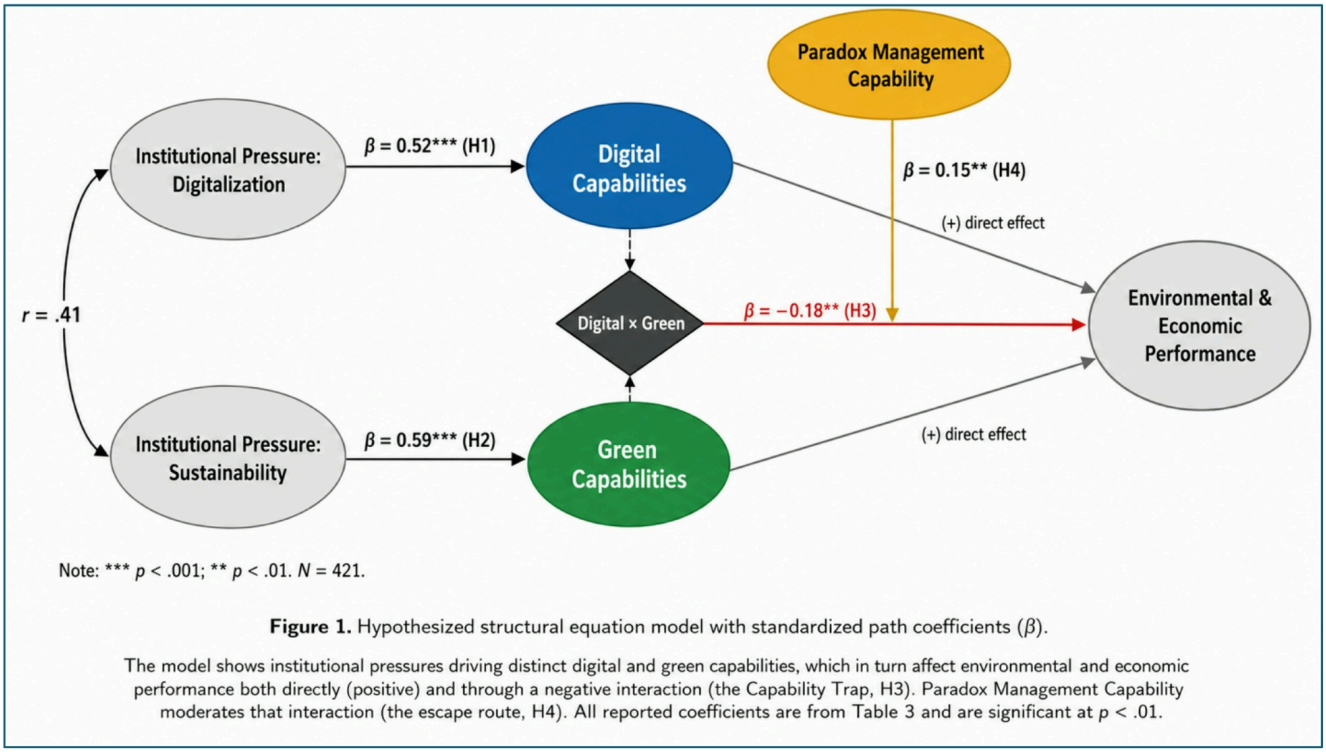


Figure 1. Hypothesized structural equation model with standardized path coefficients (β).

The model shows institutional pressures driving distinct digital and green capabilities, which in turn affect environmental and economic performance both directly (positive) and through a negative interaction (the Capability Trap, H3). Paradox Management Capability moderates that interaction (the escape route, H4). All reported coefficients are from Table 3 and are significant at $p < .01$.

Figure 1

See image above for figure legend.

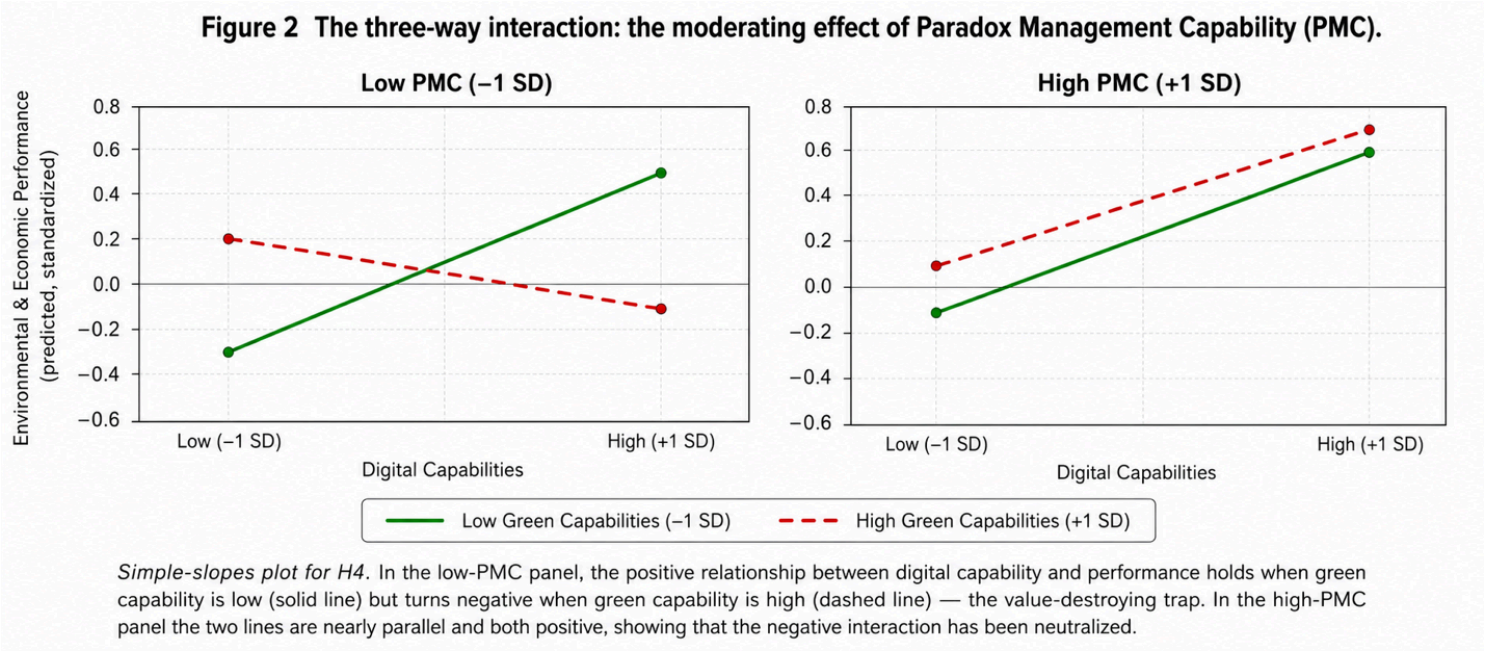


Figure 2

See image above for figure legend.

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- Appendices.docx