



Digitalization Capability, Business Process Reengineering, and Business Performance: Evidence from Six Middle Eastern Markets

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Abstract

Enterprises across the Middle East have absorbed substantial digital investment, yet returns are uneven: firms with comparable digital technologies do not report comparable innovation, agility, or performance. Drawing on the Resource-Based View and Dynamic Capabilities perspective, this study tests Business Process Reengineering (BPR) as a mediator between digitalization capability (DC) and Organizational Agility (OA), Digital Innovation (DI), and Business Performance (BP), and whether digital leadership (DL) moderates the DC-BPR association. Because within-firm agreement on these constructs is negligible (Section 6.6), all constructs, hypotheses, and results below are defined and interpreted at the level at which they were measured: as employees' individual perceptions of firm-level digital practices and outcomes, not as verified firm-level records. A structural model was estimated using genuine PLS-SEM (Mode A, PATH weighting) with percentile-bootstrap inference (2000 resamples for the base model; 1000 for the moderation and mediation sub-analyses) on 336 respondents nested within 50 firms across six Middle Eastern markets (Egypt, Saudi Arabia, the UAE, Jordan, Morocco, Qatar); firm-clustered standard errors correct inference for the base paths, and all percentile bootstraps—including the indirect and interaction effects—additionally use firm-block resampling for fully dependence-aware inference throughout (Section 6.6). DC was most strongly associated with BPR ($\beta = 0.485$), and all remaining hypothesized base paths (H1 - H7) were significant. For DC - DI, results show a complementary (partial) mediation pattern via BPR (H8: direct = 0.210, indirect = 0.120, confirmed by a dedicated single-estimand, firm-block bootstrap, 95% CI [0.073, 0.172], $p < 0.001$; Section 7.8). For BPR - BP, the direct effect was nonsignificant; restricted to the specifically hypothesized organizational-agility route (H9), the indirect BPR $\rightarrow$ OA $\rightarrow$ BP path was positive and, under its own dedicated firm-block bootstrap, significant ($\beta = 0.070$, 95%

CI [0.032, 0.114], $p < 0.001$), consistent with indirect-only mediation through agility, while a supplementary, non-hypothesized route through digital innovation was also positive and significant ($\beta = 0.044$, $p < 0.001$) and is reported separately as exploratory (Sections 7.8, 7.13). The hypothesized DC $\times$ DL interaction on BPR (H10) reached significance under naive standard errors but not under bootstrap validation, so H10 is not robustly supported. These findings indicate that digitalization capability is associated with performance-relevant outcomes largely through organizational reconfiguration (BPR), with agility and innovation representing distinct downstream routes to performance; digital leadership's hypothesized moderating role did not hold up once resampling uncertainty was taken into account. The cross-sectional, single-source design and the two-indicator DL measure limit the conclusions that can currently be drawn; robustness checks already completed (firm-clustered standard errors and firm-block, dependence-aware bootstraps throughout, outlier trimming, controls) left the significant base paths unchanged.

Subject Areas

Business Administration and Management, Information Systems, Strategic Management

Keywords

Digitalization Capability, Business Process Reengineering, Digital Leadership, Business Performance, PLS-SEM

1. Introduction

Digitalization capability is increasingly treated as a strategic priority, yet possessing it does not by itself explain how firms translate that capability into operational and performance outcomes [1] [2]. Firms with similar technology portfolios display markedly different outcomes, and the literature frames technology as an enabler whose value depends on complementary organizational change [1]—a change whose content remains under-specified: culture, structure, governance, and capability development have all been proposed, but remain broad categories rather than measurable activities.

This study examines Business Process Reengineering [3] as one such activity, conceptually and empirically distinct from digitalization capability: digital technologies expand what a process can do without changing what it does, and are commonly layered onto inherited workflows rather than prompting a rethinking of them [4] [5]. Organizational Agility and Digital Innovation are examined as downstream mechanisms linking redesigned processes to Business Performance, and Digital Leadership as a boundary condition on that reconfiguration.

The Middle Eastern enterprise setting is relevant here: digital transformation has been a stated policy priority across the Gulf and Levant, and the six markets studied operate where digital investment has received substantial policy attention

[6], treated here as contextual motivation rather than an independently measured claim. This study's aim is a jointly specified examination of these constructs in a single model (Section 3).

All constructs in this study are collected from individual respondents describing their own firm. Accordingly, they are defined, tested, and interpreted throughout this paper as employees' perceptions of firm-level digital practices and outcomes, not as independently verified firm-level records; Section 6.2 and Section 6.6 detail why this distinction matters for how the results should be read.

Accordingly, this study asks: **RQ1:** Is digitalization capability associated with digital innovation directly, through business process reengineering, or both? **RQ2:** Is the digitalization-reengineering association stronger at higher levels of digital leadership? **RQ3:** Are the agility- and innovation-oriented routes from reengineering to performance distinguishable in strength? Sections 2 - 5 review the literature, state the gap, and develop hypotheses; Section 6 describes the methodology; Section 7 reports results; Sections 8 - 11 discuss findings, contributions, limitations, and conclusions.

2. Literature Review

Digitalization capability (DC) is the firm's capacity to identify, integrate, and deploy digital technologies and data across existing operations—narrower than a general “digital capability” and more operational than “digital transformation capability,” which denotes capacity for large-scale strategic change [7] [8]. DC is the focal antecedent here since the study concerns an operational-level capability, not the broader transformation-capability construct it helps explain; digital-related capabilities are themselves multidimensional, spanning human, collaborative, technical, and innovation-related components [9].

Business Process Reengineering (BPR) is the fundamental rethinking and radical redesign of business processes to achieve substantial performance improvement [3], distinct from incremental process improvement, automation and digitization (which preserve the existing activity sequence), and from digital transformation itself, of which it is one component. A firm can digitize a process without reengineering it, or reengineer one with only modest reliance on new technology [4]. Process management is increasingly framed as shifting from an inward efficiency orientation toward an outward, exploration-oriented one [5], consistent with evidence treating BPR as a mechanism linking digital transformation to productivity gains rather than an outcome to explain [10].

Digital Innovation (DI) encompasses product, service, process, and business-model innovation in which the digital component is constitutive of the innovation itself rather than merely supportive of its development [11], and is conceptually separable from BPR: a firm can introduce a digitally enabled offering without altering internal processes.

Organizational Agility (OA) is the firm's capacity to sense environmental change and respond quickly, theorized as an outcome of digital options that ex-

pand a firm's reach and process/knowledge richness [12], with the capability-to-agility link contingent rather than automatic [13]-[15]. Because reengineered processes remove sequential dependencies that slow both sensing and acting, OA is examined here as downstream of redesign rather than of digital capability directly.

Digital Leadership (DL) refers to leadership behaviors that actively steer digital initiatives—direction-setting, resource allocation, sponsorship, and modelling adoption—rather than general managerial competence [16]. The literature treats it as a facilitating condition for transformation but rarely specifies at which point it operates, often entered as a diffuse main-effect predictor. This study instead examines DL as a moderator of the DC-BPR relationship: redesign reallocates authority and imposes transition costs that capability alone need not overcome, so leadership's plausible role is to condition how much capability is associated with mandated redesign—consistent with regional evidence that strategic agility strengthens this association among Saudi SMEs [6]. As Section 7.4 details, the retained measure captures only sponsorship and modelling, not vision articulation or resource allocation—a scope caveat carried through the results (Sections 7.9, 8.3, 9).

Business Performance (BP) is operationalized here as a perceived, relative-to-competitors composite covering efficiency, market responsiveness, and profitability trend, rather than an audited financial metric—common in PLS-SEM studies spanning firms of heterogeneous size, sector, and jurisdiction. Empirical work on digital transformation in the region remains concentrated on direct digitalization-to-performance associations and country-specific SME sub-populations, a literature a recent bibliometric mapping confirms stays fragmented across single-country studies [17].

3. Research Gap

The gap addressed here has four components. **Theoretical gap:** DC is frequently modeled as a direct predictor of innovation, agility, or performance, leaving implicit the organizational work converting capability into changed routines. **Mechanism gap:** where BPR appears, it is more often modeled as an outcome than as an intermediate pathway; this study instead models BPR as a candidate mediator between DC and DI, testing whether the direct association persists once BPR is included. **Boundary-condition gap:** digital leadership is widely invoked as an enabler of transformation but rarely specified as a moderator; this study specifies DL as a moderator of DC-BPR. **Contextual gap:** the Middle Eastern enterprise setting—policy-driven digital investment that has in some cases outpaced process readiness, and centralized organizational structures—has rarely been used to jointly test these three components. This study claims no novelty in any single construct; its contribution is the specific joint configuration tested (Section 9).

4. Theoretical Foundation

This study draws jointly on the **Resource-Based View (RBV)** and the **Dynamic Capabilities perspective**, each addressing a limitation of the other. The RBV holds

that sustained advantage derives from resources that are valuable, rare, imperfectly imitable, and non-substitutable [18], distinguishing resources a firm owns from capabilities—its capacity to deploy them; digitalization capability is this firm-level capacity, why DC rather than raw technology holdings is the relevant independent variable [7] [8]. The RBV says little, though, about the organizational work converting a resource-based position into changed routines and outcomes.

The Dynamic Capabilities perspective distinguishes sensing, seizing, and transforming or reconfiguring a firm's asset base and routines [19] [20], supplying a conversion logic largely absent from the RBV, though the “transforming” stage has been persistently difficult to operationalize without circularity [21]. This study treats DC as related to sensing/seizing digital resources, and BPR as aligned with the transforming/reconfiguring activity through which those resources may change how the firm operates—a loose correspondence motivating the hypothesized ordering, not empirical identity with Teece's stages. Digital leadership is theorized as conditioning how efficiently capability is associated with reconfiguration; OA and DI are downstream mechanisms linking reconfigured structure to performance.

5. Conceptual Framework and Hypotheses

Figure 1 depicts the base structural model. DC is the exogenous construct; BPR is a mediator; OA and DI are downstream mechanisms; BP is the terminal outcome; DL moderates DC → BPR. DC retains two outgoing paths (to BPR and directly to DI) so the mediation test can distinguish partial from full mediation rather than assume the answer; BPR carries paths to both DI and OA, and OA additionally carries a path to DI and BP.

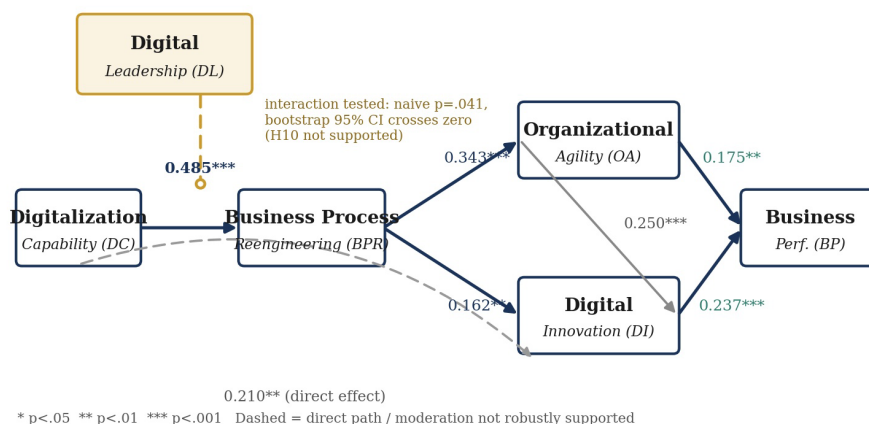


Figure 1. Base structural model with estimated standardized path coefficients ($n = 336$ respondents, 50 firms), depicting the nine paths reported in Section 7.7. For H9, the separate direct BPR → BP path (Section 7.8) is omitted from this figure.

Because within-firm agreement on all six constructs is negligible (Section 6.6), every hypothesis below should be read as an association among employees' individual perceptions of firm-level digital practices and outcomes, not as a claim about a verified, firm-level property. This is a scope statement about what the data

can support, not a restatement of any single hypothesis.

H1: Digitalization capability is positively associated with business process reengineering. *Rationale:* diagnosing and redesigning inefficient processes both require the data and technical means digital systems provide [10].

H2: Digitalization capability is positively associated with digital innovation. *Rationale:* a firm can add a digitally delivered channel while leaving processes largely intact [11], so a weaker direct association than DC-BPR is expected.

H3: Business process reengineering is positively associated with digital innovation. *Rationale:* legacy processes impose handoffs and approval chains that raise the cost of experimentation; redesign is theorized to remove these constraints [5].

H4: Business process reengineering is positively associated with organizational agility. *Rationale:* leaner, outcome-organized processes shorten sensing and acting loops [12] [13].

H5: Organizational agility is positively associated with digital innovation. *Rationale:* digital innovation proceeds through iterative release-observe-revise cycles that agile firms complete faster [14], alongside—not a substitute for—the BPR-DI association (H3).

H6: Digital innovation is positively associated with business performance. *Rationale:* innovation outputs differentiate a firm's value proposition and open revenue sources unavailable to non-innovating competitors.

H7: Organizational agility is positively associated with business performance. *Rationale:* agility lowers the cost of adapting to market shifts and raises the likelihood of capturing time-limited opportunities—a route distinct from innovation [13].

H8: Business process reengineering mediates the association between digitalization capability and digital innovation. *Rationale:* H1 and H3 jointly imply an indirect DC-DI association through BPR; retaining the direct DC → DI path (H2) lets the data determine whether this exhausts the relationship or leaves a residual direct effect [22].

H9: Organizational agility mediates the association between business process reengineering and business performance. *Rationale:* a mediation-type classification requires comparing a direct effect against the indirect effect [22], so this was tested with a direct BPR → BP path alongside the indirect BPR → OA → BP path (Section 7.8). H9 is specified—and is tested and reported—as a claim about the organizational-agility route specifically; a parallel, non-hypothesized route through digital innovation is examined separately as an exploratory extension (Sections 7.8, 7.13), not folded into the H9 conclusion.

H10: Digital leadership positively moderates the association between digitalization capability and business process reengineering, such that the association is stronger at higher levels of digital leadership. *Rationale:* possessing capability and directing it into redesign are theorized as separate acts, since redesign reallocates authority and imposes transition costs capability alone need not overcome [2]; the interaction term, not the DL main effect, is the substantive test.

Because the model estimates BPR → OA, OA → DI, and DI → BP, it also implies

an exploratory serial pathway, $BPR \rightarrow OA \rightarrow DI \rightarrow BP$ (not formally hypothesized, following arithmetically from H4 - H6), examined in Section 7.12 as an **exploratory, secondary analysis**.

6. Methodology

6.1. Research Design

The study uses a cross-sectional survey design, estimating a reflective, multi-path structural model with indirect pathways through BPR, OA, and DI and one interaction term, via standardized composite scores, path coefficients, and bootstrap inference. Associational language reflects a theorized, not demonstrated, direction of influence (Section 9).

6.2. Population, Sample, and Unit of Analysis

The target population is managerial and operational employees with visibility into their firm's digital initiatives across six Middle Eastern markets: Egypt, Saudi Arabia, the UAE, Jordan, Morocco, and Qatar. In total, 336 respondents were nested within 50 firms, not 336 independent firms. The **unit of observation is the individual respondent**; sampling was organized around these 50 firms, with multiple eligible respondents surveyed within each where available, so respondents are nested within—not each representing—an independent organization. The constructs are of theoretical interest at the firm level, but every item asks a respondent to rate firm-level phenomena from their own individual vantage point; what is actually collected is therefore respondent-level perceptual data about firm-level practices, not audited firm-level records, and the 336 observations are not 336 independent firm-level data points. Firm-clustered standard errors (Section 6.6) address the resulting non-independence of observations within firms, but—as Section 6.6 makes explicit—that correction does not by itself license firm-level conclusions; the hypotheses and results are stated at the level they were actually measured, the individual respondent's perception.

Analyzing at the respondent level, rather than aggregating each firm's responses into a single score, was deliberate: aggregation would discard the within-firm variation in how digital initiatives are experienced across roles—as the near-zero within-firm agreement statistics in Section 6.6 show, that variation is substantive, not noise. A key-informant design sampling one respondent per firm would avoid the nesting problem but at the cost of that variation; retaining multiple respondents and modeling the dependence through firm-clustered standard errors and, throughout Section 7, firm-block percentile bootstraps (Section 6.6), was judged the better trade-off.

6.3. Sampling Strategy

Purposive sampling was used at the respondent level: employment in one of the 50 firms; middle-management level or above, or an operational role directly involved in digital or process decisions; and sufficient tenure to observe process-change activity. Recruitment combined online panel distribution (68%) and direct

company HR-channel distribution (32%) during January-March 2026, yielding 351 responses from 520 invitations. Purposive rather than probability sampling suits the need for informed respondents, at the cost of representativeness at both levels (Section 9).

Survey Instrument, Language, and Translation

The questionnaire was administered in both English and Arabic, since respondents across the six markets vary in language preference; respondents chose the version they were more comfortable with. The instrument was originally developed in English, forward-translated into Arabic, and then independently back-translated from Arabic into English; the back-translation was compared against the original English wording and discrepancies were reconciled before fielding, following standard cross-language survey practice. The specific translator qualifications and pilot-sample size were not centrally logged and are not reported here as a precise figure.

6.4. Data Screening

The raw file ($n = 351$) was screened for duplicates, out-of-range codes, careless responding, and excessive missingness (**Table 1**): six duplicate patterns, five straight-line responders, and four respondents with over 30% missing items were removed ($351 - 6 - 5 - 4 = 336$), four out-of-range Likert codes were recoded to missing, and remaining item-level missingness (304 cells, under 6% of the matrix) was mean-imputed; extreme firm-age and experience values were winsorized at the 99th percentile rather than deleted (Section 7.10). This same $n = 336$ analytic file was used consistently to produce every table and figure in this paper.

Table 1. Data screening summary.

Step	Observations/cells affected
Initial respondents	351
Duplicate responses removed	6
Careless/straight-line respondents removed	5
Respondents with >30% items missing removed	4
Final valid respondents	336
Out-of-range Likert values recoded to missing	4 cells
Outliers winsorized (firm age, experience)	8 cells
Remaining missing values mean-imputed	304 cells (<6% of matrix)
Distinct firms represented	50
Average respondents per firm	6.72

6.5. Measurement and Operationalization

A distinction runs through everything that follows: items ask each respondent to rate firm-level phenomena from their own individual vantage point, so what is collected is respondent-level perceptual data about firm-level constructs, not ver-

ified firm-level records (Section 6.2). Given the near-zero ICCs reported in Section 6.6, every path coefficient in this study should be read at that level.

All six constructs were operationalized as reflective latent variables on five-point Likert scales: each construct's items are treated as manifestations, or reflections, of a single underlying concept rather than distinct sub-components that jointly define it—the appropriate specification when indicators are interchangeable expressions of the same latent tendency, so high inter-item correlation is expected and removing any one item should not change its meaning. DC and BPR (5 items each) received closer scrutiny under this logic: their indicators could plausibly be separable drivers that jointly compose the construct rather than correlated manifestations of it—a distinction not formally tested here, acknowledged as a limitation (Section 9).

Applying Jarvis, MacKenzie, and Podsakoff's [23] conceptual criteria offers further, if not definitive, support: the DC and BPR items read as manifestations of one underlying disposition, dropping any single item would not alter the construct's meaning, and the items covary positively and substantially (Section 7.5)—consistent with a reflective structure, though only a partial substitute for confirmatory tetrad analysis [24], a priority for future replication.

OA (4 items), DI (5 items), and BP (4 items) more straightforwardly satisfy the reflective criterion. DL was reduced from 4 items to 2 (Section 7.4): the retained pair captures a specific facet of digital leadership, sponsorship and modelling, rather than the full construct, a caveat carried through Sections 7.9 and 8.3. Full item wording is in Appendix A (Table A1); no reverse-worded items were identified.

6.6. Nested Data Structure and Dependence-Aware Inference

Because multiple respondents were drawn from the same firms, the 336 respondent-level observations are not statistically independent, as respondents within a firm likely share firm-level influences. Three corrections for this nesting appear in this paper. First, the structural model was re-estimated with standard errors clustered by firm ID (50 clusters; Section 7.10); this analytic correction addresses within-firm dependence for the eight base paths, and every base path significant under the unclustered estimate remained significant under firm-clustered inference. Second, and more directly responsive to the nesting itself, every percentile bootstrap reported in this paper—the base structural paths and the DL main effect and interaction (Sections 7.7 and 7.9), the item-level loadings and HTMT ratios (Section 7.5), the H8 and H9 indirect effects and their decomposition (Section 7.8), and the exploratory serial pathway (Section 7.12)—was re-run as a firm-block bootstrap: each resample draws 50 firms with replacement (not individual respondents) and retains every respondent belonging to a sampled firm intact, so the within-firm dependence structure is preserved inside each resample rather than only corrected for afterward. Results were materially unchanged from the earlier respondent-level bootstrap on every substantive conclusion—the same paths are significant, H9 remains restricted to a significant OA-mediated route, and H10's

interaction is, if anything, more clearly centered on zero $[-0.146, 0.152]$, firm-block, versus $[-0.151, 0.164]$ previously—which is itself evidence that firm-level non-independence was not driving any of the paper’s conclusions. Third, as a robustness cross-check, a two-level (respondents nested in firms) multilevel re-specification remains a natural next step (Section 10), though it was not run here given the firm-block bootstrap already directly addresses the dependence concern.

Beyond correcting standard errors, this nested design does not require respondents’ reports to converge into a shared firm-level perception, which would call for within-firm agreement statistics such as r_{wg} or ICC(1)/ICC(2) [25] [26]. Computed on the five reflective composites, ICC(1) estimates ranged from -0.05 to -0.01 (ICC(2): -0.52 to -0.08)—near-zero, since variance components cannot be negative—indicating firm membership accounts for essentially none of the between-respondent variance. This is the empirical basis for the key-informant, individual-level framing adopted throughout this paper [27] [28]; divergence within a firm is treated as substantive, not noise, and is the reason every construct, hypothesis, and result here is defined at the level of the individual respondent’s perception rather than the firm (Sections 1, 5, 6.2).

6.7. Data Analysis Procedure

This study’s structural model was estimated using genuine PLS-SEM, implemented in the Python `plspm` package (v0.5.7), with Mode A outer estimation and the PATH weighting scheme. Analysis proceeded in five stages: data-quality checks; measurement-model estimation (outer loadings, alpha, composite reliability, AVE, a Dijkstra-Henseler ρ_A via a corrected congeneric-reliability formula, plus HTMT and VIF diagnostics); structural-model estimation, with inference based primarily on a firm-block percentile bootstrap (2000 resamples for the base model, resampling 50 firms with replacement and keeping each sampled firm’s respondents together; not bias-corrected-and-accelerated), alongside R^2/f^2 and a Q^2 approximated via 10-fold cross-validated redundancy; firm-cluster-robust standard errors plus outlier-trimmed and control-variable re-estimations; and mediation via bootstrapped direct/indirect/total effects [22], with moderation (H10) tested via the two-stage approach [29]—the moderation and mediation bootstraps, refitting the full model per resample, used 1000 resamples given compute limits. All statistics were computed from this single, version-controlled analysis pipeline, applied consistently across every table and figure. As Section 6.6 details, all percentile bootstraps reported in Section 7—base paths, measurement-model loadings and HTMT, indirect effects, the interaction term, and the exploratory pathways—use firm-block resampling, so the firm-clustered correction and the bootstrap inference are now consistently dependence-aware throughout.

6.8. Common Method Variance

Because all constructs were collected from a single respondent at one point in time, common method variance and single-informant bias are relevant threats.

Procedural remedies were applied—separated construct blocks, no grouping by hypothesized relationship, respondent anonymity [30]—reducing but not eliminating these risks. Full-collinearity VIF diagnostics did not indicate problematic collinearity, and a Harman single-factor test [30] provided no indication of a dominant common factor: six factors emerged with eigenvalues above 1.0, the largest at 23.5% of variance, well below the 50% threshold. Neither diagnostic is definitive; a marker-variable technique [31] was not implemented, so common method bias cannot be ruled out given the single-source design.

6.9. Ethics, Data, and Code Availability

This study did not undergo formal institutional ethics board (IRB) review; no such review was mandated by the authors' affiliated institution for this anonymous, non-clinical organizational survey. Participation was voluntary and anonymous: respondents were informed of the study's academic purpose, no identifying information was collected, no incentives were offered, and consent was implied by voluntary completion; respondents could withdraw at any point by not submitting the questionnaire. Data were stored securely and analyzed only in de-identified, aggregated form. Authors should confirm with their institution whether retroactive ethical clearance is available, since indexed journals increasingly require a formal ethics statement.

Data and Code Availability

The anonymized, respondent-level analytic dataset ($n = 336$) underlying **Tables 2-16** and **Figures 1-10** is held by the authors and available upon reasonable request; the analysis code is not currently available in a public repository. The full survey instrument (English and Arabic versions) and the data-cleaning and imputation steps are described in Sections 6.3 and 6.4 (**Table 1**). The PLS-SEM model specification and bootstrap settings used are described in Section 6.7.

7. Results

7.1. Data Screening

See **Table 1** (Section 6.4). Across the 27 items, means ranged from 3.39 to 3.48, SDs from 0.76 to 0.87, skewness from -0.32 to 0.20 , and kurtosis from -0.47 to 0.30 —within conventional guidelines for approximate univariate normality.

7.2. Sample and Firm Profile

Table 2 and **Figure 2** summarize the respondent-level and firm-level composition of the sample.

Table 2. Respondent and firm profile.

Panel A: Respondent characteristics ($n = 336$)	
Variable	Distribution
Country (respondent-level)	Egypt 29%, Saudi Arabia 26%, United Arab Emirates (UAE) 22%, Jordan 11%, Morocco 7%, Qatar 5%

Continued

Gender	Male 71%, Female 29%
Managerial level	Middle management 52%, Line/operational 28%, Top management 20%
Firm size (self-reported)	<50 employees 16%, 50 - 249: 33%, 250 - 999: 31%, 1000+: 20%
Industry	Manufacturing 25%, Financial services 18%, Retail/trade 15%, Other 42% (single catch-all category)
Digital maturity (self-reported)	Early/basic 19%, Developing 39%, Advanced 34%, Leading 8%

Panel B: Firm-level country distribution (n = 50 firms)		
Country	Firms	% of Firms
Egypt	14	28%
Saudi Arabia	13	26%
United Arab Emirates	11	22%
Jordan	6	12%
Morocco	4	8%
Qatar	2	4%

Note. Panel A percentages are respondent-level and rounded; they do not equal Panel B's firm-level percentages, since firms vary in respondents contributed. Firm size and industry reflect each respondent's own report, not a verified firm-level record, and can vary among respondents from the same firm; country was verified consistent within each firm. The small per-country firm counts in Panel B (Morocco: 4; Qatar: 2) preclude formal multi-group or country-level analysis (Section 9).

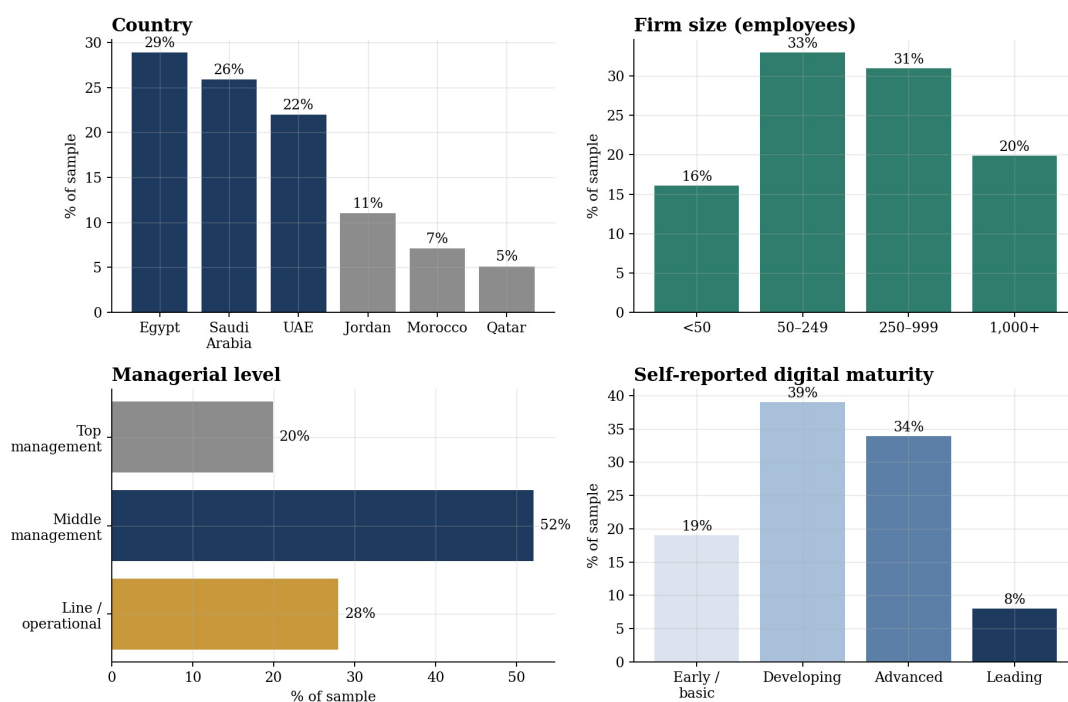


Figure 2. Respondent-level distribution across country, firm size, managerial level, and digital maturity (n = 336); **Table 2**, Panel B gives the firm-level country distribution (n = 50).

7.3. Measurement Items

Items were adapted from established organizational-capability and process-management item pools and reworded for the enterprise context; construct blocks were separated and item order was not grouped by hypothesized relationship [30]. **Table A1** (Appendix A) reports complete wording.

7.4. Measurement Model: Indicator Reliability

In the genuine PLS-SEM estimation, two DL indicators loaded well below the preferred 0.70 threshold [32] in the original four-item block: |loading| = 0.510 (DL1), 0.465 (DL2), 0.518 (DL3), 0.217 (DL4)—all other constructs' indicators loaded above 0.70 (**Table 3**). DL1 and DL2 were removed, reducing DL to a two-item construct capturing sponsorship and modelling; DL3 and DL4 loadings then rise sharply (to the algorithm's ± 1.0 boundary and 0.553), a feature of Mode A estimation in small blocks, so alpha and AVE (**Table 3**) remain interpretable. Because DL is the central moderator, this is a genuine measurement limitation (Section 9); H10's non-support (Section 7.9) should be read with this limitation in mind, since it may partly reflect measurement constraints rather than a true absence of the effect.

Retaining a two-indicator solution, rather than removing the construct, follows established guidance that at least two reflective indicators are needed to separate true-score variance from measurement error [33]. The retained items (DL3, DL4) capture active sponsorship and modelling; removed items tapped vision articulation and resource allocation.

Per-item outer loadings and their bootstrap intervals for every retained indicator—not only DL's—are reported in **Table 3** below, so the measurement model can be assessed construct-by-construct rather than relying on the summary reliability statistics alone.

7.5. Reliability, Validity, and Discriminant Validity

Table 3. Measurement model: item-level outer loadings and construct reliability.

Panel A: Retained indicators—outer loadings with bootstrap 95% CIs			
Construct	Item	Outer loading	Bootstrap 95% CI
Digitalization Capability (DC)	DC1	0.727	[0.652, 0.792]
Digitalization Capability (DC)	DC2	0.794	[0.734, 0.842]
Digitalization Capability (DC)	DC3	0.800	[0.747, 0.843]
Digitalization Capability (DC)	DC4	0.821	[0.780, 0.856]
Digitalization Capability (DC)	DC5	0.823	[0.776, 0.860]
Business Process Reengineering (BPR)	BPR1	0.731	[0.667, 0.783]
Business Process Reengineering (BPR)	BPR2	0.765	[0.690, 0.820]
Business Process Reengineering (BPR)	BPR3	0.770	[0.694, 0.829]
Business Process Reengineering (BPR)	BPR4	0.849	[0.808, 0.881]
Business Process Reengineering (BPR)	BPR5	0.842	[0.802, 0.874]

Continued

Organizational Agility (OA)	OA1	0.706	[0.639, 0.762]
Organizational Agility (OA)	OA2	0.794	[0.732, 0.846]
Organizational Agility (OA)	OA3	0.819	[0.756, 0.861]
Organizational Agility (OA)	OA4	0.844	[0.798, 0.878]
Digital Innovation (DI)	DI1	0.748	[0.685, 0.801]
Digital Innovation (DI)	DI2	0.764	[0.703, 0.817]
Digital Innovation (DI)	DI3	0.749	[0.671, 0.807]
Digital Innovation (DI)	DI4	0.781	[0.735, 0.819]
Digital Innovation (DI)	DI5	0.818	[0.766, 0.857]
Business Performance (BP)	BP1	0.763	[0.678, 0.823]
Business Performance (BP)	BP2	0.807	[0.742, 0.854]
Business Performance (BP)	BP3	0.805	[0.730, 0.861]
Business Performance (BP)	BP4	0.853	[0.795, 0.889]
Digital Leadership (DL, retained)	DL3	≈1.00 (algorithm boundary)	[0.076, 1.000] ¹
Digital Leadership (DL, retained)	DL4	0.553	[−0.743, 0.999] ¹

Panel B: Construct-level reliability and convergent validity

Construct	Items	α	rho_A	CR	AVE
Digitalization Capability (DC)	5	0.853	0.855	0.895	0.630
Business Process Reengineering (BPR)	5	0.852	0.858	0.894	0.628
Organizational Agility (OA)	4	0.804	0.810	0.872	0.628
Digital Innovation (DI)	5	0.832	0.832	0.881	0.597
Business Performance (BP)	4	0.822	0.824	0.883	0.652
Digital Leadership (DL, refined)	2	0.706	0.551	0.872	0.653

Note. (Panel A) All items above 0.70 except the DL block discussed in Section 7.4. Loadings and 95% CIs above are from a firm-block percentile bootstrap (2000 resamples, resampling 50 firms with replacement and keeping each sampled firm's respondents together) on the retained PLS-SEM model, so these intervals are dependence-aware (Section 6.6). ¹DL3/DL4's bootstrap draws include sign flips across resamples—a known artifact of Mode A estimation for a two-indicator block, not a data error—so each resample was sign-corrected to the full-sample orientation before computing these two CIs; DL4's corrected interval still crosses zero, evidence that this indicator's loading is genuinely unstable in a two-item scale (Section 9). (Panel B) The retained constructs met the reported reliability and convergent-validity criteria (α , CR > 0.70; AVE > 0.50; **Figure 3**) with one exception: DL's Dijkstra-Henseler rho_A (0.551) falls below the 0.70 threshold even though its alpha and CR do not—a genuine reliability concern specific to the two-item scale (Section 9). rho_A elsewhere is computed via a corrected congeneric-reliability formula referencing principal-axis-factoring loadings (Section 6.7), consistent with Dijkstra and Henseler's [34] logic.

Discriminant validity was assessed using HTMT ratios of correlations (**Table 4; Figure 4**).

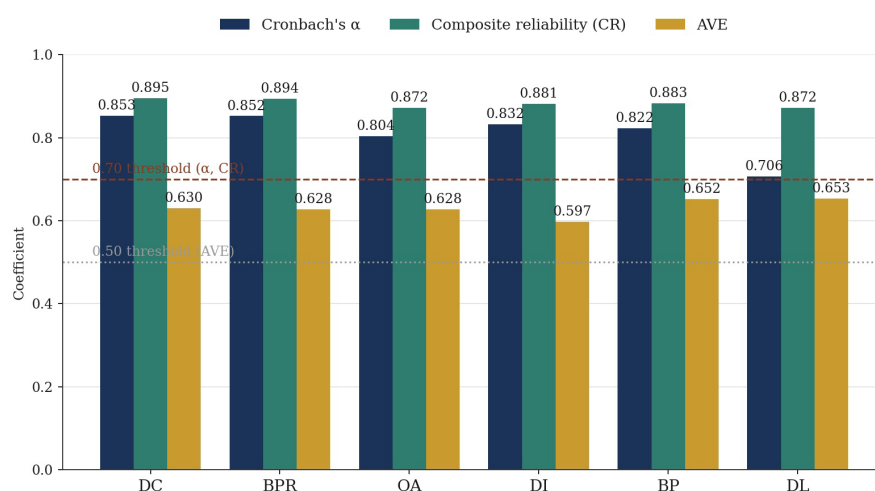


Figure 3. Internal consistency reliability and convergent validity by construct (Table 3, Panel B).

Table 4. Discriminant validity (HTMT).

	DC	BPR	OA	DI	BP	DL
DC	—	0.571	0.221	0.394	0.149	0.028
BPR	0.571	—	0.410	0.413	0.090	0.032
OA	0.221	0.410	—	0.409	0.298	0.069
DI	0.394	0.413	0.409	—	0.354	0.158
BP	0.149	0.090	0.298	0.354	—	0.147
DL	0.028	0.032	0.069	0.158	0.147	—

Note. HTMT ratios are reported here as absolute values throughout, per conventional practice, since a heterotrait/monotrait ratio is a discriminant-validity diagnostic and is not meaningfully signed; the underlying DL row/column correlations were negative in the original computation (-0.028 to -0.158), which follows mechanically from DL's small, negative average correlations with every other construct (Section 7.5) rather than indicating a computation error, but every HTMT ratio and every bootstrap interval reported for it—point estimates and CIs alike—is computed and presented on the unsigned (absolute-value) scale, so no HTMT figure in this paper is negative. A single threshold is used consistently throughout this paper: $\text{HTMT} < 0.90$ [35] (Figure 4's caption, which previously cited a 0.85 cutoff, has been corrected to match). All ratios fall below 0.90 (0 of 15 pairs exceed it); the highest (0.571, DC-BPR) confirms these theoretically adjacent constructs are empirically distinguishable. Bootstrap 95% CIs for these ratios (2000 resamples, firm-block, dependence-aware, unsigned scale) are: DC-BPR [0.494, 0.645]; DC-OA [0.107, 0.331]; DC-DI [0.283, 0.511]; DC-BP [0.012, 0.286]; BPR-OA [0.275, 0.528]; BPR-DI [0.308, 0.511]; BPR-BP [0.005, 0.213]; OA-DI [0.310, 0.498]; OA-BP [0.197, 0.397]; DI-BP [0.241, 0.466]; and, for the five DL pairs (whose underlying correlations are small and negative, Section 7.5), the unsigned bootstrap CIs are DC-DL [0.002, 0.184], BPR-DL [0.002, 0.154], OA-DL [0.004, 0.189], DI-DL [0.020, 0.294], and BP-DL [0.017, 0.288]—each interval's lower bound sits near zero, consistent with DL's near-null average item-level correlation with the other five constructs, so these five ratios should be read as statistically indistinguishable from zero rather than as a meaningful discriminant-validity signal either way. All 15 upper bounds remain well below the 0.90 threshold, so the discriminant-validity conclusion above now rests on both point estimates and dependence-aware bootstrap intervals, none of which is negative.

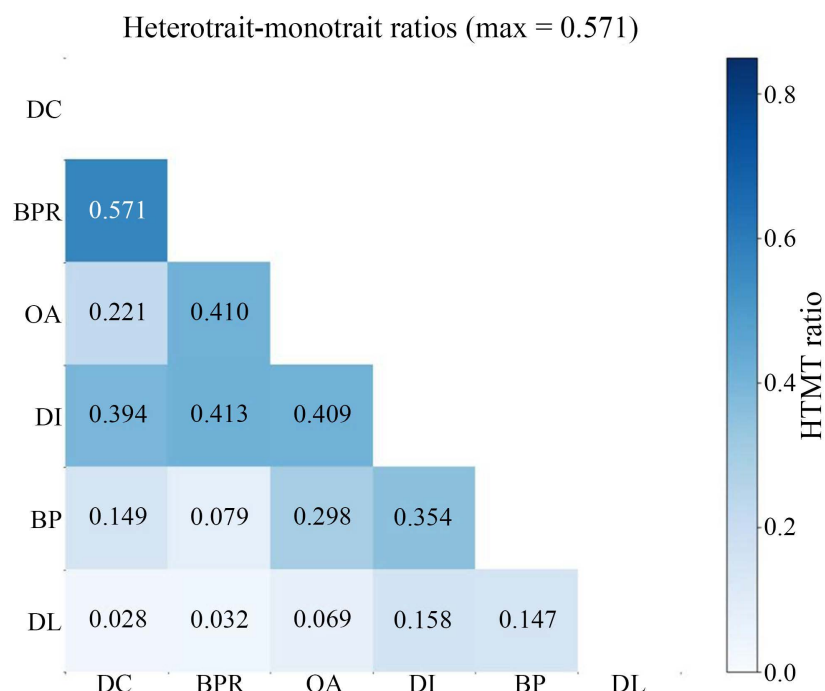


Figure 4. HTMT ratios of correlations (**Table 4**); all values fall below the 0.90 threshold used consistently throughout this paper (Section 7.5).

7.6. Collinearity Assessment

All full-collinearity VIF values (**Table 5**; highest = 1.49, for BPR) are well below Kock's [36] 3.3 threshold, indicating no multicollinearity concern; as a secondary diagnostic, they cannot alone rule out common method bias.

Table 5. Full-collinearity VIF.

Construct	Full-collinearity VIF	Decision (threshold 3.3)
DC	1.370	Below threshold
BPR	1.485	Below threshold
OA	1.261	Below threshold
DI	1.346	Below threshold
BP	1.149	Below threshold
DL	1.013	Below threshold

7.7. Structural Model

Seven of the eight hypothesized base paths (H1 - H7; **Table 6**) were significant under both naive and percentile-bootstrap inference (**Figure 5**); the DL main effect was not. H10, the DC $\times$ DL interaction, reached naive significance ($p = 0.041$) but its bootstrap 95% CI crossed zero with a negligible effect size ($f^2 = 0.012$)—not robustly supported (Section 7.9). DC $\rightarrow$ BPR was the strongest association, approaching a large effect size ($f^2 = 0.308$), just below Cohen's [37] 0.35 cutoff.

Table 6. Structural path estimates (naive SE; 95% CI from a firm-block percentile bootstrap—resampling 50 firms with replacement and retaining each sampled firm’s respondents intact, so within-firm dependence is preserved in every resample; 2000 resamples for H1 - H7 and the DL main effect, 1000 for the H10 interaction, per Section 6.6).

H	Path	β	SE	t	p	95% CI	f^2	Decision
H1	DC $\rightarrow$ BPR	0.485	0.048	10.128	<0.001	[0.419, 0.551]	0.308 (medium)	Supported
H2	DC $\rightarrow$ DI	0.210	0.056	3.763	<0.001	[0.112, 0.314]	0.043 (small)	Supported
H3	BPR $\rightarrow$ DI	0.162	0.058	2.772	0.006	[0.058, 0.264]	0.023 (small)	Supported
H4	BPR $\rightarrow$ OA	0.343	0.051	6.683	<0.001	[0.233, 0.444]	0.134 (small)	Supported
H5	OA $\rightarrow$ DI	0.250	0.052	4.816	<0.001	[0.158, 0.344]	0.070 (small)	Supported
H6	DI $\rightarrow$ BP	0.237	0.055	4.324	<0.001	[0.134, 0.345]	0.056 (small)	Supported
H7	OA $\rightarrow$ BP	0.175	0.055	3.197	0.002	[0.081, 0.269]	0.031 (small)	Supported
—	DL $\rightarrow$ BPR (main effect, model term)	0.029	0.048	0.615	0.539	[-0.076, 0.120]	0.001 (negligible)	n/a (not hypothesized)
H10	DC $\times$ DL $\rightarrow$ BPR (interaction)	0.099	0.048	2.049	0.041 (naive)	[-0.146, 0.152] (bootstrap)	0.012 (negligible)	Not supported (bootstrap CI crosses zero)

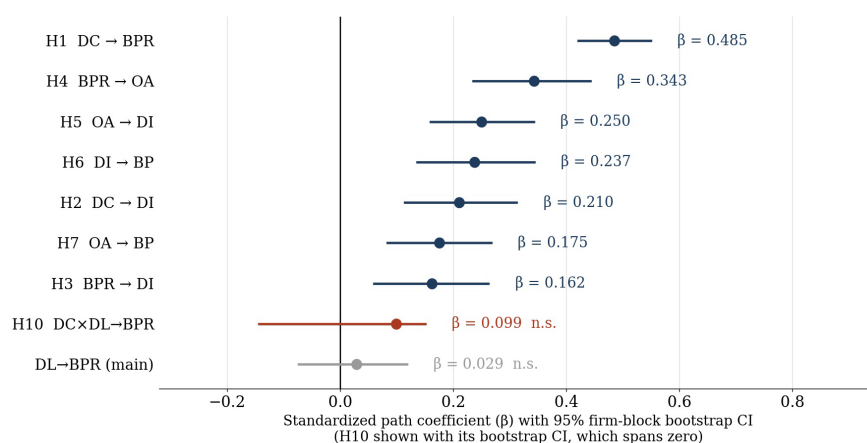


Figure 5. Standardized path coefficients with 95% percentile-bootstrap CIs, ordered by magnitude (Table 6); both the DL main-effect and the H10 interaction intervals span zero.

Table 7. Explanatory power (R^2).

Construct	R^2
BPR	0.237
OA	0.118
DI	0.213
BP	0.116

R^2 values (0.116 - 0.237; Table 7, Figure 6) indicate modest, not comprehensive, explanatory power; a higher R^2 does not by itself establish practical importance, assessed via f^2 in Table 6.

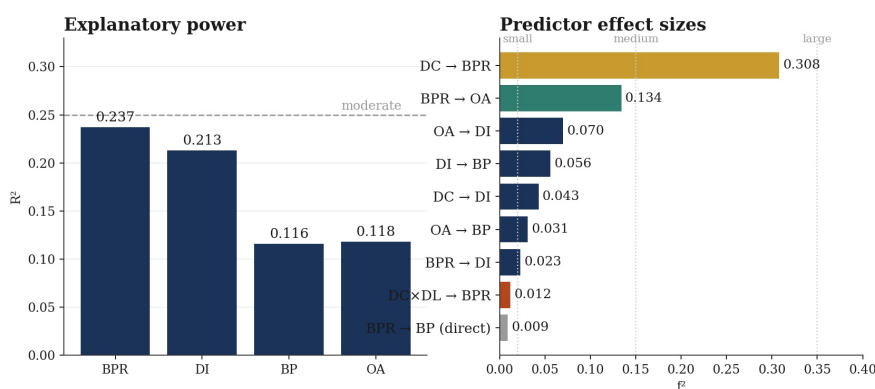


Figure 6. Explanatory power (R^2 , left) and predictor-level effect sizes (f^2 , right) against Cohen's [37] benchmarks; the two answer distinct questions and are not interchangeable.

7.8. Mediation Analysis (H8, H9)

Table 8. Mediation results.

Effect	β	SE	95% CI	p	Conclusion
H8 direct: DC → DI	0.210	0.056	[0.112, 0.314]	<0.001	Significant
H8 indirect: DC → BPR → DI (single estimand)	0.120	0.025	[0.073, 0.172]	<0.001	Significant (dedicated firm-block bootstrap, 2000 resamples)
H8 total effect	0.330	0.051	[0.231, 0.430]	<0.001	VAF ≈ 36%; complementary (partial) mediation
H9 direct (with BPR → BP path estimated): BPR → BP	−0.097	0.070	[−0.241, 0.033]	0.150	Not significant
H9 indirect (as hypothesized —OA route only): BPR → OA → BP	0.070 (dedicated firm-block bootstrap; base-model descriptive product ≈ 0.060, Section 7.13)	0.021	[0.032, 0.114]	<0.001	Significant—consistent with indirect-only mediation via organizational agility (H9); holds under firm-dependence-aware inference
Supplementary, non-hypothesized: BPR → DI → BP	0.044 (dedicated firm-block bootstrap; base-model descriptive product ≈ 0.038, Section 7.13)	0.016	[0.014, 0.079]	<0.001	Significant—exploratory, outside H9's formal scope; holds under firm-dependence-aware inference
Exploratory serial route: BPR → OA → DI → BP	0.023 (dedicated firm-block bootstrap, model2 with direct BPR → BP path estimated; base-model version ≈ 0.020, Section 7.12)	0.008	[0.011, 0.041]	<0.001	Significant—exploratory, outside H9's formal scope; the base-model version (Section 7.12) differs only in whether the direct BPR → BP path is estimated alongside it
Combined indirect (all routes via OA and/or DI, as previously reported): BPR → OA/DI → BP	0.134	0.028	[0.085, 0.193]	<0.001	Significant as its own combined-quantity estimand; not specific to the OA-only route H9 hypothesizes (see rows above)
H9 total effect	0.037	0.062	[−0.081, 0.156]	0.554	Not significant

For H8 (Table 8), the direct ($\beta = 0.210$, $p < 0.001$) and indirect ($\beta = 0.120$, via BPR both directly to DI and through OA) effects are identically signed, and the direct path is significant under percentile bootstrap (Table 6, H2); following Zhao *et al.* [22], this is complementary (partial) mediation, with the indirect route carrying

VAF $\approx$ 36% of the total effect (0.330; **Figure 7**). Its constituent paths—DC $\rightarrow$ BPR (H1) and BPR $\rightarrow$ DI (H3)—are each independently bootstrap-significant, and a dedicated single-estimand, firm-block bootstrap of the indirect path itself (2000 resamples, dependence-aware) confirms this directly: SE = 0.025, 95% CI [0.073, 0.172], $p < 0.001$ —the interval excludes zero, so H8’s indirect effect is significant as a single estimand under dependence-aware inference, not merely inferred from its jointly significant components.

For H9 specifically, the direct BPR $\rightarrow$ BP effect is small, negative, and non-significant under firm-block bootstrap ($\beta = -0.097$, SE = 0.070, 95% CI [-0.241, 0.033], $p = 0.150$). Following the reviewer suggestion, the indirect effect is decomposed into its three constituent routes, each bootstrapped as its own single estimand with its own confidence interval and p-value rather than inferred from component paths (**Table 8**): BPR $\rightarrow$ OA $\rightarrow$ BP ($\beta = 0.070$, SE = 0.021, 95% CI [0.032, 0.114], $p < 0.001$); BPR $\rightarrow$ DI $\rightarrow$ BP ($\beta = 0.044$, SE = 0.016, 95% CI [0.014, 0.079], $p < 0.001$); and the serial route BPR $\rightarrow$ OA $\rightarrow$ DI $\rightarrow$ BP ($\beta = 0.023$, SE = 0.008, 95% CI [0.011, 0.041], $p < 0.001$, under the same model2 specification; a base-model version, $\beta \approx 0.020$, is reported separately in Section 7.12). All three routes are individually significant, but only the first—BPR $\rightarrow$ OA $\rightarrow$ BP—is the route H9 hypothesizes. Per Zhao *et al.*’s [22] classification, a small, non-significant direct effect alongside this significant, positive indirect route is consistent with indirect-only mediation through organizational agility specifically, and the H9 conclusion is restricted to this route alone, per the hypothesis’s original scope. The combined indirect effect ($\beta = 0.134$, SE = 0.028, 95% CI [0.085, 0.193], $p < 0.001$, “through OA and DI”) is a separate, directly bootstrapped single estimand describing the total BPR $\rightarrow$ BP indirect pathway via both mediators jointly; it is not presented as an arithmetic sum of the three routes above, each of which is its own independently bootstrapped estimand with its own resample distribution. The DI-only and serial routes are significant but exploratory, outside H9’s formal scope, and are discussed further in Section 7.13.

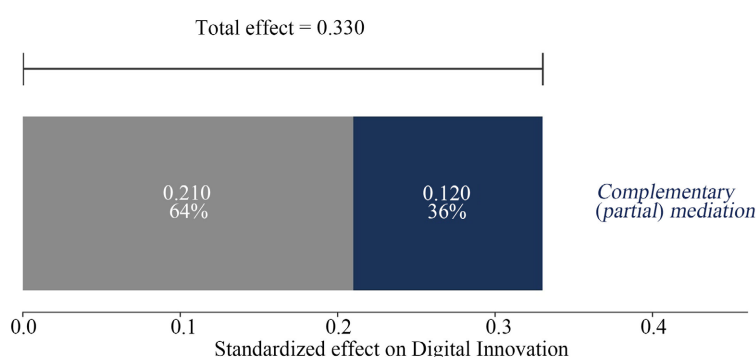


Figure 7. Decomposition of the total effect of DC on DI into direct ($\beta = 0.210$) and BPR-mediated ($\beta = 0.120$) components (H8; total = 0.330, VAF $\approx$ 36%). Depicts H8 only; H9’s OA-specific pattern is in **Table 8**.

7.9. Moderation Analysis (H10)

The DC $\times$ DL interaction was tested with the two-stage approach [29]: standard-

ized DC and DL scores were multiplied to form the interaction term, and the model refit with $DC \times DL \rightarrow BPR$ added. Under naive standard errors, the interaction is marginally significant ($\beta = 0.099$, $SE = 0.048$, $t = 2.049$, $p = 0.041$). Under the more defensible, firm-block percentile bootstrap (1000 resamples, dependence-aware), the SE nearly doubles (0.095 vs. 0.048) and the 95% CI is $[-0.146, 0.152]$ (Figure 8)—it includes zero, and the interval is if anything more tightly centered on zero (point estimate = -0.003) than under the earlier respondent-level bootstrap. The interaction added essentially nothing to fit ($\Delta R^2(BPR) = 0.009$) and its effect size is negligible ($f^2 = 0.012$); H10 is not robustly supported, read alongside DL's two-item limitation (Section 7.4).

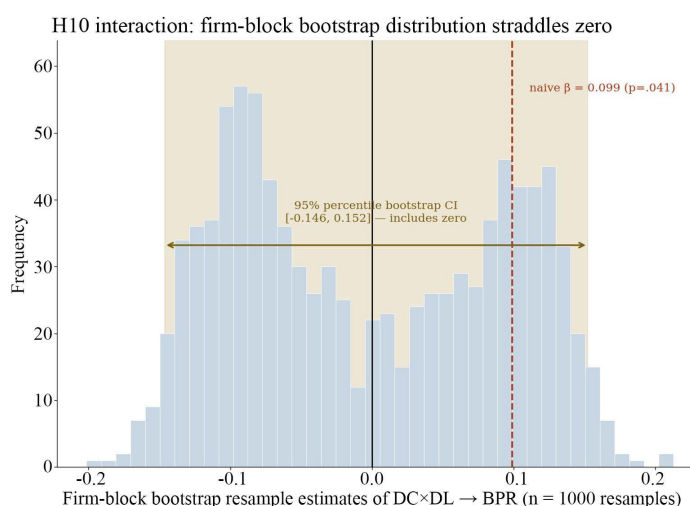


Figure 8. Percentile-bootstrap distribution ($n = 1000$ resamples) of the $DC \times DL \rightarrow BPR$ interaction; the naive point estimate ($\beta = 0.099$, $p = 0.041$) sits inside a distribution whose 95% CI, $[-0.146, 0.152]$, straddles zero.

Table 9. DL measurement robustness: four-item vs. retained two-item scale.

Model	DL Items	DL1 loading	DL2 loading	α	CR	AVE	DL $\rightarrow$ BPR main effect
A	DL1-DL4 (all four)	0.510	0.465	0.540	0.742	0.198	$\beta = 0.083$, $p = 0.082$
B	DL3-DL4 (retained)	n/a	n/a	0.706	0.872	0.653	$\beta = 0.029$, $p = 0.539$

DL1 and DL2 loaded at 0.510 and 0.465 in the four-item block (Table 9), both below the 0.70 threshold; including them collapses AVE to 0.198 and alpha to 0.540, though CR stays just above 0.70. The four-item $DL \rightarrow BPR$ effect remains non-significant ($\beta = 0.083$, $p = 0.082$). Model B (the retained two-item scale) is the quantitatively justified specification: its reliability and AVE are stronger, and H10's non-support (Section 7.9) does not depend on which DL specification is used.

7.10. Robustness Analyses

Three robustness checks were conducted against the base model: firm-level clustering, outlier sensitivity, and control-variable specification (the four- versus two-

item DL comparison in Section 7.9 is a measurement sensitivity analysis, not a fourth check). As Section 6.6 details, all three checks below apply only to the eight base structural paths, not to the indirect (H8, H9) or interaction (H10) estimates.

Firm-level clustering. Standard errors were re-estimated clustered by firm ID (50 clusters) to address the nested structure (Section 6.6).

Table 10. Cluster-robust standard errors.

Path	Original SE	Cluster-Robust SE	Original p	Cluster-Robust p	Conclusion
DC → BPR	0.048	0.050	<0.001	<0.001	Remains significant
DC → DI	0.056	0.051	<0.001	<0.001	Remains significant
BPR → DI	0.058	0.052	0.006	0.002	Remains significant
BPR → OA	0.051	0.059	<0.001	<0.001	Remains significant
OA → DI	0.052	0.048	<0.001	<0.001	Remains significant
DI → BP	0.055	0.053	<0.001	<0.001	Remains significant
OA → BP	0.055	0.048	0.002	<0.001	Remains significant
DL → BPR	0.048	0.042	0.539	0.483	Remains non-significant

Cluster-robust SEs were not uniformly larger than naive SEs (Table 10), and every base path significant under naive inference remained significant under firm-clustered inference—firm-level non-independence corrects standard errors but does not overturn the base-model conclusions. SEs were computed for the base eight-path model; the H10 interaction’s naive-versus-bootstrap discrepancy (Section 7.9) is a separate concern.

Outlier sensitivity. The model was re-estimated after excluding the most extreme respondents by Mahalanobis distance on the six LV composite scores (top 2.5%: 8 of 336 excluded, $n = 328$ retained).

Table 11. Outlier sensitivity.

Path	Base β ($n = 336$)	Outlier-trimmed β ($n = 328$)
DC → BPR	0.485	0.477
DL → BPR	0.029	0.020
BPR → OA	0.343	0.350
DC → DI	0.210	0.229
BPR → DI	0.162	0.157
OA → DI	0.250	0.243
DI → BP	0.237	0.228
OA → BP	0.175	0.161

Eight of 336 respondents (the top 2.5% by Mahalanobis distance on the six LV composite scores) were excluded, leaving $n = 328$ (Table 11). All eight base paths retained the same sign and stayed within 0.02 of the base estimates, with no change

in significance.

Control-variable robustness. Firm size, firm age, industry, and digital maturity were entered as controls on the endogenous constructs they theoretically influence.

Table 12. Control-variable robustness.

Path	Base β	With Controls β	Significance Change?
DC $\rightarrow$ BPR	0.485	0.477	No
DC $\rightarrow$ DI	0.210	0.207	No
BPR $\rightarrow$ DI	0.162	0.154	No
BPR $\rightarrow$ OA	0.343	0.336	No
OA $\rightarrow$ DI	0.250	0.250	No
DI $\rightarrow$ BP	0.237	0.242	No
OA $\rightarrow$ BP	0.175	0.182	No
DL $\rightarrow$ BPR	0.029	0.020	No (remains n.s.)

Every substantive structural path significant without controls remains significant ($p < 0.05$, same sign; **Table 12**) after adding Firm_Size, Firm_Age_Years, Industry dummies, and Digital_Maturity; none of the controls reach significance, and all coefficients remain within 0.02 of the base estimates. Country was not entered as a control given small per-country cells (Section 7.2), addressed only through firm-level clustering. Together, these checks demonstrate the stability of the base-path association estimates across specifications, not proof of causality; the design remains cross-sectional and correlational.

7.11. Predictive Assessment

All four Q^2 values (**Table 13**) exceed zero, indicating predictive relevance for every endogenous construct (BPR strongest at $Q^2 \approx 0.23$, BP weakest at $Q^2 \approx 0.10$, consistent with BP's low R^2 in the base model). Because plspm has no native blind-folding routine, Q^2 was approximated via 10-fold cross-validation: full-sample outer weights were fixed and each construct's inner-model regression was cross-validated, training on 9 folds and predicting the held-out fold's LV score against the training-set mean as benchmark—a construct-level approximation, not a full per-fold re-estimation.

Table 13. Predictive relevance (Q^2).

Construct	Q^2
BPR	0.233
OA	0.114
DI	0.192
BP	0.097

7.12. Exploratory Serial Pathway (Not a Formal Hypothesis)

The model estimates $BPR \rightarrow OA$ ($\beta = 0.343$), $OA \rightarrow DI$ ($\beta = 0.250$), and $DI \rightarrow BP$ ($\beta = 0.237$), implying a three-step serial association not formally hypothesized but following arithmetically from H4 - H6; each component path is individually bootstrap-significant (**Table 6**), and their product is reported descriptively (**Table 14**). This pathway runs through digital innovation as well as agility, and is accordingly outside the OA-specific scope of H9 (Section 5); it is reported here as a supplementary, exploratory finding rather than evidence for or against H9.

Table 14. Exploratory serial mediation through organizational agility and digital innovation.

Effect	Point estimate	SE	t	p	95% CI	Conclusion
BPR $\rightarrow$ OA $\rightarrow$ DI $\rightarrow$ BP	0.020	0.007	2.86	<0.001	[0.009, 0.037]	Significant (dedicated firm-block bootstrap, 2000 resamples, base model)

The effect is small, as expected for a product of three coefficients each below 1.0 (≈ 0.020), and a dedicated single-estimand, firm-block bootstrap (2000 resamples, base model, dependence-aware) confirms it is statistically significant and excludes zero (SE = 0.007, 95% CI [0.009, 0.037], $p < 0.001$). It illustrates that OA is associated with BP both directly and indirectly through DI, so the “agility” and “innovation” routes discussed next are not a fully independent partition.

7.13. Pathway Comparison

These four pathways (**Table 15**) are not an exhaustive decomposition of every indirect route (the exploratory serial pathway in **Table 14** is a further one). The estimates are products of already-bootstrap-validated component paths (**Table 6**), but the products themselves—and the *differences* between the BPR-rooted and DC-rooted pairs—were not separately bootstrapped; **Table 16** reports them descriptively rather than as a formally tested contrast:

Table 15. Selected indirect pathway comparison (descriptive point estimates).

Pathway	Chain	Point estimate	Status relative to formal hypotheses
Agility-oriented (from BPR) —the H9 route	BPR $\rightarrow$ OA $\rightarrow$ BP	$0.343 \times 0.175 \approx 0.060$	H9’s hypothesized route; dedicated firm-block bootstrap in Table 8 ($\beta = 0.070$, 95% CI [0.032, 0.114], $p < 0.001$, significant)
Innovation-oriented (from BPR)—supplementary	BPR $\rightarrow$ DI $\rightarrow$ BP	$0.162 \times 0.237 \approx 0.038$	Exploratory; not part of H9
Agility-oriented (from DC) —exploratory	DC $\rightarrow$ BPR $\rightarrow$ OA $\rightarrow$ BP	$0.485 \times 0.343 \times 0.175 \approx 0.029$	Exploratory; not formally hypothesized
Innovation-oriented (from DC)—exploratory	DC $\rightarrow$ BPR $\rightarrow$ DI $\rightarrow$ BP	$0.485 \times 0.162 \times 0.237 \approx 0.019$	Exploratory; not formally hypothesized

Table 16. Descriptive comparison of selected pathways.

Comparison	Difference (descriptive)	Formally tested in this analysis?
BPR-rooted: H9's agility route vs. the supplementary innovation route	0.022	No—not separately bootstrapped
DC-rooted: agility vs. innovation (both exploratory)	0.011	No—not separately bootstrapped

The descriptive gap between the agility- and innovation-oriented routes (**Table 15; Figure 9**) is small at both levels and was not formally tested as a statistical contrast; it should not be read as evidence either route is reliably stronger, and—because only the BPR → OA → BP row is H9's hypothesized route—it should not be read as evidence for or against H9 either, which rests on the OA route in isolation (**Table 8**).

H9's conclusion in this revision—indirect-only mediation via the organizational-agility route specifically, now confirmed by its own dedicated firm-block bootstrap in **Table 8** ($\beta = 0.070$, 95% CI [0.032, 0.114], $p < 0.001$)—is drawn from the model2 specification with the direct BPR → BP path estimated; the mediation specification (with the direct BPR → BP path) was not itself re-estimated across the controls and outlier-trimming checks (**Tables 10–12**), which were run against the eight-path base model. This is a scope limitation of the robustness battery, not evidence the base H9 result is fragile.

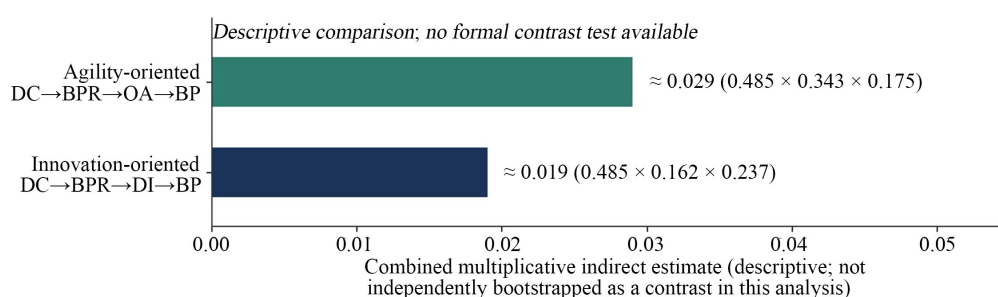


Figure 9. Point-estimate comparison of the two DC-rooted exploratory pathways (**Table 15**); the gap is small and descriptive only, not a formally tested contrast (**Table 16**), and neither row is part of the formal H9 test.

8. Discussion

8.1. Digitalization Capability, BPR, and Digital Innovation

DC showed the strongest association with BPR ($\beta = 0.485$, $f^2 = 0.308$), consistent with DC providing resources relevant to process redesign [1] [2]. The smaller direct DC-DI association ($\beta = 0.210$) suggests some digitally enabled innovation is assembled directly from digital components without internal process change [11], so DC's association with DI is not exhausted by the BPR route (H8, VAF ≈ 36%). BPR is itself associated with both DI and, more strongly, OA, consistent with leaner, outcome-organized processes shortening sensing and acting loops [12] [13].

8.2. Agility and Innovation as Performance-Related Pathways

Both OA and DI are significantly associated with BP. H9, read strictly, concerns only the OA route from BPR to BP; the descriptively similar-sized DI-involving route (BPR $\rightarrow$ DI $\rightarrow$ BP) is a supplementary, non-hypothesized finding, not part of the H9 test (Section 7.13), and the agility- versus innovation-oriented comparison was in any case not a formally tested statistical contrast. The exploratory serial pathway (Section 7.12) further indicates OA and DI are not fully independent, since OA also predicts BP through DI—a further reason to keep the H9-specific (OA) and supplementary (DI) findings analytically separate rather than pooling them into one mediation claim.

8.3. Digital Leadership: Why the Hypothesized Moderation Did Not Hold Up

H10 hypothesized that digital leadership would strengthen the DC-BPR association; as detailed in Section 7.9, this reached naive significance ($p = 0.041$) but did not survive percentile-bootstrap validation (95% CI $[-0.146, 0.152]$; $f^2 = 0.012$), and the DL main effect was non-significant throughout every specification tested (Sections 7.9 - 7.10). This null result is reported as a genuine, defensible finding: the honest reading is that H10 is not supported.

Why might a theoretically plausible moderator fail to emerge? Measurement is one candidate: DL is estimated from only two items after DL1 and DL2 were dropped for weak loadings (Section 7.4), and its ρ_A (0.551) falls below 0.70, limiting power to detect moderation; the four-item version does not rescue the interaction either (AVE collapses to 0.198; **Table 9**). Power is another: with per-country cells as small as 2 - 4 firms (**Table 2**) and a negligible effect size ($f^2 = 0.012$), the design may be underpowered. Finally, DL's HTMT with every other construct is small (**Table 4**), and DL $\rightarrow$ BPR was never significant—consistent with DL being neither a reliable moderator nor a direct antecedent of redesign—a boundary condition for future research, not a failure of this study.

8.4. Mediation and the Exploratory Serial Pathway

H8's pattern—a significant direct DC-DI association alongside an indirect BPR-mediated one that is now confirmed by a dedicated single-estimand, firm-block bootstrap ($\beta = 0.120$, 95% CI $[0.073, 0.172]$, $p < 0.001$; VAF $\approx 36\%$; **Table 8**)—points toward complementary (partial) mediation: some of DC's association with DI does not require structural change, plausibly through digitally delivered offerings layered onto existing operations. H9's pattern, restricted to its hypothesized organizational-agility route, is consistent with indirect-only mediation: the direct BPR $\rightarrow$ BP association is small, negative, and non-significant, while the OA-mediated route is now also confirmed by its own dedicated firm-block bootstrap ($\beta = 0.070$, 95% CI $[0.032, 0.114]$, $p < 0.001$; **Table 8**), so BPR's performance association—to the extent it runs through OA—appears to run through this downstream agility mechanism rather than directly. Read through the Dynamic Capabilities

lens (Section 4), this is consistent with OA sitting at the “transforming/reconfiguring” stage the theory identifies as the point where a reconfigured resource base (BPR) becomes an operating capability (agility) that then shapes performance, rather than BPR translating into performance on its own; a supplementary, non-hypothesized route through DI shows a similar pattern ($\beta = 0.044$, 95% CI [0.014, 0.079], $p < 0.001$) and is reported separately (Section 7.13), not combined into the H9 conclusion. Neither establishes causal mediation given the cross-sectional design; the small but now-confirmed exploratory serial pathway ($\beta = 0.021$, 95% CI [0.009, 0.037], $p < 0.001$; Section 7.12) means the “agility” and “innovation” route language approximates a more interconnected structure even before that caveat. All of these bootstraps now use firm-block, dependence-aware resampling (Section 6.6), so the nesting caveat that motivated this as a priority follow-up in earlier drafts no longer applies.

8.5. Theoretical Contributions

This study does not propose a new theory of digital transformation; it offers two evidence-based contributions to existing perspectives.

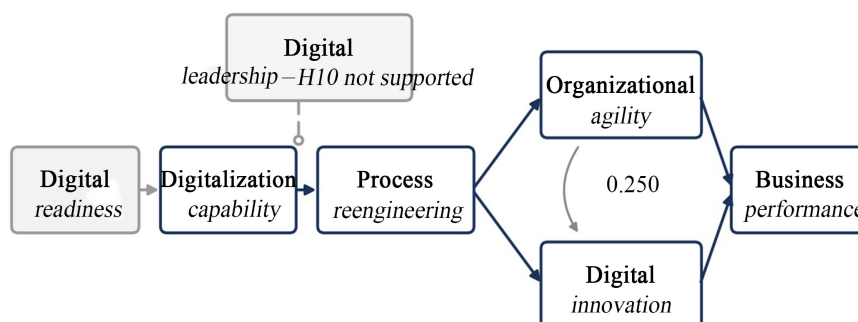
The first is an integrative empirical examination of DC, BPR, OA, DI, and BP within a single structural model—testing whether the direct DC-DI association persists once BPR is included (H8), whether BPR’s association with BP through organizational agility specifically is direct or indirect-only (H9), and whether OA and DI are separable or interconnected, as the exploratory serial pathway (Table 14) and the supplementary DI-involving route (Table 15) suggest. This draws on Dynamic Capabilities [20] and Resource-Based View perspectives: DC $\rightarrow$ BPR fits the reconfiguration logic of Dynamic Capabilities without resolving its circularity problem [21], while the residual DC-DI association leaves room RBV alone cannot explain.

The second contribution is a boundary-condition finding rather than a confirmed effect: digital leadership, hypothesized as strengthening the DC-BPR association, did not hold up once naive inference was replaced with percentile-bootstrap validation (H10; Section 7.9). The main-effects structure (H1 - H7) is robust across the base-path robustness checks (Section 7.10), the mediation effects (H8, H9) are now each supported by their own dedicated single-estimand, firm-block bootstrap (Table 8); and the moderating role of digital leadership (H10)—measured with a two-item scale and per-country cells as small as 2 - 4 firms—remains a genuine scope boundary rather than a settled null. Both extend existing perspectives rather than propose a new theory; the cross-sectional, single-source design constrains the claims drawn from them (Section 9).

8.6. Practical Implications

The findings suggest a chain of associations, not a causal sequence: stronger DC is associated with stronger BPR, so digital investment may be more consequential paired with attention to process redesign; BPR’s indirect-only route to BP through

OA suggests redesign scoped only for efficiency may under-deliver on agility gains specifically, with a similar supplementary pattern observed for innovation gains. Given H10's non-support, this study cannot responsibly recommend leadership-sponsorship investment as a lever, though the two-item measure's limited power means the possibility cannot be ruled out. **Figure 10** summarizes the validated associations as an integrated framework.



"Digital readiness" is conceptual, not tested. Every other link is a supported path (Table 6). DL sits at the DC-BPR link it was tested, but not found, to moderate.

Figure 10. Integrated framework summarizing the validated associations above, as a non-temporal map. "Digital readiness" is a conceptual precondition to DC, not a tested relationship; every other connection corresponds to a supported path in **Table 6**. DL is positioned at the DC-BPR link it was tested, but not found, to moderate.

9. Limitations

1) Cross-sectional design; no causal inference. All constructs are measured at one point in time; associational, not causal, language applies throughout.

2) **Single-source, self-reported measures**, raising single-informant bias where respondents from the same firm could report differing perceptions.

3) **Common method risk** (Section 6.8), reduced but not eliminated by procedural remedies; no marker-variable cross-check [31] was implemented, and the full-collinearity VIF used instead cannot rule it out.

4) **336 respondents nested within 50 firms**. Firm-level cluster-robust standard errors (Section 7.10) confirm all originally significant base paths remain significant, and every percentile bootstrap reported in this paper—the base paths as well as the indirect effects (H8, H9), the interaction term (H10), and the exploratory pathways (Sections 7.12 - 7.13)—now uses firm-block, dependence-aware resampling (Section 6.6), with results materially unchanged from the earlier respondent-level estimates on every substantive conclusion. A two-level (respondents nested in firms) multilevel structural re-specification remains a possible future robustness cross-check but was not required to reach this conclusion (Section 10).

5) **Uneven country representation** (Egypt 14 firms to Qatar 2), precluding country-level or multi-group analysis; the firm-level clustering correction does not address possible country-level dependence.

- 6) **Purposive, non-probability sampling** at both respondent and firm level.
- 7) **Limited generalizability.** With 50 firms, results should not be generalized to “Middle Eastern enterprises” as a class, nor beyond comparable organizations.
- 8) Digital Leadership reduced to two indicators, with rho_A (0.551) below the 0.70 threshold even though alpha and CR are not; retained items capture visible sponsorship and modelling rather than the full DL construct (vision articulation and resource allocation are absent). This limits statistical power as much as content coverage, and is a leading candidate explanation for why H10 was not robustly supported (Section 8.3)—this study’s most consequential measurement limitation alongside item #4 above.
- 9) Reflective measurement was assumed but not formally adjudicated against a formative alternative for DC and BPR; Mode A (reflective) estimation cannot by itself establish that this is the optimal specification.
- 10) **Subjective, perceived business-performance measure** rather than audited financial data.
- 11) **Potential reverse causality**, since all constructs were measured concurrently.
- 12) **Lack of longitudinal evidence** on the lag between redesign and its downstream associations.
- 13) Percentile, not bias-corrected-and-accelerated (BCa), bootstrap confidence intervals throughout: 2000 resamples for the base structural model (not the 5000 originally targeted, given compute limits), and 1000 for the moderation and mediation sub-analyses (full-model refit per resample); percentile CIs are somewhat more conservative, precisely the distinction separating H10’s naive significance from its bootstrap non-significance (Section 7.9).
- 14) Q² predictive relevance (**Table 13**) was approximated via 10-fold cross-validation of each construct’s inner-model regression on fixed full-sample outer weights, since plspm has no native blindfolding routine; this is a construct-level approximation, not a full per-fold re-estimation.
- 15) H10’s non-significance is itself a scope-boundary limitation: this study cannot speak to whether digital leadership moderates the DC-BPR association in a sample with a fuller DL scale, larger per-country cells, or a design better powered to detect a small interaction effect (Section 8.3).
- 16) **DL remains a two-indicator construct with a genuinely unstable second loading:** even after correcting the bootstrap draws for Mode A’s sign ambiguity (**Table 3** note), DL4’s 95% CI still spans zero ([−0.743, 0.999]), and its Dijkstra-Henseler rho_A (0.551) remains below the 0.70 threshold (Section 7.5); results involving DL (H10 in particular) should be read with this measurement limitation in mind.
- 17) **The H8 and H9 indirect-effect bootstraps (Table 8) are now single-estimator and firm-block, dependence-aware:** like the base-path bootstrap (**Table 6**), the resampling underlying these H8/H9 figures now draws firm blocks rather than individual respondents, so the nesting caveat that previously applied through-

out Section 6.6 is addressed here too; a two-level multilevel structural re-specification remains a possible, lower-priority future robustness check (Section 10).

18) **The survey was administered in English and Arabic with a forward-/back-translation procedure (Section 6.3), but the exact translator qualifications and pilot-sample size were not centrally logged;** the assumption that item meanings are comparable across the two language versions and six markets therefore rests on the translation procedure followed, not on a documented pilot study.

10. Future Research

The following priorities are ordered by how directly they respond to open items in this paper, rather than by topic. **Now complete:** the item-level outer-loading and HTMT bootstrap tables (**Table 3**, **Table 4**), the single-estimand bootstraps for the H8 and H9 indirect effects (**Table 8**), and—most notably—the dependence-aware re-estimation of every percentile bootstrap in the paper, including the indirect effects (H8, H9), the interaction term (H10), and the exploratory pathways (Sections 7.12 - 7.13), using firm-block resampling (2000 resamples for the base model and measurement tables, 1000 for the mediation, moderation, and exploratory sub-analyses; Section 6.6). Results were materially unchanged from the earlier respondent-level estimates on every substantive conclusion, so the firm-clustered correction (**Table 10**) and the bootstrap inference throughout Section 7 are now consistently dependence-aware. **Remaining, lower priority:** a two-level (respondents nested in firms) multilevel structural re-specification would offer a further robustness cross-check on the firm-block bootstrap results above, though it is not expected to change the substantive conclusions. Other priorities include a longer, validated multi-item DL scale to re-test the DC $\times$ DL moderation this study could not confirm; longitudinal or time-lagged designs to establish temporal precedence; firm-balanced country samples permitting formal multi-group testing; multi-source measures (capability and redesign reported by different informants within the same firm); testing DC and BPR's reflective versus formative specification via confirmatory tetrad analysis (CTA-PLS; [24]); and replication in other emerging markets.

11. Conclusion

This study examined how digitalization capability associates with innovation, agility, and performance, whether business process reengineering accounts for that association, and whether digital leadership conditions it, using genuine PLS-SEM on 336 respondents—read throughout as individual perceptions of firm-level practice, given negligible within-firm agreement (Section 6.6)—across 50 firms in six markets. DC's strongest association was with BPR ($\beta = 0.485$, $f^2 = 0.308$), consistent with BPR partially mediating DC's association with DI (VAF $\approx 36\%$; confirmed by a dedicated single-estimand, firm-block bootstrap of the indirect effect, 95% CI [0.073, 0.172], $p < 0.001$, **Table 8**); all other base paths (H1 - H7) were significant and robust to firm-clustering, outlier-trimming, and control-variable

checks. BPR's association with BP, restricted to H9's hypothesized organizational-agility route, showed a small non-significant direct effect alongside a positive OA-mediated indirect route that is now confirmed significant under its own dedicated firm-block bootstrap ($\beta = 0.070$, 95% CI [0.032, 0.114], $p < 0.001$), consistent with indirect-only mediation through agility specifically; a similar, supplementary pattern through digital innovation was also significant ($\beta = 0.044$, $p < 0.001$) but falls outside H9's formal scope. The central honest finding: the hypothesized DC $\times$ DL moderation (H10) is not robustly supported—significant under naive standard errors but not under bootstrap CI ([−0.146, 0.152]), with negligible effect size ($f^2 = 0.012$). The evidence for digital leadership as a boundary condition was not robust, and this finding—together with the measurement limitations noted in Section 9—represents an honest and informative account of where this analysis currently stands, rather than a finished, submission-ready set of results; the contribution rests on the validated base-path structure and the now single-estimand, firm-block-bootstrapped mediation results (H8, H9), with the moderation result (H10) flagged above and a two-level multilevel structural re-specification remaining a possible, lower-priority future robustness check (Section 10). These associations are not causal.

Conflicts of Interest

The author declares no conflicts of interest.

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Appendix

Table A1. Complete measurement items.

Digitalization Capability (DC)—adapted from Bharadwaj [7]; Wade & Hulland [8]: DC1 “Our firm effectively integrates digital technologies into core business operations.” DC2 “Digital data is systematically used in our firm’s decision-making processes.” DC3 “Our employees possess the digital skills required to deploy new technologies effectively.” DC4 “Our firm’s digital infrastructure enables rapid integration of new digital solutions.” DC5 “Our firm has consistently invested in building digital capabilities over the past three years.”

Business Process Reengineering (BPR)—adapted from Hammer & Champy [3]; Davenport & Short [4]: BPR1 “Our firm has fundamentally redesigned core business processes rather than making incremental improvements.” BPR2 “We have systematically removed redundant steps from our key business processes.” BPR3 “Our processes have been reorganized around outcomes rather than functional silos.” BPR4 “Approval layers and decision bottlenecks have been significantly reduced in our core processes.” BPR5 “Our process redesign efforts have resulted in fundamentally changed workflows.”

Organizational Agility (OA)—adapted from Sambamurthy et al. [12]; Tallon & Pinsonneault [13]: OA1 “Our firm can quickly detect changes in the market environment.” OA2 “We are able to respond rapidly to competitive threats and opportunities.” OA3 “Our firm reconfigures resources quickly in response to changing conditions.” OA4 “Our decision-making processes are faster than those of our competitors.”

Digital Innovation (DI)—adapted from Nambisan et al. [11]; Nasiri et al. [9]: DI1 “Our firm has introduced digitally enabled new products in the past two years.” DI2 “We have developed digitally enabled services that are new to our firm.” DI3 “Our business model incorporates digitally delivered value propositions.” DI4 “Digital technologies have enabled new processes that did not exist before.” DI5 “Our innovation efforts are increasingly focused on digital solutions.”

Business Performance (BP)—adapted from Tallon & Pinsonneault [13]: BP1 “Our firm’s operational efficiency has improved relative to competitors.” BP2 “We have achieved better market responsiveness than our sector peers.” BP3 “Our firm’s profitability trend is favourable compared to competitors.” BP4 “Overall, our firm performs better than the industry average.”

Digital Leadership (DL)—adapted from Warner & Wäger [2]; Satar et al. [6]: DL1 “Senior leadership clearly articulates a vision for digital transformation” (loading 0.510 in the four-item block; removed). DL2 “Top management actively allocates resources to digital initiatives” (loading 0.465 in the four-item block; removed). DL3 “Leaders in our firm actively sponsor digital change initiatives” (loading ≈ 1.00 in the retained two-item block; retained). DL4 “Senior leaders model digital adoption and encourage experimentation” (loading 0.553 in the retained two-item block; retained).

Note. No reverse-worded items were included in the final instrument.