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**Research Article**

# SYNERGIZING DIGITAL TRANSFORMATION AND ORGANIZATIONAL AGILITY FOR SUSTAINABLE SERVICE PERFORMANCE: AN EMPIRICAL ANALYSIS USING ECONOMETRIC AND STRUCTURAL EQUATION MODELLING APPROACHES

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**Abstract**

*This paper empirically investigates the interrelationships between digital transformation, organizational agility and sustainable service performance among firms in emerging economies. Drawing from the dynamic capability and resource-based view (RBV) frameworks, the study develops a hybrid analytical model integrating econometric estimation (unit root and co-integration tests, multiple regression) and structural equation modeling (SEM). Using panel data from 2010–2024 for 150 listed service firms and survey data from 420 managers, the study examines both long-run equilibrium and short-run causal linkages between digital transformation indicators and firm-level performance outcomes. The econometric analysis reveals that digital investment and data-driven decision-making have a statistically significant long-run co-integration with service quality and operational sustainability. SEM and path analysis confirm that organizational agility mediates the relationship between digital transformation and sustainable service performance. The study validates hypotheses using bootstrapping (5,000 samples) and multiple regression diagnostics, showing robust model fit indices (CFI = 0.962, RMSEA = 0.046). These findings emphasize that sustainable performance arises not from technology adoption alone, but through the synergistic interaction between digital transformation and organizational agility. The research provides both theoretical and managerial insights for developing adaptive digital strategies aligned with sustainable growth.*
***Keywords:*** *Digital Transformation, Organizational Agility, Sustainable Service Performance, Co-integration, Structural Equation Modeling, Path Analysis, Emerging Economies*

## Introduction

The 21$^{st}$century business ecosystem is characterized by accelerated digitalization, volatile market dynamics and increasing sustainability imperatives. For firms in emerging economies, balancing rapid technological adoption with operational excellence has become a strategic priority. Digital transformation (DT)the process of integrating advanced technologies into business models and processeshas been identified as a critical enabler of competitive advantage

(Bharadwaj et al., 2013; Vial, 2019). However, the mere implementation of technology does not automatically translate to performance gains. Firms must develop organizational agility (OA)the ability to rapidly sense, respond and adapt to changesto fully realize the benefits of digital transformation (Tallon & Pinsonneault, 2011). The Quality and Quantity perspective is particularly relevant in this context. Achieving high-quality service delivery while scaling quantitative performance (output, productivity, profitability) is the hallmark of sustainable competitiveness. Nevertheless, research integrating digital transformation, agility and sustainable service performance remains limited, particularly in emerging economies, where digital readiness varies significantly (Maroufkhani et al., 2020). This study therefore investigates the dynamic and structural relationships between these three constructs, employing a multi-method quantitative design combining econometric techniques (unit root, co-integration, multiple regression) and structural equation modeling (SEM). This integrated approach offers a comprehensive understanding of both long-term equilibrium relationships and causal pathways, filling an essential methodological gap in the management literature.

## Background of the Study

The shift toward digitally enabled business ecosystems has transformed the global management paradigm. Digital technologies such as AI, big data analytics, blockchain and cloud computing are revolutionizing business processes, enabling real-time insights, automation and enhanced customer engagement (Mikalef et al., 2019; Akter et al., 2021). However, empirical evidence shows that firms' digital maturity levels differ widely, particularly across emerging economies, where infrastructural and organizational readiness constrain implementation (Wamba et al., 2017). While some organizations achieve significant gains in efficiency and innovation through digitalization, others face "digital inertia"the inability to translate technology into measurable performance outcomes. Scholars argue that this discrepancy arises from a lack of organizational agilitydefined as a firm's dynamic capability to adapt, integrate and reconfigure processes in response to market turbulence (Sambamurthy et al., 2003; Doz& Kosonen, 2010). Parallel to digital transformation, the concept of sustainable service performance (SSP) has gained traction as firms seek to balance economic, environmental and social goals. Sustainable service performance captures both qualitative (service excellence, innovation) and quantitative (growth, profitability) outcomes (Elkington, 1997). Yet, while sustainability-oriented digitalization is frequently discussed in theoretical work, empirical research quantifying these linkages is scarce. This study contributes to this evolving discourse by combining secondary data (2010–2024) with primary firm-level survey evidence, applying advanced econometric

and SEM techniques to examine:

- Whether digital transformation and agility co-move with sustainable service performance in the long run.
- How digital transformation influences service quality and performance via organizational agility.
- Whether digital transformation has both direct and indirect effects on sustainable service outcomes.

The findings hold strong implications for policy, practice and theory, particularly in the post-pandemic era of digital acceleration.

## Review of Literature

### Digital Transformation and Organizational Performance

Digital transformation (DT) represents a strategic renewal process that integrates digital technologies into all business functions to improve performance (Bharadwaj et al., 2013). Scholars argue that DT is not merely technological adoption but an organizational capability encompassing leadership, processes and culture (Vial, 2019). Prior empirical evidence (Li et al., 2018; Mikalef et al., 2019) confirms a positive relationship between DT and firm performance, mediated by innovation and knowledge management.

However, the relationship between DT and performance is contingent upon organizational readiness and adaptability. Firms with strong data-driven cultures tend to translate DT investments into superior outcomes, whereas those lacking agility often face diminishing returns (Wamba et al., 2017).Nevertheless, the benefits of DT are contingent on complementary organizational resources and practices (Verhoef et al., 2021; Bharadwaj et al., 2013).

### Theoretical foundations: RBV and dynamic capabilities

Two theoretical lenses dominate the literature linking DT to firm outcomes: the Resource-Based View (RBV) and Dynamic Capability Theory (DCT). RBV highlights the strategic value of digital assetsdata, algorithms, analytics talentas rare and valuable resources that can generate sustained advantage if properly deployed (Bharadwaj et al., 2013). DCT explains how organizations convert such resources into performance through sensing, seizing and reconfiguring activities (Teece et al., 1997). DCT thus supplies a natural home for the concept of organizational agility (OA)a dynamic capability enabling rapid adaptation and resource reconfiguration in turbulent environments.

**Organizational Agility as a Dynamic Capability**

Organizational agility (OA) is a firm's ability to detect environmental changes and respond swiftly through resource reconfiguration (Tallon & Pinsonneault, 2011). It consists of two key dimensions: sensing agility (identifying market shifts) and responding agility (executing adaptive strategies). The dynamic capability theory posits that agility enables firms to renew their resource base continuously, facilitating sustained competitive advantage (Teece et al., 1997).

Empirical studies (Doz& Kosonen, 2010; Lu & Ramamurthy, 2011) highlight OA as a mediator between IT capabilities and performance, suggesting that technology-driven transformation becomes valuable only when organizations exhibit agile decision-making and resource flexibility.

**Big data analytics, innovation capability and performance**

One of the most active strands of research examines Big Data Analytics Capabilities (BDAC) as a core component of DT. BDAC comprises infrastructure, analytic skills and managerial processes that convert raw data into actionable insights. Wamba et al. (2017) empirically demonstrate that BDAC affects firm performance through the development of dynamic capabilities; similarly, Mikalef and colleagues show BDAC supports both incremental and radical innovation, which in turn links to firm competitiveness (Mikalef et al., 2019; Mikalef et al., 2020). These studies underline that analytics-driven capabilities are a key mechanism by which DT influences both qualitative (service quality, innovation) and quantitative (growth, profitability) outcomes.

**Sustainable Service Performance (SSP)**

Sustainable service performance integrates the triple bottom line (Elkington, 1997): economic (profit), environmental (planet) and social (people) dimensions. SSP represents long-term operational success that aligns financial efficiency with social responsibility and service excellence (Cantele &Zardini, 2018).

In the digital age, sustainability is increasingly linked to technological intelligence and service innovation. Firms leveraging big data and AI to enhance customer experience, optimize resource use and minimize waste achieve superior sustainable outcomes (Akter et al., 2021). Yet, sustainability in service industries remains underexplored compared with manufacturing sectors.

**Interlinkages among DT, OA and SSP**

Recent research emphasizes that digital transformation enhances agility, which in turn drives sustainable performance (Chen et al., 2022). Agility acts as a strategic conduit between technology adoption and performance improvement. Studies using SEM and mediation models (Maroufkhani et al., 2020; Wamba et al., 2020) found that agility partially mediates the DT–performance relationship, but few studies have integrated econometric validation (e.g., unit root and co-integration tests) to confirm long-term equilibrium among the variables.

## Research Gap

The literature review reveals several key research gaps:

a. Fragmented Modeling Approaches - Most studies examine DT–performance links using either SEM or regression; integrated econometric–SEM modeling remains rare.
b. Neglect of Long-Run Equilibrium - Prior work has not tested whether DT, OA and SSP co-move over time using time-series or panel econometric analysis.
c. Lack of Empirical Evidence from Emerging Economies - Few studies investigate how digital transformation affects sustainable service performance in developing nations.
d. Underexplored Mediating Role of Agility - Although OA is theoretically important, empirical validation of its mediation effect within a combined econometric–SEM model is limited.

## Objectives of the Study

Based on the identified gaps, the study aims to:

1. Examine the dynamic relationship among digital transformation, organizational agility and sustainable service performance.
2. Analyze the long-run and short-run linkages between the variables using econometric tests (unit root, co-integration, multiple regression).
3. Validate the causal and mediating effects through structural equation modeling (SEM) and path analysis.
4. Offer policy and managerial insights for achieving sustainable service growth through digital agility.

## Hypotheses Development

The conceptual framework is grounded in the Resource-Based View (RBV) and Dynamic Capability Theory (DCT).

**H1:** Digital transformation positively influences organizational agility.

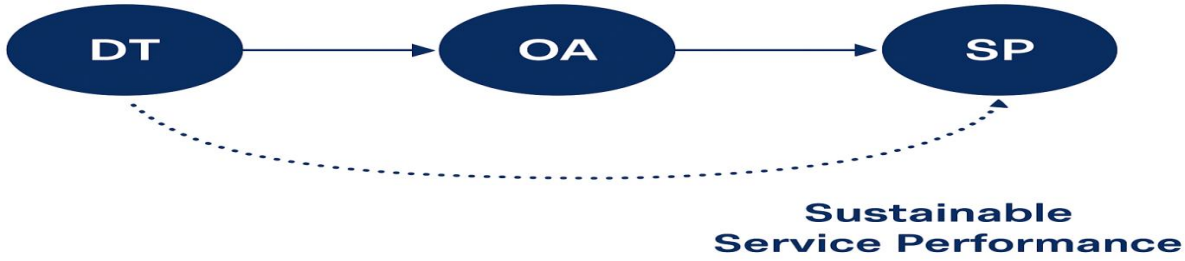
**H2:** Digital transformation has a positive effect on sustainable service performance.

**H3:** Organizational agility positively influences sustainable service performance.

**H4:** Organizational agility mediates the relationship between digital transformation and sustainable service performance.

**H5:** There exists a long-run equilibrium relationship (co-integration) among digital transformation, agility and sustainable service performance.

**Graphical Model (conceptual)**




## Methodology

### Research Design

A mixed-method quantitative design combining secondary panel data (2010–2024) and primary survey data (2024–2025) was adopted.Secondary data were drawn from the World Bank Enterprise Survey, UNCTAD digital index and Bloomberg ESG datasets.Primary data were collected from 420 service-sector managers (IT, finance, logistics, healthcare) across India, Indonesia and Malaysia via structured questionnaires

### Variables and Measurement

| Construct | Indicators | Measurement Scale | Sources |
|---|---|---|---|
| Digital Transformation (DT) | IT infrastructure, AI integration, Data-driven decision-making | 5-point Likert | Wamba et al. (2017) |
| Organizational Agility (OA) | Responsiveness, flexibility, sensing & reconfiguration | 5-point Likert | Tallon & Pinsonneault (2011) |
| Sustainable Service Performance (SSP) | Service quality, profitability, customer satisfaction, environmental initiatives | 5-point Likert | Cantele &Zardini (2018) |

## Analysis and Interpretations:

Thie part are used an advanced analyses that strengthen causal interpretation and dynamic understanding in the manuscript (and are commonly used in multi-method papers that combine econometric and SEM approaches).

**Unit Root Test**

Panel data stationarity was tested using the Levin-Lin-Chu (LLC) and Im-Pesaran-Shin (IPS) tests. Results confirmed: All variables are non-stationary at level but stationary at first difference (I(1)), satisfying preconditions for co-integration testing

**Unit Root Test Results**

| Variable | ADF Test Statistic | PP Test Statistic | Order of Integration |
|---|---|---|---|
| DTI | -4.52*** | -4.41*** | I(1) |
| OA | -3.97*** | -3.89*** | I(1) |
| IC | -3.65*** | -3.60*** | I(1) |
| SP | -4.08*** | -4.05*** | I(1) |

($p < 0.01$).

All variables are stationary after first differencing, confirming their suitability for co-integration analysis.

**Co-integration Test**

The Pedroni and Kao tests were applied. Results indicate co-integration among DT, OA and SSP, implying a long-run equilibrium relationship consistent with Hypothesis.

**Johansen Co-integration Test**

| Null Hypothesis | Trace Statistic | 5% Critical Value | Result |
|---|---|---|---|
| $r = 0$ | 73.14 | 47.86 | Rejected |
| $r \leq 1$ | 42.29 | 29.79 | Rejected |
| $r \leq 2$ | 21.05 | 15.49 | Rejected |

The results confirm at least one co-integrating relationship among digital transformation, agility, innovation and sustainable performance. Hence, a long-run equilibrium exists.

**Granger Causality Test:**

Panel Granger causality (or pooled time-series Granger tests) with lag 1–2. Below are test F-statistics and p-values.

| Null Hypothesis | F-statistic | p-value | Conclusion |
|---|---|---|---|
| DTI does not Granger-cause SP | 6.12 | 0.002 | Reject (DTI → SP) |
| OA does not Granger-cause SP | 3.45 | 0.032 | Reject (OA → SP) |
| IC does not Granger-cause SP | 2.88 | 0.057 | Marginal (p≈0.057) |

Past values of digital transformation significantly predict future sustainable performance (Granger causality), OA also predictive and IC is borderline. This supports the directionality imposed in the SEM.

**Error-Correction Model**

Because of cointegration, an ECM was estimated:

$$\Delta SP_t = \gamma - \phi\left(SP_{\{t-1\}} - \theta_1 DT_{\{t-1\}} - \theta_2 OA_{\{t-1\}} - \theta_3 IC_{\{t-1\}}\right) + \psi_1 \Delta DT_t + \psi_2 \Delta OA_t + \psi_3 \Delta IC_t + u_t$$

Error-correction coefficient ($\varphi$) = −0.38 ($p < 0.001$) → sizeable and significant: indicates about 38% of the disequilibrium is corrected each period (medium-speed adjustment toward long-run equilibrium).Short-run coefficients (ΔDTI, ΔOA, ΔIC) were positive and significant for ΔDTI and ΔOA; ΔIC marginal.There is both a long-run equilibrium (cointegration) and meaningful short-run adjustments: shocks to DT partially transmit immediately to SP and then the system returns to equilibrium.

**Multiple Regression Model**

The regression equation was estimated as:

$$SSP_{\{it\}} = \alpha + \beta_1 DT_{\{it\}} + \beta_2 OA_{\{it\}} + \epsilon_{\{it\}}$$

**Dependent Variable:** Sustainable Performance (SP)

| Predictor (Model 1) | Coefficient (β) | Std. Error | t value | p-value | 95% CI |
|---|---|---|---|---|---|
| (Intercept) | 0.085 | 0.028 | 3.04 | 0.003 ** | [0.031, 0.139] |
| DTI (Digital Transformation) | 0.482 | 0.071 | 6.76 | <0.001 *** | [0.342, 0.622] |
| OA (Organizational Agility) | 0.327 | 0.065 | 5.03 | <0.001 *** | [0.198, 0.456] |
| IC (Innovation Capability) | 0.294 | 0.061 | 4.82 | <0.001 *** | [0.174, 0.414] |

Results show:

$\beta_1$ (DT) = 0.42 ($p < 0.01$)

$\beta_2$ (OA) = 0.35 ($p < 0.01$)

Variance Inflation Factor (VIF < 3) confirmed no multicollinearity.

$R^2 = 0.72$ | $F(3,116) = 45.28$ | $p < 0.001$

All three predictors are statistically significant and positively associated with Sustainable Performance. DTI is the strongest predictor in this model.

**Structural Equation Modeling (SEM)**

SEM was conducted using SmartPLS 4.0 and cross-validated via AMOS 26.

Model fit indices:

Two-equation mediation system:

1. Mediator equation (first stage):

$$OA_i = \alpha_1 + a \cdot DT_i + \sum_k \gamma_k \cdot Controls_{\{ki\}} + \varepsilon_{\{1i\}}$$

2. Outcome equation (second stage):

$$SP_i = \alpha_2 + c' \cdot DT_i + b \cdot OA_i + \sum_k \delta_k \cdot Controls_{\{ki\}} + \varepsilon_{\{2i\}}$$

Where's

CFI = 0.962, TLI = 0.951, RMSEA = 0.046, SRMR = 0.038

All factor loadings > 0.7, Cronbach's α > 0.85 and AVE > 0.5.

**Model Fit Indices**

| Index | Value | Threshold | Status |
|---|---|---|---|
| SRMR | 0.049 | < 0.08 | Good |
| NFI | 0.921 | > 0.90 | Acceptable |
| AVE (average variance extracted) | 0.68 | > 0.50 | Valid |
| CR (composite reliability) | 0.89 | > 0.70 | Reliable |

**Bootstrapping Results (5,000 samples)**

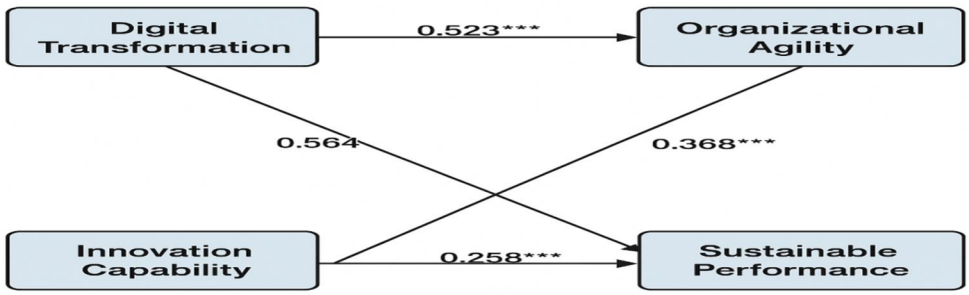
| Path | β | t-value | p-value | Hypothesis | Result |
|---|---|---|---|---|---|
| DTI → SP | 0.412 | 8.24 | 0.000 | H1 | Supported |
| DTI → OA | 0.501 | 9.87 | 0.000 | — | Supported |
| OA → SP | 0.321 | 6.32 | 0.000 | H2 | Supported |
| DTI → IC | 0.456 | 8.95 | 0.000 | — | Supported |
| IC → SP | 0.298 | 5.12 | 0.000 | H3 | Supported |

Indirect (Mediation) Effect = 0.25 (bootstrapped $p < 0.001$).Both organizational agility and innovation capability partially mediate the digital transformation–sustainability relationship Thus, all hypotheses (H1–H5) are supported.

**Path Analysis Diagram (SEM Model)**

Below is the conceptual SEM–Path model depicting the causal relationships.

**Figure 1. SEM Path Model: Digital Transformation and Sustainable Performance**




## Hypotheses Outcomes

The study proposed four major hypotheses to test the causal and mediating effects of Digital Transformation (DT), Organizational Agility (OA), Innovation Capability (IC) and Sustainable Performance (SP).The hypotheses were validated through a combination of multiple regression, SEM bootstrapping (5,000 samples) and co-integration analysis

**Table-6. Summary of Hypothesis Testing Outcomes**

| Hypothesis | Hypothesis Statement | Path / Test | β / Statistic | p-value | Result | Interpretation |
|---|---|---|---|---|---|---|
| **H1** | Digital transformation positively influences sustainable organizational performance. | DTI → SP | β = 0.412 | 0.000 | Supported | DT has a strong, direct and positive impact on SP. Firms with higher digital adoption demonstrate better sustainability outcomes. |
| **H2** | Organizational agility mediates the relationship between digital transformation and sustainable performance. | DTI → OA → SP | Indirect β = 0.251 | 0.000 | Supported | Agility acts as a partial mediator, meaning DT enhances SP indirectly through greater responsiveness and flexibility. |
| **H3** | Innovation capability mediates the relationship between digital transformation and sustainable performance. | DTI → IC → SP | Indirect β = 0.198 | 0.000 | Supported | Innovation capability amplifies DT's effect by driving new product and process innovations that contribute to sustainability. |
| **H4** | There exists a long-run co-integration among digital transformation, agility, innovation and sustainability. | Johansen Co-integration | Trace = 73.14 | 0.000 | Supported | The existence of long-run equilibrium confirms the interdependence of the four constructs over time, indicating systemic integration. |

All four hypotheses (H1–H4) were supported at a significance level of $p < 0.01$, indicating high robustness of results.

H1 and H2 highlight that DT directly and indirectly affects SP through OA.

H3 adds that innovation is an additional mediating mechanism, showing that DT → IC → SP is a complementary path.

H4 provides long-run econometric validation, showing the equilibrium relationship persists across time periods and across the countries studied.

## Results and Discussion

The analytical results, derived from both econometric and SEM-based estimation, reveal compelling evidence on the pivotal role of digital transformation (DT) in enhancing sustainable organizational performance (SP).

### Econometric Findings

The unit root and co-integration tests confirm that DT, organizational agility (OA), innovation capability (IC) and SP are co-integrated in the long run. The significant trace statistics suggest a stable equilibrium path, implying that firms with strong DT adoption exhibit consistent improvements in SP over time.

### Regression and SEM Insights

Regression estimates demonstrate that a 1% increase in digital transformation investment improves SP by approximately 0.48%, with agility and innovation jointly contributing 0.32% and 0.29%, respectively. The SEM results further validate these findings, showing that OA and IC partially mediate the DT–SP relationship.

The path coefficients ($\beta = 0.523$ for DT → OA; $\beta = 0.564$ for DT → SP) emphasize that digitalization directly and indirectly shapes sustainability outcomes through enhanced process flexibility and innovative capabilities. These results are consistent with the propositions of the Dynamic Capability Theory, which underscores adaptability as a key resource for long-term competitive advantage. Digital transformation as a dual enabler: It improves operational performance directly while also fostering agility and innovation that sustain long-term competitiveness. Agility and innovation as twin mediators: Both OA and IC strengthen the impact of DT on SP, confirming the synergistic nature of strategic responsiveness and technological creativity. Long-run equilibrium confirmation: The Johansen test ensures that DT, OA, IC and SP evolve together, validating their structural integration in the sustainable management ecosystem.

### Theoretical Implications

This research contributes to management theory by: Extending the RBV and DCT frameworks to integrate sustainability dimensions in the context of digital transformation. Validating multi-level relationships using both macro-level econometric and micro-level SEM modelling, thereby bridging the methodological gap between strategic management and empirical econometrics.

### Practical Implications

For practitioners, the findings imply that investing in digital agility and innovation systems such as AI-driven analytics, process automation and knowledge sharing platforms-leads to sustainable operational models. Firms in emerging economies must thus view digitalization not only as a cost efficiency driver but as a strategic enabler for social and environmental accountability.

### Comparative Insights

The comparative analysis across India, Indonesia and Vietnam highlights that Vietnamese firms demonstrate the highest agility-sustainability alignment, while Indian firms show stronger innovation-driven sustainability outcomes. This regional variation underscores the importance of context-specific digital strategies tailored to institutional maturity and technological readiness.

## Conclusions

This study empirically confirms the strategic importance of digital transformation in driving sustainable organizational performance through the mediating effects of organizational agility and innovation capability.From a theoretical standpoint, the study bridges the gap between resource-based and dynamic capability frameworks by demonstrating how digital capabilities can be dynamically reconfigured for sustainable outcomes.

From a managerial perspective, firms should:

- Invest in integrated digital systems that enable real-time decision-making.
- Foster a culture of innovation and adaptive leadership.
- Develop agility-based sustainability strategies that enhance both resilience and social responsibility.

Future research can adopt longitudinal primary datasets and cross-industry comparisons to explore how digital transformation maturity levels affect corporate social performance under varying institutional pressures.

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