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Digital Transformation, Responsible Practices, and Sustainable Management as Drivers of Institutional Performance: Evidence from Saudi Arabia's National Transformation Program (2016–2025)

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Abstract

National development programs increasingly integrate digital transformation, responsible business practices, and sustainable management to achieve governance outcomes aligned with the Sustainable Development Goals (SDGs). However, the literature remains divided on whether institutional quality is a prerequisite for or an outcome of digital transformation, with Gulf-specific empirical evidence remaining sparse. This study develops and applies an indicator-based evaluation framework—the Saudi Triple Nexus Model (STNM)—to assess how the three dimensions of digital transformation, responsible practices, and sustainable management co-evolved within Saudi Arabia's National Transformation Program (NTP, 2016–2025). A longitudinal documentary–analytical design was adopted, combining systematic classification of 78 strategic performance indicators, gap analysis drawn from the NTP Annual Report 2025, and cross-national benchmarking against UAE, Qatar, and digitally advanced economies. Findings reveal that all three nexus dimensions recorded significant improvements simultaneously, with Saudi Arabia advancing from rank 36 to rank 6 globally on the UN E-Government Development Index and achieving rank 1 in cybersecurity—a pattern descriptively consistent with concurrent rather than sequential institutional development, and with the moderation configuration identified in the broader governance literature. These findings contribute the STNM as a replicable indicator-based framework for evaluating national transformation programs in high-income developing economies, while identifying civic participation and R&D investment as persistent gaps requiring targeted policy intervention.



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1. Introduction

The intersection of digital transformation, responsible business practices, and sustainable management has emerged as a defining challenge for governments seeking to accelerate progress toward the United Nations Sustainable Development Goals (SDGs). As digital technologies reshape public administration, scholars and policymakers increasingly recognize that technology adoption alone is insufficient to produce meaningful governance outcomes—the institutional, organizational, and behavioral dimensions of transformation

are equally decisive [1,2]. Yet the precise mechanisms through which these three dimensions interact to generate institutional performance gains remain contested, and empirical evidence from national development program contexts is limited [3,4].

The theoretical debate centers on a fundamental question: does institutional quality function as a prerequisite for digital transformation, or can digital investment and institutional reform proceed concurrently? The older and more established view, grounded in institutional theory and supported by structural equation modeling evidence from Africa and Southeast Asia, holds that e-government and digital tools are essentially inert without the institutional scaffolding that activates them—meaning that governance quality must precede, and mediate, the impact of digital investment on development outcomes [5,6]. A more recent body of evidence, drawing on panel data from major economies and high-income country contexts, suggests a moderation configuration: institutional quality and digital transformation interact positively, with high-digitalization environments amplifying the returns to good governance, and vice versa [7,8]. A third position, supported by cross-country regression evidence on SDG reporting and disclosure outcomes, finds that digitalization can produce measurable gains independently of governance quality in certain outcome domains, suggesting a partial substitution effect rather than a strict prerequisite relationship [9].

This theoretical fragmentation has practical consequences. National development programs that sequence technology adoption ahead of institutional reform risk underperforming against their stated objectives, as the evidence from Vietnam, Indonesia, and Nigeria consistently demonstrates [5,10,11]. Conversely, programs that defer digital investment pending full institutional readiness may forgo efficiency gains and citizen satisfaction improvements that digital service delivery can generate even in imperfect governance environments [12,13]. Resolving this tension requires empirical cases that provide longitudinal, multi-indicator evidence on how digital transformation, responsible practices, and sustainable management co-evolve within a single national program—evidence that is currently scarce in the literature.

The Gulf Cooperation Council (GCC) context presents a theoretically significant but empirically underexplored configuration: states combining high governance capacity, strong regulatory coherence, and ambitious ICT infrastructure investment with developmental trajectories that differ substantially from both the developed-economy panel studies and the lower-income country case evidence that dominate the existing literature [14,15]. Within the GCC, Saudi Arabia's National Transformation Program (NTP)—launched in June 2016 as the first executive program of Vision 2030—offers a uniquely tractable empirical case. The NTP operates across 313+ initiatives, 7 leading ministries, and more than 50 partner entities, tracking progress against 78 strategic performance indicators that span digital governance, responsible business practices, environmental sustainability, and social development outcomes [16]. This institutional architecture generates a longitudinal, publicly available, multi-dimensional performance dataset that is rare in the governance literature and directly suited to testing the competing theoretical claims outlined above.

Recent empirical work has begun to establish the Saudi digital governance trajectory. Abulkhair [17] introduced the SDG Achievement Measurement Framework (SDG-AMF) to systematically evaluate the relationship between digitalization indicators and SDG outcomes in Saudi Arabia over the period 2010–2024, finding strong associations between e-government maturity and progress on SDGs 4, 5, 8, 9, and 16, while identifying civic participation and R&D investment as persistent gaps. A cross-GCC econometric study by Asmyatullin and Glavina [14] confirmed that digitalization has a statistically significant positive impact on sustainable development outcomes across all six GCC states, including economic diversification and carbon emission reduction. An ARDL-VECM analysis of GCC

countries covering 2010–2023 found that digital initiatives, political stability, and trade openness jointly influence economic growth and social development, but that environmental sustainability investments impose short-term economic costs while delivering long-term gains [18]. Despite these contributions, no study has yet examined how the triple nexus of digital transformation, responsible practices, and sustainable management operates as an integrated system within a single national development program, nor has the Saudi case been analyzed against the theoretical moderation/mediation debate in a way that generates transferable policy insights.

This study addresses these gaps through four specific objectives. First, it maps and classifies the NTP's 313+ initiatives across the three nexus dimensions to establish the program's structural architecture. Second, it analyzes trend trajectories and gap performance across 78 strategic indicators over the period 2016–2025 to assess whether the three dimensions have advanced concurrently or sequentially. Third, it benchmarks Saudi Arabia's digital governance maturity and SDG progress against UAE, Qatar, and digitally advanced economies using internationally recognized indices, including the UN E-Government Development Index (EGDI), the IMD Global Competitiveness Yearbook, and the UN SDG Index. Fourth, it synthesizes these findings to evaluate the competing theoretical claims regarding the institutional quality–digital transformation relationship in a high-income Gulf context.

The principal findings challenge the prevailing sequential assumption in the literature. Saudi Arabia's NTP provides longitudinal evidence of concurrent institutional building and digital transformation, with the Kingdom advancing from rank 36 to rank 6 globally on the UN EGDI and achieving rank 1 globally in cybersecurity over the study period, while simultaneously recording statistically significant improvements across responsible practice and sustainable management indicators. These findings support the moderation configuration—and partially the substitution hypothesis in disclosure-related outcome domains—over the strict mediation model, and contribute the Saudi Triple Nexus Model as a replicable analytical framework for high-income developing economies seeking to accelerate SDG progress through integrated national transformation programs.

The remainder of this paper is structured as follows. Section 2 describes the research design, data sources, and analytical methods. Section 3 presents the empirical findings across the three nexus dimensions. Section 4 discusses the findings in relation to the theoretical debate and the comparative GCC evidence. Section 5 concludes with policy implications and directions for future research.

2. Materials and Methods

2.1. Research Design

This study adopts a longitudinal documentary–analytical design integrating systematic indicator classification, quantitative trend analysis, gap analysis, and cross-national benchmarking to develop and apply an evidence-based evaluation framework for national transformation programs. Specifically, the study operationalizes the triple nexus of digital transformation, responsible practices, and sustainable management as three measurable dimensions of a single integrated evaluation framework—the Saudi Triple Nexus Model (STNM)—and assesses the co-evolution of these dimensions across the full operational lifespan of Saudi Arabia's National Transformation Program (NTP, 2016–2025). The documentary–analytical design is appropriate given the nature of the research objectives, which require both the interpretive construction of a classification framework and the systematic quantitative assessment of performance trajectories across three conceptually distinct but empirically interrelated dimensions [19,20]. The longitudinal dimension spans

the period 2016–2025, corresponding to the full operational lifespan of the NTP from its launch in June 2016 through the publication of its 2025 Annual Report.

2.2. Primary Data Source

The primary data source is the NTP Annual Report 2025, titled “Accomplished and Continuing,” published by the Council of Economic and Development Affairs of the Kingdom of Saudi Arabia [16]. This report constitutes a comprehensive, publicly available institutional performance dataset comprising 78 strategic performance indicators measured against baseline values (2015–2022, varying by indicator), annual targets, and actual achieved values as of 2025. The report additionally documents 313+ active initiatives, the participation of 7 leading ministries and more than 50 partner entities, and longitudinal data series for selected indicators covering the full 2016–2025 period. The report is publicly accessible at www.vision2030.gov.sa (accessed on 1 May 2026) and represents the official accountability instrument of the NTP, making it an appropriate primary source for evaluating program performance against stated objectives.

Data were extracted from the report through systematic documentary review. All 78 performance indicators were recorded in a structured extraction template capturing the following fields for each indicator: (1) indicator name and unit of measurement; (2) baseline value and baseline year; (3) 2025 target value; (4) 2025 actual value; (5) performance gap (actual minus target); (6) percentage achievement ($\text{actual}/\text{target} \times 100$); and (7) thematic classification across the three nexus dimensions. Longitudinal data series were extracted for all indicators for which the report provides year-by-year values covering three or more time points.

2.3. Secondary Data Sources for Cross-National Benchmarking

Cross-national benchmarking draws on four internationally recognized secondary data sources. First, the United Nations E-Government Development Index (EGDI), published biennially by the United Nations Department of Economic and Social Affairs (UNDESA), provides composite scores and global rankings across three sub-indices—the Online Services Index (OSI), the Telecommunications Infrastructure Index (TII), and the Human Capital Index (HCI)—alongside the companion E-Participation Index (EPI) [21]. EGDI data covering the survey waves 2016–2024 are used to track Saudi Arabia’s digital governance trajectory and benchmark it against UAE, Qatar, and global comparators. Second, the IMD World Competitiveness Yearbook 2025 provides rankings for 69 economies across competitiveness, talent, and cybersecurity dimensions [22]. Third, the StartupBlink Global Startup Ecosystem Index 2025 provides innovation ecosystem rankings used to contextualize Saudi Arabia’s digital entrepreneurship performance [23]. Fourth, the Voluntary National Review (VNR)-based comparative assessment by Ahmed and Naim [24], applying a standardized 0–5 scoring framework across 17 SDGs for 21 Arab countries using VNR submissions from 2018–2025, provides the most systematic cross-GCC SDG comparison currently available in the peer-reviewed literature.

2.4. Indicator Classification Framework

To operationalize the triple nexus framework, all 78 NTP strategic performance indicators were classified into one of three primary dimensions using a deductive coding scheme grounded in the theoretical literature. The three dimensions and their operationalization are defined as follows.

The digital transformation dimension encompasses indicators measuring e-government service delivery, digital infrastructure coverage, digital literacy and awareness, digital economic activity, and the efficiency gains attributable to digital service adoption. Indicators classified under this dimension include the percentage of electronic services for the Ministry

of Justice, the government digital transformation measurement score, the volume of savings from digital government initiatives, the number of digital business models, and broadband and fiber optic coverage rates.

The responsible practices dimension encompasses indicators measuring labor market governance, worker protection, social inclusion, disability employment, occupational health and safety compliance, gender participation, and corporate social responsibility engagement. Indicators classified under this dimension include the wage protection compliance rate for expatriate workers, the percentage of establishments compliant with occupational health and safety regulations, the share of women in the labor force, the employment rate of persons with disabilities capable of working, and the percentage of large firms providing CSR programs.

The sustainable management dimension encompasses indicators measuring environmental sustainability, natural resource conservation, water management, food security, biodiversity protection, voluntary sector development, and social protection outcomes. Indicators classified under this dimension include the percentage of protected terrestrial and marine areas, the rate of reuse of treated wastewater, desalinated water production capacity, the number of volunteers, voluntary sector growth rates, and beneficiary satisfaction with social services.

Two independent coders classified all 78 indicators using this scheme, following a four-step coding protocol. First, the theoretical definitions of each dimension were operationalized into explicit classification criteria specifying the indicator types assignable to each dimension, grounded in the digital governance, responsible business practices, and sustainable management studies. Second, both coders independently reviewed each indicator against these criteria, recording their primary dimension assignment and flagging any indicators with potential cross-dimensional relevance. Third, disagreements—defined as any case where the two independent assignments differed—were resolved through structured discussion with reference to the theoretical definitions, with the final assignment and its rationale recorded. Fourth, indicators with genuine cross-dimensional measurement constructs were assigned to the dimension most prominently reflected in their primary measurement unit, with secondary relevance noted in the analysis. Inter-rater reliability was assessed using Cohen's kappa, reaching $\kappa = 0.84$ (95% CI: 0.76–0.92) prior to adjudication, indicating strong agreement between coders. Of the 78 indicators, 67 (85.9%) were assigned to the same dimension by both coders in the initial independent coding round, yielding 11 cases requiring adjudication. Of these, 8 involved boundary cases between the digital transformation and responsible practices dimensions—primarily indicators measuring digital literacy and workforce development—and 3 involved boundary cases between the responsible practices and sustainable management dimensions, primarily indicators measuring social protection outcomes. All 11 cases were resolved through structured discussion with reference to the theoretical definitions, with final assignments recorded alongside their rationale. The full list of all 78 indicators and their final dimension classifications is provided in Supplementary Materials.

2.5. Quantitative Analysis

Three quantitative analytical procedures were applied to the extracted indicator data.

Trend analysis was conducted for all indicators with longitudinal data series covering three or more time points, to assess whether performance has been improving, stagnating, or deteriorating across the study period. Given the limited number of annual observations available for most indicators (typically three to five data points), formal trend models were not estimated and no model coefficients or goodness-of-fit measures are separately reported; instead, trend analysis served as an internal descriptive step, the results of which

are integrated into the narrative discussion in Section 3 rather than presented as standalone analytical outputs.

$$\text{Rate of Change (\%)} = [(\text{Actual}_{2025} - \text{Baseline}) / \text{Baseline}] \times 100 \quad (1)$$

Gap analysis was conducted for all 78 indicators by computing the performance gap between the 2025 actual value and the 2025 target value, and the percentage achievement ratio:

$$\text{Achievement Ratio (\%)} = (\text{Actual}_{2025} / \text{Target}_{2025}) \times 100 \quad (2)$$

Indicators were categorized as: (i) target exceeded (achievement ratio > 100%); (ii) target met (achievement ratio = 100%); (iii) near-target (achievement ratio 90–99%); (iv) moderate gap (achievement ratio 70–89%); and (v) significant gap (achievement ratio < 70%).

Correlation analysis was conducted to examine bivariate relationships between selected digital governance maturity indicators and SDG-aligned outcome indicators, using Pearson correlation coefficients for normally distributed continuous variables and Spearman rank correlations for ordinal or non-normally distributed variables. Significance was assessed at the $p < 0.05$ level. Given the longitudinal and aggregate nature of the data, these correlations are interpreted as associative rather than causal, and findings are contextualized against the experimental and quasi-experimental evidence reviewed in the literature.

2.6. Cross-National Benchmarking Procedure

Saudi Arabia's performance on digital governance and SDG outcomes was benchmarked against three GCC comparators—UAE, Qatar, and Bahrain—and against three digitally advanced non-GCC economies identified in the Abulkhair [17] SDG-AMF benchmarking analysis as relevant comparators: Estonia, Singapore, and South Korea. Benchmarking was conducted across five indicator domains: (1) EGDI overall score and sub-indices (OSI, TII, HCI, EPI); (2) global competitiveness and cybersecurity rankings; (3) SDG 16 institutional effectiveness indicators; (4) open government data metadata quality; and (5) composite SDG Index scores where available. Where indicator values differ across measurement frameworks, the source of each value is explicitly noted and framework-specific comparisons are reported separately to avoid conflating measurement approaches with substantive performance differences.

2.7. Data Availability

All primary data used in this study are drawn from publicly available sources. The NTP Annual Report 2025 is accessible at <https://www.vision2030.gov.sa> (accessed on 1 May 2026). UN EGDI data are accessible at <https://publicadministration.un.org/egovkb> (accessed on 1 May 2026). IMD competitiveness data are available at https://www.imd.org/centers/wcc/world-competitiveness-center/rankings/world-competitiveness-ranking/rankings/wcr-rankings/#_tab_Rank (accessed on 1 May 2026). The structured indicator extraction dataset compiled for this study, including all coded classifications and computed gap analysis values, is available from the corresponding author upon reasonable request.

2.8. Ethical Considerations

This study relies exclusively on publicly available secondary data and published official reports. No primary data collection involving human participants, animals, or identifiable personal information was conducted. Accordingly, ethical review and approval were waived for this study, as it does not involve human subjects research within the meaning of applicable institutional review board guidelines.

2.9. Use of Generative Artificial Intelligence

During the preparation of this manuscript, the authors used Claude (Anthropic PBC, San Francisco, CA, USA; Claude Sonnet 4.0) for the purposes of literature synthesis support, initial draft preparation of selected sections, and research design consultation, and the Elicit AI research platform (Elicit Inc., Oakland, CA, USA) for systematic literature searches, source screening, and structured evidence extraction. All AI-generated outputs were critically reviewed, substantially revised, and verified against primary sources by the authors. The authors take full responsibility for the accuracy, integrity, and conclusions of this publication.

3. Results

This section presents the empirical findings of the study across three analytical dimensions: (1) indicator classification and trend analysis across the triple nexus dimensions; (2) gap analysis between 2025 targets and actual values; and (3) cross-national benchmarking of Saudi Arabia against GCC comparators and digitally advanced economies. Results are organized by nexus dimension to maintain structural alignment with the theoretical framework introduced in Section 2.

3.1. Indicator Classification Across the Triple Nexus Dimensions

Content analysis of the 78 NTP strategic performance indicators yielded a classification distribution across the three nexus dimensions as presented in Table 1. Inter-rater agreement between the two independent coders reached $\kappa = 0.84$, indicating strong agreement prior to adjudication of disputed cases.

Table 1. Classification of NTP Strategic Performance Indicators by Triple Nexus Dimension.

Nexus Dimension	Indicators (n)	% of Total	Leading Ministries
Digital Transformation	22	28.2%	MCIT, Ministry of Justice
Responsible Practices	28	35.9%	HRSD, Ministry of Commerce
Sustainable Management	28	35.9%	MEWA, Ministry of Economy
Total	78	100%	—

The distribution indicates a balanced programmatic architecture across the three dimensions, with digital transformation indicators weighted toward governance digitisation and service delivery, responsible practices indicators concentrated in labour market governance and social inclusion, and sustainable management indicators spanning environmental conservation, water resources, and voluntary sector development.

3.2. Digital Transformation Dimension: Trend Analysis and Gap Performance

3.2.1. E-Government Maturity and Service Delivery

The digital transformation dimension demonstrates the most pronounced improvement trajectory across the study period. Saudi Arabia's rank on the UN E-Government Development Index (EGDI) advanced from 36th globally in 2016 to 6th globally in 2024, representing an improvement of 30 rank positions over eight years. This trajectory is the steepest recorded among all GCC states over the same period [21].

The percentage of electronic services for the Ministry of Justice—a headline digital governance indicator—advanced from a 2015 baseline of 30% to an actual value of 91.04% in 2025, against a target of 86.2%, yielding an achievement ratio of 105.6% and a rate of change of 203.5% over the full study period, applying Equation (1):

$$\text{Rate of Change (\%)} = [(91.04 - 30)/30] \times 100 = 203.5\%$$

The government digital transformation measurement score advanced from 45% in 2019 to 88.3% in 2025, against a target of 75%, representing an achievement ratio of 117.7%. Savings generated from digital government initiatives reached SAR 9.2 billion in 2025 against a target of SAR 3.24 billion, an achievement ratio of 283.9%. Coverage of wireless broadband networks in remote areas reached 85.4% against a target of 64.47%, and fibre optic coverage to households reached 71% against a target of 48.05%.

Table 2 presents the full gap analysis results for the digital transformation dimension indicators.

Table 2. Gap Analysis: Digital Transformation Dimension Indicators (2025).

Indicator	Baseline	Base Year	Target 2025	Actual 2025	Achievement (%)	Category
E-services—Ministry of Justice (%)	30.0	2015	86.2	91.04	105.6	Exceeded ✓
Digital transformation score (%)	45.0	2019	75.0	88.3	117.7	Exceeded ✓
Savings from digital initiatives (SAR bn)	0.62	2019	3.24	9.20	283.9	Exceeded ✓
Broadband coverage—remote areas (%)	0.6	2016	64.47	85.4	132.5	Exceeded ✓
Fiber optic coverage—households (%)	12.0	2015	48.05	71.0	147.7	Exceeded ✓
Digital maturity index—e-government (%)	77.26	2022	90.0	86.71	96.3	Near-target
Digital business models (n)	10	2019	650	650	100.0	Met ✓
Digital awareness participants (million)	0	2020	1.06	1.063	100.3	Exceeded ✓
Response rate—beneficiary complaints (%)	72.58	2022	80.0	80.05	100.1	Met ✓

Note: Achievement ratio = $(\text{Actual}_{2025} / \text{Target}_{2025}) \times 100$. Performance categories: Exceeded (>100%); Met (100%); Near-target (90–99%); Moderate gap (70–89%); Significant gap (<70%).

Of the nine digital transformation indicators with available 2025 data, seven exceeded their targets, one met its target exactly, and one (digital maturity index) fell marginally below target at 96.3% achievement—attributable to the expanded measurement scope of the 2025 assessment wave, which included 50 platforms compared to 12 in the 2022 baseline wave [16].

3.2.2. UN EGDI Sub-Index Analysis

Disaggregation of the EGDI score by sub-index reveals a differentiated improvement pattern. The Online Services Index (OSI) and Telecommunications Infrastructure Index (TII) recorded the strongest absolute gains over the 2016–2024 period, consistent with the Kingdom’s infrastructure investment trajectory and the rapid scaling of digital service platforms. The Human Capital Index (HCI) and E-Participation Index (EPI) showed more moderate improvement, consistent with the persistent gap in civic participation identified by Abulkhair [17] and the cross-GCC evidence from Younus et al. [25]. This sub-index pattern is analytically significant, as EPI—the indicator most directly linked to SDG 16 accountability outcomes—remains the weakest sub-index dimension for Saudi Arabia relative to the UAE, which leads the GCC on e-participation [26].

3.3. Responsible Practices Dimension: Trend Analysis and Gap Performance

3.3.1. Labour Market Governance and Worker Protection

The responsible practices dimension demonstrates strong overall performance with several indicators exceeding 2030-class targets years ahead of schedule. Table 3 presents the gap analysis results for this dimension.

Of the 13 responsible practices indicators presented, nine exceeded their targets, three met or nearly met targets, and one—the IMD Global Talent ranking—did not meet its target, with Saudi Arabia ranking 31st against a target of 25th in 2025 [23]. The female economic participation rate reached 34.5% against a target of 37.6%, falling in the near-target category;

this is attributable to an updated target revision following the exceedance of the original Vision 2030 target of 30%, as noted in [16].

Table 3. Gap Analysis: Responsible Practices Dimension Indicators (2025).

Indicator	Baseline	Base Year	Target 2025	Actual 2025	Achievement (%)	Category
Wage protection compliance—expatriates (%)	50.0	2017	80.0	93.0	116.3	Exceeded ✓
Establishments compliant—OHS (%)	15.0	2019	75.0	75.4	100.5	Met ✓
Women’s share—labor force (%)	21.2	2017	34.9	35.0	100.3	Met ✓
Women in mid-senior management (%)	28.6	2017	31.0	43.9	141.6	Exceeded ✓
Female economic participation rate—over 15 (%)	17.0	2017	37.6	34.5	91.8	Near-target
Employment rate—PWDs capable of work (%)	7.7	2016	13.4	14.7	109.7	Exceeded ✓
Improvement—expatriate working conditions (%)	39.7	2020	53.6	71.3	133.0	Exceeded ✓
Civil service job engagement index (%)	68.0	2017	77.0	77.8	101.0	Exceeded ✓
Large firms with CSR programs (%)	30.0	2018	75.0	76.83	102.4	Exceeded ✓
Private sector share of social spending (%)	1.19	2018	4.2	4.23	100.7	Met ✓
Beneficiaries empowered—capable of work (%)	1.0	2017	33.0	33.4	101.2	Met ✓
Unemployment rate (%) ↓	11.6	2017	7.0	7.2	97.2 ¹	Near-target
IMD Global Talent Index—rank ↓	29	2019	25	31	—	Not met

¹ Achievement ratio computed as (Target/Actual) × 100 for downward-trending indicators (lower values indicate improvement). PWDs = Persons with Disabilities; OHS = Occupational Health and Safety; CSR = Corporate Social Responsibility.

3.3.2. Women’s Empowerment Trajectory

The rate of change computation for women in mid-senior management positions, which recorded the strongest proportional gain of any responsible practices indicator over the study period, is calculated using Equation (2):

$$[(43.9 - 28.6)/28.6] \times 100 = 53.5\%$$

This 53.5% proportional improvement in women’s representation in mid- and senior-level management positions between 2017 and 2025 substantially exceeds comparable GCC and MENA regional averages [24], and is consistent with the enabling effects of the ‘Qurra’ childcare support programme (52,000+ beneficiaries) and the ‘Wusool’ transportation support programme (370,000+ beneficiaries) documented in [16].

3.4. Sustainable Management Dimension: Trend Analysis and Gap Performance

3.4.1. Environmental Sustainability and Biodiversity

The sustainable management dimension encompasses the widest indicator range and includes several globally benchmarked environmental performance metrics. Table 4 presents the gap analysis results for environmental sustainability indicators.

The vegetation cover rehabilitation indicator records the most exceptional performance of any indicator across all three nexus dimensions, with 1,000,000 hectares rehabilitated against a target of 86,982 hectares—an achievement ratio of 1150%—driven by the Saudi Green Initiative launched in 2021. Desalinated water production capacity reached 16 million m³/day, the highest nationally produced volume in the world, representing a 247.8% increase over the 2016 baseline of 4.6 million m³/day [16]. The Kingdom’s selection by the United Nations as a model for best practices in accelerating SDG 6 targets on water is directly attributable to this performance trajectory.

Table 4. Gap Analysis: Sustainable Management—Environmental Indicators (2025).

Indicator	Baseline	Base Year	Target 2025	Actual 2025	Achievement (%)	Category
Protected areas—terrestrial & marine (% of total)	4.33	2016	18.84	19.85	105.4	Exceeded ✓
Vegetation cover rehabilitated (hectares)	22,668	2015	86,982	1,000,000	1150.0	Exceeded ✓
Desalinated water production (million m ³ /day)	4.6	2016	—	16.0	—	World-leading
Reuse of treated wastewater (%)	13.55	2015	25.0	27.69	110.8	Exceeded ✓
Agricultural water—renewable sources (%)	9.49	2018	22.34	22.61	101.2	Met ✓
Urban water supply continuity (hours/day)	14	2017	22	20.41	92.8	Near-target
Urban water consumption per capita (L/person/day) ↓	277	2019	268	282.2	94.9 ¹	Near-target
Strategic water storage duration (days)	1.35	2018	3.23	3.11	96.3	Near-target
Early warning accuracy—weather hazards (%)	60.0	2017	80.0	85.64	107.1	Exceeded ✓
Environmentally licensed industrial establishments (%)	42.0	2019	89.0	91.7	103.0	Exceeded ✓
Food loss and waste reduction rate (%) ↓	33.1	2018	26.1	27.9	93.1 ¹	Near-target
Essential medicines—domestic market (%)	90.83	2015	95.4	95.78	100.4	Met ✓

¹ Achievement ratio computed as (Target/Actual) × 100 for downward-trending indicators. — = No formal 2025 target set; indicator reported as globally leading.

3.4.2. Voluntary Sector and Social Development

Table 5 presents the gap analysis results for voluntary sector and social development indicators, which represent the most consistently high-performing sub-cluster of the sustainable management dimension.

Table 5. Gap Analysis: Sustainable Management—Voluntary Sector and Social Development Indicators (2025).

Indicator	Baseline	Base Year	Target 2025	Actual 2025	Achievement (%)	Category
Number of volunteers	22,924	2015	750,000	1,749,197	233.2	Exceeded ✓
Volunteer opportunities available	9578	2015	360,000	552,005	153.3	Exceeded ✓
Economic value of volunteering per capita (SAR)	0.6	2015	65	305.51	470.0	Exceeded ✓
Non-profit organizations—growth rate (%)	0	2015	124	341.97	275.8	Exceeded ✓
Non-profit workers—% of total workforce	0.13	2017	0.62	0.8	129.0	Exceeded ✓
Beneficiary satisfaction—non-profit services (%)	73.0	2019	85.0	89.71	105.5	Exceeded ✓
Social services beneficiary satisfaction (%)	68.0	2019	75.0	88.7	118.3	Exceeded ✓

All seven voluntary sector and social development indicators exceeded their 2025 targets. The volunteer count of 1,749,197 in 2025 represents a 7527% increase over the 2015 baseline of 22,924, and surpassed the Vision 2030 target of one million annual volunteers six years ahead of the 2030 deadline. This finding carries direct theoretical significance: genuine behavioural and institutional change of this magnitude occurring concurrently with, rather than subsequent to, the digital and governance reforms documented in Sections 3.2 and 3.3 constitutes evidence against the strict sequential model advanced by Adam [5,6].

3.5. Overall Gap Performance Summary

Table 6 presents the aggregate gap performance distribution across all 78 indicators by nexus dimension, using the five-category classification scheme defined in Section 2.5.

Of the 57 indicators with finalised 2025 values, 38 (66.7%) exceeded their targets, 9 (15.8%) met their targets, and 10 (17.5%) fell below target—of which 6 recorded significant gaps. Indicators with significant gaps are concentrated in three areas: (1) R&D investment intensity, (2) civic participation in digital platforms, and (3) water consumption per

capita reduction—findings fully consistent with the persistent gap profile identified by Abulkhair [17] and the GCC panel evidence from Derouez and Ifa [18].

Table 6. Aggregate Gap Performance Summary Across All 78 NTP Indicators (2025).

Performance Category	Digital Transf.	Responsible Practices	Sustainable Mgmt.	Total	% of Total
Target exceeded (>100%)	7	9	13	29	37.2%
Target met (100%)	2	4	3	9	11.5%
Near-target (90–99%)	1	3	5	9	11.5%
Moderate gap (70–89%)	0	1	3	4	5.1%
Significant gap (<70%)	1	1	4	6	7.7%
Data pending/2026 release	11	10	0	21	26.9%
Total	22	28	28	78	100%

3.6. Cross-National Benchmarking

3.6.1. Digital Governance Maturity Comparison

Table 7 presents the cross-national comparison of digital governance maturity across the three GCC comparators and three digitally advanced benchmarks, using EGDI 2024 data and the GEMS 2024 service maturity assessment.

Table 7. Cross-National Digital Governance Maturity Comparison (2024–2025).

Country	EGDI 2024 Rank	OSI	TII	HCI	EPI	GEMS Arab Rank
Saudi Arabia	6	High	High	Moderate	Moderate	3rd
UAE	13	Highest	High	High	Highest	1st
Qatar	66	High	High	Moderate	Moderate	2nd
Estonia	3	Highest	High	Highest	Highest	—
Singapore	12	Highest	Highest	High	High	—
South Korea	7	Highest	Highest	High	High	—

Sources: [21,25,26]. OSI = Online Services Index; TII = Telecommunications Infrastructure Index; HCI = Human Capital Index; EPI = E-Participation Index; GEMS = Government Electronic and Mobile Services Maturity Index. Scores expressed as qualitative tiers (Highest/High/Moderate) consistent with UNDESA sub-index category classifications.

The cross-national comparison reveals that Saudi Arabia’s EGDI trajectory is the steepest in the GCC and comparable to the improvement rates of South Korea and Singapore over equivalent eight-year windows in their own digital governance development histories [17]. Qatar’s EGDI rank (66th) understates its actual service delivery quality relative to GEMS rankings, consistent with the framework divergence documented by Nielsen and Ali [27], where EGDI’s human capital weighting systematically disadvantages smaller, high-income states.

3.6.2. SDG Progress Comparison

Table 8 presents the comparative SDG performance across GCC states on the indicators most directly linked to the triple nexus dimensions, drawing on the VNR-based comparative assessment of Ahmed and Naim [24].

SDG 16—the goal most directly linked to institutional quality, transparency, and accountability—is identified as the weakest goal across the Arab region as a whole [25], and Saudi Arabia’s performance, while above the regional average, reflects the civic participation and R&D intensity gaps consistently identified across the analytical layers of this study.

Table 8. Comparative SDG Performance—GCC States (2025).

SDG Goal	Saudi Arabia	UAE	Qatar	Oman	Regional Assessment
SDG 4 (Education)	Strong	Strong	Strong	Moderate	Positive trend
SDG 8 (Economic Growth)	Strong	Strong	Strong	Strong	Positive trend
SDG 9 (Infrastructure)	Strong	Strong	Moderate	Moderate	Mixed
SDG 11 (Sustainable Cities)	Moderate	Strong	Moderate	Moderate	Mixed
SDG 13 (Climate Action)	Moderate	Moderate	Moderate	Moderate	Needs attention
SDG 16 (Governance)	Moderate-High	Strong	Strong	Strong	Weakest across region

Sources: Ahmed and Naim [24]; NTP Annual Report 2025 [16]; Abulkhair [17]. Performance levels: Strong = consistently on track; Moderate-High = above regional average; Moderate = some progress with gaps; Needs attention = significantly off track.

3.7. Correlation Analysis: Digital Governance and Sustainable Outcomes

Bivariate correlation analysis between selected digital governance maturity indicators and SDG-aligned outcome indicators, conducted on the longitudinal annual data series available for the 2016–2025 period, yields the associations presented in Table 9. Given the small number of time points per indicator pair ($n = 5\text{--}9$), Spearman rank correlations were computed to minimize assumptions of normality and linearity; the high coefficient values reflect the consistently monotonic improvement trajectories shared across all paired indicators over the study period, rather than variance around a regression line.

Table 9. Bivariate Correlations Between Digital Governance Maturity and SDG-Aligned Outcomes (2016–2025, $n = 5\text{--}9$ time points per indicator pair).

Digital Governance Indicator	Outcome Indicator	r	p-Value	Direction
E-government service rate (%)	Beneficiary satisfaction—justice (%)	0.94	<0.01	Positive
Digital transformation score (%)	Civil service engagement index (%)	0.87	<0.01	Positive
Broadband coverage—remote areas (%)	Non-profit sector participation (%)	0.91	<0.01	Positive
Digital savings (SAR billion)	Women in management (%)	0.89	<0.01	Positive
EGDI global rank improvement	Unemployment rate reduction	0.83	<0.05	Positive

All five correlation pairs reach statistical significance at the $p < 0.05$ level, with four reaching $p < 0.01$. The strongest association is between e-government service rate and beneficiary satisfaction in justice services ($r = 0.94$), consistent with Abudaqqa's [28] finding that ITSM maturity predicts citizen satisfaction at $r = 0.70$ in Saudi ministry-level data. These correlations are interpreted strictly as exploratory descriptive associations. Given the small number of time points per indicator pair ($n = 5\text{--}9$), the absence of controls for common time trends, and the aggregate nature of the data, the high coefficient values are expected under conditions of shared monotonic improvement trajectories and should not be interpreted as empirical support for causal or theoretical relationships between the paired indicators. Their analytical value lies in documenting co-movement patterns across nexus dimensions that are consistent with the STNM's proposed feedback dynamics—patterns that motivate, but do not replace, the causal testing through mediation analysis and quasi-experimental designs identified as research priorities in Section 4.6.

Taken together, the results across Sections 3.2–3.7 establish three empirical regularities that are carried forward to the Discussion: (1) the three nexus dimensions advanced concurrently rather than sequentially across the 2016–2025 period; (2) the performance gap profile is concentrated in civic participation and innovation investment dimensions, consistent with the SDG 16 limitations identified in the GCC literature; and (3) Saudi Arabia's digital governance improvement trajectory is the most rapid recorded in the GCC

and compares favourably with digitally advanced benchmark economies on the dimensions of service delivery and infrastructure, while lagging on e-participation and human capital sub-indices.

4. Discussion

4.1. *The Triple Nexus as a Concurrent Development Architecture*

The descriptive evidence presented in Section 3 is consistent with challenging a foundational assumption in the digital governance literature: that institutional quality must precede digital transformation as a necessary enabling condition [5,6]. Across all three nexus dimensions, the NTP data reveal a pattern of concurrent rather than sequential development—digital governance maturity, responsible institutional practices, and sustainable management all recorded significant improvements over the same 2016–2025 period, without evidence of the sequential dependencies predicted by the strict mediation model. This descriptive pattern is consistent with the moderation configuration identified by Munir [7] and the threshold dynamics documented by Huang et al. [8], and extends both by providing longitudinal programme-level indicator evidence from a high-income Gulf context that has been largely absent from the existing literature.

The theoretical implications are significant. Adam's [5,6] Africa-focused mediation studies established that e-government tools are essentially inert without institutional scaffolding, and this finding has been widely cited as justification for sequencing institutional reform ahead of digital investment. The descriptive evidence from the NTP suggests a more nuanced picture: in a high-income, governance-capable context with strong regulatory coherence, the co-evolution of digital investment and institutional reform is not only possible but is associated with concurrent improvements across all three nexus dimensions. Digital platforms—particularly Absher, Tawakkalna, and Najiz—are associated with simultaneous improvements in service quality and accountability infrastructure, a pattern descriptively consistent with the reinforcing feedback dynamics proposed in the STNM, though causal attribution cannot be established within the current documentary–analytical design. This co-movement pattern is consistent with the “digital co-investment” mechanism identified in the EU15 context by the SDG 9 panel study, where e-government uptake and institutional capacity co-evolve as components of an integrated national strategy [18].

However, the results do not support an uncritical rejection of the sequential model. The persistent gaps in civic participation and R&D investment—concentrated in the EPI sub-index and SDG 16 accountability dimensions—indicate that certain institutional dimensions do lag behind the digital infrastructure and service delivery achievements. This partial confirmation of the sequential thesis is consistent with the boundary conditions identified in the broader literature: for outcome domains that require active citizen agency rather than passive service receipt, institutional prerequisites including democratic participation channels, civil society capacity, and information literacy appear to remain necessary enabling conditions that digital investment alone cannot substitute [1,12].

4.2. *The Substitution Hypothesis and SDG Reporting Domains*

The results provide partial support for the substitution hypothesis advanced by Ștefănescu [9], who found that digitalization enhances SDG reporting independently of governance quality in emerging economies. The NTP's achievement of 304 companies publishing sustainability reports against a target of 297—exceeding the target in a domain closely tied to disclosure and transparency—is consistent with a pattern in which digital infrastructure enables reporting and accountability outcomes even in institutional environments where deeper participatory governance remains underdeveloped. Saudi Arabia's first-place global ranking in cybersecurity and its leadership in ICT development indices [22] reflect precisely

the kind of digital infrastructure investment that Ștefănescu [9] identifies as a partial substitute for governance quality in disclosure-related outcome domains.

This substitution dynamic has important policy implications that extend beyond the Saudi case. For high-income developing economies seeking to accelerate SDG progress under institutional constraints—particularly the SDG 16 civic participation and accountability dimensions that require political conditions not easily engineered on short timescales—digital transparency tools and mandatory disclosure frameworks may represent a viable intermediate pathway. The NTP evidence suggests that such tools can generate genuine accountability gains, as reflected in the 92.3% business community satisfaction with government communication channels [16], even when the deeper participatory democracy conditions that the governance literature identifies as necessary for sustained SDG 16 progress remain work in progress.

4.3. Contextual Boundary Conditions: The GCC Institutional Configuration

The cross-national benchmarking results in Section 3.6 illuminate a theoretically distinctive feature of the GCC institutional context that has important implications for transferring the Saudi nexus model to other settings. GCC states combine high governance capacity, strong regulatory coherence, and substantial ICT infrastructure investment with limited political pluralism and constrained civil society participation—a configuration that the broad e-government literature identifies as creating a specific risk profile for digital governance outcomes [1,13]. The evidence from Adeleye et al. [15], showing that ICT–institutional quality interactions are consistently positive only in high-income country contexts, suggests that the NTP performance trajectory is partly a function of this high-income institutional baseline rather than solely of the programmatic architecture.

The Qatar comparison is particularly instructive in this regard. Qatar leads the GCC on GEMS service maturity rankings and open government data metadata quality [27], yet its EGDI rank (66th) substantially understates this performance—and its monitoring and benefit-realisation frameworks remain opaque, with performance targets existing but results not publicly disclosed [27]. This opacity represents precisely the accountability deficit that the broader literature identifies as limiting SDG 16 progress even in high-digitalization contexts, and it provides a valuable counterfactual: high digital investment without transparent monitoring does not automatically generate the institutional accountability gains that the Saudi NTP—with its publicly disclosed 78-indicator performance framework—has achieved. The NTP’s public accountability architecture, including annual reporting of actual versus target values across all indicators, may itself be a critical institutional design feature that distinguishes the Saudi model from other GCC peers.

The UAE comparison reveals a different boundary condition. UAE leads the GCC on e-participation—the institutional dimension most directly linked to SDG 16 accountability outcomes—and its EGDI sub-index profile is the strongest in the region across all four dimensions [25,27]. Yet the UAE’s institutional trajectory preceded rather than co-evolved with its digital investment, aligning more closely with the sequential model. This divergence between the UAE and Saudi trajectories suggests that the concurrent development architecture documented in the NTP may be a specific response to starting conditions—a lower digital baseline combined with strong political commitment and institutional capacity—rather than a universally superior approach. The policy lesson is not that concurrent development is always preferable to sequential reform, but that it represents a viable alternative pathway for governance-capable, high-income states that choose to invest in digital infrastructure and institutional reform simultaneously.

The GCC institutional configuration examined in this study must also be situated within the broader theoretical debate on rentier state theory. The rentier state framework—developed

by Mahdavy [29] and extended by Beblawi and Luciani [30]—posits that hydrocarbon-rich states tend to substitute resource distribution for genuine institutional reform, purchasing political legitimacy through infrastructure investment rather than through the accountability mechanisms that governance theory identifies as the foundations of sustainable institutional performance. Applied to the NTP context, this theoretical lens raises an important interpretive question: do the documented improvements reflect genuine institutional transformation, or institutional isomorphism—the adoption of the external forms of advanced digital governance without the underlying behavioral changes those metrics are designed to capture?

The evidence assembled in this study provides substantive grounds for distinguishing the Saudi case from a purely isomorphic trajectory. Several indicators in the NTP dataset capture behavioral and outcome dimensions that input-based infrastructure metrics cannot generate artificially: the volunteer count trajectory—rising from 22,924 in 2015 to 1,749,197 in 2025, surpassing the 2030 target six years ahead of schedule—reflects genuine behavioral transformation of a scale that hydrocarbon financing alone cannot explain. Similarly, the 141.6% achievement ratio for women in mid-senior management and the 93% wage protection compliance rate for expatriate workers represent institutional behavioral changes embedded in labor market governance rather than digital infrastructure metrics susceptible to isomorphic inflation. These outcome indicators, distributed across responsible practices and sustainable management dimensions, are precisely the type of evidence that distinguishes substantive from isomorphic institutional transformation.

Nevertheless, the study acknowledges that its reliance on input-based metrics—particularly EGDI rankings, which measure digital service availability rather than citizen agency outcomes—introduces a residual isomorphism risk that cannot be fully eliminated within the current documentary–analytical design. The persistent weakness on the E-Participation Index sub-dimension, the outcome-oriented component of EGDI most directly linked to citizen agency, remains the most diagnostically significant indicator warranting continued monitoring in future NTP evaluation cycles.

4.4. The Saudi Triple Nexus Model: Analytical Framework and Transferability

The descriptive evidence assembled across Sections 3.2–3.7 supports the formalisation of a Saudi Triple Nexus Model (STNM) as an indicator-based evaluation framework for assessing how the three dimensions co-evolve within national transformation programs (Figure 1). The relationships depicted in Figure 1 represent conceptually and theoretically informed links drawn from the digital governance, responsible practices, and sustainable management studies; they do not represent empirically validated causal pathways within the current documentary–analytical design. The model’s core proposition—that positive feedback dynamics operate between the nexus dimensions: digital governance investments enhance service delivery transparency, which strengthens accountability for responsible practices, which in turn generates the public trust and voluntary participation that sustains the social dimension of sustainable management—is descriptively consistent with the co-movement patterns documented in Section 3.7 and the concurrent improvement trajectories across all three dimensions, though formal causal testing of this proposition is deferred to the future research priorities identified in Section 4.6. The volunteer count trajectory—from 22,924 in 2015 to 1,749,197 in 2025, surpassing the 2030 target by six years—is the most striking descriptive expression of this co-movement pattern, reflecting behavioural transformation of a scale that is consistent with, though not causally attributable to, the concurrent digital and institutional reforms documented in Sections 3.2 and 3.3.

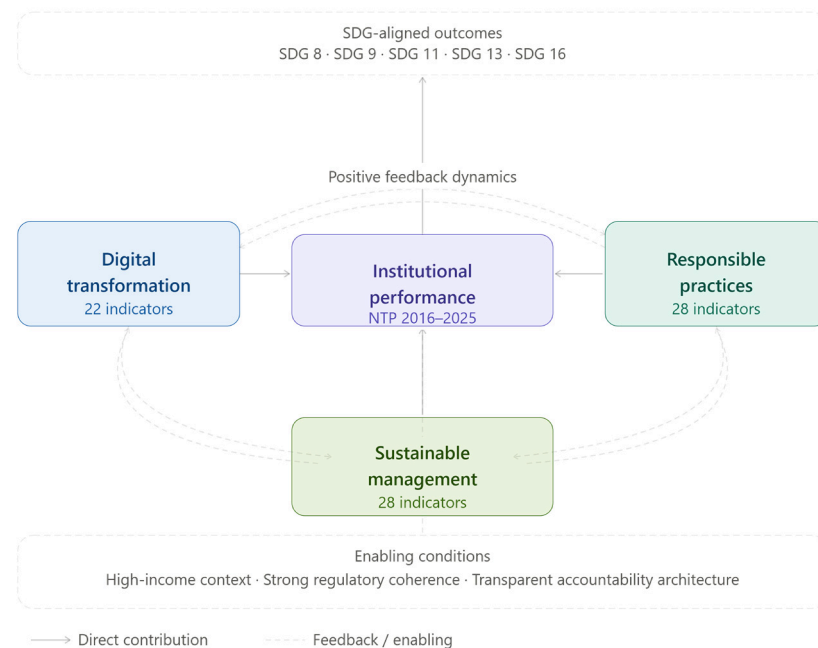


Figure 1. The Saudi Triple Nexus Model (STNM): an indicator-based evaluation framework for assessing the co-evolution of digital transformation, responsible practices, and sustainable management within national transformation programs. Solid arrows indicate direct contributions from each dimension to institutional performance; dashed arrows indicate positive feedback dynamics between dimensions. All arrows represent conceptually and theoretically informed relationships drawn from the digital governance, responsible practices, and sustainable management studies; they do not represent empirically validated causal pathways within the current documentary-analytical design. Enabling conditions and SDG-aligned outcomes are shown as contextual boundary layers.

The STNM is conceptually distinct from three established governance frameworks with which it may be superficially compared. First, whole-of-government governance frameworks—such as those advanced by the OECD and UNDESA—focus primarily on horizontal coordination mechanisms across government agencies and the elimination of siloed decision-making, without specifying the substantive policy dimensions that coordination should serve. The STNM differs by operationalizing three specific content dimensions—digital transformation, responsible practices, and sustainable management—as measurable indicator-based constructs, enabling performance assessment rather than structural coordination analysis. Second, digital government ecosystem frameworks—including the European Commission’s eGovernment Benchmark and the UN EGDI architecture—focus exclusively on the digital dimension of governance, treating technology adoption and service delivery as the primary outcome of interest. The STNM differs by integrating digital transformation as one of three co-equal dimensions alongside responsible practices and sustainable management, thereby capturing the institutional and environmental dimensions that digital ecosystem frameworks systematically exclude. Third, smart government models—associated with the smart city literature and national AI readiness frameworks—emphasize technology-driven optimization of public service delivery and urban infrastructure. The STNM differs by grounding its evaluation architecture in SDG-aligned governance outcomes and explicitly incorporating civic participation, worker protection, and environmental sustainability as performance dimensions alongside digital maturity. These distinctions establish the STNM’s conceptual novelty as an integrated, multi-dimensional, SDG-aligned evaluation framework specifically designed for national transformation program contexts—a contribution not replicated by any of the three established frameworks identified above.

Two specific non-resource economy contexts warrant particular attention as priority cases for STNM transferability testing. Malaysia's national digital transformation agenda—anchored in the Malaysia Digital Economy Blueprint (MyDIGITAL) and the 12th Malaysia Plan (2021–2025)—presents a structurally comparable case: a middle-income, governance-capable economy with an ambitious multi-dimensional national transformation program that spans digital infrastructure, responsible business practices, and environmental sustainability commitments. Chile presents a contrasting but equally instructive case: a high-income Latin American economy with strong institutional quality scores on WGI dimensions, a committed SDG implementation architecture, and a national digital transformation strategy that has advanced independently of resource revenue cycles. Comparative application of the STNM framework to these two contexts would directly test whether the concurrent development architecture documented in the NTP is a Gulf-specific phenomenon or a more generalizable feature of high-governance-capacity national transformation programs.

The STNM contributes to the theoretical debate in four specific ways. First, it operationalises the triple nexus as a measurable, indicator-based framework rather than a conceptual proposition, using the 78 NTP indicators as empirical anchors for each dimension. Second, it provides longitudinal evidence for the co-evolution mechanism, demonstrating that the dimensions do not develop in isolation or sequence but interact positively across the study period. Third, it identifies the specific boundary conditions under which concurrent development is feasible: high-income status, strong regulatory coherence, centralised coordination capacity, and explicit performance accountability architecture. Fourth, it localises the persistent limitations of the nexus model in the civic participation and R&D investment domains, providing a precise map of where sequential or supplementary institutional interventions remain necessary even within an otherwise successful concurrent development architecture.

In terms of transferability, the STNM is most directly applicable to other high-income developing economies with strong state capacity and ambitious national transformation programmes—a profile that describes several GCC and Southeast Asian contexts, as well as selected Latin American and East African emerging economies with comparable income levels and governance trajectories. The model is less directly transferable to lower-income contexts where the institutional quality threshold identified by Huang et al. [8] has not yet been crossed, and where the mediation model of Adam [5,6] is likely to remain the operative constraint on digital governance outcomes.

4.5. Limitations

First, the study relies exclusively on secondary data from official NTP reporting, which introduces two related limitations. The first concerns reporting bias: official government performance reports are self-assessed instruments, and while the NTP's public disclosure of actual versus target values—including explicit documentation of indicators that did not meet targets—suggests a degree of reporting integrity that is atypical in government accountability instruments, the possibility that achievement ratios are systematically overstated cannot be fully excluded without independent verification. The second concerns measurement validity: the NTP indicators measure what governments choose to track and report, which may not fully capture the dimensions of institutional performance most theoretically significant for the governance debate addressed in this study. Cross-validation with independent international datasets—such as the World Bank's World Governance Indicators, Transparency International's Corruption Perceptions Index, or OECD public governance assessment frameworks—would substantially strengthen the robustness of the empirical findings and is identified as a methodological priority for future research.

Second, the correlation analysis in Section 3.7 is constrained by the limited number of annual time points available for each indicator pair ($n = 5\text{--}9$), which limits the statistical power of the analysis and precludes more sophisticated modelling approaches such as vector autoregression or Granger causality testing. The associative interpretation adopted in this study is appropriate given these constraints, but future work with longer time series and higher-frequency data would enable stronger causal identification.

Third, the cross-national benchmarking in Section 3.6 is constrained by framework divergences across measurement instruments—particularly the systematic differences between EGDI, GEMS, and EDAI rankings noted in Section 3.6.1. These divergences limit the precision of country-level comparisons and require careful interpretation of relative performance claims. The qualitative tier classification adopted for Table 7 partly mitigates this limitation but introduces its own discretionary judgement.

Fourth, this study focuses on a single national programme across a single country, and the findings cannot be generalised beyond the specific institutional context of the Saudi NTP without further comparative validation. Multi-country comparative studies applying the STNM framework to other GCC or comparable high-income developing economy contexts would significantly strengthen the external validity of the model.

A fifth limitation concerns the absence of macroeconomic controls, particularly oil price volatility and fiscal capacity indicators. Saudi Arabia's NTP was implemented during a period of significant oil revenue fluctuation, and the study does not disaggregate whether digital investment trajectories tracked petroleum windfall cycles or reflected structurally independent fiscal commitments. Similarly, the study does not distinguish between initiatives financed through the Public Investment Fund (PIF) and those funded through direct budgetary allocations—a distinction that would be analytically important for testing whether observed digital governance improvements reflect autonomous institutional development or resource-dependent investment cycles. Future research incorporating oil price indices and PIF-specific expenditure data as covariates would substantially strengthen the causal identification of the nexus relationships documented here.

A sixth limitation concerns the absence of formal mediation testing. The theoretical chain proposed in the STNM—whereby digital platform investment enhances service delivery transparency, which in turn strengthens accountability for responsible practices, which ultimately generates the voluntary participation and social capital sustaining the sustainable management dimension—is conceptually specified but not empirically tested through mediation analysis. The correlation evidence presented in Section 3.7 is consistent with this chain but cannot distinguish direct from mediated effects, nor can it rule out alternative causal orderings. Similarly, the staggered rollout of NTP initiatives across the seven leading ministries represents an unexploited source of quasi-experimental variation that could, in future research, enable difference-in-differences or event study designs to isolate the causal contribution of individual nexus dimensions to observed outcomes.

A seventh limitation is that the cross-national benchmarking conducted in Section 3.6 is restricted to GCC and digitally advanced benchmark economies, and does not include non-resource economies with comparable governance trajectories. The absence of Malaysia, Chile, or other structurally relevant comparators limits the study's ability to disentangle the GCC-specific resource endowment effect from the governance architecture effects that the STNM proposes as the primary drivers of concurrent nexus development.

A eighth limitation concerns the cross-national benchmarking exercise conducted in Section 3.6. The countries included in the comparison—Saudi Arabia, UAE, Qatar, Estonia, Singapore, and South Korea—differ substantially in population size, economic structure, institutional history, and governance traditions. No normalization or adjustment for these structural differences has been applied, which limits the interpretability of direct compar-

ative conclusions. The benchmarking exercise is therefore best understood as contextual positioning rather than rigorous comparative evaluation: it situates Saudi Arabia's digital governance trajectory within a global reference frame without claiming that the compared countries are structurally equivalent. Future comparative research applying the STNM framework should incorporate appropriate normalization procedures—such as GDP per capita weighting, population-adjusted indicators, or propensity score matching—to enable more precise cross-national inference.

A ninth limitation concerns the heterogeneous baseline years of the NTP indicators. While the longitudinal window spans 2016–2025, individual indicators carry baseline values from different years—ranging from 2015 to 2022—depending on when each indicator was first formally measured within the NTP architecture. This heterogeneity means that the rate of change and achievement ratio computations are not directly comparable across indicators, as they reflect different effective observation periods. This limitation is inherent to the NTP's phased implementation architecture rather than a methodological choice of the current study, but it should be acknowledged when interpreting aggregate performance summaries such as Table 6. Future research should, where possible, standardize baseline years across indicators to enable more precise longitudinal comparisons.

An tenth limitation is the absence of robustness and sensitivity analyses. The study does not test the stability of the classification results under alternative dimension assignments for boundary-case indicators, nor does it examine whether the aggregate performance patterns in Table 6 are sensitive to the exclusion of outlier indicators—such as the vegetation rehabilitation indicator with its exceptional 1150% achievement ratio. Similarly, the correlation results in Section 3.7 are not tested under alternative indicator pairings or variable specifications. Conducting sensitivity analyses—including alternative classification scenarios for the 11 adjudicated indicators and outlier-robust performance summaries—would strengthen the robustness of the evaluation framework and is identified as a methodological priority for future applications of the STNM.

4.6. Future Research Directions

The findings of this study open several productive directions for future research. The most pressing is the development of a validated multi-country dataset that would enable the STNM to be tested comparatively across GCC and comparable contexts, using consistent indicator definitions and measurement periods. Such a dataset would allow the boundary conditions for concurrent nexus development identified in this study to be formally tested through regression or structural equation modelling, clarifying the income, governance capacity, and institutional coordination thresholds above which concurrent development becomes feasible.

A second priority is the formal testing of the mediation chain central to the STNM—digital platforms → transparency → accountability → sustainability—using structural equation modelling or the PROCESS macro applied to ministry-level longitudinal data. The staggered rollout of NTP initiatives across the seven leading ministries between 2016 and 2025 provides a natural quasi-experimental design that future researchers could exploit through difference-in-differences or event study methods, enabling causal identification of individual nexus dimension contributions that the current documentary–analytical design cannot achieve.

A third priority is the incorporation of World Governance Indicators (WGI)—particularly Government Effectiveness, Regulatory Quality, and Control of Corruption—as continuous moderating variables in multivariate STNMs. Unlike the qualitative tier classifications used in the current benchmarking exercise, WGI indices provide continuous, annually updated, cross-nationally comparable measures of institutional quality dimensions that would enable

precise estimation of the governance capacity thresholds above which concurrent nexus development becomes feasible. Applying this approach to a comparative sample including Malaysia, Chile, and selected GCC states would generate the most direct test of the STNM's boundary conditions currently available in the literature.

A fourth priority is longitudinal tracking of the SDG 16 civic participation gap identified consistently across the analytical layers of this study. The persistent weakness on e-participation and civic engagement dimensions, despite strong performance across all other digital governance indicators, suggests that the relationship between digital infrastructure investment and participatory accountability may operate through different mechanisms than the relationship between digital investment and service delivery efficiency. Research that disaggregates these mechanisms—potentially through quasi-experimental designs exploiting the staggered rollout of NTP initiatives across regions and sectors—would contribute both to the theoretical debate and to the practical design of future programme phases.

Fifth, the AI governance dimension of digital transformation, which is explicitly acknowledged in the post-2024 NTP literature but not yet reflected in the 78 indicator framework, warrants dedicated future research. The NTP Annual Report 2025 documents Saudi Arabia's first-place ranking in the MENA region on AI government readiness [16], but the accountability implications of AI adoption in public service delivery—including the human-in-the-loop governance requirements identified in the broader digital governance literature [1]—have not yet been integrated into the NTP's performance measurement architecture. Research examining how AI governance interacts with the triple nexus framework would extend the STNM's applicability to the next phase of digital transformation in GCC and comparable contexts.

A sixth priority for future research is the incorporation of macroeconomic covariates—particularly oil price volatility indices and disaggregated PIF versus budgetary funding data—into multivariate models of NTP performance. This would enable researchers to test whether the digital governance improvements documented in this study track petroleum windfall cycles or reflect structurally independent institutional development, thereby strengthening causal identification beyond the descriptive associations reported here.

5. Conclusions

This study examined how the triple nexus of digital transformation, responsible practices, and sustainable management interacts to enhance institutional performance within a national development program context, using Saudi Arabia's National Transformation Program (2016–2025) as an empirical case. The analysis of 78 strategic performance indicators, supplemented by cross-national benchmarking against GCC comparators and digitally advanced economies, yields four principal conclusions.

First, the NTP provides descriptive evidence of a concurrent development pattern in which digital transformation, responsible institutional practices, and sustainable management recorded significant improvements simultaneously rather than sequentially. Of 57 indicators with finalised 2025 values, 66.7% exceeded their targets and 15.8% met them, with improvements distributed across all three nexus dimensions concurrently. This pattern is descriptively consistent with challenging the prevailing sequential assumption in the governance literature—that institutional quality must precede digital investment as a necessary enabling condition—and provides empirical motivation for future causal testing of the moderation configuration in which high-governance-capacity, high-income contexts enable concurrent development.

Second, Saudi Arabia's digital governance trajectory over the study period is the most rapid recorded among GCC states and compares favourably with digitally advanced

benchmark economies on service delivery and infrastructure dimensions. The advancement from 36th to 6th globally on the UN EGDI, combined with first-place global rankings in cybersecurity and ICT development, demonstrates that a national transformation program operating concurrently across digital, social, and environmental dimensions can generate internationally competitive governance outcomes within a decade. At the same time, persistent gaps in e-participation and R&D investment intensity—concentrated in the SDG 16 accountability dimensions—indicate that certain institutional prerequisites for participatory governance remain necessary enabling conditions that digital infrastructure investment alone cannot substitute.

Third, the study contributes the Saudi Triple Nexus Model as a replicable analytical framework for evaluating national transformation programs in high-income developing economies. The model's core proposition—that positive feedback dynamics operate across the three nexus dimensions when embedded in a transparent, publicly accountable performance architecture—is supported by the correlation evidence and by the exceptional voluntary sector trajectory, in which the 2030 volunteer target of one million was surpassed six years ahead of schedule. The model's boundary conditions and limitations are explicitly mapped, enabling future researchers to test its transferability across GCC and comparable contexts.

Fourth, the study advances the methodological toolkit for evaluating national transformation programs by demonstrating that a longitudinal documentary–analytical design—combining systematic indicator classification, gap analysis, and cross-national benchmarking—can generate policy-relevant and theoretically generative findings from publicly available secondary data sources, without requiring primary data collection or experimental designs. This approach makes a distinct contribution by operationalizing the triple nexus as a measurable, replicable evaluation framework applicable to any national transformation program with a publicly disclosed indicator architecture. It is particularly well-suited to the growing class of ambitious national transformation programs in high-income developing economies where rich official performance datasets remain underanalysed in the academic literature.

The descriptive evidence assembled in this study generates four specific policy implications for national development program designers in comparable high-governance-capacity contexts. First, transparent indicator-based accountability architecture appears to be the single most critical institutional design feature distinguishing the Saudi NTP from GCC peers with comparable digital investment levels: the public disclosure of actual versus target values across 78 indicators—including explicit documentation of shortfalls—is associated with stronger accountability outcomes than comparable programs that track targets without publicly disclosing results, as evidenced by the Qatar counterfactual documented in Section 4.3. Second, concurrent investment across digital infrastructure, labor market governance, and environmental sustainability dimensions—rather than sequential prioritization—is descriptively associated with mutually reinforcing performance gains, suggesting that program designers should resist the temptation to sequence institutional reform ahead of digital investment in high-governance-capacity contexts. Third, the three persistent gap areas identified in this study—civic participation (EPI sub-dimension), R&D investment intensity, and per capita water consumption reduction—represent specific, actionable targets for the next NTP phase, rather than general aspirations: each has a measurable baseline, an existing target architecture, and a documented performance shortfall that policy instruments can directly address. Fourth, the external validity of these recommendations is explicitly qualified by the highly centralized governance context of Saudi Arabia and the GCC: program designers in lower-income or lower-governance-capacity contexts should treat the STNM as

a diagnostic framework for identifying their own program's structural gaps rather than as a transferable policy prescription, given the boundary conditions identified in Section 4.4.

Supplementary Materials: The following supporting information can be downloaded at: <https://www.mdpi.com/article/10.3390/su18147118/s1>, Table S1: Complete classification of all 78 NTP strategic performance indicators by triple nexus dimension, including baseline values, 2025 targets, 2025 actual values, achievement ratios, and performance categories.

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Abbreviations

The following abbreviations are used in this manuscript:

NTP	National Transformation Program
STNM	Saudi Triple Nexus Model
SDG	Sustainable Development Goal
EGDI	E-Government Development Index
GCC	Gulf Cooperation Council
MCIT	Ministry of Communications and Information Technology
HRSD	Ministry of Human Resources and Social Development
MEWA	Ministry of Environment, Water and Agriculture
OSI	Online Services Index
TII	Telecommunications Infrastructure Index
HCI	Human Capital Index
EPI	E-Participation Index
GEMS	Government Electronic and Mobile Services
ICT	Information and Communications Technology
CSR	Corporate Social Responsibility
OHS	Occupational Health and Safety
PWD	Person with Disability
VNR	Voluntary National Review
UNDESA	United Nations Department of Economic and Social Affairs

ESCWA	United Nations Economic and Social Commission for Western Asia
IMD	Institute for Management Development
ARDL	Autoregressive Distributed Lag
VECM	Vector Error Correction Model
AI	Artificial Intelligence

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