

# From Theory to Practice: Refining the Digital Innovation Performance Model and Developing a Policy Implementation Framework for UAE Public Sector Organizations

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## Abstract

**Background:** An empirical study (Alhammadi, manuscript under review-b) conducted a companion test of a multi-theoretical model connecting data ethics, digital transformation, technology adoption, digital governance, and transformational leadership with digital innovation performance in 26 UAE public organisations (N = 404). The findings showed the existence of different pathway efficacies: not all hypothesized relationships were highly supported, and it was necessary to refine the model and translate the findings into practice.

**Objective:** This paper extends the empirical findings by (a) refining the original conceptual model based on the pattern of supported and unsupported hypotheses, (b) conducting a comparative pathway analysis across organizational characteristics, and (c) developing a phased policy implementation framework for UAE public sector leaders.

**Methods:** Building on the PLS-SEM results reported in the companion study, this paper employs a model refinement methodology that reclassifies variable roles based on empirical evidence, introduces pathway typology analysis, and develops an implementation model grounded in the Diffusion of Innovation and Institutional theory perspectives.

**Results:** The refined model reconceptualizes the original nine-hypothesis framework into a three-tier architecture: a primary structural tier (digital transformation → governance → innovation), a leadership-activated tier (ethics and adaptation pathways contingent on transformational leadership), and a contextual tier (organizational size and sector type as boundary conditions). A four-phase implementation framework Assess, Architect, Activate, and Accelerate is proposed for policy translation.

**Conclusions:** The refined model provides a more parsimonious and actionable representation of digital innovation mechanisms in public sectors. The implementation framework offers government leaders a structured approach to deploying governance, ethics, technology, and leadership interventions for digital innovation.

**Keywords:** digital innovation performance; model refinement; policy implementation; digital governance; transformational leadership; UAE public sector; smart government; Industry 4.0

## 1. Introduction

The recent high rate of Industry 4.0 adoption in the United Arab Emirates has both presented opportunities

and challenges to the performance of the public sector organizations aiming at improving their digital innovation performance [1,2]. An associated conceptual paper (Alhammadi, manuscript under review-a) has created a multi-theoretical framework that hypothesizes 9 propositions between data ethics and digital transformation, technology adaptation and digital governance, and transformational leadership and digital innovation performance. An empirical study that follows the hypothesis testing (Alhammadi, manuscript under review-b) hypothesized these hypotheses in the context of 404 employees working in 26 UAE-based organizations in the public sector through PLS-SEM and found these hypotheses to be statistically significant, with 71.2% of the variance in the outcome of digital innovation performance being explained. The results of the empirical studies demonstrated the intricate and differentiated pattern: certain pathways received strong evidence (digital transformation as the key direct driver; digital governance as a strong mediator; transformational leadership as a selective moderator), whereas some pathways were not supported (direct effects of data ethics and technology adaptation; moderation of the transformation-innovation connection by leadership). Such a trend in favoritism poses significant theoretical and practical questions. What would be the theoretical method of refining the initial model to incorporate empirical evidence? Which are dominant, which conditional, which must be reclassified? In practice, how do the leaders of the public sector have priorities in their investments in technology, governance, ethics, and leadership development to achieve the maximum results of innovation?

The paper will answer these questions by considering three overlapping objectives. First, it optimizes the initial conceptual model through reclassification of the positions of variables and establishing a tiered pathway model according to the empirical findings pattern. Second, it performs comparative analysis of the pathway effectiveness against the organizational characteristics (size and type of sector) applying the initial sample data. Third, it formulates a stage plan for policy delivery a phased policy implementation model, the 4 A Model (Assess, Architect, Activate, Accelerate) that converts the refined model into practical advice to be used by the UAE government and policymakers.

The paper has three contributions to companion studies. First, it shifts the hypothesis testing to model development by integrating justified and disproven results into a narrowed empirically based structure. Second, it proposes a typology of pathways including structural, leadership-activated, and contextual pathways that can be offered to gain a more detailed perspective on the functioning of various mechanisms in the digital innovation of the public sector. Third, it will address the gap between theory and practice by converting the perfected model into policy implementation framework based on UAE strategic priorities such as the UAE Vision 2021, the National Innovation Strategy and the UAE AI Strategy [3,4,5].

## 2. Synthesis of Empirical Findings from the Companion Study

Before proceeding to model refinement, this section summarizes the key findings from the companion empirical study (Alhammadi, manuscript under review-b) to establish the empirical basis for the present analysis. The full methodological details, measurement properties, and statistical results are reported in that paper; this section presents only the findings relevant to model refinement.

**Table 1 Summary of Empirical Results from the Companion Study**

H	Pathway	Effect	p-value	Interpretation	Status
H1	DE → DIP	Direct	0.372	Non-significant	Rejected
H2	DE → DG → DIP	Mediation	0.029	Sig. but VAF=16%	Weak

<b>H3</b>	TA → DIP	Direct	0.583	Non-significant	Rejected
<b>H4</b>	TA → DG → DIP	Mediation	0.588	Non-significant	Rejected
<b>H5</b>	DT → DIP	Direct	<0.001	Strongly significant	Supported
<b>H6</b>	DT → DG → DIP	Mediation	0.002	Sig., VAF=22%	Supported
<b>H7</b>	DE × TFL → DIP	Moderation	0.047	Significant	Supported
<b>H8</b>	TA × TFL → DIP	Moderation	0.003	Significant	Supported
<b>H9</b>	DT × TFL → DIP	Moderation	0.572	Non-significant	Rejected

Note. DE = Data Ethics; DT = Digital Transformation; TA = Technology Adaptation; DG = Digital Governance; TFL = Transformational Leadership; DIP = Digital Innovation Performance; VAF = Variance Accounted For.

These results give rise to three major patterns. To begin with, the only independent variable that has a substantial direct impact on the innovation performance is digital transformation, and it additionally plays through digital governance as an intermediate one. Second, data ethics and technology adaptation have no major direct impact but are consequential after being moderated by the transformational leadership. Third, transformational leadership has a selective moderating role, in which direct structural effects are not present (ethics, adaptation), in contrast to enhancing an existing strong direct pathway (transformation). The following patterns are the empirical foundations of the model refinement described in the next section.

### 3. Refining the Conceptual Model: A Three-Tier Pathway Architecture

The initial framework hypothesized a flat system whereby all the three independent variables were placed as equal direct predictors all mediated through governance and moderated through leadership. The empirical findings indicate that the data does not support the specification of equal weight. Rather, the data demonstrates the hierarchical nature of where various variables act in a qualitatively different manner. This part suggests a sophisticated model that is divided into 3 levels.

#### 3.1 Tier 1: The Structural Pathway (Technology-Governance-Innovation)

The main structural pathway is the one between digital transformation and digital governance to digital innovation performance. This is the foundation of the model, and it has three characteristics. To begin with, the direct influence of digital transformation on the innovation performance is the greatest ( $t = 3.705$ ,  $p < 0.001$ ) which proves the idea that it is the main driver. Second, digital transformation exerts the most significant influence on the aspect of digital governance ( $\beta = 0.738$ ,  $t = 23.492$ ,  $p < 0.001$ ) which proves that the presence of technology investment is the key driver of governance development in governmental spheres. Third, digital governance is a significant predictor of the performance of innovation ( $\beta = 0.182$ ,  $p = 0.002$ ), which forms a partial mediation path (VAF = 22%) by which transformation mediates the performance of innovation.

In theory, such structural pathway has been explained by DOI theory [6]: the onset of the digital technologies in the public sector organizations introduces governance needs (data ownership, retention policies, access monitoring) which once established, contribute to the increase of the level of innovation further. The pathway functions mostly without leadership style (H9 not supported), indicating that the structural forces of digital transformation cloud computing, big data analytics, IoT platform, and digital

business model are strong enough to spur innovation across governance mechanisms without the need to amplify leadership function.

### **3.2 Tier 2: Leadership-Activated Pathways (Ethics and Adaptation)**

The second tier entails the dormant pathways that are activated once the relationship is moderated by the leadership. Data ethics and technology adaptation did not show any significant direct performances on innovation performance (H1, H3 rejected). Nonetheless, the transformational leadership played a significant moderating role in the relationship between ethics and innovation (H7:  $p = 0.047$ ) and adaptation and innovation (H8:  $p = 0.003$ ).

This trend is indicative of a completely different causal process as opposed to the structural pathway. Where Tier 1 is enforced by institutional systems and governance, Tier 2 is implemented by human actors and leadership. Transformational leaders stimulate these hidden paths in four ways that are based on the framework of Bass and Riggio (2006) [7]. Leaders can influence data ethics by employing idealized influence which sets the example of ethical behavior in a way that turns it into an obligation rather than an innovation driver. They express a vision through inspirational motivation, to relate the technology adaptation to innovation objectives of an organization. They motivate employees to make use of modified technologies creatively through intellectual stimulation. According to personal consideration, they manage to meet the distinctive obstacles that personal workers have on their way to innovative action through the prism of ethical awareness and technological ability.

Its practical implication is that investment in data ethics programs and technology adjustment programs will not be effective in generating returns of innovation unless they are combined with transformational leadership development. This fact solves what seems to be the paradox in the matter of pursuing ethics and technology without quantifiable direct impact on innovation: the investment is not wasted, but it is stored until the time of leadership.

### **3.3 Tier 3: Contextual Boundary Conditions**

The third level deals with the organizational features that act as a boundary condition to the model. The companion study gathered data in organizations of various sizes (small: 10–100 employees,  $n = 100$ ), types of sectors (utilities:  $n = 75$ , municipalities:  $n = 35$ , health:  $n = 120$ , education:  $n = 174$ ). Although the companion study was an experiment of the model on the aggregate level, the organizational heterogeneity of the sample occupies that the effectiveness of the pathways in test subjects might differ significantly between these subgroups.

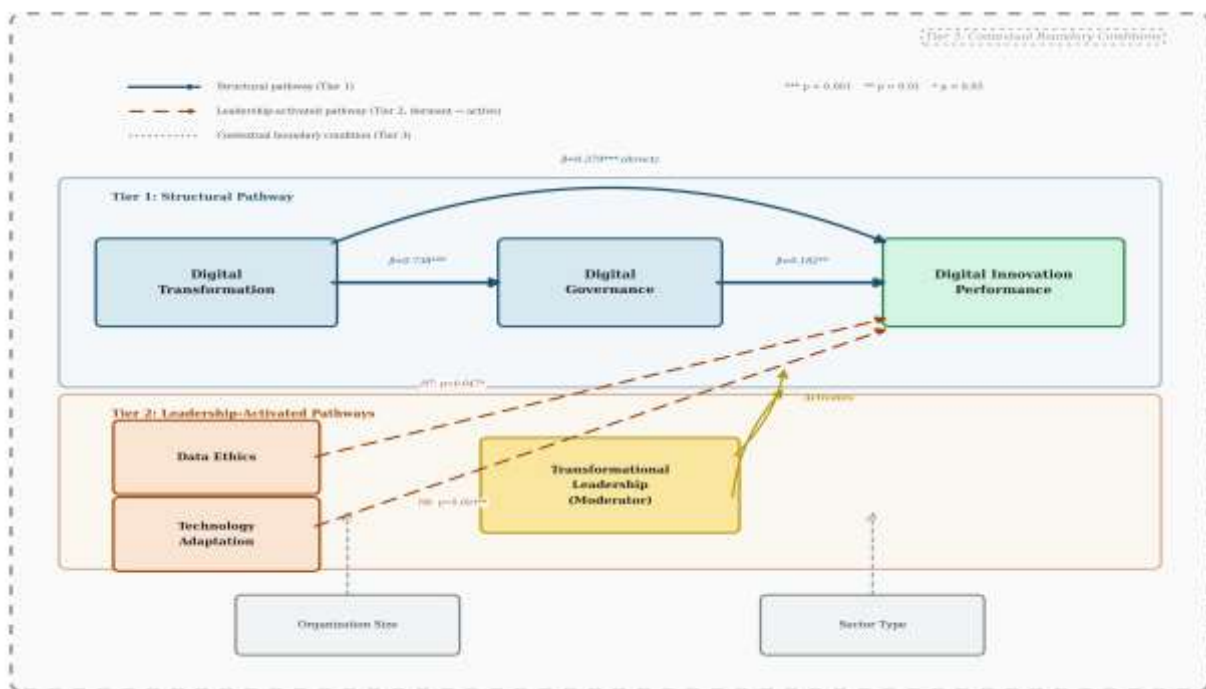
The theoretical background of such variation is found in the institutional theory [8]. Corresponding institutional environment is produced by different organizational sizes: small organisations can be more dependent on the leadership-activated pathways because of the lack of formal governance structures, whereas large organisations can be more dependent on the structural pathway because of the formal governance infrastructures. Equally, regulatory environment, technological maturity, and innovation expectations on various sectors vary which may moderate the effectiveness of pathways.

**Table 2 Proposed Contextual Variations in Pathway Effectiveness Across Organizational Characteristics**

Context Variable	Structural Pathway (Tier 1)	Leadership-Activated (Tier 2)	Dominant Mechanism
Small organizations	Weaker (limited governance infrastructure)	Stronger (reliance on leader)	Leadership-driven
Medium organizations	Moderate (developing governance)	Moderate (shared influence)	Balanced
Large organizations	Stronger (mature governance)	Weaker (systemic processes)	Structure-driven
Utilities sector	Stronger (tech-intensive)	Moderate	Technology-governance
Health sector	Moderate (regulatory constraints)	Stronger (ethical sensitivity)	Ethics-leadership
Education sector	Moderate	Stronger (human-centric)	Leadership-adaptation
Municipalities	Moderate	Moderate	Balanced

Note. Proposed variations are derived from institutional theory reasoning and the organizational characteristics observed in the sample. Empirical validation requires subgroup analysis with larger samples.

### 3.4 The Refined Three-Tier Model: Diagram



[FIGURE 1 The Refined Three-Tier Digital Innovation Performance Model. Tier 1 (Structural Pathway): Digital Transformation → Digital Governance → Digital Innovation Performance (solid arrows, primary

mechanism). Tier 2 (Leadership-Activated Pathways): Data Ethics → DIP and Technology Adaptation → DIP, both activated by Transformational Leadership moderator (dashed arrows becoming solid when TFL is present). Tier 3 (Contextual Boundary Conditions): Organization Size and Sector Type as moderators of tier effectiveness (dotted boundary box). The diagram shows DT as the dominant entry point feeding both direct and governance-mediated paths, while DE and TA feed conditional paths that require TFL activation.]

#### 4. Comparative Pathway Analysis: Structural Versus Leadership-Activated Mechanisms

This section presents a systematic comparison of the two primary pathway types identified in the refined model, examining their theoretical mechanisms, empirical indicators, conditions of activation, and practical implications.

**Table 3**  
**Comparative Analysis of Structural and Leadership-Activated Innovation Pathways**

Dimension	Tier 1: Structural Pathway	Tier 2: Leadership-Activated Pathway
<b>Primary driver</b>	Digital Transformation ( $\beta = 3.705$ , $p < 0.001$ )	Data Ethics and Technology Adaptation (direct: n.s.)
<b>Mediating mechanism</b>	Digital Governance (VAF = 22%)	None confirmed (VAF = 16% for DE)
<b>Moderating condition</b>	Not required (H9: $p = 0.572$ )	Transformational Leadership required (H7: $p = 0.047$ ; H8: $p = 0.003$ )
<b>Theoretical foundation</b>	DOI Theory + Institutional Theory	Transformational Leadership Theory + Ethical Theory
<b>Activation mechanism</b>	Technology investment → governance structures → innovation	Leader behavior → employee motivation → innovation
<b>Time horizon</b>	Medium to long term (infrastructure-dependent)	Short to medium term (leadership-dependent)
<b>Resource requirement</b>	High capital investment in digital infrastructure	Investment in leadership development and training
<b>Risk profile</b>	Lower risk (structural, systemic)	Higher risk (leader-dependent, variable)
<b>Scalability</b>	High (institutionalized across organization)	Moderate (dependent on leadership density)
<b>Sector sensitivity</b>	Higher in tech-intensive sectors (utilities)	Higher in human-centric sectors (health, education)

The comparison shows that the two types of pathways are a complement of each other as opposed to com-

petitive mechanisms. It is the structural pathway that gives the infrastructure that underlies digital innovation: without digital transformation and governance, there are no organizational circumstances of innovation. The leadership-activated route offers the human and motivational environment that opens the further potential of innovation by the ethical practices and technology adaptation capacity. The best digital innovation strategy, then, involves investing in both channels simultaneously, with the latter channel being the structural channel and the former channel being the leadership channel.

This two-way structure is also one way out of a real-life conundrum many organizations in the public sector frequently encounter; why do investments in technology not always lead to innovation returns? The answer to this model is that technology investment (Tier 1) is not only required but should be supplemented by governance structures that guide its potential and leadership behaviors that engage other pathways that involve ethics and adaptation (Tier 2). Those companies that invest in technology alone but do not build governance and establish leadership will accomplish a minor portion of their innovation potential.

There are other significant points of difference between the two types of pathways about their temporal dynamics. The structural path involves long-term and long-term investment: The creation of digital infrastructure, the creation of systems of governance, the incorporation of data management practices requires organizational investment in years and not months. The leadership-activated pathway, in its turn, may provide quite prompt results because it is supported by behavioral mechanisms (leader modeling, intellectual stimulation, inspirational communication) that can transform the motivation and innovative engagement of the employees within a shorter duration of time. This temporal asymmetry has major sequencing implications of the implementation framework: the structural pathway needs to be activated first (due to its longer gestation time), and the leadership pathway activated at the same time or shortly thereafter to maximize the returns on early innovation as structural foundations are being established.

In addition, the two kinds of pathways may have synergy rather than an additive relationship with each other. In Tier 1 governance systems or Tier 2 the opening of pathways by the leadership, they create an organizational environment in which they can perform better. The rules and guidelines that make ethical behavior and application of technology relevant in the sphere of innovation and the vision and motivation that actualize these rules and guidelines are provided by governance and leadership, respectively. Conversely, the leadership-activated pathways that are formed in an appropriate manner may be effective because they make the organizational members committed to the governance practices rather than memorize them. This hypothetical interaction between levels is a dynamic capability [11] that organizations can create over time and suggests that the explanatory power of the refined model can only increase going forward when it is applied longitudinally when cross-tier interactions can be measured.

## **5. The 4A Policy Implementation Framework**

Translating the refined three-tier model into actionable policy requires a structured implementation approach. This section presents the “4A Framework” Assess, Architect, Activate, Accelerate designed for UAE public sector leaders and policymakers seeking to optimize digital innovation performance. Each phase is grounded in the empirical findings and theoretical mechanisms identified in the companion studies and the refined model.

### **5.1 Phase 1: Assess (Diagnostic Phase)**

During the initial stage, a thorough organizational evaluation of the existing conditions of each model aspect is conducted. The stage is used to resolve the Tier 3 contextual boundary conditions by establishing

the size of the organization, the type of sector, the level of digital maturity, the governance infrastructure, leadership competencies, and ethical behavior. Certain assessment activities involve completing a digital maturity audit to assess the current state of digital transformation, assess the current data governance practices against the three-dimensional framework (structural, procedural, and relational practices), evaluate the ethical practices used to manage data, by survey of the employees regarding the 14 dimensions of data ethics utilized in the study, profile the existing leadership capabilities against the four transformational dimensions of leadership (idealized influence, inspirational motivation, intellectual stimulation, individualized consideration), and benchmark the organization with the UAE National Innovation Strategy (NIS) requirements and Global Innovation Index indicators.

The results of the Assess phase are a Digital Innovation Readiness Profile that determines the state of the organization in each of the model dimensions, the comparative power of structural versus leadership-activated pathways, and areas of priority intervention.

### **5.2 Phase 2: Architect (Structural Foundation Phase)**

The second stage aims at establishing the Tier 1 structural route: digital transformation and digital governance infrastructure. This step has been given priority since the empirical results proved that digital transformation is the main source of performance of innovation and the most powerful predictor of development of governance. The activities of this phase include designing a digital transformation strategy consistent with the UAE AI Strategy and NIS goals, investing in the IR 4.0 technology stack (cloud computing, big data analytics, IoT, AI platforms, cybersecurity), creating an overarching digital governance framework (including structural practices (clear data ownership, data value determination), procedural practices (data retention policy, data backup policy, data access monitoring, policy cost-versus-value monitoring), and relational practices (educating users on data management, reporting policy outcomes) and having Chief Innovation Officers and Chief Data Officers with clear governance mandates. The deliverable of the Architect phase is a working-level digital-governance-innovation pipeline that takes the Tier 1 structural pathway operational. The duration of this phase can be 12-24 months of complete implementation, based on the size of the organization and the level of digital maturity.

### **5.3 Phase 3: Activate (Leadership and Ethics Phase)**

The third step is concerned with the development of Tier 2 pathways that are developed at the time of the leadership activation. The empirical results indicated that transformational leadership triggers the dormant ethics-innovation and adaptation-innovation-innovation-innovation-innovation tracts. The interventions during this phase will include the design and implementation of transformational leadership program development to senior and middle managers, with the focus on the four core competencies defined by Bass and Riggio (2006) [7], instigating data ethics into organizational culture instead of making it a separate compliance activity by introducing ethical thinking in the adoption of new technologies, innovation project reviews, and performance reviews, putting technology adaptation support programs in place, which couples technical training with intellectual stimulation by transformational leaders so that employees not only adopt but also use new technologies innovatively, forming cross-functional innovation teams led by managers with demonstrated transformational leadership behaviors.

The work product of the Activate phase is the organizational environment where the Tier 2 leadership-activated pathways are operationalized that is, data ethics and technology adaptation lead to the outcomes of innovation in the leadership-mediated mechanisms.

### **5.4 Phase 4: Accelerate (Scaling and Sustainability Phase)**

The fourth stage is devoted to the organization-wide extension of the model and the maintenance of the

innovation performance in the long term. The phase deals with the dynamic nature of the model such as the reinforcing feedback mechanisms between the digital transformation, governance, and innovation. These are the implementation of systems of innovation performance measurement in accordance with the dimensions of the dependent variable which will be used in this research (market introduction of innovative products, product extensions and changes, replacement rate, percentage of innovative products in business), the creation of knowledge-sharing mechanisms across sectors, as envisaged in the NIS objective of having an updated database of innovative practices shareable across entities in the public sector, regular governance audit to maintain that governance structures are consistent with changing technology environments and innovation needs, the implementation of the 1 percent of budget-innovation budget as stipulated by the NIS,

The products of the Accelerate stage are the self-sustaining digital innovation ecosystem in the public sector organization, with its features of a continuous improvement, the learning across the organization, and orientation to the national strategic goals.

**Table 4**  
**The 4A Implementation Framework: Summary of Phases, Activities, and Outputs**

Phase	Duration	Key Activities	Output
<b>1. Assess</b>	2–4 months	Digital maturity audit, governance evaluation, ethics assessment, leadership profiling, NIS benchmarking	Digital Innovation Readiness Profile
<b>2. Architect</b>	12–24 months	DT strategy, IR 4.0 investment, governance framework, CIO/CDO appointments, data quality systems	Structural pathway pipeline (Tier 1)
<b>3. Activate</b>	6–12 months	TFL development programs, ethics integration, TA support, innovative teams, incentive structures	Leadership-activated pathways (Tier 2)
<b>4. Accelerate</b>	Ongoing	Performance measurement, knowledge sharing, governance audits, 1% budget, benchmarking, PPPs	Self-sustaining innovation ecosystem

## 6. Discussion

### 6.1 Theoretical Contributions of the Refined Model

The sophisticated three-level model brings the literature forward in several significant ways. First, it goes beyond the premise of equal-weight, parallel systems that define most innovative models. The model offers a more detailed and empirically precise explanation of digital innovation in the sphere of inner workings because it proves that various antecedents have different mechanisms of operation, structural or leadership based. This hierarchical design is in line with the institutional theory view of change by Greenwood and Hinings (2006) in that the results of change are predetermined by how structures, activities, and actions interact at various levels [10].

Second, the theory of leadership-activated pathways brings a novel theoretical process into the digital innovation literature. The frameworks in place tend to place leadership either as a predictor or a universal

moderator. The current results indicate a narrower application: transformational leadership can be seen as a compensatory activator that opens innovation potential in the organizational capabilities (ethics, adaptation) that otherwise would not be activated (innovation). This process is comparable to the notion of having dynamic capabilities [11] wherein the opportunity to detect and capture it is enabled by managerial cognitive frames, in this instance, the frames created by transformational leadership behaviors. Third, contextual boundary conditions (Tier 3) further allow the model to be applied by since there is no single pathway configuration that applies well across every organization. This extension is based on contingency theory and specifically on the UAE public sector where the organizations may include small municipal departments all the way to large national utility and highly regulated sectors (health) and innovation-oriented sectors (education). The suggested contextual variations (Table 2) produce both the testable hypotheses to be used in future research and the immediate practical advice on the differentiated implementation strategies.

### **6.2 Practical Contributions of the 4A Framework**

The 4A implementation framework converts the refined model into a systematic, staged process that bridges a gap in the digital innovation literature: the paucity of actionable implementation to be applied in the public sector organisations [12]. The framework is consistent with some of the policy tools present in the UAE. The Architect phase is a direct operationalization of the NIS objectives of technology infrastructure innovation and regulation frameworks of innovation. The Activate stage helps to sustain the call of the NIS to engage government staff in training and equipping them with innovative skills and encourages employees to come up with innovative ideas. The Accelerate phase will realize the NIS vision of having national databases of innovative practices and integrating the culture of innovation in the government entities.

The staged structure of the framework acknowledges that the digital innovation ability should be established in stages: governance infrastructure (Phase 2) should be developed first since the empirical evidence indicates that governance mediates the transformation–innovation relationship, which offers the structural framework within which the leadership-activated avenues may operate. Trying to bring about ethics and adaptation channels (Phase 3) before initially establishing governance infrastructure (Phase 2) would be comparable to trying to bring about electricity without first putting in the wiring.

### **6.3 Implications for UAE Smart Government and Smart City Initiatives**

The polished model and implementation framework is directly applicable to the case of UAE ambitions of smart government and smart city. A smart city is often defined as an advanced city which provides sustainable economic growth and quality of life through excellence in several domains: economy, mobility, environment, people, living, and government [13]. The three-tier architecture of the refined model can be projected to the smart city paradigm: the structural pathway is the technological and governance infrastructure that forms the backbone of the smart, the leadership-activated pathway is the human capital and ethical dimension that makes the smart still the smart city, and the contextual tier is the implementation that is specific to the needs of various municipal, utility, health, and education organizations that are part of the ecosystem of the smart city.

The Expo 2020 of the UAE (which will be held in 2021–2022) showed the world that the country can be an innovative and collaborative powerhouse in a large scale. The Accelerate step of the refined model clearly facilitates the sustenance of this momentum by public-private collaboration, cross-sectoral knowledge exchange, and compliance with the UAE Centennial Plan 2071 [14]. UAE has been comparing itself against the Global Innovation Index since the launch of the National Innovation Strategy in 2015

and has since been on the number one position of Arab countries in both 2017 and 2018. There is a Chief Innovation Officer in every government department, and it is aimed at achieving global innovation leadership [5]. The 4A framework offers these Chief Innovation Officers with an ordered, evidence-based approach to fulfilling their mandates.

Another key issue the model resolves within the context of smart city development is the alignment of digital innovation with various government units having various mandates, sizes and technological maturities. Bryson et al. (2017) found that cities approach smart city development differently, with some relying on formal approaches and others adopting more open approaches by using living labs and innovation platforms that unite stakeholders with citizens to co-create value [9]. The three-layer model is flexible in accommodating both of those approaches: the structural pathway sustains formal strategic approaches by means of governance infrastructure, and the leadership-activation pathway sustains more organic and human-focused innovation by means of ethical practices and technology adaptation enabled by transformational leaders.

In the case of data protection dimensions, the fine-tuned model identifies the complementary aspects of data ethics and data governance as the key dimensions of responsible digital innovation. An example of such technology is blockchain technology that is considered as a digital privacy element with the highest level of security of data protection but needs to be heavily regulated to ensure that the processes of its implementation are controlled. The role of ethics as a leadership-activated variable and governance as a structural mediator described in the refined model gives the theoretically supported model of how to incorporate such new technologies within the public sector innovation ecosystem. It is in the interest of organizations to develop ethical awareness (via leadership) as well as governance structures (via institutional mechanisms) to be in the best position to adopt the next-generation privacy-preserving technologies and keep the innovation momentum going.

## 7. Limitations and Future Research Agenda

There are several limitations that outline the scope of this paper and the way in which future research can be done. First, the model refinement is anchored on one empirical research, which has cross-sectional design. The proposed tiered architecture should be tested through longitudinal research that will help in the validation of this architecture, as well as in the exploration of the time-order effects suggested by the 4A implementation framework. Second, the contextual differences in Tier 3 (Table 2) are theoretical propositions that have not been empirically validated by subgroup analysis. To confirm these hypothesized differences, future studies need to use a multi-group analysis that uses bigger sample sizes and these samples must be stratified according to organizational size and type of sector. Third, the implementation model is not tested empirically. The 4A model should be put to test in practical situations of implementing the model in the public sector through action research or case studies.

Fourth, the participants of the study were restricted to UAE public sectors only and the applicability of the refined model in other GCC countries, OECD countries or in the context of developing countries is to be studied. It would be especially useful to compare studies in other systems of national governance. Fifth, the refined model has taken into consideration the original framework variables only. Future studies ought to examine other variables that can potentially affect digital innovation performance such as organizational culture, employee digital literacy, availability of financial resources, change acceptance, digital HR practices as well as management by walking around (MBWA) which has been found to be potentially significant alternative to transformational leadership in cases of innovation [15]. Sixth, it would be a

qualitative aspect such as in-depth interviews with public sector leaders, Chief Innovation Officer, and Chief Data Officer to get deeper insights into how governance, ethics, and leadership interact in practice. Future research is suggested to be conducted with the following specific research questions in place to constitute a structured research agenda as the sequella of this paper. To begin with, is the three-tier pathway architecture holdable when longitudinal data is employed? Second, are the suggested contextual differences (Table 2) supported in multi-group PLS-SEM analysis? Third, are there demonstrated benefits in digital innovation performance when the 4A implementation framework is applied in actual working public sector environments? Fourth, which other leadership constructions (digital leadership, distributed leadership, servant leadership) can be considered activators of pathways to transformational leadership? Fifth, does the polished model apply outside of the UAE GCC settings where governance systems and levels of digital maturity vary? Sixth, how would new technologies like blockchain and advanced AI transform the governance–innovation pathway? These questions give us a detailed agenda of the future studies that are based based on the current series of papers.

## 8. Conclusion

The paper has built upon the companion conceptual and empirical research by developing the initial model of digital innovation performance into a three-level architecture and transferring it into a policy implementation plan to apply to the UAE public sector organizations. The simplified model redefines the initial nine-hypothesis model into a more parsimonious and practical framework: a structural tier where digital transformation becomes a source of innovation due to governance of actions, a leadership-activated tier where transformational leadership makes use of the innovation potential of data ethics and technology adaptation, and a contextual tier where boundary conditions or organizational size and sector type influence the relative efficacy of each pathway.

It is integrated into the 4A implementation framework, comprising of Assess, Architect, Activate, accelerate frameworks that enable business leaders in a government to build digital innovation capability in an organized and sequential manner. The framework aligns with UAE strategic priorities and policy tools and Chief Innovation Officer and managers working in the public sector can apply it to offer an evidence-based strategy to deliver on the national innovation objectives.

The three articles of this series (conceptual framework, empirical test and current refinement and implementation paper) provide a comprehensive, theoretically grounded and practically practiced method of comprehending the essence and functionality of digital innovation within the organizations of the public sector. The last, and perhaps the most plausible contribution is a model that is both academic and practically realistic towards the closure of the gap between theoretical knowledge and the burning real-life problem of creating innovative, ethical and well-managed digital government in the future.

The environment of innovation in the public sector will continue to change with the rate of increasing digital disruption (by expanding artificial intelligence, machine learning, blockchain, and quantum computing) in the future. The three-tier model and the 4A implementation model are designed in a manner that it is flexible enough to enable the changing technologies to accommodate their structure-based and leadership-driven pathways. The need to implement evidence-based and theoretically grounded approaches towards managing digital innovation will continue to increase as the UAE moves into its vision of Centennial Plan 2071. Hopefully, this paper and the academic project it represents will contribute positively to that ongoing endeavor to dispel the belief that technology, governance, ethics, and leadership

have crossed over into a complex nexus that characterizes the digital innovation challenge of the present day.

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