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Service Digitalization Impacts on Public Governance Quality in Morocco: A Two-Stage Least Squares Approach

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Abstract:

Morocco has implemented a consistent and long-term digital transformation strategy, achieving notable successes in service digitization, anti-corruption infrastructure, and institutional modernization. This study investigates how large-scale digital service inputs (such as online services, telecom infrastructure, investments in telecom services, human capital index, e-information, e-consultation, e-decision making, and connectivity) affect the quality of public management governance, measured by the average of six standardized governance indicators (government effectiveness, regulatory quality, rule of law, control of corruption, voice and accountability, and political stability) in Morocco over the period 2003 to 2024. The paper contributes to existing literature by providing robust econometric evidence on the causal link between service digitalization and governance outcomes in Morocco, specifically through citizen e-participation and e-government development, using a Two Stage Least Square approach to address endogeneity concerns that have limited previous research. The results show that e-government development has a positive and statistically significant impact on governance quality, reflecting the fruitful governmental efforts. Meanwhile, e-participation has a negative and statistically significant effect, indicating insufficient citizen engagement. In light of these findings, the paper proposes a strategic roadmap over the long-term linking efficient service digitalization transition to the public management governance quality.

Keywords: Digital services. Governance, Morocco; E-Participation; E-Government; 2SLS

JEL classification: H11; H83; C26; O33; L86; D73

Introduction:

The intersection of digital transformation and public governance has emerged as a critical domain of inquiry, particularly within developing country contexts where institutional legacies and resource constraints shape distinct trajectories of e-government adoption. Within this line, Morocco is a pioneer country in terms of public administration digital transition, and a major industrial hub in Africa (Haidar, 2026). To do so, it is taking steps to transform its administration and ensure the sustainable growth of its emerging digital economy and society. Indeed, it has established a dedicated ministry responsible for steering the national digitalization agenda, allocated substantial financial and institutional resources to this objective, and achieved

significant progress in the modernization of public services (Ministry of Digital Transition and Administration Reform, 2024). Over the past two decades, the Kingdom has launched several ambitious strategies, including e-Morocco, Maroc Numeric, and Digital Morocco 2025, aimed at enhancing the efficiency, transparency, accessibility, and quality of public services through the integration of ICTs in its public administration (World Bank, 2022; OECD, 2018).

These initiatives seeked all together on thing: the promotion of governance quality, measuring the quality of political leadership and steering capability in the transformation processes to market economy, which includes political decision-making and structural difficulties facing, it assesses level of difficulty, steering capability, resource efficiency, consensus-building, and international cooperation (Brusis et al., 2012)

The digital transformation of public services has become a central pillar of administrative reform in Morocco, reflecting a broader commitment to improving governance and strengthening the relationship between citizens and public institutions (Agence de Développement du Digital, 2024). Digital platforms, e-government services, online administrative procedures, and interoperable information systems have progressively reshaped the delivery of public services, reducing bureaucratic burdens and facilitating citizens' access to government services, Digital platforms have been shown to facilitate citizen-government interactions, reduce bureaucratic delays, and improve public trust in institutions (World Bank, 2022; OECD, 2018). Furthermore, the relationship between digitalization and governance may be subject to endogeneity issues, as better-governed administrations are also more likely to adopt digital technologies successfully (Bertot et al, 2010).

Despite these advances, questions remain regarding the extent to which service digitalization contributes to improving public management governance. While digital technologies are expected to enhance transparency, accountability, operational efficiency, and public trust (Margetts & Dunleavy, 2013; OECD, 2020), empirical evidence on their actual impact remains limited, particularly in developing countries. To the best of our knowledge, no prior study has provided a rigorous methodological and empirical assessment of how the deployment of a digital framework, encompassing in total ten digital indicators covering all aspects of digital transformation, has enhanced governance quality by fostering e-participation and e-government development within the Moroccan context.

The methodological challenges inherent in establishing causal relationships between digitalization and governance outcomes deserve explicit attention. Much of the existing

literature relies on case study designs, cross-sectional correlations, or perceptual measures of governance quality. While these approaches generate valuable descriptive insights and hypothesis-generating observations, they are limited in their ability to address endogeneity concerns, omitted variable bias, and reverse causation. Furthermore, As Oubayoucef et al. (2025) noted, the relationship between digital platform adoption and governance quality is likely bidirectional: effective digital services may build trust, but pre-existing trust levels condition initial adoption decisions. This creates a potential endogeneity problem that the present study's instrumental variables approach is designed to address.

Research Gaps and Contributions

Despite the accumulating body of research on digitalization and governance in Morocco, several gaps remain that the present study addresses.

First, while qualitative case studies have documented e-government initiatives and their implementation challenges, there is limited econometric evidence on the causal effects of digitalization on specific governance indicators. The 2SLS approach provides a rigorous framework for estimating these relationships while addressing endogeneity concerns.

Second, existing research has typically examined individual governance dimensions in isolation, rather than simultaneously assessing effects across multiple indicators.

Third, this study adopts a standardized composite governance quality index as the final dependent variable, by taking the unweighted arithmetic mean of the six Worldwide Governance Indicators: voice and accountability, political stability and absence of violence/terrorism, government effectiveness, regulatory quality, rule of law, and control of corruption. Those indicators, when are put collectively, enable comparisons of effect heterogeneity across governance domains. This multi-dimensional approach is particularly valuable for the present study, as it acknowledges that digitalization produces heterogeneous effects that may be captured by different governance indicators.

Third, except Didi's (2026) which proved that the sustainability of digital governance transformations depends critically upon human capital availability in the Moroccan context. At the best of our knowledge, no one has integrated the human capital dimension as an instrument directly correlated to the adoption and the proficiency of digital inputs, beyond the intuitive intuition nor considered the direct investments in telecom services as an instrumental variable.

Against this backdrop, this study investigates the impact of service digitalization on public management governance in Morocco. To address potential endogeneity concerns, and establish a more robust causal relationship, the analysis employs a 2SLS estimation approach. By examining the governance outcomes associated with the digital transformation of public services, this research contributes to the growing literature on digital government and public sector innovation, while providing evidence-based insights for policymakers seeking to strengthen administrative performance and governance quality.

2. Literature Review

2.1. Digitalization of Public Services and E-Government

The digital transformation of public administrations has emerged as a major component of public sector modernization worldwide. Digitalization refers to the integration of information and communication technologies (ICTs) into administrative processes and public service delivery to improve efficiency, accessibility, transparency, and responsiveness (OECD, 2020). The concept of e-government encompasses the use of digital technologies by public institutions to provide services, exchange information, and interact with citizens, businesses, and other governmental entities (United Nations, 2024).

Early studies emphasized the capacity of digital technologies to reduce transaction costs, simplify administrative procedures, and improve service quality (West, 2004). According to Dunleavy et al. (2006), the emergence of Digital-Era Governance marked a shift from traditional bureaucratic systems toward integrated and citizen-centered public services. More recent research highlights the role of digital platforms, artificial intelligence, cloud computing, and big data analytics in transforming public administration and enhancing governmental performance (Mergel et al., 2019).

The literature suggests that digitalized public services contribute to greater administrative efficiency by reducing paperwork, accelerating decision-making processes, and facilitating information sharing across governmental agencies (OECD, 2020). Furthermore, digital government initiatives can improve citizens' access to public services, particularly in geographically dispersed regions, thereby promoting inclusiveness and reducing administrative barriers (United Nations, 2024).

2.2. Public policy evaluation

Public policy evaluation is the systematic assessment of government interventions to determine their effectiveness, efficiency, and social impact (Rossi et al., 2019). It examines whether a policy achieves its stated objectives and produces the intended outcomes (Vedung, 2017). Evaluation distinguishes between policy outputs and policy outcomes (Weiss, 1998). A rigorous evaluation estimates the causal effect of a policy by comparing observed outcomes with an appropriate counterfactual (Gertler et al., 2016). Quantitative approaches include randomized controlled trials, difference-in-differences, regression discontinuity, and instrumental-variable methods (Angrist & Pischke, 2009). Qualitative approaches provide important insights into implementation processes, institutional contexts, and stakeholder experiences (Patton, 2015). A credible evaluation must address selection bias, confounding factors, and measurement error (Imbens & Rubin, 2015). Cost-benefit and cost-effectiveness analyses assess whether policy benefits justify the resources invested (Boardman et al., 2018). Policy evaluation strengthens evidence-based decision-making, public accountability, and the efficient allocation of resources (OECD, 2020). Ultimately, evaluation provides evidence for improving, scaling, redesigning, or terminating public policies (Rossi et al., 2019).

2.2. Digitalization and public governance

Public governance refers to the processes, institutions, and mechanisms through which public authority is exercised and public resources are managed. It is characterized by transparency, accountability, effectiveness, participation, and rule of law (Kaufmann et al., 2010).

The term "e-government" emerged in the late 1990s in the state of Florida, USA, and was officially introduced at a conference in Italy in 2001. There are two distinct definitions of e government, with one emphasizing the intensive use of information technologies across government functions and the broader goals of public service delivery, managerial efficiency, and democratic values. The other definition focuses on the transmission of government information via the internet to citizens and businesses, as well as between government agencies (Rarhoui, 2024). In the same line, e-participation emerges as a critical mechanism linking digital inputs to governance outcomes throughout civic engagement, though its effectiveness depends fundamentally on trust, usability, and inclusive access conditions (Kim & Lee, 2012; Santamaría-Philco & Wimmer, 2018).

A growing body of literature argues that digitalization can significantly enhance governance quality. Bertot et al. (2010) contend that ICTs promote transparency by increasing public access to governmental information and reducing opportunities for corruption. Similarly, Nam (2012)

focuses on participation and citizen-government interaction: and suggests that e-government initiatives strengthen accountability by facilitating citizen oversight and improving administrative traceability. Nevertheless, developing countries often face challenges related to infrastructure deficiencies, limited digital literacy, and unequal access to technology. According to the United Nations (2024), the digital divide remains one of the principal barriers to achieving inclusive digital governance. These constraints may limit the effectiveness of digitalization policies and create disparities in access to public services.

Several empirical studies have found positive relationships between digital government development and governance indicators. Andersen (2009) demonstrates that e-government adoption contributes to lower corruption levels and improved public sector performance. Likewise, Shim and Eom (2008) report that digital technologies enhance administrative transparency and reduce discretionary behavior among public officials.

However, the literature also recognizes that the relationship between digitalization and governance is not automatic. Digital initiatives may fail to generate governance improvements when institutional quality is weak, technological infrastructure is insufficient, or digital exclusion persists (Heeks, 2002). Consequently, the effectiveness of digital transformation depends on complementary factors such as political commitment, organizational capacity, regulatory frameworks, and human capital development.

2.3. The theory of digital governance

Several theoretical perspectives are underpinning the digital transformation domains such as the Digital Governance Theory and Public Value Theory, the Digital State Paradigm (DSP), which posits that information and communication technologies fundamentally restructure state-citizen relationships, administrative coordination mechanisms, and service delivery architectures. Digital Governance Theory argues that the adoption of ICTs can fundamentally transform public administration by enhancing transparency, efficiency, accountability, service delivery, and citizen participation (Dunleavy et al., 2006; Bertot et al., 2010; OECD, 2020). Through digital platforms and e-government initiatives, public institutions can strengthen interactions with citizens, facilitate access to information, and promote more participatory and responsive governance processes (Hien et al., 2024).

2.4. The theory of public value

Complementing this perspective, Public Value Theory posits that public sector initiatives generate value when they improve citizens' well-being, trust in government, and satisfaction

with public services (Moore, 1995). Together, these theoretical frameworks suggest that service digitalization can enhance public management governance by improving administrative performance, fostering citizen engagement, and creating greater public value. In the Moroccan context, they provide a relevant lens through which to examine the governance outcomes associated with the digital transformation of public services.

2.3. Empirical evidence from developing countries

The impact of service digitalization on governance has attracted growing attention in developing economies. Studies conducted in Asia, Latin America, and Africa generally report positive effects of e-government initiatives on transparency, public service quality, and administrative efficiency (Nkohkwo & Islam, 2013).

For Africa, E-government has emerged as a strategic priority across Africa as governments increasingly seek to leverage Information and Communication Technologies (ICTs) to transform public administration and improve interactions with citizens, businesses, and other government institutions. The modernization of public services through digital technologies is widely recognized as a key driver of institutional strengthening, transparency, accountability, and administrative efficiency (United Nations, 2024). Strong and effective institutions are essential for Africa's socio-economic development and democratic consolidation, making digital government initiatives an important component of public sector reform. However, The adoption of e-government across African countries is uneven and influenced by factors such as public awareness, institutional capacity, and the allocation of financial resources. While countries such as South Africa, Mauritius, Tunisia, and Morocco have achieved notable progress through effective technical implementation and strong political commitment, other nations continue to face challenges stemming from limited resources, political instability, and insufficient strategic vision. Over recent years, many African countries have substantially improved their telecommunications infrastructure, creating a strong foundation for advancing digital government initiatives. Nevertheless, significant digital divides remain, posing persistent obstacles to inclusive digital transformation. Consequently, targeted support and capacity-building efforts are essential, particularly for low-income and lower-middle-income countries, as well as countries facing special developmental circumstances, to ensure equitable progress toward digital governance.

In this context, the African Union and its High-Level Panel on Emerging Technologies (APET) have advocated for the adoption and expansion of e-government services across the continent.

Consequently, digital transformation has become a central objective of numerous regional and national policy frameworks aimed at enhancing governance and service delivery (African Union, 2015). E-government initiatives generally encompass three major dimensions: Government-to-Government, Government-to-Business and Citizen, and Government-to-Citizen interactions (Fang, 2002). Through these channels, governments employ digital platforms, internet-based applications, and other ICT tools to improve access to public services, streamline administrative processes, and facilitate citizen engagement (United Nations, 2024).

Moreover, the success of digital transformation efforts depends on their alignment with broader socio-economic development objectives. E-government reforms can contribute significantly to the realization of both the African Union's Agenda 2063 and the United Nations Sustainable Development Goals (SDGs) by promoting inclusive governance, economic growth, and social development (African Union, 2015; United Nations, 2024), with the synergy offered by several continental and international organizations that have collaborated to strengthen digital governance ecosystems across Africa (Rarhoui, 2024).

Nevertheless, the benefits of digital transformation cannot be fully realized without adequate institutional capacity, financial resources, regulatory frameworks, and strategic policy direction OECD. (2020). In the absence of these enabling conditions, digitalization may exacerbate existing inequalities, contribute to job displacement, and raise concerns related to cybersecurity, data protection, and privacy (United Nations, 2024). Therefore, a comprehensive and inclusive approach to e-government implementation is essential to ensure that digital transformation contributes effectively to sustainable development and good governance across the continent.

Recent studies emphasize the importance of evaluating digital transformation through rigorous econometric approaches capable of addressing endogeneity concerns (Oubayoucef et al., 2025). Governments with stronger governance structures may be more likely to adopt advanced digital technologies, creating reverse causality between digitalization and governance outcomes. Instrumental variable techniques, such as 2SLS, have become increasingly relevant in empirical analyses examining the causal effects of digital governance (Andersen & Rand, 2020).

2.4. Digital transformation and governance in Morocco

Morocco has positioned digital transformation at the center of its public sector modernization strategy. Since the launch of the e-Maroc initiative and subsequent national digital strategies, the government has invested substantially in the development of digital public services, administrative interoperability, and electronic governance systems (OECD, 2018).

The establishment of the Ministry of Digital Transition and Administration Reform reflects Morocco's commitment to accelerating the digitalization of public services and improving governance performance. National initiatives such as Maroc Numeric, Digital Morocco 2025, and Digital Morocco 2030 have sought to increase administrative efficiency, enhance transparency, and strengthen citizen engagement through digital technologies (Oubayoucef et al., 2025). Recent institutional developments suggest accelerating momentum. A framework agreement between Morocco's Ministry of Digital Transition and Administrative Reform and the General Directorate of National Security seeks to institutionalize digital identity verification as a key enabler of e-government expansion (Express TV, 2025). Furthermore, the Digital for Sustainable Development Hub and the Artificial Intelligence and Data Science Alliance, launched in partnership with the United Nations Development Programme (UNDP), aim to position Morocco as a regional platform linking African and Arab digital ecosystems (UNDP, 2025; Ministry of Digital Transition and Administrative Reform, 2025). These initiatives reflect the Moroccan government's broader strategic vision of digital transformation as a central pillar of the country's development model and regional digital leadership (UNDP, 2025).

However, Morocco's shift to digital government is real but asymmetrical; curricular content and delivery technologies are advancing faster than credential governance and rural infrastructure (Didi, 2026). The lack of inclusive digital governance, including fiscal incentives for co-design of digital-industry programs, rapid fiber rollout tied to upskilling benchmarks, and campaigns for gendered visibility (Didi, 2026). Moreover, the empirical evidence on digitalization's corruption-reducing effects requires careful interpretation. Morocco's Transparency International Corruption Perception Index ranking has exhibited volatility over the past decade, suggesting that digital interventions operate within broader institutional ecologies where complementary reforms are necessary for transformative impact. Moreover, as Aicha and El Yousfi (2026) reported, digital transformation introduces new risk vectors, including algorithmic bias, surveillance capacity concentration, and the potential for digital exclusion to replicate or exacerbate existing inequalities

Although several reports document significant progress in Morocco's digital government development (World Bank, 2023; OECD, 2018), empirical evidence regarding the governance effects of service digitalization remains limited. Existing studies primarily focus on technological adoption, e-government readiness, and administrative modernization, while relatively few investigate the causal relationship between digitalization and governance

outcomes. This gap is particularly important given the potential endogeneity between governance quality and digital transformation.

Based on, this study seeks to bring a structured and comprehensive response to the following problematic: “what are the effects of the implementation of digital services on the public management governance quality in the Moroccan context?”.

To examine this problematic, the following main hypothesis is stated:

H: Digital services implementation positively affects the governance quality in Morocco.

From which arise the following specific hypotheses

H_a: The adoption of digital public services positively influences the e-government development performance, which promote the public management governance quality in Morocco.

H_b: The implementation of digital public services positively affects the e-participation of citizens, which enhance the public management governance quality in Morocco

Accordingly, this study contributes to the literature by providing empirical evidence on the impact of service digitalization on the governance quality in Morocco using a Two stage Least Square (2SLS) framework. By addressing endogeneity concerns, the analysis seeks to offer more reliable estimates of the governance effects associated with public service digitalization.

3. METHODS

3.1. The Two Stage Least Square

The study employs the Two-Stage Least Squares (2SLS) approach to address potential endogeneity in the empirical model. 2SLS is appropriate when one or more explanatory variables may be correlated with the error term, potentially resulting in biased and inconsistent OLS estimates. The approach relies on instrumental variables that are correlated with the endogenous regressors but satisfy the exclusion restriction (Wooldridge, 2010; Hansen, 2022).

3.1.1. The 2SLS first stage

The potentially endogenous variables are regressed on the proposed instrumental variables and the relevant exogenous control variables. The purpose of this stage is to assess whether the instruments provide sufficient explanatory power for the endogenous variables. Instrument relevance is evaluated using a joint Wald test, which examines whether the instruments are jointly statistically significant. A statistically significant and sufficiently large Wald statistic

provides evidence of instrument relevance and helps address concerns regarding weak instruments (Wooldridge, 2010; Hansen, 2022).

3.1.2. The 2SLS second stage

The predicted component of the endogenous variables generated from the first stage is used in the structural estimation. This allows the estimation to rely on the variation in the endogenous variables explained by the instruments, thereby reducing the bias arising from endogeneity and producing consistent instrumental-variable estimates under the required identification assumptions (Wooldridge, 2010; Hansen, 2022).

3.1.3. The residuals inclusion approach

In addition to the conventional 2SLS procedure, the study employs the residual inclusion (control-function) approach to assess endogeneity. Following the first-stage estimation, the residuals obtained from the first-stage regressions are incorporated into the structural model. This approach captures the component of the potentially endogenous variables that is not explained by the instruments and controls for its possible correlation with the structural error term (Davidson & MacKinnon, 1993; Wooldridge, 2010).

The statistical significance of the first-stage residuals provides a direct indication of endogeneity. If the residuals are statistically significant in the augmented structural model, this suggests that the potentially endogenous variables are correlated with the structural disturbance. Conversely, if the residuals are not statistically significant, there is insufficient evidence to reject the assumption of exogeneity (Wooldridge, 2010; Hansen, 2022).

3.1.4. The joint Wald test for endogeneity

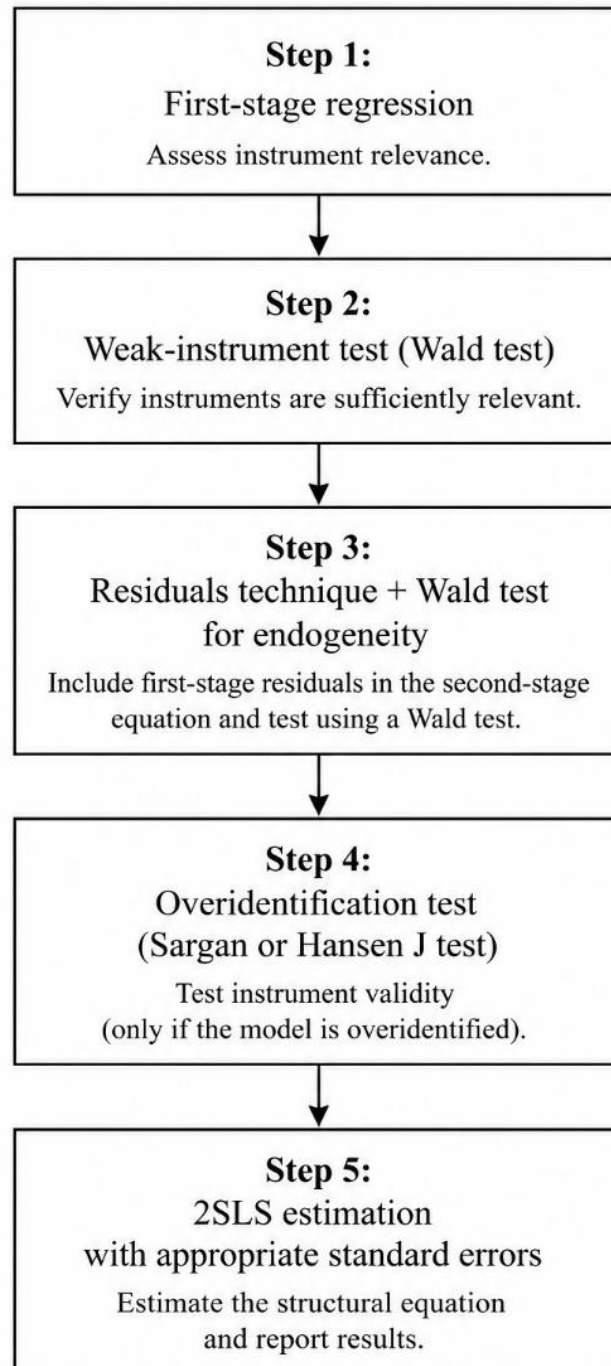
Rather than relying on the Durbin–Wu–Hausman (DWH) test, the study employs a joint Wald test of the first-stage residuals to assess endogeneity. This approach is particularly useful when more than one explanatory variable may be endogenous because it allows the residual terms to be evaluated simultaneously.

The null hypothesis of the joint Wald test is that the coefficients of the first-stage residuals are jointly equal to zero, implying that the relevant explanatory variables can be treated as exogenous. Rejection of the null hypothesis indicates that the residuals are jointly significant and provides evidence of endogeneity. The residual-inclusion approach therefore offers a direct control-function-based assessment of endogeneity within the 2SLS framework (Davidson & MacKinnon, 1993; Wooldridge, 2010; Hansen, 2022).

3.1.5. Methodological procedure

The empirical strategy followed in this study can be summarized in a step-by-step empirical evidence organigram represented in the following Figure 1:

Figure 1: Methodological procedure



Source: Authors own elaboration

3.2. The variables presentation

The following Table 1 represents the variables used in the empirical evidence, alongside their functions in the 2SLS method, acronyms, description, and respective resources

Table 1: The variables presentation

Variables	Name	Acronym	Description	Sources
The main dependent variable	Governance Quality	GQ	The average of composite indicators summarizing six dimensions of governance: as defined by the World Bank, including, Government Effectiveness, Political Stability Regulatory Quality, Rule of Law, Control of Corruption and Voice and Accountability.	<u>Worldwide Governance Indicators</u>
The composite variables of the dependent variable	Government Effectiveness	GE	A measure of the quality of public services, civil service, policy formulation and implementation, and the credibility of a government's commitment to improving or maintaining these aspects.	
	Rule of Law	RL	An estimate of the extent to which the government complies with the law, courts are independent, laws transparent, justice accessible, corruption absent, and the bureaucracy is impartial with no favoritism or discrimination.	
	Regulatory Quality	RQ	An evaluation of how well regulations follow principles of transparency, efficiency, and evidence-based decision-making to minimize burdens on business.	
	Political Stability	PS	Measures the likelihood that a government will be destabilized or overthrown by unconstitutional or violent means, including terrorism and civil unrest	
	Control of Corruption	CC	Measures how much public power is used for private gain rather than the public good, to track how effectively a society limits corrupt behavior	
	Voice and Accountability	VA	Measures the extent to which a country's citizens can participate in selecting their government, along with their freedom of expression, freedom of association, and a free media	
Endogenous variables	E-Government development index	EGDI	A measure of the extent willingness and capacity of national administrations to use digital technologies to deliver public services.	<u>United Nations E-Government Survey</u>
	E-Participation index	EPI	Measures how effectively national governments use online services and	

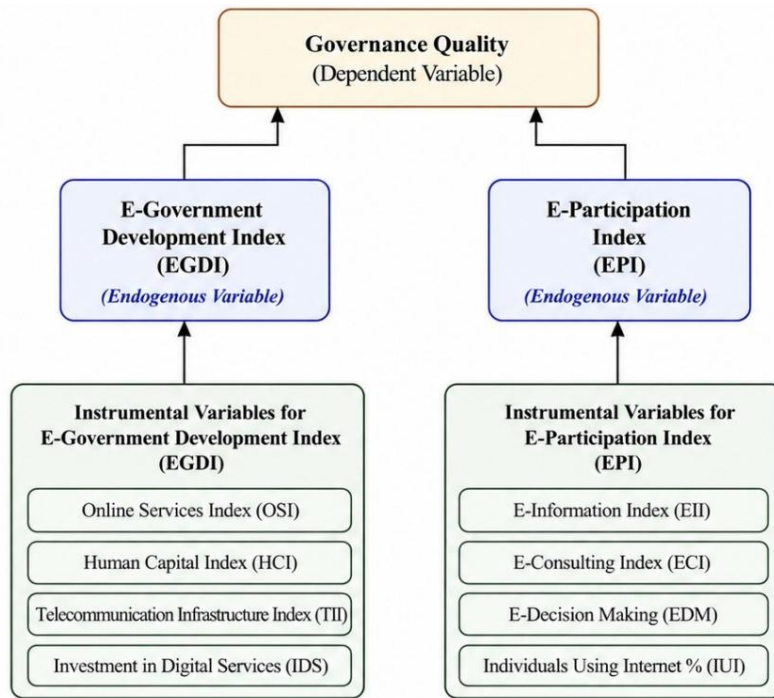
			digital tools to engage citizens in public policy and decision-making	
EPI Instrument variables	E-Information	EI	The digital publishing of public data, laws, budgets, and government reports so citizens can access them online	<u>United Nations E-Government Survey</u>
	E-Consultation	EC	The use of online tools such as surveys, public forums, or comment boxes to ask citizens for feedback on proposed laws or public services.	
	E-Decision Making	EDM	The extent of which citizens help actively shape and co-create policies or public services.	
	Population Connectivity	PC	The share of individuals using the Internet to the population	
EGDI Instrument variables	Online services index	OSI	The availability and the quality of internet services	
	Telecom Infrastructures Index	TII	The availability and the quality of telecommunications infrastructures	
	Investments in Telecom Infrastructure	ITI	The annual investment for acquiring plant (e.g., switching equipment, transmission equipment, office machinery, motor vehicles etc)	
	Human capital Index	HCI	The level of education and human capital development (literacy, enrollment, years of schooling)	

Note: All the variables are unitless, and have been normalized on a scale of [0-100], except for Investments in Telecom Infrastructure which are monetized in international US Dollar.

3.2.2. The variables functional deployment

These variables are deployed in the 2SLS method as represented in Figure 2:

Figure 2: The 2SLS functional deployment of variables



Source: Authors own reproduction

4. RESULTS

• Unit root test

As the 2SLS model uses time-series data, unit roots test should be considered because non-stationary variables can produce spurious regression results.

Table 2 represents the Augmented Dickey-Fuller unit root test outputs of all the variables

Table 2: Augmented Dickey–Fuller (ADF) outputs

Variable	Level: Constant	Level: C + Trend	Level: None	1st Diff.: Constant	1st Diff.: C + Trend	1st Diff.: None	Order of Integration
GQ	−0.373 (0.897)	−2.396 (0.371)	2.828 (0.998)	−4.849*** (0.001)	−4.711*** (0.007)	−3.499*** (0.001)	I(1)
EGDI	−0.877 (0.774)	−2.476 (0.335)	−2.332** (0.022)	−2.352 (0.167)	−2.302 (0.414)	−1.066 (0.249)	I(0)
EPI	0.187 (0.963)	0.380 (0.997)	0.031 (0.679)	−4.014*** (0.008)	−3.823** (0.041)	−4.147*** (0.000)	I(1)
EDM	−1.269 (0.624)	−1.217 (0.880)	−1.086 (0.242)	−4.135*** (0.005)	−12.212*** (0.000)	−4.237*** (0.000)	I(1)
EI	−1.250 (0.632)	−1.558 (0.775)	−1.327 (0.165)	−4.297*** (0.004)	−3.789** (0.044)	−4.379*** (0.000)	I(1)
EC	−1.227 (0.643)	−1.356 (0.844)	−1.186 (0.208)	−4.081*** (0.006)	−3.615* (0.059)	−4.175*** (0.000)	I(1)
HCI	−1.739 (0.397)	−1.970 (0.578)	−0.651 (0.422)	−3.549** (0.018)	−3.653* (0.052)	−3.601*** (0.001)	I(1)
OSI	−1.709 (0.412)	−2.223 (0.453)	−1.483 (0.126)	−2.057 (0.262)	−2.059 (0.535)	−1.961** (0.050)	I(1)

TII	−1.667 (0.432)	−2.658 (0.262)	−3.169*** (0.003)	−3.015* (0.051)	−3.205 (0.112)	−1.291 (0.175)	I(1)
NET	−6.711*** (0.000)	−7.065*** (0.000)	0.445 (0.799)	−8.054*** (0.000)	−8.599*** (0.000)	−3.268*** (0.003)	I(0)
ITS	−3.147** (0.040)	−3.016 (0.153)	1.019 (0.913)	−4.568*** (0.002)	−4.885*** (0.005)	−4.422*** (0.000)	I(0)

Notes: ADF test null hypothesis: the variable has a unit root. C + Trend = constant and trend. Values in parentheses are p-values. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

The results in Table 2 indicate mixed orders of integration among the variables, with some variables being stationary at level, I(0), while others become stationary after first differencing, I(1). These results confirm that the variables exhibit a combination of stationary and non-stationary processes. The 2SLS estimation is employed to address potential endogeneity, using appropriate instrumental variables.

- **The Ordinary Least Square (OLS) regression**

The OLS estimation provides a baseline relationship between Governance Quality (GQ) and the two potentially endogenous explanatory variables, E-Government Development Index (EGDI) and E-Participation Index (EPI), over the period 2003–2024.

The outputs of the simple OLS regression issued from Eq1 is represented in Table 3:

Table 3 : The OLS results

Variable	Coefficient	t-statistic	p-value
Constant	30.872	25.789	0.0000***
EGDI	44.007	13.226	0.0000***
EPI	−6.435	−4.321	0.0004***
R ²	0.921		
Adjusted R ²	0.913		
F-statistic	111.452		0.0000

***Significant at the 1% level.

The estimated equation from Table 3 is: $GQ_t = 30.872 + 44.007 EGDI_t - 6.435 EPI_t + \varepsilon_t$
The OLS results reveal a strong positive and significant relationship between EGDI and GQ, its coefficient of 44.007 is significant at the 1% level ($p < 0.001$), indicating that higher levels of e-government development are associated with higher governance quality, ceteris paribus. In contrast, EPI has a negative and statistically significant coefficient of −6.435 ($p = 0.0004$),

suggesting a negative association between e-participation and governance quality. The model has high explanatory power and is jointly significant, indicating that EGDI and EPI jointly explain approximately 92.15% of the variation in GQ within the sample. However, these estimates should be regarded as preliminary because potential endogeneity of EGDI and EPI may make OLS estimates biased or inconsistent. Thus, the subsequent instrumental-variable analysis is required to assess and address the potential endogeneity.

- **The second stage general 2SLS model (Governance Outcomes)**

The general 2SLS model based two endogenous variables have the following specification :

$$GQ_t = \alpha + \beta_1 \hat{EPI}_t + \beta_2 \hat{EGDI}_t + \varepsilon_t \quad (\text{Eq1})$$

Where $(\hat{EPI}_t)$ and $(\hat{EGDI}_t)$ are the predicted values of GQ coming from the first-stage regressions below. α is a constant, while, β_1 and β_2 represent the long-term elasticities and ε_t is the error term. This general model is declined to two First Stage Equations models:

- **The 2SLS first stage results**

The first stage equations seek instrumenting digitalization throughout two models:

- *Model 1 : EGDI and GQ*

$$GQ_t = \beta_0 + \beta_1 EGDI_t + \varepsilon_t$$

Where the endogenous variable EGDI is instrumented with digital inputs as following

$$(EGDI_t) = \beta_0 + \beta_1(OSI_t) + \beta_2(TII_t) + \beta_3(IUP_t) + \beta_4(HCI_t) + v_t$$

Where OSI is Online Services Index, TII is Telecommunication Infrastructure Index, ITS is Investment in Telecom Services and HCI is Human Capital Index,

- *Model 2 : EPI and GQ*

$$GQ_t = \alpha_0 + \alpha_1 EPI_t + v_t$$

Where the endogenous variable EPI is instrumented with digital inputs as following

$$(EPI_t) = \gamma_0 + \gamma_1(EI_t) + \gamma_2(EC_t) + \gamma_3(EDM_t) + \gamma_4(NET_t) + v_t$$

Where EI is E-Information, EC is E-Consultation, EDM is E-Decision Making and NET is the share of Individuals Using Internet among population.

- *The first stage Wald test*

Table 4 represents the first stage Wald test of instrument relevance outputs of the two models

Table 4 : The Wald test of the instruments relevance

Endogenous variable	Instruments	Wald F-statistic	p-value	Conclusion	Relevance
EPI	EI, EC, EDM, NET	153.33	0.0000	Reject H_0	Strong
EGDI	OSI, TII, ITI, HCI	3,406,662	0.0000	Reject H_0	Strong

$$H_0 \text{ of EGDI: } \beta_{OSI} = \beta_{TII} = \beta_{ITI} = \beta_{HCI} = 0 / H_0 \text{ of EPI: } \gamma_{EI} = \gamma_{EC} = \gamma_{EDM} = \gamma_{NET} = 0$$

As shown in Table 4, the first-stage Wald test results reject the null hypothesis that the instruments have no correlation with the endogenous explanatory variable (irrelevance), indicating that OSI, TII, ITI, and HCI are jointly significant determinants of EGDI. The Wald F-statistic is 3,406.662 ($p < 0.001$), substantially exceeding the conventional threshold of 10. This provides strong evidence of instrument relevance and suggests that weak-instrument concerns are unlikely for EGDI. Similarly, the first-stage results indicate that EI, EC, EDM, and NET are jointly significant determinants of EPI. The Wald F-statistic of 153.33 ($p < 0.001$) is substantially greater than the conventional threshold of 10, confirming strong instrument relevance and providing no evidence of weak instruments for EPI.

- *The first stage residual-inclusion*

Table 5 represents the residual-inclusion results of the two models

Table 5: Residual-inclusion results

Variable	Coefficient	t-statistic	p-value
RESID_EGDI	66.625	14.291	0.0000***
RESID_EPI	14.454	6.926	0.0000***
Constant	47.972	151.714	0.0000***

***Significant at the 1% level.

The results from Table 5 demonstrated statistically significant associations for both RESID_EGDI and RESID_EPI, showing a significance level of $p < 0.001$. Both residual coefficients are highly significant, therefore, the residual-inclusion Wald test provides strong evidence of endogeneity of EGDI and EPI.

- *Joint Wald test for endogeneity*

The following Table 6 represents the joint Wald test outputs for endogeneity

Table 6: Joint Wald test for endogeneity

Test	Statistic	df	p-value	Decision
Wald F-test	111.4515	(2, 19)	0.0000	Reject H_0
Chi-square	222.9029	2	0.0000	Reject H_0

$$H_0: \rho_{Resid_EGDI} = \rho_{Resid_EPI}, \text{ against } H_1: \text{at least one } \rho \neq 0$$

As shown, in Table 6, The Wald F-statistic of 111.45 ($p < 0.001$) rejects the null hypothesis that the first-stage residuals are jointly insignificant. This supports treating EGDI and EPI as endogenous variables and consequently justifies the use of an 2SLS estimation framework.

- *Sargan Overidentification Test*

The following Table 7 represents the Sargan overidentification test outputs

Table 7 : The Sargan overidentification test

Test	J-statistic	df	p-value	Decision at 5%
Sargan overidentification test	7.1730	6	0.3051	Do not reject H_0

H_0 :The overidentifying restrictions are valid

Results from Table 7 show that the Sargan overidentification test produces a J-statistic of 7.1730 with 6 degrees of freedom and a p-value of $0.05 < 0.3051$, the null hypothesis that the overidentifying restrictions are jointly valid cannot be rejected. Thus, the test provides no statistical evidence that the instruments are correlated with the structural error term, supporting the joint validity of the selected instruments. Therefore, the instrumental variables used for EGDI and EPI satisfy the Sargan overidentification test at the 5% significance level.

• **The 2SLS second stage estimation**

Table 8 provides the final 2SLS estimations

Table 8 : The final 2SLS estimations

Variable	Coefficient	Std. Error	t-Statistic	p-value
EGDI	44.2828	3.3397	13.2595	0.0000***
EPI	-6.6105	1.5000	-4.4069	0.0003***
Constant	30.8159	1.1988	25.7052	0.0000***
R ²	0.9214			
Adjusted R ²	0.9131			
F-statistic	111.7614			0.0000
J-statistic	7.1678			0.3056

***Significant at the 1% level.

As shown in Table 8, the 2SLS results indicate that EGDI has a positive and statistically significant effect on Governance Quality ($\beta = 44.283$; $p < 0.01$). This suggests that greater development of digital government is associated with improvements in governance quality, potentially through enhanced public service delivery, transparency, and administrative efficiency. In contrast, EPI has a negative and statistically significant effect on Governance Quality ($\beta = -6.610$; $p < 0.01$), indicating a significant inverse relationship between environmental performance and governance quality in the estimated model.

The model is jointly significant ($F = 111.761$; $p < 0.001$) and explains approximately 92.14% of the variation in Governance Quality, indicating strong overall explanatory power. Hence, the Sargan overidentification test does not reject the null hypothesis of valid overidentifying restrictions ($J = 7.168$; $p = 0.306$). This suggests that there is no significant evidence of instrument invalidity and therefore supports the reliability of the 2SLS specification.

5. DISCUSSION

The final results presented in Table 8 provide strong support for the central argument of this study that digital transformation can contribute to improvements in public management governance in Morocco. The positive and statistically significant coefficient of EGDI ($\beta = 44.283$; $p < 0.01$) is consistent with the main hypothesis and with the theoretical expectations developed in the introduction and literature review. In particular, Digital Governance Theory suggests that the adoption of digital technologies can improve administrative efficiency, transparency, accountability, service delivery, and citizen-government interactions. The finding therefore converges with previous studies such as Bertot et al. (2010), Nam (2012), Andersen (2009), and Shim and Eom (2008), which generally identify positive relationships between e-government development and governance outcomes. It also aligns with the Moroccan policy context described in the introduction, where digitalization strategies have explicitly sought to modernize public administration and improve the quality and accessibility of public services.

The magnitude and significance of the EGDI coefficient further suggest that digitalization is not merely associated with technological modernization but may have broader institutional implications. This result is particularly relevant to the literature emphasizing that digital platforms can reduce administrative delays, facilitate information sharing, and strengthen interactions between citizens and public institutions. In this respect, the findings converge with the Public Value Theory perspective presented in the literature review, according to which digital public-sector initiatives can generate value through improved service quality, citizen satisfaction, and trust in government. At the same time, the results should be interpreted in light of the more cautious strand of the literature. Scholars such as Heeks (2002) argue that digitalization does not automatically produce better governance because its effects depend on institutional capacity, infrastructure, human capital, and political commitment. The positive EGDI coefficient in the Moroccan case may therefore reflect not only the deployment of digital technologies themselves but also Morocco's relatively strong policy commitment and investment in digital public administration.

This interpretation is consistent with the introduction, which presents Morocco as a country that has progressively implemented national digital strategies and invested institutional and financial resources in public-sector digital transformation. Thus, the finding converges with the positive literature on e-government while also reinforcing the argument that the institutional context conditions the effectiveness of digitalization.

The negative and statistically significant coefficient of EPI ($\beta = -6.610$; $p < 0.01$), however, introduces an important point of divergence from the broader expectation that improvements in environmental performance should generally accompany better governance. Unlike EGDI, EPI is negatively associated with Governance Quality in the estimated model. This divergence suggests that the relationship between governance and other dimensions of public policy is not necessarily uniform. It may indicate that environmental performance operates through different institutional mechanisms or that environmental objectives and governance reforms do not progress at the same pace. The result is therefore consistent with the broader discussion in the literature that digital and institutional reforms can produce heterogeneous outcomes and that governance improvements depend on the interaction between different policy and institutional conditions. The literature review similarly emphasizes that digital transformation takes place within broader institutional environments and that its benefits cannot be separated from regulatory, organizational, and socioeconomic conditions.

Another important point of convergence concerns the methodological contribution of the study. The introduction highlights that previous research has often relied on descriptive analyses, case studies, or correlations and that reverse causality is a major concern because better-governed administrations may be more capable of adopting digital technologies. The 2SLS approach used here directly responds to this concern. The significant EGDI effect therefore provides stronger empirical evidence than a simple correlation would, because the estimation explicitly attempts to address the endogeneity problem identified in the literature. The Sargan test further strengthens this interpretation: since the null hypothesis of valid overidentifying restrictions is not rejected ($J = 7.168$; $p = 0.306$), there is no statistical evidence against the joint validity of the instruments. This result is particularly important given the methodological gap identified in previous Moroccan research.

Ultimately, the findings reveal both convergence and divergence with the existing literature. The positive and significant effect of EGDI strongly converges with the theoretical and empirical literature that associates digital government with greater administrative efficiency,

transparency, accountability, and governance quality. It also provides quantitative support for Morocco's strategy of using digital transformation as an instrument of public-sector modernization. However, the negative effect of EPI represents a divergence from a simple expectation of uniformly positive relationships between policy performance and governance. Taken together, these findings suggest that digital transformation has a particularly important role in improving governance quality in Morocco, but that governance outcomes remain multidimensional and may respond differently to other policy domains. This supports the study's broader argument that the effects of digitalization should be assessed empirically rather than assumed to be universally positive.

6. Policy implications, limitations and future directions

6.1. Policy implications

In light of these findings, a long-term strategic roadmap that links the effective digitalization of public services to improvements in public management governance quality should urgently take place, in which is emphasized a gradual and coordinated transition in which digital transformation is accompanied by institutional capacity building, human capital development, inclusive access to digital services, and stronger citizen engagement. In this perspective, service digitalization is not considered an end in itself, but rather a strategic instrument for enhancing administrative efficiency, transparency, accountability, and overall governance quality. More specifically the findings three dimensions of policy implications for Morocco.

First, the positive and significant effect of EGDI on governance quality suggests that continued investment in digital public services can contribute to improving administrative performance and governance. Moroccan policymakers should therefore prioritize the expansion and integration of digital government platforms, particularly those that simplify administrative procedures, improve access to public information, and strengthen interactions between citizens and public institutions. This is consistent with Morocco's ongoing digital transformation strategies and the broader objective of improving the efficiency, transparency, and accessibility of public services.

Second, digitalization policies should not focus exclusively on technological infrastructure. The literature reviewed in this study emphasizes the importance of institutional capacity, human capital, digital literacy, and inclusive access for ensuring that digital transformation produces effective governance outcomes. Consequently, investments in digital infrastructure should be accompanied by training programs for public officials and citizens, improved digital skills, and

measures aimed at reducing the digital divide, particularly among populations and regions with limited access to digital services.

Third, the negative and significant coefficient of EPI highlights the need for greater policy coordination between environmental policies and governance reforms. Rather than treating digital transformation, environmental performance, and governance as separate policy areas, policymakers should strengthen their integration. Digital technologies can potentially support environmental monitoring, information sharing, and more efficient public decision-making, but these benefits require appropriate institutional and regulatory arrangements.

6.2. Limitations

Despite its contributions, this study has several limitations. First, the analysis focuses on Morocco, which limits the generalizability of the findings to other countries, particularly those with substantially different institutional, economic, and technological contexts. Second, although the 2SLS approach addresses potential endogeneity, the validity of the results remains dependent on the quality and relevance of the selected instruments. The Sargan test provides no evidence against the overidentifying restrictions, but it cannot eliminate all possible concerns regarding instrument strength or specification.

Third, the use of composite indicators such as EGDI and the Governance Quality index may conceal differences between individual dimensions. Governance quality encompasses several components, including government effectiveness, regulatory quality, rule of law, control of corruption, voice and accountability, and political stability. The literature review itself recognizes that digitalization may produce heterogeneous effects across these dimensions. Therefore, the aggregate results should not necessarily be interpreted as evidence that digitalization affects every dimension of governance equally.

6.3. Future directions:

Future research could extend this analysis in several ways. First, comparative studies involving other African or developing countries would help determine whether the positive relationship between EGDI and Governance Quality observed in Morocco is specific to the Moroccan institutional context or reflects a broader pattern. This would also allow researchers to examine how differences in institutional capacity, infrastructure, and political commitment influence the effectiveness of digital transformation.

Second, future studies could disaggregate Governance Quality into its six individual dimensions to identify where the effects of digitalization are strongest or weakest. Such an

approach would provide a more detailed understanding of the mechanisms through which digital transformation influences governance.

Also, some of the future research should examine whether Moroccan regions with stronger digital skills training programs exhibit differential governance trajectories, and whether these effects are mediated by public sector absorption capacity.

Finally, future research could incorporate additional dimensions such as e-participation, human capital, digital inclusion, cybersecurity, and regional disparities. Longitudinal or panel-data approaches could also provide further evidence on the evolution of the relationship over time. Such extensions would build on the present study's 2SLS framework and contribute to a deeper understanding of the conditions under which digital transformation can generate sustainable improvements in public governance.

Conclusion

This paper examined the impact of Morocco's large-scale digital service inputs on public management governance quality over the period 2003–2024. Using a Two-Stage Least Squares (2SLS) approach to address endogeneity, the study analyzed how dimensions such as e-government development, e-participation, telecom infrastructure, and human capital affect a composite governance index comprising six standardized indicators. The empirical results yield two contrasting outcomes: E-government development exerts a strong, positive, and statistically significant effect on governance quality, confirming that institutional digitization and service modernization have paid off. Conversely, E-participation shows a negative and significant effect, revealing that citizen involvement through digital channels has not kept pace and may even be counterproductive under current conditions. Taken together, these findings paint a dual portrait of Morocco's digital transformation. On one hand, the state-led push for online services, connectivity, and administrative modernization is clearly bearing fruit, enhancing government effectiveness, regulatory quality, and control of corruption. On the other hand, the failure of e-participation to deliver positive results signals that digital access does not automatically translate into active civic engagement; rather, it may expose distrust, low digital literacy, or poorly designed feedback mechanisms that dilute rather than deepen accountability. Therefore, the paper concludes that Morocco's digital strategy must be recalibrated. The proposed long-term roadmap advocates for a two-pronged approach: continuing to strengthen e-government infrastructure while simultaneously investing in participatory culture, digital education, and responsive feedback loops. Only by bridging the gap between administrative efficiency and genuine citizen empowerment can Morocco ensure that its digital transformation becomes a true driver of inclusive, transparent, and resilient governance.

DECLARATIONS

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