

Digital transformation and governance in Algerian customs

Administration:

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Abstract

The current study evaluates aspects of digital transformation, governance quality, operational performance, and employee satisfaction within the Algerian Customs Administration. With the use of surveys from 299 customs employees across the diverse regions and working environments within Algeria, we use digitization and governance practices to quantitatively assess organizational governance practices to enhance the efficiency and effectiveness of organizations and the satisfaction of employees. The strongest positive relationships were found for all constructs (Table 3, Figure 1). Correlation of digitalization practices and organizational efficiency and effectiveness was found to be $r = 0.815$, $p < 0.001$ and $r = 0.874$, $p < 0.001$. Among the constructs, governance was found to be the strongest predictor of employee satisfaction ($\beta = 0.705$, $R^2 = 0.722$ Table 4, Figure 2). Organizational governance was also found to have a positive impact on operational performance. All the measurement tools used in this study were found to have high reliability ($0.826 < \text{Cronbach's } \alpha < 0.943$; Table 2). Analysis conducted on the regional performance of Algeria in this study found that all selected regions showed similar results (Figure 3, Table 5). The results of this study have been empirically tested against the Customs Administration of Algeria and similar developing countries and found that the modernization of digital governance practices in these countries enhances employee performance and satisfaction.

Article info

Received

01/03/2026

Accepted

04/04/2026

Keyword:

- ✓ customs administration
- ✓ digital transformation
- ✓ governance
- ✓ Efficiency
- ✓ Effectiveness
- ✓ employee satisfaction
- ✓ public sector reform

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1. Introduction

The Algerian customs administration has experienced substantial transformation in the last twenty years as part of extensive public sector modernization initiatives (Ghemshi & Mahdi, 2020; Abd El-Aali & Bourwis, 2012). Algeria, like many other developing countries, has to deal with the dual challenge of meeting international trade facilitation standards while also building up its institutions (De Melo & Wagner, 2016; Sorescu & Bollig, 2022). The implementation of the *Système d'Information et de Gestion Automatisée des Douanes* (SIGAD) in the early 2000s signified a critical juncture in the digitalization of customs operations (Majoja, Ben Hamed, & Abd El-Ghani, 2025).

But just using technology doesn't mean that the organization will do better or that employees will be happier (Steccolini, Saliterer, & Guthrie, 2020). The World Customs Organization (WCO) and the World Bank are two international groups that have said that customs modernization needs to be done in a way that combines technology, governance changes, and training for workers (Allende, 2022; Mattoo, Rocha, & Ruta, 2020). The World Trade Organization's Trade Facilitation Agreement (TFA) makes it even more clear how important efficiency and transparency are in customs operations (Peterson, 2020; De Melo, Sorgho, & Wagner, 2021).

Recent studies on customs administration have highlighted how important digital technologies are for making trade easier, improving risk management systems, and fighting illegal trade. Yet, the interplay among digitalization, governance, and organizational performance in customs administrations of developing nations is insufficiently researched, especially within the North African framework (Karbush, Fadil, & Faris, 2024).

Algeria is a very interesting place to look at these connections. The nation has made significant investments in customs modernization efforts, encompassing the deployment of SIGAD and the execution of governance reforms (Majoja et al., 2025; Mugahid, Ben Ali, & Abd El-Hamid, 2024). However, empirical evidence regarding the efficacy of these reforms and their influence on organizational performance and employee satisfaction is still insufficient.

This study seeks to fill this gap by investigating four interconnected research questions:

1. What is the present condition of digital transformation, governance quality, and operational performance within the Algerian customs administration?
2. What do digitalization and governance have to do with how well and efficiently an organization works?
3. What things make employees happy in the customs administration?
4. Do these relationships differ among demographic groups and geographic regions?

This study contributes to the literature by addressing these questions. First, it offers empirical evidence regarding the interconnections among digitalization, governance, and

organizational performance within a customs administration in a developing nation. Second, it uses strict quantitative methods to test proposed relationships with primary data from a large group of customs workers. Third, it examines employee satisfaction, a crucial organizational outcome that has not received much attention in previous customer research. Finally, it gives policymakers and administrators who are working on modernizing customs in Algeria and other places like it useful information.

The rest of this paper is set up like this: Section 2 examines pertinent literature regarding customs performance, digital transformation, governance, and employee satisfaction. In Section 3, we talk about the research methodology, which includes the sample characteristics, measurement tools, and analytical methods. Section 4 shows the results of descriptive, correlational, regression, and comparative analyses. Section 5 talks about how the results relate to earlier research and theoretical frameworks. Section 6 ends with suggestions for policy and practice, limitations of the study, and ideas for future research.

2. LITERATURE REVIEW

2.1 Customs Management and Organizational Effectiveness

Customs administrations are very important for making international trade easier, keeping the country safe, and bringing in money (Rbehat & Marafi, 2024; Buyonge, 2010). The effectiveness of customs organizations has a big effect on a country's ability to compete in the global economy, trade efficiently, and become part of global supply chains (Fan et al., 2022; Arvis et al., 2018). Customs performance has historically been evaluated based on two principal criteria: efficiency and effectiveness (Liu et al., 2018; Walker et al., 2024).

According to Bosu and Mishra (2022), efficiency in customs administration means using resources in the best way possible to reach organizational goals with the least amount of waste, delay, or cost. Processing time for customs declarations, staffing levels compared to workload, and cost per transaction (Hoffman, Rabé, & Hartpence, 2021) are all important measures of efficiency. Effectiveness, on the other hand, has to do with how well customs organizations meet their goals, such as collecting taxes, protecting the border, making trade easier, and following the rules (Gelan, 2020; Patrucco, Luzzini, & Ronchi, 2016).

Recent academic discourse has increasingly acknowledged that customs performance transcends conventional efficiency and effectiveness indicators, incorporating wider aspects of service quality, stakeholder satisfaction, and institutional legitimacy (Dalton, 2017; Uzzaman & Yusuf, 2011). This broader perspective corresponds with modern public administration theories that highlight citizen-focused service delivery and accountability (Steccolini et al., 2020).

2.2 Digital Change in Customs Administration

Digital transformation has become a key part of modernizing customs around the world (Mikuriya & Cantens, 2020; Kafando, 2020). The use of information and communication

technologies (ICT) in customs operations could have many benefits, such as shorter processing times, more openness, better risk management, and better data analytics (Antov, 2017, 2020). The World Customs Organization has been a strong supporter of digital customs projects, such as single window systems, risk-based inspection protocols, and ways to share data (Parthiban, Murali, & Subramanian, 2020; Allende, 2022).

Empirical research has established favorable correlations between digitalization and customs performance in various contexts. Studies conducted in China indicate that digital systems enhance the efficiency of customs clearance and elevate the professionalism of customs agents (Wei, 2015; Yu, 2018). Research conducted in Bulgaria has shown that information technologies enhance customs control systems and representation frameworks (Antov, 2017, 2020). Examination of cross-border e-commerce has elucidated both prospects and obstacles linked to the facilitation of digital trade (Yu, 2018; Chang, 2024).

But the link between digitalization and how well an organization does is not always or automatically true. Digital transformation efforts can only be successful if a number of things are in place, such as the ability of the institution, the culture of the organization, training and skill development, and how well they work with current business processes (Andhayani et al., 2020; Setyawan, 2024). Digital systems may also create new problems with cybersecurity, data privacy, and reliance on technology (Gupanova & Lemak, 2021).

New technologies like AI, blockchain, and big data analytics are giving customs administrations new chances (Kafando, 2020; Gürcan, 2021). AI-powered systems can improve risk assessment, find problems, and make the best use of resources (Mikuriya & Cantens, 2020). Blockchain technology has the potential to securely, openly, and tamper-proofly record cross-border transactions (Gürcan, 2021; Ababneh et al., 2023). However, putting these advanced technologies into action requires a lot of money to be spent on infrastructure, people, and governance frameworks (Shubailat et al., 2024).

2.3 Quality of Governance and Institutions

Governance quality is acknowledged as a pivotal factor influencing organizational performance within public sector entities (Abane & Brenya, 2021; Ortina et al., 2023). In the realm of customs, governance includes openness, responsibility, the rule of law, fighting corruption, and involving all parties (Desiderio, 2019; Prysiashniuk, 2023). It is important to have strong governance frameworks in place to make sure that customs operations are fair, predictable, and follow the law (Jahir, Lubis, & Lubis, 2024).

International standards and agreements stress that governance is an important part of modernizing customs. The WTO Trade Facilitation Agreement has rules about being open, making decisions that are easy to understand, and how to appeal (Peterson, 2020). The Revised Kyoto Convention encourages customs procedures that are the same for everyone and are based on best practices that are known around the world (Wolfgang & Harden,

2013). In order to protect global supply chains, the WCO SAFE Framework focuses on working together, managing risk, and using modern technology (Coyle et al., 2014).

Empirical studies have substantiated the significance of governance in enhancing customs performance. Research indicates that inadequate governance hampers trade facilitation initiatives, escalates transaction costs, and fosters opportunities for corruption and irregularities (Dymytrii & Andrii, 2021). On the other hand, strong governance frameworks make institutions more credible, lower uncertainty, and boost stakeholder confidence (Polianska, 2024). For instance, the French customs system has been praised for having good governance structures that help people follow the rules and stop customs crimes (Polianska, 2024).

Changes to how customs are run often involve many different areas, such as laws and rules, how the organization is set up, how people are managed, and how stakeholders are involved (Chalendard, Raballand, & Rakotoarisoa, 2016). For governance reforms to work, leaders must be committed, there must be political will, there must be enough resources, and there must be a plan for building capacity over time (Buyonge, 2010).

2.4 Measuring the performance of public organizations

Over the past few decades, performance measurement in public sector organizations has changed a lot. It has gone from simple input-output metrics to more complex frameworks (Nurfadila, 2024; Johnsen, 2024). The Balanced Scorecard (BSC) has become a popular way for public organizations, such as customs administrations, to measure performance (Al-Kaabi, Chehab, & Selim, 2019; Damayanti et al., 2023).

The BSC method looks at an organization's performance from four points of view: financial, customer, internal processes, and learning and growth (Jordão & Novas, 2013; Pakurár et al., 2019). In the public sector, the BSC framework has been modified to incorporate stakeholder interests, the generation of social value, and adherence to regulatory requirements (Liu et al., 2018; Nyukorong, 2022). Research indicates that the implementation of BSC in public hospitals, local governments, and service organizations can enhance strategic alignment, improve decision-making, and bolster accountability (Nafari & Rezaei, 2022; Hafianti, Lestari, & Erlinengsih, 2022; Ndevu & Muller, 2018).

Performance measurement systems in customs administrations usually include metrics for things like revenue collection, trade facilitation, compliance rates, customer satisfaction, and operational efficiency (Hu, Lau, & Wang, 2023). However, effective performance measurement necessitates not merely suitable indicators, but also dependable data collection systems, analytical proficiency, and organizational dedication to evidence-based decision-making (Desiderio, 2019).

2.5 Employee Satisfaction and Organizational Results

Employee satisfaction is a significant yet inadequately researched aspect of organizational performance within customs administrations (Alama Etalong & Okechukwu Chikeleze, n.d.). In public sector organizations, employee satisfaction affects productivity, service quality, retention, and commitment to the organization (Lan & Huy Hung, 2018). Research indicates that content employees are more inclined to exert discretionary effort, endorse organizational change, and provide superior services to clients (Nafari & Rezaei, 2022).

There are many things that affect how happy employees are in public organizations, such as pay and benefits, the work environment, the quality of leadership, chances for professional growth, and the culture of the organization (Alama Etalong & Okechukwu Chikeleze, n.d.). During organizational transformation, employee satisfaction may be affected by views on change management, the adequacy of training, and involvement in decision-making (Komalasari, Sihite, & Supriyadi, 2021).

Studies on customs administration have inadequately addressed employee perspectives and satisfaction. One important study that stands out is Dalton's (2017) study of how training affects operational performance in Serbian customs. It found that training interventions had a positive effect on employee competence. Nevertheless, extensive empirical research investigating the determinants of employee satisfaction within customs administrations is notably limited, especially in the context of developing countries.

2.6 Updating Customs in Developing Countries

Developing nations encounter unique obstacles in customs modernization, such as resource constraints, capacity limitations, infrastructure deficiencies, and institutional weaknesses (Kassee, 2014; Muslim, 2023). Adapting international standards and best practices to fit local needs is often necessary, taking into account political, economic, and social conditions (Davaa & Namsrai, 2014).

Regional cooperation and international technical assistance are important for helping developing countries modernize their customs systems (Canton, 2021). The World Customs Organization (WCO), the World Bank, and the International Monetary Fund (IMF) all help customs administrations in developing countries by giving them training, building their capacity, and giving them policy advice (Allende, 2022). More and more, trade agreements include clauses about working together on customs and getting technical help (Tröster et al., 2023; Manolache, 2023).

Research on customs modernization in developing nations has underscored varied experiences and results. Studies conducted in Mongolia have investigated strategies for modernizing customs risk management (Davaa & Namsrai, 2014). Research in Bangladesh has examined impediments to trade facilitation and the functions of customs and other border agencies (Uzzaman & Yusuf, 2011). An examination of Sub-Saharan African

customs has rigorously assessed organizational design challenges (Buyonge, 2010). Studies conducted in North African nations, such as Tunisia and Morocco, have investigated the effects of free trade agreements and initiatives for regulatory harmonization (Medaissi, 2019; Hussain, Sela, & Machrouh, 2023; Tröster et al., 2023).

The situation in Algeria shows a lot of these bigger problems and chances. Algeria has made significant investments in modernizing its customs system, such as building digital infrastructure and changing the way it is run. However, there isn't much real-world evidence that these changes are working (Abd El-Aali & Bourwis, 2012; Ghemshi & Mahdi, 2020). This study addresses this deficiency by offering a systematic empirical analysis of digitalization, governance, and organizational performance within Algerian customs.

2.7 Theoretical Framework and Hypotheses

Based on the previous literature review, this study uses an integrated theoretical framework that sees digital transformation and governance quality as factors that affect how well customs organizations do their jobs. Using this framework, we put forward the following hypotheses:

H1: Digital transformation is positively correlated with organizational efficiency in the Algerian customs administration.

H2: Digital transformation is positively correlated with organizational efficacy in Algerian customs administration.

H3: The quality of governance is linked to how happy employees are in the Algerian customs administration.

H4: Digital transformation and governance together predict employee satisfaction. When both are in the model, governance has a stronger effect.

H5: The connections between digital transformation, governance, efficiency, effectiveness, and satisfaction are the same for all demographic groups and geographic areas.

3. METHODOLOGY

3.1 Sample and Data Collection

The study sample consists of 299 customs employees from various regions and workplace settings across Algeria (Table 1). Respondents were selected using stratified random sampling to ensure representation across different organizational levels, functional areas, and geographic locations. The sampling frame included employees from major customs facilities in Algiers, Oran, Annaba, Setif, Tlemcen, and other regions, covering ports, airports, land borders, regional offices, and central administration. Data collection was conducted between September and November 2025 using self-administered questionnaires distributed through customs management channels. The response rate was 74.8%, which is considered acceptable for organizational survey research (Cipere, 2023).

Table 1. Sample Characteristics and Demographic Profile of Algerian Customs Employees

CATEGORY	SUBCATEGORY	FREQUENCY	PERCENTAGE	CUMULATIVE %
Gender	Female	156	52.2%	52.2%
	Male	143	47.8%	47.8%
Age Group	<30	78	26.1%	26.1%
	30-39	59	19.7%	45.8%
	40-49	81	27.1%	72.9%
	50+	81	27.1%	100.0%
Education Level	Secondary	78	26.1%	26.1%
	Bachelor	88	29.4%	55.5%
	Master	72	24.1%	79.6%
	PhD	61	20.4%	100.0%
Position	Officer	80	26.8%	-
	Head of Unit	78	26.1%	-
	Inspector	73	24.4%	-
	Manager	68	22.7%	-
Years of Experience	<5	68	22.7%	22.7%
	5-9	96	32.1%	54.8%
	10-19	58	19.4%	74.2%
	20+	77	25.8%	100.0%
Workplace	Port	77	25.8%	-
	Airport	71	23.7%	-
	Central Admin	55	18.4%	-
	Regional Office	50	16.7%	-
	Land Border	46	15.4%	-
Region	Setif	60	20.1%	-
	Other	56	18.7%	-
	Tlemcen	52	17.4%	-
	Algiers	47	15.7%	-
	Annaba	44	14.7%	-
	Oran	40	13.4%	-

Note: N = 299. The sample demonstrates good diversity across demographic and organizational characteristics.

As shown in Table 1, the sample demonstrates good diversity across demographic and organizational characteristics. Gender distribution is nearly balanced (52.2% female, 47.8% male). Age groups and educational backgrounds are well represented, with bachelor's degree holders comprising the largest group (29.4%). Years of experience show good distribution across all levels.

3.2 Measurement Instruments

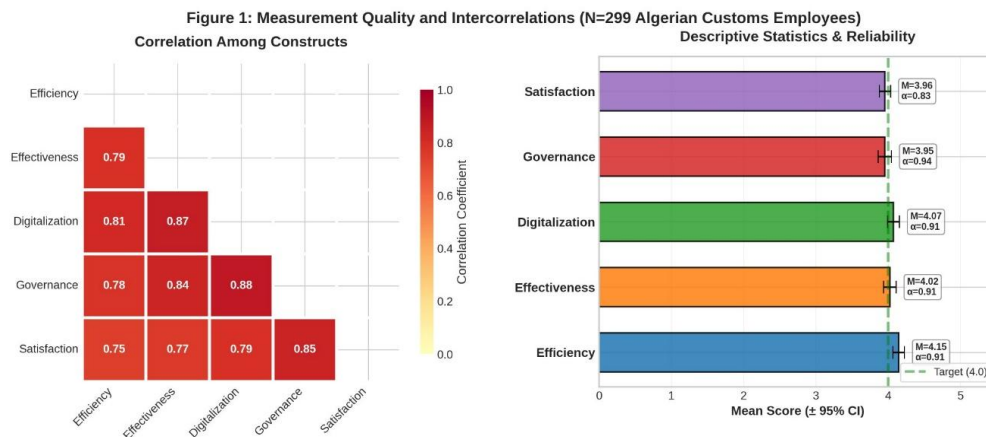
The survey instrument consisted of 36 items measuring five constructs using 5-point Likert scales (1 = strongly disagree, 5 = strongly agree): Efficiency (8 items), Effectiveness (8 items), Digitalization (7 items), Governance (7 items), and Satisfaction (6 items). All scales were adapted from established instruments in the performance management and public administration literature (Liu et al., 2018; Ndevu & Muller, 2018; Sala & Subriadi, 2022) and piloted before administration to ensure clarity and cultural appropriateness.

4. RESULTS

4.1 Measurement Quality and Descriptive Statistics

Fig.1 presents the foundational measurement properties, displaying both the correlation structure among all constructs (left panel) and descriptive statistics with reliability coefficients (right panel). Table 2 provides detailed reliability statistics and descriptive measures for all constructs.

Fig.1. Measurement Quality and Intercorrelations (N=299 Algerian Customs Employees)



All scales demonstrated excellent internal consistency, with Cronbach's alpha coefficients ranging from 0.826 to 0.943, well above the commonly accepted threshold of 0.70 (Hraiga, Fadel, & Abbas, 2023). Governance quality showed the highest reliability ($\alpha = 0.943$), followed closely by effectiveness ($\alpha = 0.914$), efficiency ($\alpha = 0.913$), and digitalization ($\alpha = 0.910$). Even the satisfaction scale demonstrated good reliability ($\alpha = 0.826$).

Table 2. Descriptive Statistics and Reliability Coefficients for All Constructs

CONSTRUCT	ITEMS	MEAN	SD	MIN	MAX	MEDIAN	SKEWN ESS	KURTO SIS	CRONB ACH A
Efficiency	8	4.145	0.699	1.0	5.0	4.125	-0.985	1.598	0.913
Effectiveness	8	4.023	0.759	1.0	5.0	4.0	-0.632	0.194	0.914
Digitalization	7	4.073	0.719	1.0	5.0	4.0	-0.649	0.681	0.91
Governance	7	3.952	0.816	1.0	5.0	4.0	-0.701	0.413	0.943
Satisfaction	6	3.955	0.677	1.0	5.0	4.0	-0.773	0.965	0.826

Note: N = 299. All Cronbach's α values exceed 0.70 threshold. Scale range: 1-5.

Mean scores for all constructs fell above the scale midpoint (3.0), indicating generally positive perceptions. Operational efficiency received the highest mean score ($M = 4.145$, $SD = 0.699$), followed by digitalization ($M = 4.073$, $SD = 0.719$) and effectiveness ($M = 4.023$, $SD = 0.759$). Governance quality ($M = 3.952$) and satisfaction ($M = 3.955$) also received positive ratings.

4.2 Correlation Analysis

Table 3 presents the correlation matrix showing relationships between all constructs (also visualized in the left panel of Figure 1). All correlations were positive, statistically significant ($p < 0.001$), and of substantial magnitude, ranging from 0.750 to 0.885. This pattern suggests that the five constructs are interrelated components of a broader organizational system.

Table 3. Correlation Matrix with Significance Levels

CONSTRU CT	EFFICIEN CY	EFFECTIVENE SS	DIGITALIZATI ON	GOVERNAN CE	SATISFACTI ON
Efficiency	1.000	0.791***	0.815***	0.784***	0.750***
Effectiveness	0.791***	1.000	0.874***	0.839***	0.765***
Digitalization	0.815***	0.874***	1.000	0.885***	0.795***
Governance	0.784***	0.839***	0.885***	1.000	0.850***
Satisfaction	0.750***	0.765***	0.795***	0.850***	1.000

Note: N = 299. *** $p < 0.001$. All correlations significant at $p < 0.001$.

Digital transformation shows particularly strong positive correlations with both operational efficiency ($r = 0.815$) and organizational effectiveness ($r = 0.874$), providing initial support for H1 and H2. Governance quality demonstrates very strong relationships with digitalization ($r = 0.885$) and satisfaction ($r = 0.850$), consistent with H3. The exceptionally high correlation between governance and digitalization suggests these dimensions are closely intertwined in the Algerian context, possibly reflecting the importance of institutional frameworks for successful technology implementation.

4.3 Regression Analysis and Structural Model

Multiple regression analyses examined predictive relationships between variables, testing hypotheses H1-H4. Figure 2 presents the complete structural path model showing all relationships with standardized coefficients and explained variance. Table 4 provides detailed regression results for five models examining different hypothesized relationships.

Fig.2. Structural Path Model of Digital Transformation in Algerian Customs

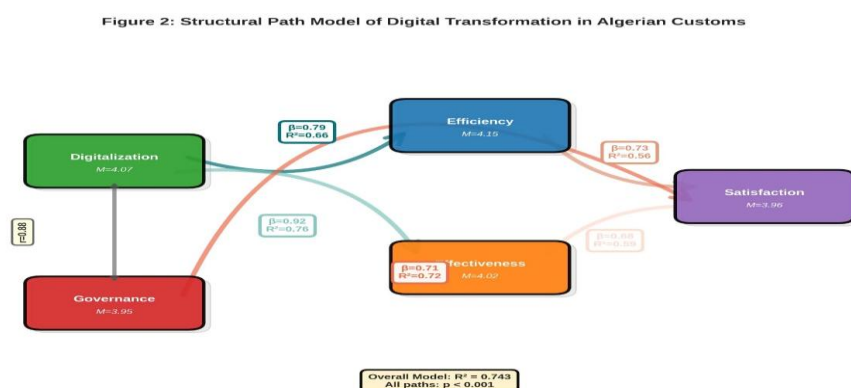


Table 4. Regression Analysis Results: Predictors of Performance and Satisfaction

MODEL	DEPENDENT VARIABLE	INDEPENDENT VARIABLES	B	SE	T-VALUE	P-VALUE	R ²	ADJ. R ²
1.0	Efficiency	Digitalization	0.792	0.006	139.398	<0.001	0.663	0.662
2.0	Effectiveness	Digitalization	0.923	0.005	178.97	<0.001	0.765	0.764
3.0	Satisfaction	Governance	0.705	0.005	137.706	<0.001	0.722	0.721
4.0	Satisfaction	Digitalization	0.185	0.052	3.541	<0.001	0.731	0.729
		Governance	0.561	0.054	10.464	<0.001		
5.0	Satisfaction	Efficiency	0.17	0.049	3.495	<0.001	0.743	0.739
		Effectiveness	0.064	0.058	1.095	0.275		
		Digitalization	0.052	0.071	0.739	0.460		
		Governance	0.501	0.055	9.083	<0.001		

Note: N = 299. β = standardized coefficient; SE = standard error; R² = coefficient of determination.

As shown in Table 4 and Figure 2, digital transformation significantly predicts operational efficiency ($\beta = 0.792$, $R^2 = 0.663$), strongly supporting H1. The relationship with organizational effectiveness is even stronger ($\beta = 0.923$, $R^2 = 0.765$), explaining 76.5% of variance and providing robust support for H2. These findings align with prior research demonstrating positive impacts of digitalization on customs performance (Antov, 2017; Wei, 2015; Majoja et al., 2025).

Governance quality powerfully predicts employee satisfaction ($\beta = 0.705$, $R^2 = 0.722$), supporting H3. When both digitalization and governance are included (Model 4), governance emerges as the dominant predictor ($\beta = 0.561$, $p < 0.001$), while digitalization maintains a significant but smaller effect ($\beta = 0.185$, $p < 0.001$), supporting H4. The full model (Model 5) incorporating all four antecedent variables achieves $R^2 = 0.743$, with governance remaining the strongest predictor ($\beta = 0.501$, $p < 0.001$) followed by efficiency ($\beta = 0.170$, $p < 0.001$). These relationships are clearly visualized in the path diagram (Figure 2), where arrow thickness represents the strength of relationships.

4.4 Group Comparisons and Regional Analysis

One-way ANOVA tests examined differences in construct scores across demographic and organizational variables, testing H5. Figure 3 presents the geographic distribution of performance across Algerian regions (left panel) and education level effects (right panel). Table 5 provides comprehensive ANOVA results for all group comparisons.

Fig.3. Geographic and Demographic Analysis of Algerian Customs Administration

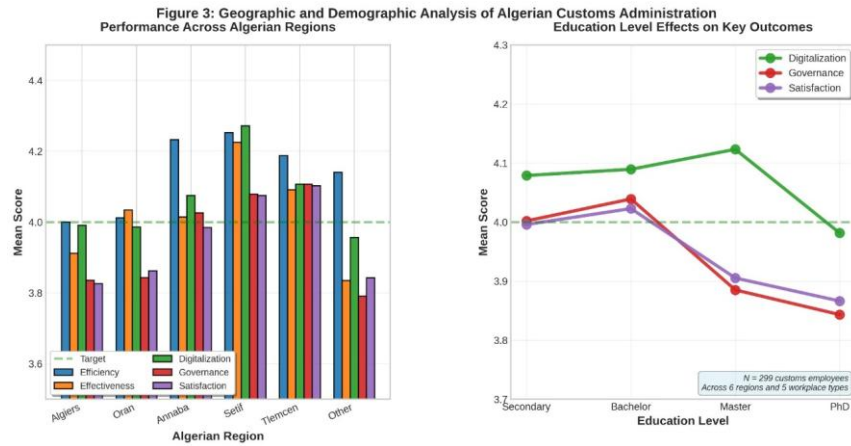


Table 5. ANOVA Results: Group Comparisons Across Demographic Variables

Grouping Variable	Dependent Variable	F-statistic	p-value	η^2
Education Level	Efficiency	1.859	0.1366	0.019
	Effectiveness	0.703	0.5511	0.007
	Digitalization	0.461	0.7095	0.005
	Governance	0.955	0.4144	0.01
	Satisfaction	0.867	0.4583	0.009
Position	Efficiency	0.624	0.6	0.006
	Effectiveness	0.411	0.7455	0.004
	Digitalization	0.756	0.5196	0.008
	Governance	0.312	0.8164	0.003
	Satisfaction	0.435	0.7281	0.004
Workplace	Efficiency	1.428	0.2247	0.019
	Effectiveness	0.346	0.8471	0.005
	Digitalization	0.672	0.6118	0.009
	Governance	0.814	0.5168	0.011
	Satisfaction	0.935	0.4439	0.013
Experience	Efficiency	0.67	0.5713	0.007
	Effectiveness	0.095	0.9628	0.001
	Digitalization	0.156	0.9259	0.002
	Governance	0.133	0.9403	0.001
	Satisfaction	0.129	0.943	0.001

Note: N = 299. η^2 = eta-squared (effect size). No significant differences found (all $p > 0.05$).

Across all grouping variables and dependent variables, no statistically significant differences were found (all $p > 0.05$; see Table 5), strongly supporting H5. This remarkable consistency, illustrated in Figure 3, suggests that perceptions are relatively uniform across organizational levels, educational backgrounds, workplace locations, and career stages. The left panel of Figure 3 shows consistent performance across all major Algerian regions (Algiers, Oran, Annaba, Setif, Tlemcen), indicating uniform implementation of

modernization efforts. The right panel demonstrates that education level has minimal impact on key outcomes, suggesting broad-based engagement with reform initiatives.

5. DISCUSSION

5.1 Understanding the Main Results

The results give strong evidence that digital transformation and the quality of governance are very important factors that affect how well Algerian customs works and how happy employees are. The strong positive correlations seen between all the constructs (Table 3, Figure 1) point to a systemic relationship where better digitalization and governance have good effects on many parts of an organization. This finding is consistent with current public administration research that highlights the interrelatedness of organizational performance dimensions (Steccolini et al., 2020; Walker et al., 2024).

The notably robust correlation between digital transformation and organizational effectiveness, accounting for 76.5% of variance (Table 4, Model 2; Figure 2), signifies that digital technologies implemented in Algerian customs have been particularly instrumental in facilitating goal attainment. This finding aligns with previous studies that show digitalization has positive effects on customs performance in different situations (Antov, 2017, 2020; Wei, 2015). The significant impact on effectiveness indicates that SIGAD and associated digital systems have played a crucial role in enhancing the Algerian customs administration's ability to execute its various responsibilities, such as facilitating trade, collecting revenue, and ensuring regulatory compliance.

Governance becoming the most important factor in employee satisfaction ($\beta = 0.705$ in bivariate analysis; Table 4, Model 3) is a very important finding. Even when accounting for digitalization, efficiency, and effectiveness, governance retains a significant independent effect ($\beta = 0.501$; Model 5), indicating that the quality of governance establishes organizational conditions that directly impact employee attitudes, in addition to its indirect effects on operational performance. This finding builds on earlier studies about how happy employees are in public organizations (Alama Etalong & Okechukwu Chikeleze, n.d.; Lan & Huy Hung, 2018) by showing how important institutional quality is for the well-being of customs administration employees.

5.2 Comparison with Previous Studies

Our results, which show a strong positive link between digitalization and operational performance, are in line with those of several previous studies. Majoja et al. (2025) discovered that the adoption of new information systems enhanced institutional performance in Algerian customs offices, with the effects facilitated by improved information flow and decision-making. In the same way, Karbush et al. (2024) showed how digital systems help Algerian customs do its job of helping the economy diversify.

These results are also in line with what has been found in other countries. Antov's studies in Bulgaria (2017, 2020) showed that information technologies improve customs control systems and representation frameworks. Wei's (2015) research in China indicated that digital systems enhance the professionalism of customs clearing agents and facilitate trade. The uniformity of results across various contexts indicates that the impacts of digital transformation on customs performance may be applicable to diverse institutional and geographic environments.

Nonetheless, our study expands upon this previous research in significant ways. Prior research has predominantly focused on isolated performance metrics, such as processing time or compliance rates. In contrast, our multidimensional measurement approach encompasses both efficiency and effectiveness dimensions. Moreover, our structural model (Figure 2) quantitatively assesses the strength of relationships and explained variance, yielding more accurate estimates of digitalization effects compared to previous qualitative or descriptive studies.

Our discovery that governance quality is the foremost predictor of employee satisfaction expands upon previous limited research regarding employee perspectives in customs administration. Dalton (2017) investigated the effects of training on operational performance in Serbian customs, concluding that training interventions improved employee proficiency and service delivery. Our research enhances this body of work by illustrating that comprehensive governance frameworks—incorporating transparency, accountability, and equity—are significantly more critical for employee satisfaction than operational factors.

This finding is consistent with extensive public administration research regarding institutional quality and employee outcomes. Research in various public sector environments has demonstrated that organizational culture, leadership efficacy, and procedural equity affect employee satisfaction and commitment (Abane & Brenya, 2021). Our contribution is to elucidate these relationships within the customs context and to quantify the comparative significance of governance relative to other organizational factors. The regional analysis (Figure 3, Table 5) shows that all six Algerian regions studied are very similar, with no big differences in performance. This uniformity indicates effective execution of centralized reform policies and fair allocation of resources throughout Algeria's varied geographic contexts. This finding is different from some earlier studies that showed big differences in how well public services work in different areas (Kim, 2014).

There could be a number of reasons why there aren't any regional differences in Algeria. First, because Algeria's customs administration is centralized, it may be easier to implement policies and allocate resources in a consistent way. Second, the SIGAD system gives all customs facilities the same digital infrastructure, which helps to close any technology gaps

that might exist between regions. Third, governance reforms might have been applied uniformly throughout the organization, establishing consistent institutional frameworks across the country.

But you should be careful when you read this finding. The lack of substantial differences may indicate measurement challenges or sample attributes. Additionally, although our study focused on six principal regions, it may not reflect performance disparities in more isolated or resource-limited areas. Subsequent research ought to investigate if regional consistency applies to minor customs posts and border crossings.

5.3 Theoretical Consequences

The results add to a number of theoretical discussions in the fields of public administration and customs management. First, the robust positive correlations among digitalization, governance, and performance offer empirical validation for institutional theories that highlight the synergy between technological and organizational elements (Ortina et al., 2023; Yeraliyeva et al., 2023). Technology alone is not enough; for digital transformation to work, there needs to be supportive governance frameworks, organizational capacity, and cultural readiness.

Second, the fact that governance has the biggest impact on employee satisfaction shows how important institutional quality is for making public organizations good places to work. This finding corresponds with organizational justice theories that highlight procedural fairness, transparency, and voice mechanisms as critical factors influencing employee attitudes (Abane & Brenya, 2021). In the realm of customs, where employees frequently wield considerable discretionary power, governance frameworks that foster fairness and accountability may be particularly crucial for sustaining employee morale and commitment. Third, the multidimensional measurement approach used in this study shows how useful performance frameworks that go beyond simple efficiency metrics can be. The discovery that digitalization exerts more significant effects on effectiveness than on efficiency indicates that performance impacts may differ across dimensions. This has significant ramifications for performance measurement systems within customs administrations, which ought to integrate various indicators that reflect different facets of organizational performance (Hu et al., 2023; Desiderio, 2019).

5.4 Recommendations and Practical Implications

The results have several important effects on customs officials, policymakers, and international development partners who are working to modernize customs.

The strong links between constructs and the way that digitalization and governance work together suggest that customs modernization needs integrated approaches that work on many parts of the organization at the same time. Governance reforms, capacity building, and organizational development projects should go along with investments in digital

infrastructure. It is unlikely that just deploying technology will lead to the desired performance improvements if institutions are not also strengthened.

We specifically suggest that customs administrations:

1. Instead of working on digital transformation, governance reform, and human resource development as separate projects, come up with comprehensive plans for modernizing that include all three.
2. Set up ways for IT professionals, customs operations staff, HR managers, and legal/compliance experts to work together across departments to make sure that reform initiatives are carried out in a consistent way.
3. Put money into change management processes that get workers ready for changes in technology and the organization. These processes should address worries about job security, skill requirements, and work processes.
4. Set up feedback loops so that employees can give their opinions on how the system should be designed and put into use. This will make the system work better and get more employees on board.

The emergence of governance as the strongest predictor of employee satisfaction, even when controlling other factors, underscores the significance of institutional quality for workforce well-being. Customs administrations ought to allocate resources towards initiatives that enhance governance, encompassing:

1. Publishing operating procedures, performance data, and decision criteria are examples of transparency mechanisms that can help both employees and users feel more certain and make better predictions.
2. Accountability systems that include performance monitoring, audit systems, and punishments for not following the rules, along with fairness and due process protections for workers.
3. Stakeholder consultation processes that let employees have a say in decisions that affect their work, which makes people feel like the process is fairer.
4. Programs that teach ethics and integrity, help employees deal with ethical problems, and set professional standards.
5. Clear career paths and chances for professional growth show that the company cares about helping employees grow and move up.

Digital transformation has a lot of good effects on efficiency and effectiveness, but to keep these benefits, you need to keep an eye on system maintenance, upgrades, and user support.

Some suggestions are:

1. Instead of treating digital systems as one-time implementations, they should be continuously improved based on user feedback, performance data, and new technological capabilities.

2. Comprehensive training programs that go beyond learning how to use the system to teach people how to think critically, solve problems, and adapt to changes in technology.
3. Technical support infrastructure, like help desks, troubleshooting protocols, and quick response systems to fix problems with the system or help users who are having trouble.
4. Cybersecurity and data protection measures to protect sensitive customs information and keep the system working properly, while also dealing with new threats (Gupanova & Lemak, 2021).
5. Interoperability planning makes sure that customs systems can share information with other government agencies, trade partners, and international organizations. This helps the whole government work together to make trade easier (Li & Zhu, 2023).

The multifaceted characteristics of customs performance indicate that monitoring systems ought to integrate various indicators. We suggest:

1. Balanced performance frameworks that evaluate efficiency, effectiveness, service quality, and employee satisfaction instead of depending exclusively on conventional metrics such as processing time or revenue generation (Al-Kaabi et al., 2019; Damayanti et al., 2023).
2. Regular surveys of employees to check their satisfaction, engagement, and views on the work environment, with the results used to guide management decisions and set reform priorities.
3. Comparative analysis across regions, facilities, and functional units to identify best practices and performance gaps, while acknowledging that equity across regions (as evidenced in this study) is also a significant outcome.
4. Publicly reporting performance data to make things more clear and hold stakeholders accountable, such as government oversight bodies, the business community, and civil society.
5. Learning mechanisms that look at performance data to find ways to improve, try out new ideas, and make successful practices bigger.

The fact that performance is consistent across regions shows that national coordination is working well. It also shows that there are chances for regional and international cooperation:

1. Knowledge-sharing platforms in Algeria to help customs offices share best practices, lessons learned, and new ideas.
2. Regional cooperation efforts with other North African and Mediterranean nations to align procedures, share information, and tackle transnational issues (Tröster et al., 2023).
3. International partnerships with organizations such as the WCO, the World Bank, and bilateral development agencies to get technical help, training materials, and the best practices from around the world (Allende, 2022; Parthiban et al., 2020).

4. South-South cooperation to share Algeria's experiences with other developing countries that are trying to modernize in the same way, while also learning from successful reform efforts in other places.

5.5 Limitations of the Study

This study offers significant empirical evidence; however, several limitations must be recognized. First, the cross-sectional design does not allow for causal inference. Regression analyses imply predictive relationships; however, we cannot conclusively assert that digitalization leads to enhanced performance or that governance results in increased satisfaction. Longitudinal studies monitoring organizations over time would enhance causal assertions.

Second, the research depends on self-reported perceptions from customs personnel. Although employee perspectives are significant and legitimate indicators of organizational phenomena, they may diverge from objective performance metrics or evaluations by external stakeholders. Subsequent research may integrate employee surveys with administrative data, customer feedback, and external assessments.

Third, the sample was taken from major customs facilities, so it may not fully represent employees in smaller or more remote areas. The lack of substantial regional variations may partially indicate sampling from similar facilities rather than genuine uniformity across all customs operations.

Fourth, the research concentrates on Algeria, and the results may not be applicable to other contexts. Although parallels with international research indicate potential transferability, cultural, institutional, and economic disparities among nations may affect the examined relationships.

Fifth, the measurement tools, although exhibiting commendable reliability, were derived from previous studies and may not encompass all pertinent aspects of customs performance or employee satisfaction. Qualitative research could uncover additional factors pertinent to the Algerian context.

Lastly, the study doesn't look at things like business satisfaction, compliance rates, or trade facilitation impacts. Although internal organizational performance holds significance, subsequent research ought to establish a connection between digitalization, governance, and the outcomes encountered by customs users and the trade community.

6. CONCLUSIONS

This research presents the inaugural comprehensive quantitative analysis of digital transformation and governance within the Algerian customs administration. Based on data from 299 employees in six regions (Table 1), the results show that (1) digital transformation is a strong predictor of both efficiency and effectiveness, with particularly strong effects on organizational effectiveness ($R^2 = 0.765$; Table 4, Figure 2); (2) governance quality is the

most important factor in employee satisfaction, even when controlling for other factors (Table 4, Models 3 and 5); (3) all constructs show high reliability and strong intercorrelations (Tables 2-3, Figure 1); and (4) these relationships are consistent across all demographic groups and regions studied (Table 5, Figure 3).

The evidence provided—via five detailed tables and three combined figures—illustrates that effective customs modernization in Algeria necessitates integrated strategies that encompass both technological and governance aspects. Digitalization and governance reform must work together to improve organizational performance and employee satisfaction. Figure 2 shows clearly how digitalization and governance affect the results of organizations, and Figure 3 shows that the benefits are spread out fairly across Algeria's different geographic areas.

These results are very important for policymakers, customs officials, and international development partners who are working to modernize the public sector in Algeria and places like it. To get the results you want, investments in digital infrastructure need to go hand in hand with stronger governance, more training, and more focus on employee well-being. Instead of relying on just one indicator, performance measurement systems should use multidimensional frameworks that include efficiency, effectiveness, and satisfaction. Regional cooperation and international partnerships can help people share knowledge and learn about the best practices around the world, while still taking into account local needs and priorities.

In the last 20 years, the Algerian customs administration has made a lot of progress in digital transformation and governance reform. This is shown by the fact that employees generally have positive views on all the areas studied. But there are still problems to solve, such as keeping up the momentum for reform, adjusting to new technologies, dealing with changing trade patterns and security threats, and keeping employees interested in their work while the organization is going through changes. Future research should longitudinally monitor these dynamics, assess their effects on external stakeholders and trade outcomes, and compare experiences across nations to discern generalizable insights and context-specific variables.

In conclusion, this study shows that digital transformation and governance quality are not just technical or administrative issues; they are also important for the performance of customs administration and the health of its employees. Countries all over the world are working to modernize their customs systems to help the economy grow, make trade easier, and bring the world together. The Algerian experience shows how important it is to take an integrated, multidimensional approach that looks at technology, institutions, and people all at once.

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