Technical-Institutional Decoupling in Domestic Water Services: Evidence from Southern Algeria

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Abstract

Water service performance is conventionally assessed through technical indicators such as network coverage, pressure levels, and supply continuity. Yet empirical evidence increasingly suggests that infrastructural conditions and institutional governance do not necessarily move in the same direction, producing misleading assessments when treated as equivalent. This study examines the relationship between technical performance and institutional governance in domestic water distribution services in El Oued, southeastern Algeria, a Saharan region characterized by arid environmental conditions, groundwater dependency, and persistent urban–rural service disparities. Drawing on a sequential explanatory mixed-methods design, the study combines a stratified household survey **($n = 300$)** with semi-structured interviews **($n = 30$)** to measure and interpret urban–rural differences across both dimensions. Quantitative results reveal a large and statistically significant urban advantage in technical performance **($d = 1.359$)**, while institutional governance was rated substantially more positively in rural areas **($d = -0.825$)**. Critically, the two dimensions are strongly and negatively correlated **($r = -0.487$, $p < 0.001$)**, indicating structural decoupling rather than incidental divergence. Qualitative findings explain this pattern through contrasting evaluative frameworks: urban residents assess governance against expectations of formal responsiveness, while rural residents do so through institutional proximity and visible local effort. These findings challenge single-dimension approaches to water service evaluation and argue that technical investment and governance quality must be assessed and addressed as structurally distinct policy levers.

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1. Introduction and Theoretical Framework

The performance of domestic water distribution services has long been evaluated through a predominantly technical lens. Network coverage rates, hydraulic pressure, leakage ratios, and supply hours per day constitute the standard vocabulary through which utilities, regulators, and national governments describe and compare service conditions **[1]**. These indicators capture real material conditions that directly affect household access and public health **[2]**, but say little about whether users trust the institutions responsible for service delivery, whether local operators are perceived as responsive, or whether governance arrangements translate technical capacity into reliable everyday access **[3]**. When service assessment stops at the physical network, it produces an incomplete and sometimes distorted picture of how water actually reaches households in practice **[4]**.

This limitation is especially acute under intermittent supply, where formal connection may mask a reality of water available only a few hours per week at insufficient pressure and no reliable schedule **[5][6]**. The Algerian water sector illustrates this tension clearly: despite sustained investment in infrastructure since the early 2000s, many users continue to experience discontinuous delivery, weak pressure, and significant distribution losses, and resort to costly household-level coping strategies such as private storage tanks and tanker water purchases **[7] [8]**. This persistence raises a question technical indicator alone cannot answer: what role does institutional governance play in shaping service outcomes, and does it follow the same spatial logic as technical performance?

Addressing this question requires a framework that treats technical infrastructure and institutional governance as analytically distinct dimensions of service performance. The socio-technical perspective developed by **Geels (2004)** and applied to urban water management by **Franco-Torres et al. (2021)** and **Manny (2023)** provides this basis: rather than treating water distribution as a purely hydraulic operation, it conceptualizes service provision as the outcome of interactions between material systems, organizational structures, and governance arrangements that are co-constitutive rather than equivalent. Standard technical metrics systematically overestimate access by conflating physical infrastructure with effective service delivery **[1][6]**, while governance quality constitutes a structurally distinct policy variable requiring specific analytical frameworks **[3]**. At the organizational level, water service performance depends critically on alignment across strategic, operational, and reflexive governance levels **[9]**; and institutional proximity—the organizational closeness between providers and communities—can improve perceived responsiveness and user satisfaction independently of formal service quality **[10]**. In the Algerian context, where governance challenges are compounded by a centralized sector structure and uneven translation of national policy into local operational capacity **[11]**, systematic evidence on how users experience governance across territorial contexts remains limited.

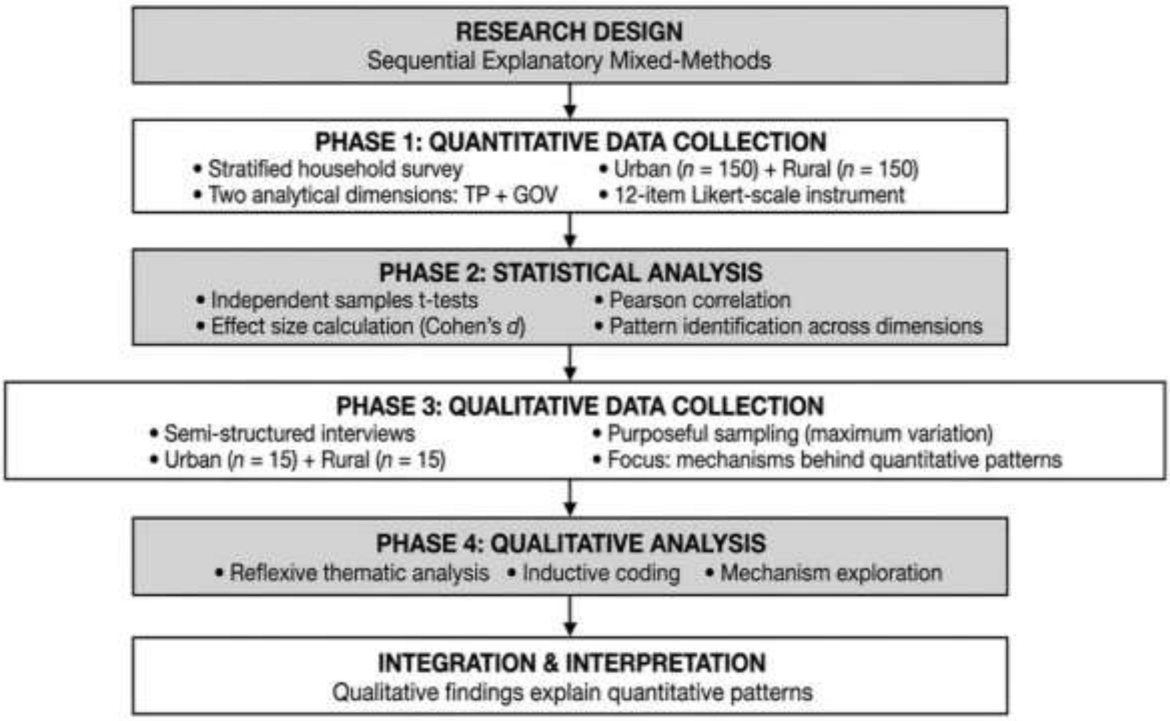
Existing studies address technical performance or institutional governance in isolation: engineering studies neglect governance, while governance studies treat infrastructure as background. No study in the North African literature examines both dimensions simultaneously as independent variables across urban and rural contexts, a pattern consistent with the broader global literature, where integrated frameworks capable of explaining divergence between the two dimensions remain comparatively rare **[3][12]**. This study addresses that gap directly. By applying a socio-technical framework to the comparative analysis of urban and rural water service in El Oued, and combining quantitative measurement of both dimensions with qualitative investigation of underlying mechanisms, it produces evidence on structural decoupling, the condition in which technical and governance dimensions not only diverge in magnitude but also move in structurally opposite directions across territorial contexts. Three specific questions guide the analysis. First, how do technical service conditions differ between urban and rural settings within the region? Second, does institutional governance follow the same territorial pattern as technical performance, or does it diverge from it? Third, what mechanisms explain the relationship, or decoupling, between these two dimensions across urban and rural contexts? This article makes three contributions: it provides quantitative evidence of structural decoupling in a North African arid context; it offers a qualitative account of the mechanisms through which this decoupling is produced; and it argues that single-dimensional assessments of water service performance risk systematically misidentify where policy intervention is most needed.

Methodology

Research Design

This study adopts a sequential explanatory mixed-methods design in which quantitative analysis is conducted first to identify and measure patterns of variation across both analytical dimensions, and qualitative inquiry is subsequently mobilized to interpret the mechanisms underlying those patterns. This sequencing reflects a deliberate choice grounded in the research problem: when the objective is not only to quantify differences between territorial contexts but to explain why those differences take the form they do, a design that treats numerical and interpretive evidence as successive and complementary stages is more appropriate than one that privileges either strand in isolation **[13]**. The study is grounded in a pragmatic socio-technical posture, pragmatic in that method selection is driven by the research questions, and socio-technical in that both design and analytical categories are organized around the premise that water service performance is the outcome of interactions between material infrastructure, institutional organization, and the actors operating within and around them **[14][15]**. Technical performance and institutional governance are therefore treated as structurally distinct dimensions requiring independent measurement and joint interpretation. **Figure 1** presents a schematic representation of this design.

Figure 1. Sequential explanatory mixed-methods design adopted in the study.



Study Area

The empirical focus is the El Oued region in southeastern Algeria (Oued Souf area), a Saharan territory characterized by strong hydro-environmental constraints, rapid demographic growth, and persistent pressures on water service infrastructure. El Oued depends heavily on groundwater, including the shallow water table, the *Complexe Terminal*, and the *Continental Intercalaire* aquifers, under specific resource and ecological constraints, including groundwater rise and overexploitation, that interact with the operational condition of distribution infrastructure **[16][7]**. Crucially, the region presents a meaningful internal contrast between urban and rural service configurations within the same broader territorial and hydrological system, making it possible to compare two service contexts that differ in their infrastructural and institutional conditions while sharing the same resource base and national regulatory framework **[11][8]**, an advantage that cross-regional studies cannot easily replicate.

Population, Sampling, and Data Collection

The quantitative phase drew on a stratified sample of 300 households, divided equally between urban (n = 150) and rural (n = 150) sites, stratified by territorial location and accounting for variation in housing conditions within each stratum. Technical Performance (TP) and Institutional Governance (GOV) were measured through 6 items each on a five-point Likert scale, with Cronbach's alpha of 0.881 and 0.858, respectively, both indicating good reliability **[3][6]**.

Table 1. Survey dimensions and measurement items used to assess household water service perceptions

Dimension	Measurement items	Scale
Socio-Demographic characterization	Sex, age, education level, Monthly income, household size	Categorical/continuous
Technical performance	Regularity of water supply, pressure level, water quality, repair responsiveness, adequacy of supplied water, seasonal continuity	5-point Likert scale
Institutional performance	Administrative accessibility, compliance with supply schedules, complaint handling, prior notice of interruptions, bill fairness, trust in service improvement	5-point Likert scale

The qualitative phase drew on a purposeful sample of 30 semi-structured interviews equally divided between urban (n = 15) and rural (n = 15) residents, selected following maximum-variation logic to reflect diversity in age, gender, household structure, length of residence, and type of service experience **[17]**. Interviews were conducted in Arabic using the local dialect and subsequently translated into English with attention to preserving meaning and contextual nuances. All participants provided informed consent; survey responses were anonymized, and interview recordings were de-identified before analysis.

Table 2. Study Sample Characteristics and Instrument Reliability

Panel A – Instrument Reliability				
Dimension	**Code**	**Items**	**Cronbach's α**	**Rating**
Technical Performance	TP	6	0.881	Good
Institutional Governance	GOV	6	0.858	Good

Note. Dimensions are theoretically distinct constructs; total-scale α was not computed.			
Panel B – Quantitative Survey Sample (n = 300)			
Characteristic	**Urban (n = 150)**	**Rural (n = 150)**	**p-value**
Age (years), M (SD)	40.7 (10.9)	48.6 (13.3)	**< .001**
Household size, M (SD)	4.6 (1.9)	6.8 (2.4)	**< .001**
Monthly income (DZD), M (SD)	76,720 (30,304)	43,997 (21,709)	**< .001**
Gender, n (%)			**.043**
Male	121 (80.7%)	132 (88.0%)	
Female	29 (19.3%)	18 (12.0%)	
Education level, n (%)			**< .001**
No formal education	10 (6.7%)	37 (24.7%)	
Primary	37 (24.7%)	63 (42.0%)	
Secondary	65 (43.3%)	41 (27.3%)	
University	38 (25.3%)	9 (6.0%)	
Note. M = Mean; SD = Standard Deviation; DZD = Algerian Dinar. p-values based on independent samples t-test for continuous variables and chi-square test for categorical variables.			
Panel C – Qualitative Interview Sample (n = 30)			
Characteristic	**Urban (n = 15)**	**Rural (n = 15)**	**Total (N = 30)**
Age (years), M (SD)	42.0 (8.8)	51.0 (10.7)	45.2 (11.0)
Household size, M (SD)	4.7 (1.7)	7.2 (1.9)	5.9 (2.2)
Gender, n (%)			
Male	11 (73.3%)	13 (86.7%)	24 (80.0%)
Female	4 (26.7%)	2 (13.3%)	6 (20.0%)
Education level, n (%)			
No formal education	1 (6.7%)	5 (40.0%)	6 (20.0%)
Primary	2 (13.3%)	6 (46.7%)	8 (26.0%)
Secondary	7 (46.7%)	4 (13.3%)	11 (36.7%)
University	5 (33.3%)	0 (0.0%)	5 (16.7%)
Household type, n (%)			
Nuclear	10 (66.7%)	4 (26.7%)	14 (46.7%)
Extended	5 (33.3%)	11 (73.3%)	16 (53.3%)
Residence ≥ 20 years, n (%)	7 (46.7%)	13 (86.7%)	20 (66.7%)
Note. M = Mean; SD = Standard Deviation. Percentages may not sum to 100 due to rounding.			

Analytical Procedures

Quantitative data were analyzed using independent samples t-tests with Welch correction; effect sizes were calculated as Cohen's d. Before parametric testing, distributional assumptions were assessed using the **Shapiro-Wilk test**. Results indicated non-normal distributions across all four group-dimension combinations; full results are reported in **Table 3**.

Table 3. Shapiro-Wilk Normality Tests by Dimension and Group

Dimension	Group	n	W	p	Normality
Technical Performance	Urban	150	0.954	< .001	Non-normal
Technical Performance	Rural	150	0.973	.004	Non-normal
Institutional Governance	Urban	150	0.977	.012	Non-normal
Institutional Governance	Rural	150	0.970	.002	Non-normal

Note: W = Shapiro-Wilk statistic. Non-normality indicated at $p<.05$ non-normal distribution was detected across all four group-dimension combinations, warranting Mann-Whitney U tests as non-parametric robustness checks for all parametric comparisons.

Homogeneity of variance was assessed using Levene's test; results indicated no significant variance heterogeneity for either dimension — Technical Performance, $F(1, 298) = 2.94$, $p = .088$; Institutional Governance, $F(1, 298) = 0.95$, $p = .331$. Welch correction was nonetheless retained as a conservative approach given the consistent non-normality detected across all groups. Given these violations, Mann-Whitney U tests were conducted alongside all parametric analyses as non-parametric robustness checks, and Spearman rank correlations were computed as a robustness check for the bivariate analyses. Pearson correlation coefficients examined the bivariate relationship between dimensions across the full sample and within each territorial context. Qualitative data were analyzed through reflexive thematic analysis **[18]**, with inductive coding organized around the two analytical dimensions, reinforced through transparent procedures and systematic attention to disconfirming evidence **[19]**.

Results

Sample Profile and Demographic Characteristics
The quantitative sample comprised 300 respondents equally distributed between urban and rural areas; the qualitative subsample comprised **30 interviewees** equally split by territory. Full demographic characteristics and instrument reliability statistics are presented in **Table 2 (Panels A–C)**. The demographic asymmetries between urban and rural respondents—younger urban respondents (M = 40.7 vs. 48.6 years), smaller urban household sizes (M = 4.6 vs. 6.8), higher urban incomes (M = 76,720 vs. 43,997 DZD), and higher urban educational attainment , accurately reflect the structural socioeconomic conditions of the El Oued region rather than sampling bias **[16][11]**, and are treated as features of the service environment that interact with how both dimensions are experienced.
Technical Performance: A Large and Significant Urban Advantage
Urban respondents reported substantially higher Technical Performance scores **(M = 4.099, SD = 0.651)** than rural respondents **(M = 3.150, SD = 0.743)**. This difference was statistically significant **(t = 11.767, df = 293, p < .001)** and associated with a large effect size **(d = 1.359)**, indicating that the urban–rural gap in technical service conditions is not only statistically robust but substantively consequential. Shapiro-Wilk tests indicated non-normal distributions across all four group-dimension combinations **(see Table 3)**. A Mann-Whitney U test conducted as a non-parametric robustness check confirmed the urban advantage in technical performance: U = 18,532, z = 9.69, p < .001, r = .56, fully consistent with the parametric result in both direction and magnitude. The full comparative statistics are presented in **Table 4**.
Institutional Governance: A Reversed Territorial Pattern
The institutional dimension produced a strikingly different result. Rural respondents rated Institutional Governance substantially more positively **(M = 3.497, SD = 0.912)** than urban respondents **(M = 2.780, SD = 0.823)**. This difference was statistically significant **(t = −7.143, df = 295, p < .001)** and associated with a large effect size in the opposite direction **(d = −0.825)**.
The reversal of the territorial advantage—urban in the technical dimension, rural in the institutional dimension—constitutes the central empirical finding of this study. This reversed pattern suggests that while urban areas enjoy better physical infrastructure, rural contexts benefit from higher **institutional proximity**, where shorter social and administrative distances between users and providers enhance perceived responsiveness and accountability **[10][3]**. **Figure 2** visually captures this crossing effect, representing the core of the technical-institutional decoupling.

Figure 2. Urban–rural interaction plot revealing the technical-institutional decoupling.

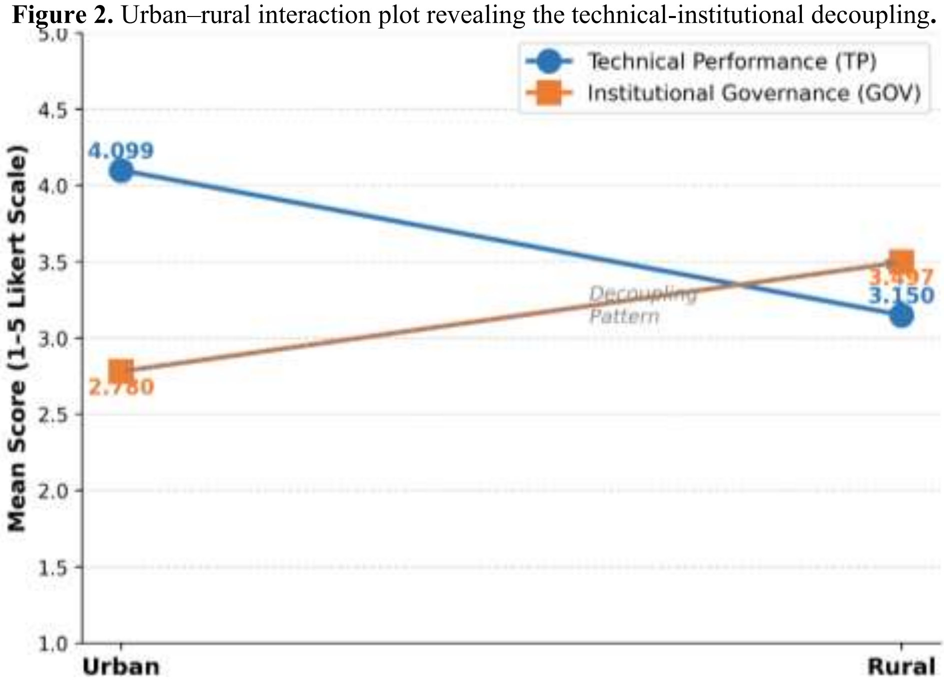


Figure 2 represents the interaction plot of Technical Performance and Institutional Governance across urban and rural settings. The declining TP line (urban M = 4.099, rural M = 3.150) and the rising GOV line (urban M = 2.780, rural M = 3.497) intersect, visually capturing the structural decoupling between the two dimensions.
A Mann-Whitney U test conducted as a non-parametric robustness check confirmed the significance and direction of this result: U = 6,430, z = −6.42, p < .001, r = .37. The full urban–rural comparison across both dimensions is presented in **Table 4**, and effect sizes are further illustrated in **Figure 3**.

Table 4. Independent sample t-test: urban-rural comparisons across analytical dimensions.

Dimension	Urban M (SD)	Rural M (SD)	Difference	t	df	p	Cohen's d	Effect
Technical Performance	4.099 (0.651)	3.150 (0.743)	+0.949	11.767	293	< 0.001	1.359	Large
Institutional Governance	2.780 (0.823)	3.497 (0.912)	−0.717	−7.143	295	< 0.001	−0.825	Large

Note: Welch correction applied; degrees of freedom computed via Satterthwaite approximation (TP: df = 293; GOV:

df = 295). Shapiro-Wilk tests indicated non-normal distributions across all groups **(see Table 3)**. Levene's test indicated no significant variance heterogeneity: TP, $F(1, 298) = 2.94$, $p = .088$; GOV, $F(1, 298) = 0.95$, $p = .331$. Mann-Whitney U robustness checks confirmed all findings: TP, $U = 18{,}532$, $z = 9.69$, $p < .001$, $r = .56$; GOV, $U = 6{,}430$, $z = -6.42$, $p < .001$, $r = .37$.

Figure 3. Effect sizes (Cohen's d) for urban–rural differences across analytical dimensions

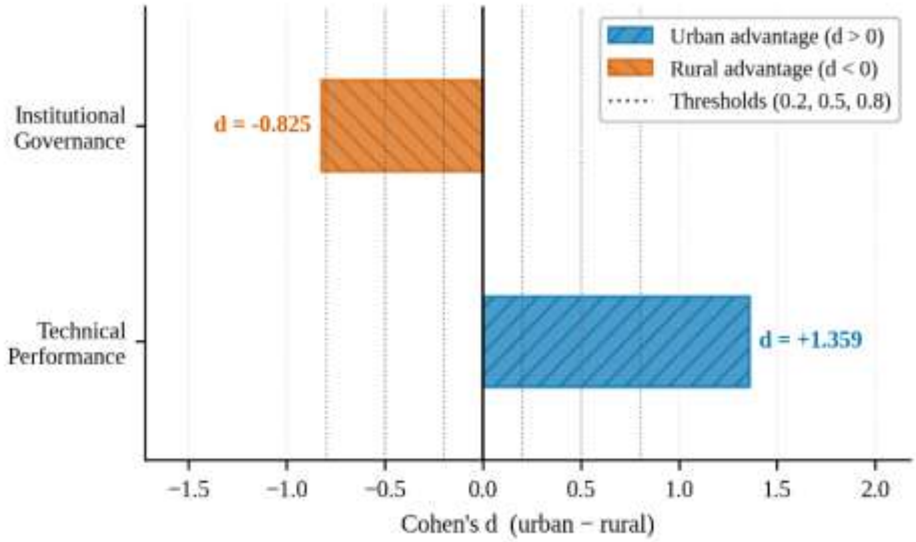


Figure 3 shows the effect sizes (Cohen's d) for urban–rural differences across analytical dimensions. Dashed lines indicate conventional thresholds (0.2, 0.5, 0.8). Opposing directions indicate a decoupling structure.

The Technical-Institutional Relationship: Evidence of Structural Decoupling

Beyond the separate urban–rural comparisons, the relationship between Technical Performance and Institutional Governance across the full sample provides the most analytically significant result. Pearson correlation analysis revealed a strong negative association between Technical Performance and Institutional Governance across the full sample **($r = -.487$, $p < .001$, 95% CI [−.569, −.396], $n = 300$)**, indicating that higher technical performance scores were consistently associated with lower governance ratings, and vice versa. Critically, within-context analyses confirmed that this inverse relationship is not an artifact of between-group clustering: a significant negative association was also observed among urban respondents alone **($r = -.336$, $p < .001$, 95% CI [−.471, −.186])** and among rural respondents alone **($r = -.372$, $p < .001$, 95% CI [−.502, −.225])**. The consistency of this negative pattern within each territorial context independently — not only across them — confirms that the decoupling structure operates at the household level and cannot be reduced to a compositional effect of group separation. As a robustness check given non-normality, Spearman rank correlations confirmed all findings: **$\rho = -.474$ (full sample), −.360 (urban), −.359 (rural), all ps < .001**. These results are presented in **Table 5**. The magnitude of this inverse correlation rules out incidental variation and confirms a structural condition in which the two dimensions are systematically opposed. This finding has a direct methodological implication: Technical Performance and Institutional Governance cannot be treated as interchangeable components of a single service quality construct, as their negative covariance indicates they respond to different underlying drivers—confirming the need for diagnostic frameworks that treat governance as a distinct analytical variable **[3][1]**.

Table 5. Pearson and Spearman Correlations Between Technical Performance and Institutional Governance.

Sample	n	Pearson r	95% CI	Spearman ρ	p
Full sample	300	−.487	[−.569, −.396]	−.474	< .001
Urban only	150	−.336	[−.471, −.186]	−.360	< .001
Rural only	150	−.372	[−.502, −.225]	−.359	< .001

Note: 95% CI computed via Fisher's z transformation. Spearman ρ was reported as a robustness check given non-normal distributions across all groups. The negative association between Technical Performance and Institutional Governance is statistically significant within each territorial context independently, confirming that the decoupling structure is not a compositional artifact of group separation.

Figure 4. Scatter plot of Technical Performance against Institutional Governance by territorial context, with full-sample regression line

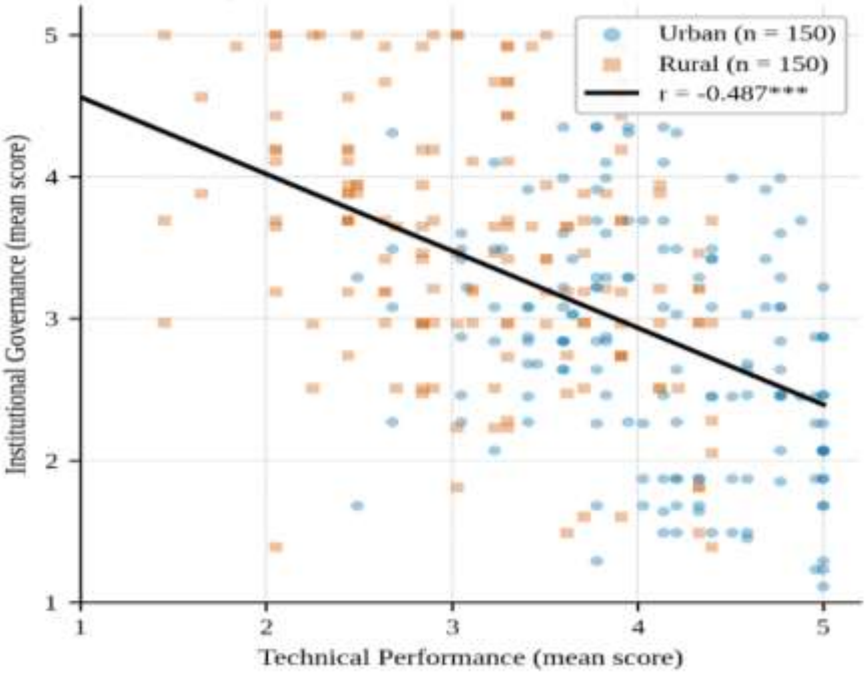


Figure 4 is a scatter plot of Technical Performance against Institutional Governance by territorial context, with a full-sample regression line. The negative slope ($r = -0.487$, $p < 0.001$) and spatial clustering by context jointly illustrate the decoupling structure.

Qualitative Explanations of the Decoupling Pattern

The Infrastructure Divide: Material Conditions and Their Social Consequences

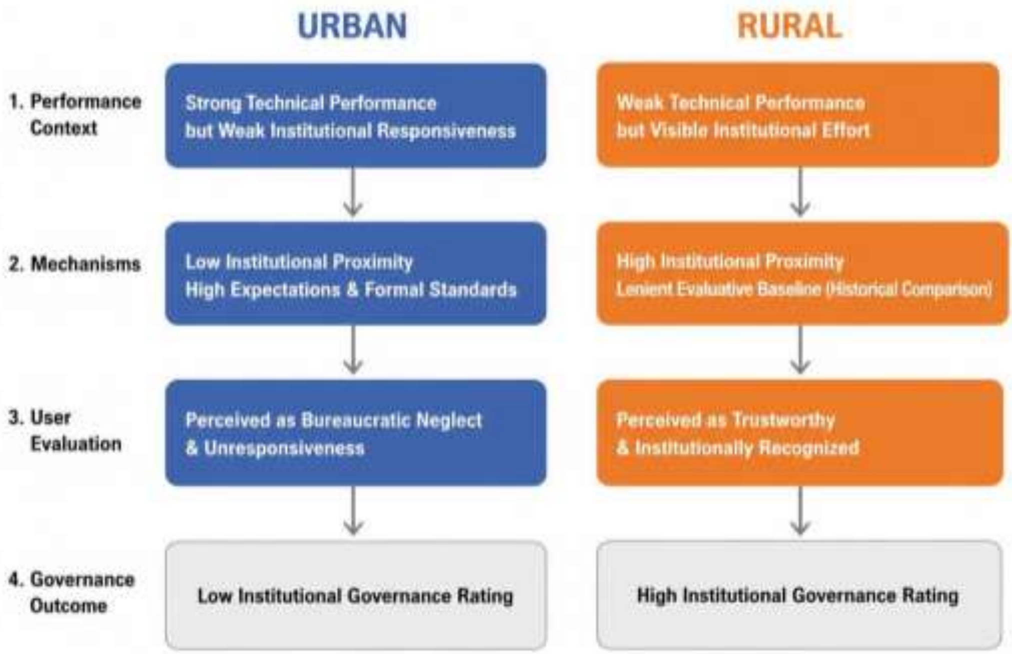
The qualitative findings strongly corroborate the quantitative evidence of a large urban–rural gap in technical performance. Urban interviewees generally described water as sufficiently reliable for routine domestic management, with complaints centered on pressure variability: **"The water is generally here, but the pressure drops without warning, which is frustrating"** (U2, urban female, age 45). Rural residents described a materially different reality of weak pressure, infrequent supply, long waits to fill storage tanks, and recurrent dependence on tanker water: **"We organize our lives around the water schedule, but it rarely comes on time or with enough force"** (R5, rural male, age 37). The associated costs and sense of territorial neglect described across rural interviews add interpretive depth to the large effect size ($d = 1.359$), demonstrating that the infrastructure divide shapes not only daily logistics but perceptions of territorial equity and the citizen–state relationship **[7][15]**.

The Governance Paradox: Institutional Proximity and Contrasting Evaluation Frameworks

Two mechanisms emerge from the interviews to explain the unexpected governance finding. The first is **institutional proximity**: rural participants repeatedly described local water offices as small, accessible, and personally familiar. **"If there's a problem, we know exactly who to talk to. We can go to the local office and find someone we know"** (R12, rural male, age 46). This proximity was experienced as a form of institutional accountability where informal pathways of responsiveness often proved more effective than formal bureaucratic procedures **[10]**, and the visible efforts of local operators fostered trust even when the system was technically weak **[3]**.

The second mechanism is a **divergence in evaluative reference frameworks**. Urban respondents assessed governance against demanding expectations shaped by exposure to more developed service environments and formal administrative procedures, expectations local governance consistently failed to meet: **"You file a complaint about the bill, and you hear nothing for weeks. It feels like they don't care"** (U6, urban male, age 41). Rural respondents, by contrast, evaluated governance against a historical baseline of near-total formal service absence; the existence of a local office and occasional technician visits constituted meaningful institutional presence: **"Years ago, there was nothing. Now, at least there is an office and someone to call. It is better than before"** (R3, rural male, age 63). Governance was thus assessed not against an abstract normative standard but against a lived experience of what institutions had historically done under difficult conditions **[15]**.

Figure 5. Simplified thematic network: contrasting mechanisms produce opposite perceived governance outcomes in urban and rural contexts.



4. Discussion

Decoupling Technical and Institutional Dimensions

The large urban–rural gap in Technical Performance (d = 1.359) confirms what the intermittent supply literature has established: a household formally connected to a distribution system in a rural locality in El Oued may receive water for a few hours on irregular days, at insufficient pressure, with no reliable schedule, a qualitatively different service environment characterized by structural unreliability, compensatory coping, and normalized inadequate provision **[20][21]**. National indicators reporting high formal access rates without disaggregating by continuity, pressure, and reliability systematically overstate the quality of service rural populations actually receive, thereby understating the scale of infrastructural deficit that targeted investment needs to address **[3][6]**. Yet the data equally caution against treating technical performance as the sole dimension of service assessment: the strong negative correlation **($r = -0.487$, $p < 0.001$)** between Technical Performance and Institutional Governance confirms that these dimensions are not only distinct but structurally opposed, a result that a purely technical assessment framework would obscure entirely. The strong infrastructure does not guarantee a positive institutional experience; weak infrastructure does not preclude one. The two dimensions are governed by separate operational and political logics that produce decoupling as a structural outcome rather than an anomaly **[1][14]**. The reference framework effect partly explains this: technically better-served urban populations develop more demanding governance expectations shaped by exposure to formal administrative standards, making them highly sensitive to inadequacies that less-served populations may not prioritize **[7]**. As rural populations gain reliable infrastructure, their expectations will likely evolve toward urban baselines; if institutional arrangements do not evolve in parallel, the governance deficit currently characterizing urban areas may migrate to rural contexts.

Governance as a Relational Experience

The finding that Institutional Governance was rated significantly more positively in rural areas (d = −0.825) despite substantially weaker technical service is the most theoretically generative result of this study. Its interpretation requires moving beyond formal institutional design and engaging with the relational dimensions through which governance quality is produced and evaluated in practice. **Herrera & Post (2014)** demonstrate that institutional proximity can improve perceived responsiveness and user satisfaction independently of formal service quality metrics; governance is not only delivered through administrative structures but enacted through everyday encounters between users and local institutions. The qualitative findings provide direct empirical support: rural residents evaluated governance through the lived experience of what local offices actually did, how accessible they were, and how visible their efforts were—not through abstract standards of what water institutions should do.

Franco-Torres et al. (2021) complement this by showing that misalignment across strategic, operational, and reflexive governance levels is a primary source of institutional failure. In El Oued, the urban governance deficit reflects precisely this misalignment: urban residents are aware of what responsive water service governance should look like and evaluate the gap between that expectation and the institutional reality they encounter. This has a broader theoretical implication: governance quality in water services is a relational condition co-produced by institutional arrangements and the evaluative frameworks users bring to their encounters with those arrangements. Assessing governance through standardized indicators without accounting for this relational dimension risks producing assessments that are technically rigorous but contextually misleading **[22]**. Governance investment must therefore not be treated as a secondary complement to infrastructure expansion but as a structurally co-equal priority, requiring local institutional presence, transparent communication, and complaint responsiveness alongside pipe rehabilitation **[9][10]**.

5. Conclusion

This study documents three principal findings: a large urban–rural gap in technical performance (d = 1.359) demonstrating that physical connectivity does not equate to functional service quality; a governance paradox in which rural respondents rated institutional governance more positively than urban ones (d = −0.825), driven by institutional proximity and contrasting evaluative reference frameworks; and a strong negative correlation between the two dimensions (r = −0.487, p < 0.001) confirming that technical-institutional decoupling is a structural condition that cannot be captured by composite performance indices **[6][10][3]**. At the policy level, national water authorities should disaggregate technical performance from governance quality in reporting to avoid the masking effect of composite scores. In urban contexts, priority is restoring institutional legitimacy through digitized complaint-tracking and transparent communication; in rural areas, policy must both protect and formalize local institutional proximity as a governance asset while directing infrastructure rehabilitation toward distribution-level renewal—recognizing that the higher cost of rural coping strategies (such as tanker water) imposes a regressive economic burden requiring urgent territorial equity in investment allocation. The TP–GOV diagnostic instrument (α = 0.881 and 0.858) demonstrated high reliability and should be applied across other arid regions to establish the boundary conditions of the decoupling hypothesis. The ultimate goal of water policy in arid zones must be to recouple technical and institutional development, ensuring that infrastructure investment translates into sustained and legitimate service delivery.

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