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The Device Divide: A PLS-SEM Analysis of Mediating Digital Exclusion in Algerian Households

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Purpose. This study examines household digital infrastructure readiness in Algeria and tests the "Device Divide" as a mediating mechanism between socio-economic deprivation and digital exclusion. It shifts focus from network coverage to material possession thresholds. **Design / Method / Approach**. Using micro-data from the 2019 Multiple Indicator Cluster Survey (N=31,325), a causal model was tested via Partial Least Squares Structural Equation Modeling using Smart-PLS software. This approach measured latent variables and analyzed direct and indirect paths. **Findings**. Hardware ownership (computer or smartphone) is the strongest predictor of access (β =0.530). Mediation analysis confirms wealth and education effects largely pass through the "hardware channel," linking digital poverty to material deprivation. Urban-rural disparities persist independently of economic factors. **Theoretical Implications**. The research validates Resources and Appropriation Theory in a developing context, demonstrating that material access is a sequential prerequisite for usage, not a given**. Practical Implications**. Policies must shift to demand-side interventions. Recommendations include targeting device affordability for vulnerable groups and establishing rural access points to mitigate the "mobile underclass" phenomenon. **Originality / Value**. This is among the first studies to apply a structural mediation model to national Algerian data to explain the "first-level divide," moving beyond descriptive statistics. **Research Limitations / Future Research**. Cross-sectional data limits longitudinal inference. Future work should include skills and outcomes variables across income quintiles. **Article Type**. Empirical Paper.

Keywords:

ICT policy, MENA region, social inequality, ICT Adoption, PLS-SEM, digital inclusion

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Мета. Дослідження аналізує готовність цифрового оснащення домогосподарств Алжиру та емпірично перевіряє «розрив у доступі до цифрових пристроїв» як медіаційний механізм між соціально-економічною депривацією та цифровим виключенням. Акцент зміщено з покриття мережі на порогові рівні матеріального забезпечення. **Дизайн / Метод / Підхід**. На основі мікроданих кластерного обстеження за багатьма показниками (Multiple Indicator Cluster Survey) 2019 року (N = 31 325) перевірено причинну модель шляхом моделювання структурними рівняннями за методом часткових найменших квадратів (PLS-SEM) із використанням програмного забезпечення Smart-PLS. Здійснено вимірювання латентних змінних та аналіз прямих і опосередкованих шляхів. **Результати**. Встановлено, що володіння пристроями (комп'ютером або смартфоном) є статистично ключовим чинником доступу (β = 0.530). Аналіз медіації підтвердив, що вплив багатства та освіти значною мірою проходить через «апаратний канал», поєднуючи цифрову бідність із матеріальною депривацією. Міжміські та сільські диспропорції зберігаються незалежно від економічних чинників. **Теоретичне значення**. Робота підтверджує Теорію ресурсів та апропріації (Resources and Appropriation Theory) у контексті країни, що розвивається, демонструючи, що матеріальний доступ є необхідним етапом використання, а не наперед заданою умовою. **Практичне значення**. Політика має зміститися до заходів стимулювання попиту. Рекомендації передбачають підвищення доступності пристроїв для вразливих груп та створення сільських пунктів доступу з метою пом'якшення феномену «нижчого мобільного класу». **Оригінальність / Цінність**. Робота є однією з перших, у якій застосовано структурну модель медіації до національних даних Алжиру для пояснення «розриву першого рівня», що дозволяє вийти за межі дескриптивної статистики. **Обмеження дослідження / Майбутні дослідження.** Дані поперечного зрізу не дають змоги робити висновки щодо динаміки у часі. Подальші дослідження мають охоплювати показники цифрових навичок та результатів використання у різних групах за рівнем доходу (квінтилях). **Тип статті**. Емпірична стаття.

Ключові слова:

політика у сфері ІКТ, регіон MENA, соціальна нерівність, впровадження ІКТ, PLS-SEM, цифрова інклюзія

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Information and Communication Technologies (ICT) have evolved beyond a mere support sector to become the foundational infrastructure for value creation and service organization (Schwab, 2016). Within the Fourth Industrial Revolution, ICTs are reconfiguring labor, education, health, and governance models. Within this transition, access to the Internet — particularly broadband — has evolved into a structural prerequisite for socioeconomic participation. As services increasingly migrate from physical to digital realms, or blend the two, the lack of access directly correlates with restricted opportunities. The COVID-19 pandemic acted as a catalyst, transforming digital connectivity from an alternative option into a mandatory gateway for remote learning, flexible work, access to health information, and digital administrative services, thereby rendering the digital divide a critical issue of social justice (Van Dijk, 2020).

However, contemporary scholarship no longer views the digital divide through a binary lens of connectivity versus isolation. While descriptively useful, this definition fails to explain why digital exclusion persists even in environments where network coverage is improving. Literature delineates a stratified divide, moving from the first level (material access) to the second (skills) and third (outcomes) levels (Attewell, 2001; Scheerder et al., 2017). Consequently, the pertinent inquiry has shifted from "Is there a network?" to "Does the household possess the material conditions for effective access? And does this access translate into productive usage?"

In the Algerian context, a critical paradox emerges: the conflation of network supply (coverage expansion) with effective household demand. This study argues that the decisive barrier often lies within the household rather than the external infrastructure: specifically, the "Device Divide." This concept distinguishes between households possessing a comprehensive digital ecosystem (computer + smartphone + home connection) and those relying on limited or "mobile-only" connectivity, which frequently results in a "second-class" internet experience with limited productive potential (Napoli & Obar, 2014; Pearce & Rice, 2013).

The research problem addresses the inadequacy of analyses that evaluate digital progress through macro-indicators — such as subscription numbers and network coverage — while leaving household-level exclusion mechanisms insufficiently deconstructed. Within this framework, the relationship between socioeconomic deprivation and digital deprivation, particularly its material aspect, requires a causal test to demonstrate how inequality functions, not just that it exists. Specifically, does low SES lead to poor internet access because households do not perceive the value of the internet (motivational divide) (Deursen & Dijk, 2015; Ghobadi & Ghobadi, 2013; Millington & Carter, 2013)? Or because the household cannot cross the material threshold (device divide) (Millington & Carter, 2013; Book Reviews, 2007)? Or because rural location raises the costs of obtaining stable service, reducing the expected utility of investing in devices?

Accordingly, the study's problem centers on unpacking the "black box" of the relationship between socio-economic deprivation and digital exclusion in Algeria. It questions whether Socio-Economic Status (SES)—as a composite of economic and cultural capital—affects internet access only directly, or if it also operates through an indirect path via device ownership. Drawing on the "Resources and Appropriation Theory," the study posits that access is a cumulative process starting with the material threshold, the distribution of which is tied to resource distribution in society (Van Dijk, 2005). Interpretively, it relies on Bourdieu's (1986) forms of capital to understand how purchasing power intersects with the educational dimension to shape a household's propensity to invest in hardware as a gateway to opportunity.

To address this, the study aims to test a structural model using micro-data from the Multiple Indicator Cluster Survey (MICS6), employing Partial Least Squares Structural Equation Modeling (PLS-SEM). While this study relies on 2019 MICS6 micro-data, the dataset is positioned as a critical pre-pandemic baseline. It documents the structural configuration of inequality immediately preceding the global COVID-19 shock. This framing transforms temporal distance into analytical value, providing a benchmark for assessing the acceleration of forced digitalization in Algeria. The article is structured as follows: Section 2 outlines the theoretical background and research hypotheses; Section 3 details the methodology, sampling, and data analysis strategy; Section 4 presents the results of the measurement and structural models; and Section 5 discusses the findings, implications, and conclusions.

Theoretical Background

The Algerian Context: Supply Paradox vs. Demand Deficit

Digital transformation in Algeria is framed within public policy as a strategic lever for modernizing public services, improving citizen access to administration, and diversifying the economy beyond hydrocarbons (Hammal, 2025). While supply-side indicators—such as the expansion of the fiber optic backbone to remote areas and the deployment of 4G networks—have shown significant improvement (Philippe, 2020), micro-level data reveal a persistent "supply-demand paradox." Improved network availability does not automatically translate into effective household access. The MICS6 survey highlights that the household remains the central unit of digital exclusion, rather than the individual isolated from their context (Ministère de la Santé & UNICEF, 2020). Access involves a dual financial commitment: a capital expenditure (CapEx) for device acquisition and an operating expenditure (OpEx) for subscription. In a market where hardware is largely imported and costly relative to average income, the "CapEx" barrier often halts the access trajectory before it begins. Consequently, "digital readiness" must be redefined as possessing a "hardware bundle" capable of productive use, rather than mere mobile connectivity (Correa et al., 2018).

From Binary Access to the Device Divide

Early scholarship often treated access as a simple binary variable (connected/not connected), a perspective critiqued for overlooking the complexities of social inclusion (Warschauer, 2003). However, multi-level frameworks have shifted the focus to the quality and means of connection (Attewell, 2001). The "Device Divide" thesis posits that the type of hardware determines the range of possible digital activities. "Mobile-only" users often face a "second-class" digital experience compared to those with computers, as mobile interfaces may limit complex information management, content creation, and professional tasks (Napoli & Obar, 2014; Pearce & Rice, 2013). Thus, device repertoire diversity is a more accurate proxy for digital inclusion than simple connectivity.

Resources and Appropriation Theory

This study adopts Van Dijk's (2005) Resources and Appropriation Theory, which conceptualizes access as a cumulative, recursive process driven by unequal resource distribution. The process moves from motivation to material access, then to skills, and finally usage. In developing contexts, the material access stage remains a structural bottleneck. When socio-economic resources are scarce, the chain breaks at the material phase, preventing the realization of subsequent benefits. This theory provides the causal logic for our model: Socio-Economic Status determines material access (Infrastructure), which in turn enables network access.

Related Work and Research Positioning

Recent scholarship on the digital divide in Algeria has increasingly recognized it as a multifaceted development barrier. Boustil (2023) highlights the transition from a purely technical "coverage" perspective to a multidimensional approach linking digital inequality to unequal access, skills disparities, and social exclusion. While providing a valuable diagnostic of Algeria's position using comparative indicators, the study remains largely descriptive. Similarly, Jeddou (2022) examined the digital divide during the 2012–2020 period, emphasizing the challenges highlighted by the COVID-19 pandemic across various sectors. The study concluded that the Algerian economy suffers from a deep digital gap globally and regionally, necessitating more effective reduction strategies, yet it relied primarily on macro-level readiness indicators.

On a structural level, Bacha et al. (2024) analyzed broadband adoption in Algeria (2003–2019) using diffusion models (Bass, Gompertz, Logistic). Their findings linked adoption rates to market structure, institutional quality, and mobile technology diffusion. However, this macro-economic analysis focuses on the supply side and market dynamics, leaving the "black box" of household-level

adoption mechanisms unexplored. Internationally, the theoretical shift towards understanding access as a cumulative process is well-documented. Van Dijk (2006) critiqued early research for lacking causal models and precise definitions, proposing a sequential access model moving from motivation to material access, skills, and usage. Crucially, Pearce and Rice (2013) provided empirical evidence from Armenia showing that "mobile-only" users engage in a narrower range of capital-enhancing activities compared to computer users.

Research Hypotheses

– **H1:** Socio-Economic Status positively influences Digital Infrastructure ownership.
– **H2:** Socio-Economic Status has a direct positive influence on Internet Access.
– **H3:** Digital Infrastructure ownership positively influences Internet Access.
– **H4:** Digital Infrastructure mediates the relationship between Socio-Economic Status and Internet Access.
– **H5:** Urban location positively influences Internet Access, independent of Socio-Economic Status and Infrastructure.

Materials and Methods

Data Source and Sampling

This study leverages high-quality micro-data from the sixth round of the Multiple Indicator Cluster Survey (MICS6, Algeria 2019), a nationally representative household survey implemented by the Algerian Ministry of Health in collaboration with UNICEF. The survey employs a robust two-stage stratified cluster sampling design to ensure representativeness across national, regional (North, High Plateaus, South), and area (urban/rural) levels. The final analytical sample for this study consists of 31,325 households after data cleaning and excluding cases with missing values on key variables of interest. This large sample size provides high statistical power, allowing for precise estimation of structural parameters and detection of small effect sizes.

Operationalization of Variables

The structural model includes four constructs derived directly from the household questionnaire, operationalized to align with the theoretical framework of the digital divide:
– **Socio-Economic Status (SES):** This is a latent construct reflecting the household's composite capital. It is measured by two reflective indicators:
– *Wealth Index (windex5):* A quintile-based composite index of household assets and amenities, serving as a proxy for economic capital.
– *Head of Household's Education Level (helevel):* An ordinal variable representing the highest level of education attained, serving as a proxy for cultural capital.
– **Digital Infrastructure (Infrastructure):** A mediating latent construct representing "material readiness" within the home. It is measured by two binary indicators:
– *Computer Ownership (Computer_Bin):* Indicates whether the household owns a functional computer/laptop (1=Yes, 0=No).
– *Smartphone Ownership (SMARTPHONE):* Indicates whether the household owns a smartphone (1=Yes, 0=No).
– **Access:** The main dependent variable, measured by a single indicator:
– *Home Internet Connection (Internet_Bin):* Indicates the presence of a functional internet connection at home (1=Yes, 0=No).
– **Location:** A control variable representing the spatial dimension, measured by:
– *Area (Urban_Bin):* Coded as 1 for Urban and 0 for Rural.

Analytical Strategy

The study employs Partial Least Squares Structural Equation Modeling (PLS-SEM) using SmartPLS 4 software. PLS-SEM was selected over covariance-based SEM (CB-SEM) for several reasons: (1) its robustness in handling non-normal data distributions common in social science surveys; (2) its capability to estimate complex structural models containing both latent variables and binary indicators; and (3) its focus on maximizing the explained variance (R^2) of the endogenous constructs, which aligns with the study's predictive objective (Hair et al., 2019). The analysis follows a rigorous two-step protocol: first, assessing the measurement model for reliability and validity; and second, evaluating the structural model to test the hypothesized relationships.

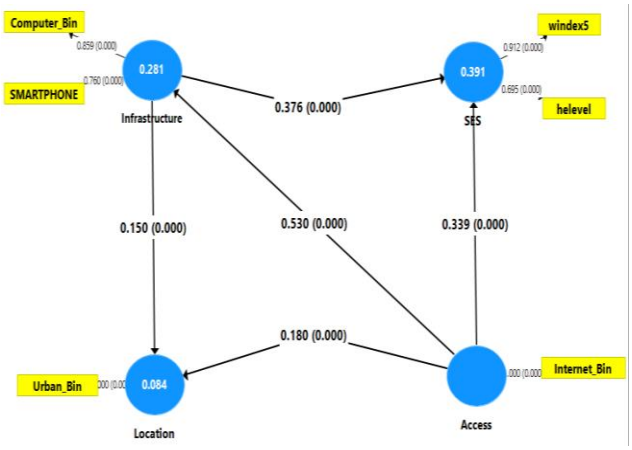

Figure 1 – Structural Model Results (Source: Developed by the authors using SmartPLS)

Results

The analysis of the structural equation model was conducted in two distinct phases: first, the assessment of the measurement model to ensure construct validity and reliability, followed by the evaluation of the structural model to test the hypothesized relationships.

Measurement Model Assessment

The evaluation of the measurement model is paramount to confirm that the observed indicators accurately reflect their underlying latent constructs. As presented in Table 1, the results demonstrate satisfactory psychometric properties.

Indicator Loadings: All indicator loadings are above the recommended threshold of 0.70, except for helevel (0.695). However, given its theoretical significance for Socio-Economic Status and its proximity to the threshold, helevel was retained (Hair et al., 2019). High loadings for windex5 (0.912) and Computer_Bin (0.859) suggest strong individual item reliability. Composite Reliability (CR): The Composite Reliability values for all multi-item constructs (SES = 0.791, Infrastructure = 0.793) are well above the commonly accepted minimum of 0.70, indicating excellent internal consistency. For single-item constructs (Access and Location), Composite Reliability is by definition 1.000. Average Variance Extracted (AVE): The AVE values for SES (0.658) and Infrastructure (0.657) exceed the 0.50 threshold, confirming adequate convergent validity. This means that more than 50% of the variance of the indicators is explained by their respective constructs.

Table 1 – Measurement Model Quality Indicators (Source: authors)

Construct	Indicator	Loading	Composite Reliability	AVE
Access	Internet_Bin	1.000	1.000	1.000
Infrastructure	Computer_Bin	0.859	0.793	0.657
	SMARTPHONE	0.760	0.793	0.657
Location	Urban_Bin	1.000	1.000	1.000
SES	windex5	0.912	0.791	0.658
	He level	0.695	0.791	0.658

Regarding the measurement model's reliability, while Cronbach's Alpha values for some constructs are below the 0.70 threshold due to the limited number of indicators (two per construct), internal consistency is confirmed via Composite Reliability (CR). Following the recommendations of Hair et al. (2019), all CR values (0.791–0.793) and Average Variance Extracted (AVE > 0.50) significantly exceed the required thresholds, confirming the reliability and convergent validity of our model. Additionally, Harman's single-factor test was conducted, showing that no single factor

accounted for > 50% of the variance, mitigating Common Method Bias concerns.

Discriminant validity was further assessed using the Fornell-Larcker criterion, as presented in Table 2. This criterion stipulates that the square root of the AVE for each construct (bolded on the diagonal) must be greater than its correlation with any other construct in the model."

Table 2 – Discriminant Validity using Fornell-Larcker Criterion (Source: authors)

Construct	Access	Infrastructure	Location	SES
Access	1			
Infrastructure	0.53	0.811		
Location	0.26	0.246	1	
SES	0.538	0.555	0.417	0.811

The results in Table 2 confirm that discriminant validity is established. For instance, the square root of AVE for Infrastructure (0.811) is greater than its correlation with Access (0.530), Location (0.246), and SES (0.555). Similarly, the square root of AVE for SES (0.811) surpasses its correlations with other constructs. This indicates that each latent variable is unique and empirically distinct from the others, providing a sound basis for evaluating the structural model.

Structural Model Assessment

After validating the measurement model, the structural model was evaluated. The assessment began with checking for multicollinearity among the predictor constructs. As shown in Table 3, all Variance Inflation Factor (VIF) values were found to be very low, ranging between 1.00 and 1.13, well below the conservative threshold of 3.0. This confirms that multicollinearity is not an issue and does not bias the path coefficients.

The model's explanatory power was assessed using the coefficient of determination (R^2). The model explains a substantial 39.1% of the variance in Access ($R^2 = 0.391$) and 28.1% of the variance in Infrastructure ($R^2 = 0.281$). These values are considered strong in social science research, where human behavior and technology adoption are influenced by numerous complex factors (Hair et al., 2019). Furthermore, the predictive relevance (Q^2) was calculated using the blindfolding procedure. The Q 2 Q 2 values for both Access and Infrastructure were positive (0.249 and 0.181 respectively), confirming that the model has satisfactory out-of-sample predictive validity for these endogenous constructs (Lakhdar et al., 2024, p. 255).

Table 3 – Structural Model Assessment Indicators (Source: authors)

Evaluation Metric	Indicator / Path	Value
Collinearity (VIF)	Computer_Bin	1.114
	SMARTPHONE	1.114
	Internet_Bin	1.000
	Urban_Bin	1.000
	windex5	1.130
	helevel	1.130
Explanatory Power (R^2)	Infrastructure	0.281
	Location	0.084
	SES	0.391
Effect Size (f^2)	Infrastructure → Access	0.390
	SES → Access	0.136
	Location → Access	0.025
	SES → Infrastructure	0.167
	Location → Infrastructure	0.018
Predictive Relevance (Q^2)	Infrastructure	0.181
	Location	0.083
	SES	0.249
	Access	0.000

The effect sizes (f^2) further highlight the relative importance of the predictors. Infrastructure has a large effect on Access ($f^2 = 0.390$), while SES has a medium effect ($f^2 = 0.136$). This reinforces the central role of material readiness in explaining digital inclusion.

Hypothesis Testing and Discussion

The structural relationships within the proposed model were rigorously tested using a bootstrapping procedure with 5,000 subsamples. As summarized in Table 3, all five hypothesized paths were statistically significant at the 99% confidence level ($p < 0.000$), providing robust empirical support for the theoretical framework.

Table 4 – Structural Path Coefficients and Significance (Source: authors)

Hypothesis	Path	β	T-Statistics	P-Values
H3	Infrastructure → Access	0.530	107.747	0.000
H1	SES → Infrastructure	0.376	74.205	0.000
H2	SES → Access	0.339	66.803	0.000
H5	Location (Urban) → Access	0.180	33.854	0.000
H4	SES → Infrastructure → Access	0.199	61.034	0.000

Discussion of Findings

The Critical Role of Socio-Economic Capital (H1)

The analysis confirmed a strong positive relationship between SES and digital infrastructure ownership (β=0.376). This finding indicates that the acquisition of digital hardware in Algerian households is not a trivial consumer choice but a function of accumulated capital. From a sociological perspective, drawing on Bourdieu (1986), wealth and education operate as interchangeable forms of capital that facilitate the conversion of economic resources into technological assets. This empirical evidence validates Van Dijk's (2005, 2020) assertion that material access is the foundational threshold of digital inclusion. Without the requisite economic capital to purchase devices and the cultural capital to perceive their utility, households remain on the wrong side of the device divide. This result aligns with global trends observed by Van Deursen and Van Dijk (2018), who noted that the first-level divide has shifted from simple connectivity to inequalities in device ownership and quality.

Direct Influence of SES on Access (H2)

Even after accounting for device ownership, SES maintained a significant direct effect on internet access (β = 0.339). This suggests that resources influence connectivity through channels beyond just hardware acquisition. Plausible explanations include the ability to sustain recurring operational costs (monthly subscriptions, data plans) and the stability of housing tenure. This finding resonates with Scheerder et al. (2017), who argued that multi-level divides often overlap; high-SES households are not only more likely to own devices but also to afford higher-quality, uninterrupted broadband services, whereas low-SES households might rely on intermittent or pay-as-you-go connectivity.

The Device Divide as a Primary Predictor (H3)

The most striking finding of this study is the magnitude of the effect of infrastructure on access (β=0.530). This confirms that possessing the "terminal equipment" is the single most critical determinant of internet adoption. This result strongly supports the "Device Divide" thesis forwarded by Pearce and Rice (2013) and Napoli and Obar (2014). It implies that network coverage is a necessary but insufficient condition; without a computer or smartphone, availability is irrelevant. Furthermore, this aligns with Wei's (2012) findings on "multimodality," suggesting that households with a diverse repertoire of devices are better positioned to integrate into the digital society than those relying on a single mode of access. This challenges supply-centric narratives (e.g., Philippe, 2020) that equate coverage expansion alone with digital progress.

Unpacking the Mediation Mechanism (H4)

The significant indirect effect (β=0.199) provides the core explanatory contribution of this paper. It empirically proves that a substantial portion of the impact of poverty on digital exclusion is mediated by the inability to cross the material threshold of device ownership. This "black box" analysis moves beyond the descriptive correlations presented in prior local studies like Boustil (2023) and Jeddou (2022). It demonstrates the mechanism of exclusion: SES → Device → Access. This finding reframes digital poverty as a structural extension of material deprivation (Boerkamp et al., 2024), where the lack of tangible assets effectively blocks participation in the digital sphere regardless of individual motivation.

The Persistence of the Spatial Penalty (H5)

Finally, the independent positive effect of urban location (β = 0.180) indicates that geography still matters. Even when controlling for wealth and devices, rural households are less likely to have internet access. This points to a "spatial penalty" likely driven by supply-side disparities, such as lower quality of service (QoS), lack of fixed-line infrastructure (ADSL/Fiber), or limited competition among ISPs in remote areas. This corroborates the macro-level findings of Bacha et al. (2024) regarding the uneven diffusion of broadband and aligns with international evidence from the ITU (2025) and OECD (2025) on the persistence of the urban-rural digital gap.

The persistent spatial penalty in rural areas (H5) warrants a nuanced interpretation. Beyond social injustice, this disparity reflects a market-driven infrastructure allocation. In Algeria, private and state-led investments often follow consumer concentration (Market Logic), where rurality intersects with lower market attractiveness. Furthermore, consistent with Van Dijk (2005), our results confirm that hardware ownership is the essential gateway; without it, economic capital cannot be converted into meaningful digital capital.

Comparative Analysis with Regional and Global Trends

The findings of this study do not exist in a vacuum but rather resonate with broader regional and global trends in the digital divide. In the North African context, Algeria shares similarities with neighboring countries where rapid mobile adoption has outpaced fixed-line infrastructure development. However, our results highlight a critical divergence: while mobile penetration is high, the "quality of access" remains stratified.

This mirrors the "mobile paradox" observed in other developing economies, where high teledensity statistics mask significant gaps in productive digital usage. Unlike developed nations where the material divide has largely been bridged, shifting the focus almost entirely to skills and usage (Van Dijk, 2020), Algeria — and similar transitional economies — is still grappling with the fundamental hurdle of material access. This duality suggests that blindly importing policy frameworks from the Global North, which assume ubiquitous device ownership, may be premature and ineffective for the Algerian reality.

The "Mobile-Only" Trap and the Emerging Underclass

A particularly concerning implication of our findings is the dominance of the smartphone as the primary, and often sole, gateway to the internet for many households. While the structural model confirms that smartphones contribute to "Infrastructure," the literature warns against equating mobile access with full digital inclusion. As Napoli and Obar (2014) argue, the "mobile internet underclass" faces systemic limitations: smaller screens, limited multitasking capabilities, restricted access to complex software, and often, capped data plans that discourage deep engagement. In the Algerian context, where the education system and job market are increasingly demanding digital proficiency, households relying exclusively on smartphones may find themselves at a severe disadvantage. They are consumers of digital content—social media, video streaming, basic communication—but are structurally impeded from becoming producers of content, software, or complex digital services. This "device hierarchy" threatens to cement existing socio-economic inequalities, creating a digital caste system where the elite wield the tools of production (computers/laptops) while the majority are relegated to the tools of consumption (phones).

Socio-Economic Status as a Gatekeeper

The robust mediation effect of SES underscores that digital exclusion is, at its core, an economic problem. The cost of technology in Algeria, often influenced by import tariffs, currency exchange rates, and lack of local manufacturing, remains a high barrier relative to the purchasing power of the average citizen. This economic reality transforms the computer from a standard household appliance into a luxury good. Consequently, digital inequality becomes a direct reflection of income inequality. Education, the second pillar of our SES construct, plays a dual role: it not only correlates with higher income but also shapes the "digital habitus" of the household. Educated heads of households are more likely to view digital devices as investments in human capital (e.g., for children's education) rather than mere entertainment devices, thereby prioritizing their acquisition even under financial constraints.

The Spatial Dimension: Beyond Infrastructure

The persistence of the urban-rural gap (H5), independent of wealth, points to systemic failures in territorial equity. While the state has made commendable efforts to extend the fiber optic backbone to remote wilayas (provinces), the "last mile" connectivity remains problematic. Rural areas often suffer from slower internet speeds, longer repair times for outages, and a scarcity of commercial points of sale for IT equipment. This "spatial penalty" effectively raises the cost of access for rural dwellers—not necessarily in monetary terms, but in terms of effort, reliability, and transaction costs. Addressing this requires a territorial planning approach that views digital connectivity as a public utility, akin to electricity and water, where universal service obligations are strictly enforced upon operators.

Conclusions

This study embarked on a critical investigation to deconstruct the mechanisms of digital exclusion within Algerian households, challenging the prevailing supply-side narratives that often equate infrastructure expansion with digital inclusion. By applying a rigorous structural equation modeling approach to a comprehensive national dataset, the research has empirically validated the central role of the "Device Divide" as a mediating mechanism. The findings demonstrate that socio-economic deprivation does not merely reduce the likelihood of internet subscription directly; rather, it fundamentally restricts the material capability to own the necessary terminal equipment—computers and smartphones—thereby structurally barring households from participation in the digital society.

The theoretical synthesis of this study reinforces the validity of the Resources and Appropriation Theory in the context of a developing economy. It illustrates that the path to digital inclusion is not a single step of "connecting," but a cumulative trajectory that must first traverse the material threshold. This distinction is critical; it suggests that current national strategies focusing heavily on fiber optic deployment and 4G coverage are necessary but insufficient. Without addressing the "demand-side" constraints — specifically the affordability of hardware — the digital divide will not close, but rather evolve into a more insidious form of inequality where the "connected" are separated from the "truly integrated."

The findings demand a shift from infrastructure-centric policies to demand-side interventions. From a practical policy perspective, we propose: (1) The implementation of a "Digital Voucher" system for low-income households to acquire laptops; and (2) Reducing import tariffs on computer components to foster affordability. The persistence of a significant "spatial penalty" for rural households, even after controlling for wealth and device ownership, serves as a stark reminder of the structural disparities in service quality. This calls for a dual-track policy approach: on one hand, targeted social interventions (subsidies, tax exemptions) to lower the barrier of device acquisition; and on the other, regulatory interventions to ensure equitable quality of service in non-urban areas. Furthermore, the strong link between education (as a component of SES) and infrastructure ownership highlights the need for digital literacy programs that go beyond basic usage to foster a culture of productive digital engagement. Ultimately, this study posits that the "first-level divide" in Algeria is far from resolved.

Ultimately, overcoming the digital divide is impossible without lowering the cost of computer hardware, as smartphone-ization alone does not ensure full digital inclusion in the labor market or educational processes. As the world moves towards an AI-driven economy, the gap between those who own productive digital tools (computers) and those who rely on passive consumption devices (smartphones) threatens to create a new "digital underclass." Addressing this requires recognizing that digital poverty is an extension of material poverty, and its solution lies at the intersection of economic policy, social justice, and technological development. Future research must continue to probe these dynamics, particularly by incorporating longitudinal data to track the long-term impact of these exclusions on social mobility and economic productivity.

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References

Attewell, P. (2001). Comment: The First and Second Digital Divides. *Sociology of Education, 74*(3), 252. https://doi.org/10.2307/2673277

Bacha, R., Gasmi, F., & Metevier, S. (2024). Broadband adoption in Algeria and the structural determinants of its pace. *Telecommunications Policy, 48*(6), 102761. https://doi.org/10.1016/j.telpol.2024.102761

Boerkamp, L. G. P., van Deursen, A. J. A. M., Laar, E. van, van der Zeeuw, A., & van der Graaf, S. (2024). Exploring Barriers to and Outcomes of Internet Appropriation Among Households Living in Poverty: A Systematic Literature Review. *Sage Open, 14*(1). https://doi.org/10.1177/21582440241233047

Book Reviews. (2007). *Asian Journal of Communication, 17*(4), 433–442. https://doi.org/10.1080/01292980701637074

Bourdieu, P. (1986). The Forms of Capital. In J. Richardson (Ed.), *Handbook of Theory and Research for the Sociology of Education* (pp. 241-258). Greenwood. https://www.marxists.org/reference/subject/philosophy/works/fr/bourdieu-forms-capital.htm

Boustil, Z. (2023). La fracture numérique en Algérie: Etat des lieux et perspectives. *Journal of Research and Human Studies, 17*(1), 1182–1201. https://asjp.cerist.dz/en/article/227167

Correa, T., Pavez, I., & Contreras, J. (2018). Digital inclusion through mobile phones?: A comparison between mobile-only and computer users in internet access, skills and use. *Information, Communication & Society, 23*(7), 1074–1091. https://doi.org/10.1080/1369118x.2018.1555270

Deursen, A. J. A. M., & Dijk, J. A. G. M. (2015). Toward a Multifaceted Model of Internet Access for Understanding Digital Divides: An Empirical Investigation. *The Information Society, 31*(5), 379–391. https://doi.org/10.1080/01972243.2015.1069770

Francis, D. V., & Weller, C. E. (2021). Economic Inequality, the Digital Divide, and Remote Learning During COVID-19. *The Review of Black Political Economy, 49*(1), 41–60. https://doi.org/10.1177/00346446211017797

Ghobadi, S., & Ghobadi, Z. (2013). How access gaps interact and shape digital divide: a cognitive investigation. *Behaviour & Information Technology, 34*(4), 330–340. https://doi.org/10.1080/0144929x.2013.833650

Hair, J. F., Risher, J. J., Sarstedt, M., & Ringle, C. M. (2019). When to use and how to report the results of PLS-SEM. *European Business Review, 31*(1), 2–24. https://doi.org/10.1108/ebr-11-2018-0203

Hammal, F. (2025). The Digital Transition in Algeria: Challenges and Opportunities. *Al Bashaer Economic Journal, 11*(3), 624–636. https://asjp.cerist.dz/en/article/278914

International Telecommunication Union (ITU). (2025). *Measuring digital development: Facts and figures*. https://www.itu.int/dms_pub/itu-d/opb/ind/d-ind-ict_mdd-2025-3-pdf-e.pdf

Jeddou, S. (2022). Diagnosing the reality of the digital divide in Algeria during the period (2012-2020): A comparative study at the global and Arab levels. *Journal of Contemporary Economic Studies, 7*(1), 177–196. https://asjp.cerist.dz/en/article/196344

Lakhdar, C., Abdelkader, K., & Ouledhaimouda, D. (2024). Modeling the Relationship between Some Leadership Styles on the Cohesion of the Educational Group using PLS modeling – a Field Study on a Sample of Primary Education Teachers in the City of Messaad. *European Journal of Management Issues, 32*(4), 249-258. https://doi.org/10.15421/192416

Millington, P., & Carter, L. D. (2013). Using Prospect Theory to Explore the Digital Divide. In J. Lewis, A. Green & D. Surry (Eds.), *Technology as a Tool for Diversity Leadership: Implementation and Future Implications* (pp. 49–61). IGI Global. https://doi.org/10.4018/978-1-4666-2668-3.ch004

Ministère de la Santé [Algeria], & UNICEF. (2020). *Enquête par grappes à indicateurs multiples (MICS6): Rapport des résultats de l'enquête*. UNICEF. https://www.unicef.org/algeria/rapports/suivi-de-la-situation-des-enfants-et-des-femmes-en-alg%C3%A9rie-0

Napoli, P. M., & Obar, J. A. (2014). The Emerging Mobile Internet Underclass: A Critique of Mobile Internet Access. *The Information Society, 30*(5), 323–334. https://doi.org/10.1080/01972243.2014.944726

OECD. (2025). *Digital connectivity expands across the OECD, but rural areas lag behind*. OECD Publishing. https://www.oecd.org/en/data/insights/statistical-releases/2025/07/digital-connectivity-expands-across-the-oecd-but-rural-areas-are-falling-further-behind.html

Pearce, K. E., & Rice, R. E. (2013). Digital Divides From Access to Activities: Comparing Mobile and Personal Computer Internet Users. *Journal of Communication, 63*(4), 721–744. https://doi.org/10.1111/jcom.12045

Philippe. (2020). *La stratégie nationale de modernisation numérique comme cadre pour les autorités locales – Ville intelligente et autorité locale*. https://www.semanticscholar.org/paper/ee00fa254380a01fc27d03a880f2363ce781fa14

Scheerder, A., van Deursen, A., & van Dijk, J. (2017). Determinants of Internet skills, uses and outcomes. A systematic review of the second- and third-level digital divide. *Telematics and Informatics, 34*(8), 1607–1624. https://doi.org/10.1016/j.tele.2017.07.007

Schwab, K. (2016). *The fourth industrial revolution*. World Economic Forum. https://law.unimelb.edu.au/__data/assets/pdf_file/0005/3385454/Schwab-The_Fourth_Industrial_Revolution_Klaus_S.pdf

Van Deursen, A. J., & Van Dijk, J. A. (2018). The first-level digital divide shifts from inequalities in physical access to inequalities in material access. *New Media & Society, 21*(2), 354–375. https://doi.org/10.1177/1461444818797082

Van Dijk, J. (2005). *The Deepening Divide: Inequality in the Information Society*. SAGE Publications, Inc. https://doi.org/10.4135/9781452229812

Van Dijk, J. (2020). *The digital divide*. John Wiley & Sons. https://google.com/books?id=6DvKDwAAQBAJ

Van Dijk, J. A. G. M. (2006). Digital divide research, achievements and shortcomings. *Poetics, 34*(4–5), 221–235. https://doi.org/10.1016/j.poetic.2006.05.004

Van Dijk, J. A. G. M. (2017). Digital Divide: Impact of Access. In *The International Encyclopedia of Media Effects*, 1–11. Portico. https://doi.org/10.1002/9781118783764.wbieme0043

Warschauer, M. (2003). *Technology and Social Inclusion: Rethinking the Digital Divide*. The MIT Press. https://doi.org/10.7551/mitpress/6699.001.0001

Wei, L. (2012). Number Matters: The Multimodality of Internet Use as an Indicator of the Digital Inequalities. *Journal of Computer-Mediated Communication, 17*(3), 303–318. https://doi.org/10.1111/j.1083-6101.2012.01578.x

Appendix A: Measurement Scales and MICS6 Question Codes

Survey Question Description	MICS6 Code	Variable in SmartPLS	Construct (in Study)
Wealth index quintile (Household economic capital).	windex5	windex5	Socio-Economic Status (SES)
Education level of the household head (Cultural capital).	helevel	He level	
Does your household have a computer/laptop/tablet?	HC8	Computer_Bin	Device Ownership
Does your household have a mobile telephone/smartphone?	HC9	SMARTPHONE	
Does your household have access to the internet at home?	HC11	Internet_Bin	Digital Access
Area of residence (Urban vs. Rural).	HH6	Urban_Bin	Household Location