

When Does National-ID-First Become a Trap?

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Status and citation boundary. This manuscript develops the theory, confirmatory hypotheses, measurement architecture, source-audit rules, and empirical strategy before outcome analysis. It reports no empirical findings. It may be cited for conceptual and methodological claims, but not as evidence that any proposed relationship has been observed.

Abstract

Payment systems, digital-identity programs, and open-finance reforms are commonly evaluated as institutional infrastructures: whether switches are connected, interfaces standardized, or official credentials available. Yet a formally interoperable ecosystem may remain unusable by a person who lacks an accepted credential, changes a SIM or device, holds accounts across provider types, cannot withdraw consent, or cannot recover from an error. This Stage 1 paper develops person-level interoperability (PLI) as a bounded evaluative category for determining whether individuals can enter proportionately, pay, consent, switch, recover, and obtain remedy across institutional boundaries. It makes four contributions. First, it separates formal capability, production implementation, personal realization, and outcomes through a linked-item architecture that identifies discordance without subtracting non-equivalent scales. Second, it specifies an eight-domain measurement program covering entry and assurance, addressing, payment reach, consent, recovery, integrity, redress, and governance. Third, it prespecifies three confirmatory hypothesis families for preregistration using all eligible Sub-Saharan African Global Findex country-waves from 2014 through 2024, supported by time-stamped legal and production evidence and six fixed sentinel cases for process tracing. Fourth, it establishes a claim ladder and moves provider-neutral addressing and progressive-assurance safety tests into separately governed Phase 2 validation propositions. National-ID-first is treated as a conditional hypothesis: strong public identity may enable trust, while rigid gating may suppress participation when coverage, correction, authentication, or acceptable alternatives are weak. The design is expressly falsifiable and preserves regulated-provider responsibility, data-protection limits, and safety non-inferiority.

Keywords: person-level interoperability; payment systems; open finance; digital identity; mobile money; progressive assurance; financial inclusion; Sub-Saharan Africa

JEL classification: G21; G28; O16; O33; O55

1. Introduction

Sub-Saharan Africa has supplied some of the clearest demonstrations that useful financial access need not wait for conventional branch banking. Mobile money reduced transaction costs, improved risk sharing, and in Kenya produced measurable long-run poverty and gender effects (Jack & Suri, 2014;

Suri & Jack, 2016). The broader evidence nevertheless cautions against treating one celebrated deployment as a general causal template. Agent density, market structure, regulation, liquidity, connectivity, product design, and research design all shape observed outcomes (Aron, 2018).

That caution matters as the region moves beyond the first mobile-money era. Instant-payment systems, national digital-identity programs, open-banking and open-finance rules, telecom access, and data governance increasingly intersect. Each reform can be successful in its own institutional terms while the combined user journey remains incomplete. A rail may connect banks and mobile-money operators while a person cannot use it because an accepted document is unavailable, a record cannot be corrected, a number has been reassigned, an alias points to a stale endpoint, consent cannot be withdrawn, recovery depends on an inaccessible channel, or responsibility is unclear after a mistaken transfer.

The conventional research unit is usually an institution, scheme, account, or technology. Those units remain necessary, but they do not answer the central question of this paper: can a person exercise the promised function continuously and safely across institutional boundaries? System interoperability is not identical to lived interoperability.

This paper names the missing evaluative category person-level interoperability (PLI): the legally governed capacity of an individual to enter proportionately, pay, consent, switch, recover, and obtain remedy across provider, account, SIM, device, and channel boundaries. PLI is not a new settlement rail, civil register, or universal identifier. It is an analytical lens and measurement program for testing whether institutional capabilities become practically realizable without weakening anti-money-laundering and counter-terrorist-financing controls, cybersecurity, data protection, consumer protection, or the allocation of regulated responsibility.

The problem is empirically important because two real achievements coexist with two persistent asymmetries. Mobile money has made a mobile-network relationship a dependable path to finance for many people, often through tiered or simplified due diligence. Digital public infrastructure, instant payments, and open finance can reduce fragmentation and duplicated proofing. At the same time, official identification remains unevenly obtainable and digitally usable, while mobile access is stratified by handset ownership, connectivity, gender, geography, literacy, and security practice. The ID4D Global Dataset 2025 estimates that about 800 million people worldwide still lack proof of legal identity, with more than 400 million in Sub-Saharan Africa, and estimates that 2.8 billion people lack access to a government-recognized digital ID (Ansar et al., 2026). Global Findex 2025, based on nationally representative surveys of about 145,000 adults in 141 economies conducted during 2024, documents both the centrality of mobile-money accounts in the region and continuing constraints involving device ownership, password protection, and recovery after payment errors (Klapper et al., 2025). Neither identity nor mobile access can be treated as a binary universal input.

These conditions create a sequencing problem. A national-ID-first strategy can improve uniqueness, verification, fraud control, and coordination where coverage, correction, and authentication work well. The same strategy can become a gate where a credential is unavailable, costly to obtain, difficult to correct, technically unverifiable, or accepted only through inaccessible channels. Conversely, finance-led credentials or proportionate entry can preserve regulated access, but may fragment assurance,

weaken recovery, or create new surveillance keys if poorly governed. The relevant question is not whether national identity is good or whether mobile money is sufficient. It is which sequence and combination of capabilities produce inclusive, safe, and contestable participation under specific institutional conditions.

The paper makes four contributions. First, it defines PLI in relation to the capability approach and infrastructure studies, shifting attention from installed systems to the conversion of infrastructure into exercisable human capability (Robeyns, 2005; Sen, 1999; Star & Ruhleder, 1996). Second, it separates formal capability, production implementation, personal realization, and outcomes through matched indicators and explicit discordance states. The framework does not use numerical subtraction across non-equivalent scales. Third, it develops an eight-domain PLI measurement program while keeping person-level outcomes separate from institutional exposures and contextual moderators. Fourth, it prespecifies falsifiable hypotheses, design gates, source-control rules, and a claim ladder spanning descriptive, associational, quasi-experimental, mechanism, and separately governed validation evidence.

The originality claim is narrow. Existing architectures already recognize that identity, payments, and data exchange must interoperate. The African Union's interoperability framework emphasizes governance, trust, data protection, and sovereignty rather than technical compatibility alone (African Union, 2022). The World Bank's ID Meets Instant proposes a Trusted Access and Credentialing Hub (TACH) and Payment Identity Credential (PIC) that can connect fast payments with reusable verified attributes without creating a new payment rail or identity database (World Bank, 2026). BIS Project Aperta demonstrates the technical feasibility of a neutral network-of-networks for open-finance connectivity while describing itself as a prototype rather than production adoption (BIS Innovation Hub, 2026). This paper does not claim to invent finance-derived credentials, instant payments, or interoperable networks. Its contribution is the combined person-level evaluation framework, the linked evidence architecture, and a falsifiable design for testing when institutional interoperability becomes personally realizable.

Section 2 defines the Sub-Saharan African interoperability problem. Section 3 positions PLI against the relevant literature and prior art. Section 4 develops the theory and measurement levels. Section 5 states the research questions, confirmatory hypotheses, and Phase 2 validation propositions. Sections 6 through 8 define the source audit, measurement architecture, and empirical strategy. Section 9 fixes reporting and decision rules. Sections 10 and 11 set out policy implications and rights-preserving safeguards. Section 12 states positionality and independence controls; Sections 13 and 14 address limitations and conclude.

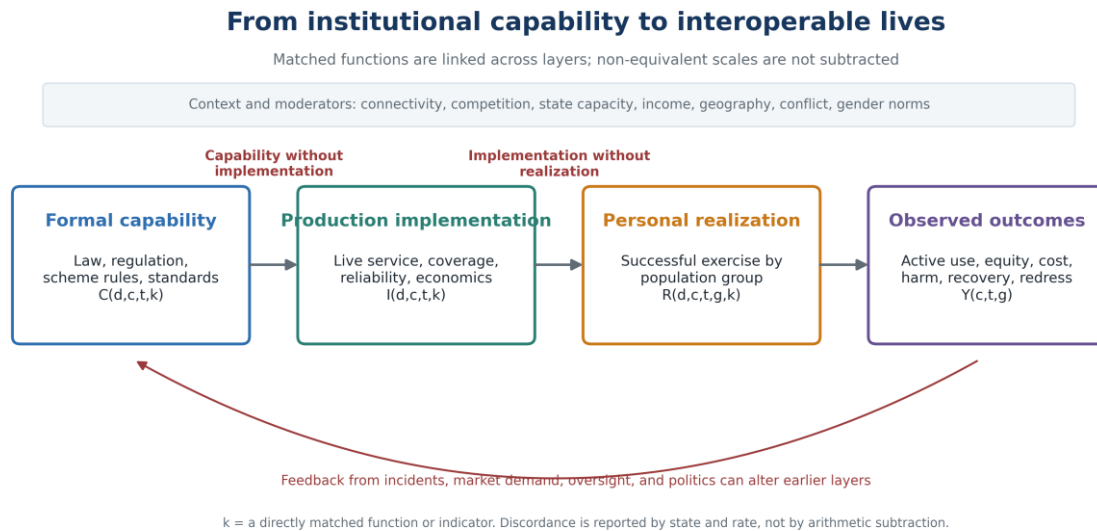


Figure 1. From institutional capability to interoperable lives: directly matched functions across four evidence layers.

Source: Author's construction.

2. The Sub-Saharan African Interoperability Problem

2.1 Mobile money as access infrastructure

Mobile money altered the feasible geography and economics of financial access in Sub-Saharan Africa. A basic handset, SIM relationship, and agent network became capable of supporting transfers, cash conversion, bill payments, and increasingly merchant payments. In some markets, a mobile-money account became the first or only formal account. Global Findex 2025 reports that Sub-Saharan Africa has the largest share of adults whose only account is a mobile-money account (Klapper et al., 2025). Mobile networks must therefore be treated as part of financial infrastructure, not as a merely adjacent communications layer.

Dependence on mobile access does not settle who controls an endpoint or whether access is continuous. Shared phones, agent-assisted transactions, SIM replacement, number recycling, provider exit, device loss, weak password use, and inconsistent network coverage are ordinary operating conditions. A technically routable alias can remain unsafe if the number lifecycle, proof-of-control, confirmation-of-payee, remapping, and dispute rules are weak. A person who can pay today but cannot recover after a lost device does not possess continuous payment capability.

Network reach also differs from person reach. Subscriber identities, wallets, and accounts are not unique-person counts. One adult may hold several SIMs or wallets while another relies on a family member's device or an agent. Tanzania illustrates both the value and the denominator problem. The Bank of Tanzania reports that the Tanzania Instant Payment System processed 452.50 million transactions valued at TZS 29,820.20 billion during 2024, with 46 participants (Bank of Tanzania, 2025, pp. 12-13). Those figures establish system use and scale; they do not establish how many unique persons transacted or whether participation was equally realizable across groups. PLI treats unit and denominator as part of the claim, not as a footnote.

2.2 Identification as an enabler and a gate

Foundational identification can reduce duplicated proofing, enable remote verification, improve the integrity of social transfers, and help regulated institutions meet due-diligence obligations. It can also support secure correction and recovery. The African Union framework accordingly treats digital-ID interoperability as a trust, governance, and mutual-recognition problem rather than a database connection (African Union, 2022).

Possession is only one conversion step. ID4D distinguishes proof-of-identity coverage from access to, ownership of, and use of digital ID. In lower-coverage economies, adults without ID report barriers involving distance, documentary requirements, and cost, and report difficulty obtaining SIMs or accessing financial services (Ansar et al., 2026). Even a person who holds a card may face a failed chip read, record mismatch, unavailable authentication service, inaccessible correction process, or provider records that do not reconcile. Coding all credential holders as equally verifiable would conceal a material implementation and realization problem.

Gate severity must therefore be measured by product tier, date, and enforcement state. A rule requiring a designated national ID only for a high-value account differs from one required for basic entry, continued use, or every transaction. An announced rule differs from a legally effective rule, and a legally effective rule differs from a consistently enforced rule.

Official country materials illustrate distinct configurations. Bank of Ghana Notice No. BG/GOV/SEC/2022/01 directed that, from 1 July 2022, the Ghana Card would be the only identification card used for transactions at institutions licensed and regulated by the Bank of Ghana, including payment service providers and dedicated electronic-money issuers (Bank of Ghana, 2022). Nigeria combines the Bank Verification Number and National Identification Number with tiered requirements: the Central Bank of Nigeria states that its December 2023 circular required Tier 2 and Tier 3 individual accounts and wallets to have both BVN and NIN, while Tier 1 accounts and wallets require either BVN or NIN (Central Bank of Nigeria, 2023b). Tanzania's 2025 SIM-registration regulations require biometric registration and link the access channel to official identity processes (Tanzania Communications Regulatory Authority, 2025). These are not interchangeable versions of a country-level binary variable called "ID required."

Ethiopia also demonstrates why source control must precede coding. Fayda is established under Proclamation No. 1284/2023 and supports biometric deduplication, authentication, and eKYC (National ID Ethiopia, 2026). Public-facing webpages are mutable and do not by themselves establish the historical or operative requirement for a phone number or any other enrollment field. The study will reconcile the proclamation, directives, enrollment manuals, effective dates, and observed production practice in the source register. An unresolved conflict is coded indeterminate rather than resolved by convenience.

2.3 Instant payments and open finance

African instant-payment reforms seek reach across banks, mobile-money operators, and other regulated providers. Their inclusive value depends on access terms, live participation, pricing, liquidity arrangements, use cases, service levels, and remedies. A scheme can have broad legal eligibility while

prefunding, certification cost, indirect access, or governance rights make participation economically unrealistic. AfricaNenda's SIIPS 2025 report explicitly assesses inclusion in both functionality and governance and limits its system inventory to live functionality as of June 2025 (AfricaNenda Foundation, 2025).

The region's reforms vary in maturity and structure. Kenya's National Payments Strategy 2022-2025 identifies full interoperability, resilient infrastructure, customer usefulness, security, and regional integration as strategic priorities (Central Bank of Kenya, 2022). Tanzania's TIPS moved retail interoperability from bilateral connections toward a multilateral system with banks and nonbanks (Bank of Tanzania, 2025). The Democratic Republic of the Congo's legal payment-system framework is grounded in Law No. 18/019 of 9 July 2018 and related central-bank instruments, while its infrastructure and provider landscape continue to evolve (Banque Centrale du Congo, 2018, 2026). These examples support a comparative design but do not by themselves establish person-level outcomes.

Open banking and open finance add a second interoperability problem: the portability of customer-permissioned data and, in some regimes, initiation rights. Nigeria's 2023 Operational Guidelines for Open Banking establish roles, registry functions, security, consent, service-level, and risk-management requirements. The existence of the guidelines establishes formal capability, not production participation, conformance, viable economics, or effective nonbank access (Central Bank of Nigeria, 2023a). International evidence similarly indicates that standardized APIs can reduce bilateral integration costs, but governance, liability, reciprocity, consent design, market incentives, and provider scope determine whether open finance improves competition or reinforces incumbency (Eroglu et al., 2026; Plaitakis & Staschen, 2020).

Payment rails, identity systems, open-finance frameworks, and telecom regimes are commonly designed in parallel. The rail optimizes message movement and settlement; the identity system manages authoritative attributes and authentication; open finance governs permissioned data exchange; and telecom rules govern numbers, SIMs, and access channels. A person experiences them as one journey. Failure at any institutional handoff can make the complete stack personally incomplete. That combined journey is the empirical object of this paper.

Table 1. Key concepts and non-negotiable boundaries

Concept	Working definition	Boundary
Civil identity	Legal identity established under national law by a competent public authority.	Never inferred from transactions, a SIM, a payment alias, or private behavioral data.
Customer identification	Collection of information required for a regulated customer relationship.	Distinct from verification, authentication, authorization, and address resolution.
Financial identity	A regulated institution's context-specific confidence for a defined	Does not establish citizenship, nationality, or civil status.

Concept	Working definition	Boundary
assurance	product, risk tier, and time.	
Person-level interoperability	Capacity to enter proportionately, pay, consent, switch, recover, and obtain remedy across institutional boundaries.	Does not transfer prudential, settlement, customer-due-diligence, or remedy responsibility.
Progressive assurance	A lawful, risk-tiered path from minimum required evidence for limited services to stronger evidence for expanded capability.	No anonymous regulated account where prohibited; no inference of civil identity from behavior.
Provider-neutral address	A user-facing pointer that resolves to a selected regulated account.	Not an account, store of value, settlement rail, civil identifier, or unrestricted analytics key.
Matched-item discordance	Mismatch among directly linked capability, implementation, and realization evidence for the same function, tier, and date.	Reported by state or rate; non-equivalent scales are never subtracted.

Note. Definitions are jurisdiction neutral and must be mapped to national law before empirical coding.

3. Literature and the Unresolved Gap

3.1 Financial inclusion beyond account ownership

The financial-inclusion literature has moved from physical access and account ownership toward use, quality, resilience, and welfare. Global Findex remains central because it measures individual behaviors across repeated cross-sections. Account ownership alone, however, cannot reveal whether a person can complete a cross-provider payment, maintain access after a SIM change, inspect and withdraw consent, or obtain timely redress. The Payment Aspects of Financial Inclusion framework similarly treats universal access to and use of regulated transaction accounts as a policy objective grounded in infrastructure, legal foundations, and catalytic pillars (Committee on Payments and Market Infrastructures & World Bank, 2020). PLI extends that work by making cross-institution conversion failures observable.

Mobile-money research provides strong evidence that payment technology can affect household outcomes. Jack and Suri (2014) identify lower transaction costs and improved risk sharing in Kenya, while Suri and Jack (2016) estimate long-run poverty and gender effects. Aron (2018) documents substantial variation in methods and warns that causal interpretation must track research design. A multi-country association cannot inherit the causal credibility of a country-specific natural experiment merely because the subject matter is similar.

The capability approach supplies the conceptual move. Resources and formal entitlements are not the same as achieved functionings because conversion depends on personal, social, and environmental factors (Robeyns, 2005; Sen, 1999). An interoperable switch is a resource. The ability to initiate a safe transfer, understand its status, correct an error where rules permit, and recover access is a capability. PLI therefore measures conversion rather than treating installation as achievement.

3.2 Infrastructure, platforms, and invisible work

Infrastructure becomes visible at breakdown. Its apparent smoothness rests on standards, maintenance, organizational arrangements, and often invisible work (Star & Ruhleder, 1996). Platform studies add attention to boundary control, data capture, and market power (Plantin et al., 2018). Together, these literatures caution against treating interoperability as an endpoint. A standard can widen connectivity while a directory operator, dominant provider, or credential issuer controls participation, discovery, or data.

This literature also motivates the separation of formal capability and production implementation. A regulation may authorize API access while providers do not expose conformant endpoints. A scheme may admit nonbanks while prefunding, certification cost, or governance arrangements make direct participation impractical. A digital-ID service may technically authenticate while outages, exception handling, or inaccessible enrollment limit realized use. Each stage has different evidence and failure modes.

3.3 Digital identity, data protection, and progressive assurance

Digital identity can reduce identification costs and support service delivery, but it also raises exclusion, privacy, nondiscrimination, cybersecurity, and correction risks (Beduschi, 2019; Gelb & Diofasi Metz, 2018). The African Union framework similarly recognizes cybersecurity, vendor lock-in, sovereignty, inclusion, and data-protection constraints even while promoting interoperability (African Union, 2022). Assurance is analytically decomposable. NIST Special Publication 800-63-4 distinguishes identity proofing, authentication, and federation (Temoshok et al., 2025). Financial regulation adds customer identification, verification, ongoing due diligence, sanctions screening, and transaction monitoring. Address resolution asks a separate question: where should a payment be routed? Collapsing these functions into one "digital identity" variable prevents the study from distinguishing documentary failure, biometric mismatch, authenticator loss, account binding, stale addressing, or policy exclusion.

Progressive assurance is the hypothesis that regulated access can expand safely when evidence and controls are proportionate to product risk and increase as capability expands. FATF's 2025 financial-inclusion guidance emphasizes proportionate risk-based implementation and warns that overly conservative application can exclude legitimate users (Financial Action Task Force, 2025a). This does not eliminate national-law requirements or final institutional responsibility. FATF Recommendation 17 permits reliance under specified conditions while retaining ultimate due-diligence responsibility with the relying institution and requiring underlying evidence to be available without delay (Financial Action Task Force, 2025b). Portable evidence is not portable liability.

3.4 Open finance and cross-domain interoperability

Open finance promises data portability, competition, and innovation, but inclusion is not automatic. CGAP's comparative work argues that framework design must address underserved users, provider diversity, viable use cases, liability, privacy, implementation, and cost allocation rather than assume that bank-account APIs will reach mobile-money-led populations (Plaitakis & Staschen, 2020). International evidence similarly highlights standardization, reciprocity, governance, liability, and market structure as implementation conditions (Eroglu et al., 2026).

Project Aperta is relevant because it demonstrates an API-based network-of-networks linking domestic open-finance arrangements across jurisdictions. Its contribution is proof of technical feasibility and policy learning, not evidence of African production adoption or person-level outcomes (BIS Innovation Hub, 2026). ID Meets Instant likewise proposes TACH and PIC architecture for reusable verified payment attributes without creating a new identity database or payment rail (World Bank, 2026). These projects narrow the originality space for any claim that finance-related credentials or neutral interconnection are unprecedented.

3.5 Prior-art positioning

The unresolved gap lies in the combination of unit, scope, evidence separation, and testability. Existing frameworks commonly evaluate a sectoral infrastructure, policy framework, or program outcome. They do not generally provide a common measurement system for following a person across entry, routing, payment, consent, recovery, integrity, redress, and governance while keeping law, production, personal realization, and outcomes distinct. Nor do they specify a falsifiable interaction between national-ID gate severity and practical ID usability across Sub-Saharan African country-waves.

Table 2. Prior-art positioning and the remaining contribution space

Framework	Primary unit	Principal contribution	Remaining gap addressed by PLI
PAFI	Transaction-account system	Legal foundations, infrastructure, and catalytic pillars for access and use.	Does not follow the full identity-data-payment lifecycle at the person level.
AU Digital ID Framework	National and continental trust framework	Digital-ID interoperability, governance, protection, and sovereignty.	Not a payment or open-finance outcome model.
SIIPS	Instant-payment system	Live functionality, provider reach, and inclusive governance.	Does not measure the full identity, consent, recovery, and redress chain.
ID Meets Instant	Reference architecture	TACH and PIC integration of digital identity with fast	Conceptual architecture rather than comparative

Framework	Primary unit	Principal contribution	Remaining gap addressed by PLI
		payments.	person-level outcome testing.
Project Aperta	Cross-border network prototype	Neutral network-of-networks for open-finance interoperability.	Prototype feasibility rather than African production or person-level outcomes.
PLI	Person plus institutional context	Eight domains, linked evidence layers, falsifiable sequencing and implementation hypotheses.	Its empirical validity remains to be tested.

Source: Author's construction from the cited frameworks.

PLI is therefore an integrative contribution, not a claim to have invented each constituent idea. Its novelty will stand or fall on construct validity, source quality, and empirical performance. The framework is designed to be revised or rejected if its domains do not cohere, if the proposed exposures cannot be measured independently of outcomes, or if the predicted relationships fail credible tests.

4. Theory: From Institutional Capability to Interoperable Lives

4.1 A linked evidence model, not an arithmetic gap

Let d index a domain, c a country or jurisdiction, t time, g a population group, and k a matched function or indicator. Formal capability, $C(d,c,t,k)$, records whether binding laws, regulations, scheme rules, or standards permit, require, and govern the function. Production implementation, $I(d,c,t,k)$, records whether the same function is live, materially covered, reliable, and economically usable. Personal realization, $R(d,c,t,g,k)$, records whether members of group g can successfully exercise that function. Outcomes, $Y(c,t,g)$, include active digital payment use, cost, completion, continuity, equity, fraud, privacy incidents, complaints, and redress.

The variables are linked but are not numerically interchangeable. A four on a legal-capability scale does not have the same cardinal meaning as a four on a production-maturity scale, and neither is equivalent to a survey-estimated probability of successful use. The manuscript therefore does not calculate $C - I$, $I - R$, or $C - R$. Instead, it compares directly matched items and reports categorical discordance states and, where justified, rates of matched-item discordance.

For a prespecified set of K directly matched functions, the implementation-discordance rate is the proportion of functions for which capability meets its threshold while implementation does not. The realization-discordance rate is the proportion of implemented functions for which a valid person-level measure remains below its preregistered success floor. Those rates are descriptive diagnostics, not causal estimands. They are calculated only when the item wording, date, tier, and unit are linked and evidence coverage meets the minimum threshold.

Table 3. Matched-item discordance states

State	Capability	Implementation	Realization	Interpretation
Aligned high	Meets threshold	Meets threshold	Meets success floor	The function is supported, live, and successfully exercised.
Capability without implementation	Meets threshold	Below threshold	Not evaluated or below floor	Rules exist but production delivery is absent or materially limited.
Implementation without realization	Meets threshold	Meets threshold	Below success floor	A live function remains unusable or unsuccessful for the measured group.
De facto implementation ahead of law	Below or unclear	Meets threshold	Observed or unknown	Production precedes clear legal capability, indicating regulatory lag or fragility.
Aligned low	Below threshold	Below threshold	Below floor or unavailable	Consistent absence is not success.
Indeterminate	Unresolved	Unresolved	Unresolved	Evidence conflict or missingness prevents classification.

Note. States are assigned only to directly matched functions with aligned dates, tiers, units, and evidence coverage.

This architecture preserves informative negative cases. Production can precede clear legal capability, indicating regulatory lag or legal fragility. Capability and implementation can both be low, producing an aligned-low state that is not success. A function can be live for one provider type or urban channel but unrealized for a subgroup. Indeterminate evidence remains visible rather than being coded as absence.

4.2 Eight domains of person-level interoperability

PLI uses eight domains. The first seven organize person-facing journeys; the eighth captures institutional governance and contestability that condition those journeys. The domain profile is the primary analytical output. A single summary score is secondary and cannot be used to prove the complementarity built into its construction.

Eight domains of person-level interoperability

The person-facing profile is primary; governance is an institutional condition



No domain is sufficient alone. Critical floors prevent strong averages from masking unsafe recovery, absent redress, or uncontrolled linkability.

Figure 2. Eight domains of person-level interoperability, centered on the person as the unit of evaluation.

Source: Author's construction.

Proportionate entry and assurance cover lawful tiered customer due diligence, accepted alternatives, assisted or remote access, and transparent upgrade paths. Addressing and routing continuity cover provider-neutral proxies, proof of control, confirmation of payee, remapping, and number recycling. Payment reach and execution cover effective cross-provider access, disclosed cost, transaction status, finality, and usable funds. Consent and data portability cover institutional scope, granularity, comprehension, revocation, minimization, and onward-use controls. Recovery and lifecycle continuity follow the person after a lost or changed device, SIM, document, authenticator, or provider. Integrity and security capability locate fraud, sanctions, financial-crime, and cyber responsibilities without arbitrary exclusion. Rights, evidence, and redress include receipts, status, liability, correction, appeal, compensation, and due process. Governance and contestability cover legal basis, oversight, participation rights, neutrality, audit, transparency, and market-power controls.

No domain is sufficient alone. An alias improves addressability only if the user controls it, the mapping is current, the receiving name can be checked without enabling enumeration, unauthorized remapping can be reversed, and liability is allocated. Data portability improves competition only if users can understand and withdraw consent, participating providers face workable terms, and recovery is possible. Progressive assurance improves inclusion only if lower tiers are lawful and useful, higher limits have a transparent upgrade path, and lower tiers do not become permanent second-class services.

Table 4. Person-level interoperability domains, units, and critical floors

Domain	Primary unit	Illustrative realization test	Illustrative critical floor
1. Entry and assurance	Person / provider	Can an eligible person enter a suitable regulated tier and upgrade without unnecessary restart?	No lawful, accessible entry or exception path.
2. Addressing and routing continuity	Person / account / directory	Can the person route correctly after changing provider, SIM, or device and detect a wrong recipient?	Uncontrolled enumeration or unreviewable remapping.
3. Payment reach and execution	Person / transaction / scheme	Can the person send, receive, know status, and access usable funds across provider types at disclosed cost?	No accountable status or failed-handoff owner.
4. Consent and data portability	Person / consent / provider	Can the person authorize a specific use, inspect it, withdraw it, and prevent hidden onward use?	Consent cannot be withdrawn or purpose cannot be bounded.
5. Recovery and lifecycle continuity	Person / credential / provider	Can the person regain access after device, SIM, document, authenticator, or provider change?	Recovery is unavailable or materially weaker than initial access.
6. Integrity and security capability	Provider / scheme / person	Are compromised journeys detected without arbitrary or unappealable exclusion?	Critical compromise lacks a stop or review mechanism.
7. Rights, evidence, and redress	Person / complaint / provider	Can the person prove what occurred and obtain timely, accessible remedy?	No accessible complaint, appeal, or evidence path.
8. Governance and contestability	Scheme / provider / authority	Can users and smaller providers contest rules or failures without dependence on a dominant operator?	No accountable rule-maker, oversight route, or participation transparency.

Note. The person-facing profile is primary. Governance and contestability are institutional conditions that shape person-level realization.

4.3 National-ID-first as a sequencing hypothesis

"National-ID-first" describes a sequence in which a designated national identifier or its digital verification becomes a prerequisite for financial entry, continued use, or meaningful transaction tiers. It is not a claim that all national-ID systems are exclusionary. The sequence may be efficient where coverage is near universal, enrollment and correction are accessible, remote or assisted authentication is reliable, alternative channels exist, and responsibility for errors is clear. It may be constraining where those conversion conditions fail.

The mechanism is an interaction between gate severity and ID usability. Gate severity records how much of the financial journey is blocked without the designated credential, differentiated by product tier, date, rule status, and enforcement. ID usability records actual coverage, distance and documentary burdens, digital verifiability, error correction, authentication availability, and acceptable alternatives. High gate severity combined with high usability may improve integrity without reducing participation. High gate severity combined with low usability should reduce entry or active use and widen distributional gaps if the hypothesis is correct.

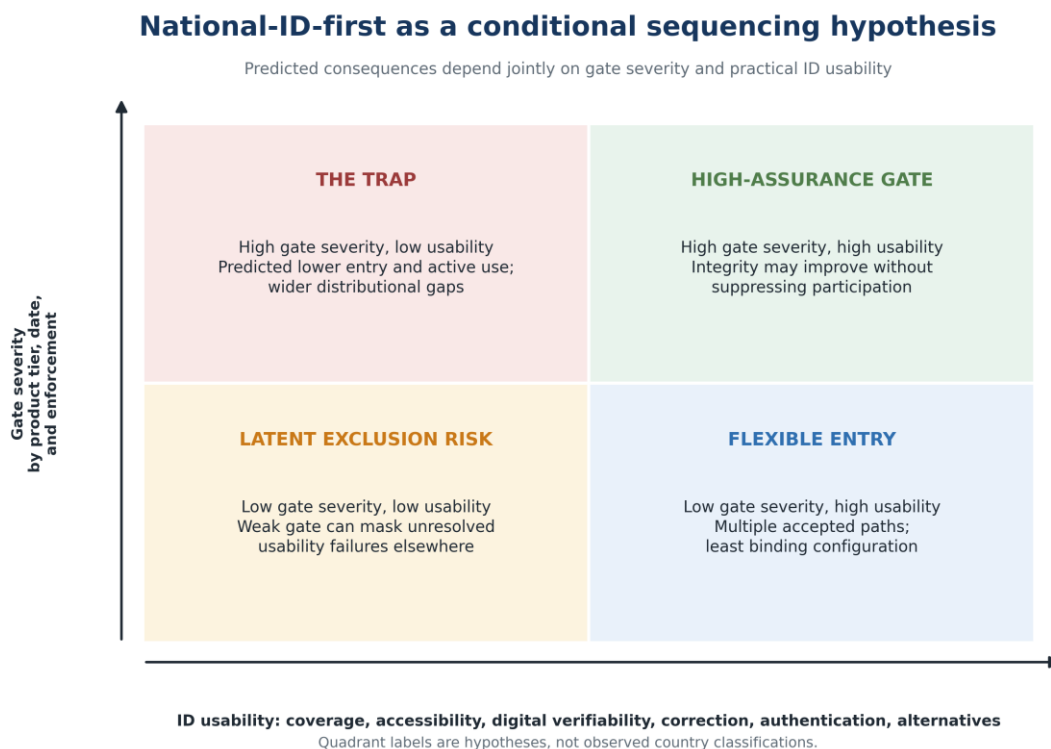


Figure 3. National-ID-first as a conditional sequencing hypothesis: predicted consequences depend jointly on gate severity and ID usability.

Source: Author's construction.

Progressive assurance is the principal alternative sequence examined, not a universal policy prescription. It permits limited regulated capability based on the minimum lawful evidence and controls appropriate to assessed risk, followed by stronger assurance for expanded capability. A national credential can remain the preferred high-assurance anchor. The decisive question is whether the lower-tier path improves regulated participation without worsening financial-crime, fraud, exclusion, or consumer-harm

endpoints beyond prespecified margins. That dual-endpoint test belongs to Phase 2 validation, not the current observational paper.

4.4 Provider-neutral continuity without universal identity

Person-level continuity may benefit from a stable payment pointer that is not permanently tied to one bank, wallet, SIM, or device. A persistent user-facing alias also creates privacy and security risks if it becomes a cross-context key. The architecture evaluated here separates a memorable address from backend resolution and assurance. Pairwise or purpose-specific tokens, controlled mapping, query throttling, logging, proof of control, confirmation of payee, remapping delay, notification, and rollback can reduce linkability and takeover risk.

This distinction is relevant to the Rego-related implementation context disclosed in Section 12, but the scientific claim is vendor neutral. The paper does not test whether one nine-digit format should become a public standard. It asks whether provider-neutral addressing under specified governance and security conditions can improve correctly routed completion, switching, and recovery while remaining non-inferior on takeover, misdirection, unauthorized remapping, privacy leakage, and unresolved harm. That question is retained as a separately governed validation proposition rather than a confirmatory hypothesis in this Stage 1 observational design.

4.5 Levels of analysis

PLI spans three levels that must not be mechanically collapsed. Person-level outcomes include entry, use, completion, recovery, comprehension, and redress. Provider- or scheme-level implementation includes participation, reliability, price, conformance, liquidity arrangements, and operational coverage. Jurisdiction-level context includes law, identity usability, market concentration, state capacity, connectivity, and conflict. Governance and contestability are chiefly institutional-context constructs, although they can be experienced through user complaint and appeal pathways.

The empirical strategy therefore treats institutional measures as exposures or moderators and person-level measures as outcomes. The domain profile may display them together for diagnosis, but an overall index is not permitted to hide the unit of each component. Every result must state its unit, denominator, time period, and evidence class.

5. Research Questions, Confirmatory Hypotheses, and Validation Propositions

The primary research question is: under what institutional, technical, regulatory, and market conditions do payment, identity, and data-interoperability capabilities become usable at the person level, and when is that realization associated with greater active and equitable financial participation?

Three confirmatory hypothesis families are tested in this Stage 1 observational paper. Two additional propositions are reserved for a separately approved Phase 2 validation protocol.

5.1 H1: implemented complementarity

H1a, core implementation bundle. After conditioning on the prespecified contextual set, the joint implementation of cross-provider payment reach, proportionate entry and assurance, and recovery or redress capability will improve grouped out-of-sample prediction of the primary active-use outcome beyond a model containing only their main effects.

H1b, open-finance extension. If the source audit identifies sufficient country-wave variation in live, usable consent and data-portability implementation, adding that implementation and its prespecified interactions to the H1a model will improve out-of-sample prediction beyond the core bundle. H1b is confirmatory only if its design gate is met before outcome inspection; otherwise it is reported as descriptive or exploratory.

H1 is not tested with a geometric-mean or balance-rewarding index because that would mechanically encode complementarity. Support requires a reduction of at least 5 percent in grouped leave-one-country-out prediction error relative to the main-effects model, improvement in at least 60 percent of held-out countries, and a directionally coherent 25th-to-75th percentile implementation-bundle contrast of at least 3 percentage points in the primary outcome. Failure occurs if predictive gain is smaller, unstable, oppositely signed, or dependent on coding announcements as production implementation. The joint predictive and marginal-effect requirements are intended to prevent a statistically detectable but practically negligible gain from being treated as substantive support.

5.2 H2: gate severity by ID usability

H2 predicts that higher national-ID gate severity is associated with lower active digital-payment use and wider gender and bottom-40-percent income gaps where acceptable ID is difficult to obtain, correct, or use digitally. The relationship may be neutral or beneficial where ID usability is high.

The primary H2 estimand is the difference in the marginal association of gate severity with active use between the 25th and 75th percentiles of ID usability. Support requires the predicted sign, a contrast of at least 2 percentage points, and an interval excluding zero after the primary-family multiplicity correction. Gender and income are the confirmatory distributional dimensions because they are harmonized across the planned Findex waves. Rural comparisons are confirmatory only for 2021 and 2024, because the 2021 Global Findex introduced a DEGURBA-based rural classification that is not comparable with the earlier subjective measure. Disability and displacement are exploratory or process-tracing dimensions unless a named, comparable external source is frozen before outcome analysis.

Failure occurs if the conditional pattern is null, oppositely signed, or too unstable across the prespecified evidence and timing windows. The result is indeterminate where historical enforcement or ID usability cannot be reconstructed.

5.3 H3: effective cross-sector scope

H3 predicts that live and economically viable participation by banks, mobile-money operators, microfinance institutions, and regulated fintechs is associated with stronger active use and contestability than bank-only or paper-only scope in mobile-money-led markets.

Paper eligibility is not the exposure. Directness of access, conformance cost, prefunding or liquidity conditions, service levels, reciprocity, governance rights, production coverage, and fee viability determine effective scope. Support requires the predicted sign, a 25th-to-75th percentile contrast of at least 3 percentage points in the primary outcome, and stability after implementation maturity and concentration controls. The hypothesis fails if legal eligibility alone drives the result, if the association disappears under the prespecified production threshold, or if effective breadth is associated with worse use after the primary controls.

5.4 Phase 2 validation propositions

VP1, addressing benefit and safety. Provider-neutral addressing should improve correctly routed completion, switching, and recovery while remaining non-inferior on takeover, misdirection, unauthorized remapping, privacy leakage, and unresolved harm.

VP2, progressive-assurance dual endpoint. A lawful progressive-assurance journey should improve regulated participation among underserved groups while remaining non-inferior on financial-crime, fraud, false-positive exclusion, and consumer-harm outcomes.

VP1 and VP2 are not empirical hypotheses of the current paper. They require operational or controlled data, exposure denominators, power calculations, adverse-event definitions, non-inferiority margins, independent monitoring, stop rules, and secure data custody. Those parameters will be defined in a separate DRC Validation Protocol after regulator, provider, security, and ethics approvals. Until then, the correct status is untested proposition, not evidence.

Table 5. Confirmatory hypotheses, estimands, and decision rules

Family	Primary estimand	Support rule	Failure or downgrade rule
H1a - core complementarity	Predictive gain and 25th-to-75th percentile bundle contrast for payment reach, proportionate assurance, and recovery/redress.	At least 5% lower grouped prediction error; improvement in at least 60% of held-out countries; at least 3 percentage-point coherent contrast.	No stable gain, opposite direction, or dependence on announcement-as-implementation coding.
H1b - open-finance extension	Additional predictive gain from live consent and data portability and prespecified interactions.	Same support logic after its variation and power gate passes.	Downgraded before outcome modeling if the source or variation gate fails.
H2 - gate severity x ID usability	Difference in the marginal association of gate severity between low and high ID usability.	Predicted sign; at least 2 percentage-point contrast; interval excludes zero after multiplicity correction.	Null, opposite, unstable, or historically unreconstructable enforcement.
H3 - effective institutional	25th-to-75th percentile contrast for live and viable cross-sector	Predicted sign; at least 3 percentage-	Legal eligibility alone drives the

Family	Primary estimand	Support rule	Failure or downgrade rule
scope	participation.	point contrast; stable after maturity and concentration controls.	result or effect disappears under production threshold.
VP1 addressing benefit and safety	Operational benefit endpoints plus prespecified safety non-inferiority risk differences.	Separate Phase 2 approval; benefit superiority and safety non-inferiority.	Absent benefit, exceeded safety margin, or inadequate denominators.
VP2 progressive assurance dual endpoint	Participation superiority plus financial-crime, fraud, exclusion, and consumer-harm risk differences.	Separate Phase 2 approval; both endpoints pass.	Failure on either endpoint or indeterminate harm ascertainment.

Note. VP1 and VP2 are not confirmatory hypotheses in the current observational paper.

6. Research Design and Case Strategy

6.1 Design overview

The study is a sequential mixed-evidence comparative design. The first component constructs time-stamped country-domain records from laws, regulations, scheme rules, technical standards, payment statistics, provider materials, supervisory decisions, and credible implementation records. The second component links those exposures to harmonized individual outcomes in repeated cross-sectional surveys and to country-period operational or harm indicators. The third component uses fixed sentinel cases and process tracing to explain high and low discordance. Any DRC simulation or staged pilot is governed and reported separately.

The temporal unit is the country-wave interval anchored to survey fieldwork or an operational observation date. A reform passes through distinguishable states: announcement, legal adoption, legal effect, technical launch, provider onboarding, and material use. Coding the latest rule or system state into an earlier survey wave would create temporal leakage and is prohibited. Every documentary indicator records start date, end or supersession date, enforcement confidence, source class, and exact locator.

6.2 Quantitative universe and sentinel cases

The primary quantitative universe is all eligible Sub-Saharan African economies with at least one Global Findex observation in 2014, 2017, 2021, or 2024 and sufficient time-aligned evidence to code the relevant exposure. The 2011 wave is retained for descriptive baselines and for outcomes whose definitions are demonstrably comparable, but it is not part of the primary active-digital-payment model because the selected primary indicator begins in 2014.

This regional universe replaces a six-country confirmatory sample. It increases the number of independent country-wave exposure units and reduces the risk that a small number of hand-picked cases determine the result. Six countries are fixed in advance as sentinel process-tracing cases: the Democratic Republic of the Congo, Ghana, Nigeria, Kenya, Tanzania, and Ethiopia. They represent variation in ID coverage and digital usability, mobile-money dependence, payment-system maturity, open-finance rules, market concentration, and reform sequencing. They do not determine inclusion in the regional quantitative model, and their outcome trends will not be inspected before the coding and sample freeze.

Table 6. Quantitative universe and sentinel-case roles

Analytic component	Scope	Selection rule	Purpose
Quantitative country-wave universe	All eligible Sub-Saharan African economies observed in Global Findex 2014, 2017, 2021, or 2024.	Time-aligned outcome, reconstructable exposure dates, minimum evidence coverage, and no unresolved exposure-defining conflict.	H1-H3 estimation with materially larger contextual sample and explicit design gates.
DRC sentinel case	Identity, payment-system, mobile-money, and infrastructure transition.	Fixed before outcome inspection; independent coding and review.	Process tracing under author-linked institutional context.
Ghana sentinel case	Ghana Card gate and regulated-finance coverage.	Fixed documentary configuration.	High-severity gate with defined effective date and broad institutional scope.
Nigeria sentinel case	BVN/NIN tiering and open-banking capability.	Fixed documentary configuration.	Interaction of tiered assurance, payments, and open-finance reform.
Kenya sentinel case	Mature mobile-money ecosystem and payments strategy.	Fixed documentary configuration.	Long-run mobile-money access and interoperability context.

Analytic component	Scope	Selection rule	Purpose
Tanzania sentinel case	SIM/identity binding and multilateral TIPS implementation.	Fixed documentary configuration.	System scale, nonbank participation, and denominator discipline.
Ethiopia sentinel case	Foundational ID, eKYC, payment, and market reforms.	Fixed documentary configuration; source conflicts remain visible.	Bundled reform and source-adjudication stress test.

Note. Sentinel cases explain mechanisms; they do not define the complete quantitative sample.

A country-wave is eligible for a hypothesis only if it has: (1) a time-aligned primary outcome; (2) reconstructable legal and production dates for the relevant exposure; (3) at least 80 percent of the fixed core matched items resolved for each included domain; (4) all critical-floor items resolved; and (5) no unresolved contradiction that makes the primary exposure unknowable. Source availability is not a selection criterion for favorable results. The final analytic sample and exclusion reasons will be published before models are run.

6.3 Data sources and licensing

The principal outcome source is the Global Findex repeated cross-section. The primary outcome is the World Bank indicator "made or received a digital payment," defined as the percentage of adults age 15 and older who report making or receiving specified payments digitally during the prior year. The indicator is available for 2014 through 2024 and is disaggregated by sex and income group; degree-of-urbanization comparisons are limited by the change in rural classification described above (World Bank Data360, 2026). The 2024 public-use microdata are version WLD_2024_FINDEX_v02_M, DOI 10.48529/bk9n-8r43. The study will use the versioned public-use files, official questionnaires, and World Bank construction scripts where available, and will document any wave-specific reconstruction. The microdata license and terms govern access and reuse. Raw microdata will not be redistributed. The study will publish nonrestricted code, variable concordances, derived country-wave estimates where permitted, synthetic schemas, and validation hashes. Dataset citations will include the reference ID, version, date downloaded, and DOI. Interpretation remains the author's responsibility, not that of the original data producer.

Complementary sources include the ID4D Global Dataset, IMF Financial Access Survey, ITU indicators, AfricaNenda scheme assessments, central-bank payment statistics, national telecom observatories, and country legal instruments. Operational evidence will prioritize primary sources. Commercial or provider materials can establish a production fact only where scope, date, and definition are explicit; they cannot independently establish neutral governance, market-wide coverage, or favorable outcomes.

6.4 Source hierarchy and conflict adjudication

Sources are ranked by the claim they can support. Binding law, regulation, official scheme rules, and versioned technical standards are primary for capability. Central-bank or scheme production statistics, conformance records, participant lists, and service-level records are primary for implementation. Weighted surveys, administrative microdata, complaints, and incident records are primary for outcomes within their definitions. Expert interviews and high-quality secondary analyses may explain mechanisms or identify documents, but do not override an authoritative primary source without a documented reason. Evidence absence is coded "not evidenced," not zero. Other admissible states are not applicable, under legal challenge, withdrawn or superseded, and indeterminate. When two official sources conflict, coders apply the following order: (1) determine whether the sources use different units, periods, or definitions; (2) prefer the instrument legally or statistically authoritative for the specific claim; (3) retain both values and document the conflict; (4) obtain clarification where feasible; and (5) code indeterminate if the conflict changes the exposure classification and cannot be resolved.

The Tanzania statistics illustrate the rule. The national annual report's main text and Annex B agree on 452.50 million TIPS transactions, TZS 29,820.20 billion in value, and 46 participants in 2024, so those values can be used. If a narrative table and annex disagree on a mobile-money count or definition, the study will not select the preferred number silently. The source register will record both figures, the unit, and the adjudication.

6.5 Independent coding and evidence freeze

Two coders will independently code a 20 percent stratified pilot sample, all critical-floor items, and all sentinel-country primary exposures. Agreement will be reported using weighted Gwet AC2 for ordinal items and unweighted AC1 or an exact agreement statistic for nominal states. The minimum acceptable coefficient is 0.80 (Gwet, 2014). If agreement is below 0.80 in a domain, the codebook will be revised and the affected items recoded before outcome data are merged. A third reviewer will adjudicate remaining disagreements with a written rationale.

The evidence freeze occurs in four steps: freeze the codebook and source hierarchy; complete and adjudicate documentary coding; freeze the eligible country-wave sample and exposure values; then merge outcomes. Any post-freeze change that affects an exposure, case, or hypothesis requires a dated amendment that states whether outcomes had been accessed. Undisclosed retroactive coding is prohibited.

7. Measurement Architecture

7.1 Capability, implementation, realization, and outcomes

The Person-Level Interoperability Measurement Program is a profile, not a license to compress all constructs. Its primary outputs are: (1) an eight-domain capability profile; (2) an eight-domain implementation profile; (3) matched-item discordance states; (4) a separate person-level outcomes dashboard; and (5) evidence-quality metadata.

Capability indicators use an ordinal scale from 0 to 4: 0, absent or prohibited; 1, policy intent without enforceable support; 2, partial authorization or materially incomplete rules; 3, enforceable support with

defined scope and responsibilities; and 4, comprehensive support including rights, exceptions, and accountability. Implementation indicators use a separate 0-to-4 scale: 0, not live; 1, pilot or isolated production; 2, live but materially limited in coverage or reliability; 3, broad production with documented residual frictions; and 4, mature, broadly accessible, reliable, and economically usable delivery. The common numeric range is only a presentation convention. Scores are never subtracted or interpreted as cardinally equivalent.

Realization measures are domain specific. Entry includes successful account opening or tier upgrade among eligible applicants, with refusal reasons where available. Payment execution includes attempted and completed cross-provider transactions, time to usable funds, cost, pending age, reversals, and status comprehension. Consent includes comprehension, successful authorization, revocation, and unauthorized onward use. Recovery includes restoration after a device, SIM, authenticator, document, or provider change. Redress includes proof, complaint-resolution time, escalation, appeal, and compensation.

Outcomes are not inserted into capability or implementation scores. Active use is distinct from ownership. Equity outcomes are person-level differences or ratios by prespecified groups, not country-level demographic proxies. Safety endpoints include fraud attempts and losses, account takeover, mistaken routing, unauthorized remapping, privacy incidents, false-positive exclusion, unresolved complaints, and financial-crime indicators with declared denominators.

7.2 Core matched items, coverage, and critical floors

Cross-country comparisons use a fixed core item set. An optional extended module provides country-specific or post-2020 depth, including open-finance implementation and newer digital-safety measures. A domain is eligible for a comparative score only when at least 80 percent of its core items are resolved and every critical-floor item is resolved. An overall profile is not published for a country-wave with unresolved critical floors.

Critical floors identify conditions that an average cannot compensate for. Examples include no legally or operationally accessible redress route; no secure recovery path; no accountable institution for a failed handoff; uncontrolled alias enumeration; an identity-correction process that is unavailable in practice; or a safety claim based on incidents without an exposure denominator. Failure of a floor is reported directly. It is not averaged away.

Within a domain, the primary summary is the equal-weight mean of the fixed resolved core items only. A median and a latent-variable estimate may be reported after construct validation. Principal-component weights are not treated as robustness because they optimize variance rather than conceptual validity and may reward data availability. Cross-domain presentation remains a profile. Any communication summary is secondary, clearly labeled, and suppressed where invariance or coverage fails.

Table 7. Measurement outputs and separation rules

Output	Typical unit	Permitted claim	Prohibited inference
Capability profile	Jurisdiction x effective-date interval x product tier x matched item	What law, rules, or standards permit or require.	That the service is live or usable.
Implementation profile	Jurisdiction x observation date x provider or scheme coverage x matched item	What is live, materially covered, reliable, and economically usable.	That a person successfully exercises it.
Discordance profile	Directly matched item x jurisdiction x date x group where available	Where capability, implementation, and realization do not align.	A cardinal arithmetic gap between non-equivalent scales.
Outcomes dashboard	Person, subgroup, transaction, complaint, provider, or country-wave as declared	Use, completion, equity, recovery, harm, and redress under stated definitions.	That outcomes are inputs to the institutional indices.
Evidence metadata	Indicator-source record	Source class, version, date, locator, denominator, quality, and adjudication.	That not evidenced equals absent.

Note. Wallets, accounts, subscriptions, SIMs, transactions, and people are not interchangeable.

7.3 Gate severity and ID usability

Gate severity is coded by journey stage and product tier. The fixed core items ask whether the designated national credential or its verification is required for: basic account or wallet opening; continuation after re-KYC; cash-in or cash-out where relevant; person-to-person payment; merchant or bill payment; access to a meaningful transaction tier; and SIM registration or recovery where the SIM is an essential financial authenticator. Each item records law, effective date, enforcement, accepted alternatives, exception process, and affected provider types.

ID usability is measured separately through: foundational-ID coverage; time and distance burden of enrollment; documentary and fee burden; availability of assisted or remote enrollment; digital verifiability; authentication availability; correction and appeal; recovery after loss; and lawful acceptable

alternatives. National coverage alone is not a usability score. A high-coverage system with unreliable authentication or inaccessible correction can remain difficult to use.

7.4 Effective institutional scope

Effective scope distinguishes formal eligibility from viable participation. The measure records which regulated provider types can participate directly; whether indirect access creates dependency; conformance and certification cost; prefunding or liquidity terms; minimum service levels; reciprocity; governance or voting rights; pricing; production coverage; and whether the provider can reach the core use cases. A provider logo on a participant page is not sufficient evidence of economically viable access. Market concentration is measured separately and treated as a contextual moderator or control. A broad scheme can still be contestability-poor if one provider controls discovery, liquidity, standards, or access. Conversely, a concentrated market may deliver broad reach while preserving structural dependency. The analysis reports both rather than encoding one as the other.

7.5 Outcome-source matrix

The outcome-source matrix fixes what each source can support and prevents later substitution of a convenient indicator. The primary Findex outcome is harmonized from 2014 through 2024. Account ownership and mobile-money account ownership are secondary outcomes. Wrong-recipient recovery, phone password protection, and other newer safety questions are 2024-only descriptive or mechanism measures unless an earlier comparable source is identified. Complaint resolution, operational completion, fraud, and redress are drawn from national administrative or provider sources only where units and denominators are explicit.

Table 8. Outcome-source matrix and confirmatory status

Outcome subgroup or	Primary source	Comparable waves / periods	Status
Made or received a digital payment	Global Findex public-use microdata and official aggregate series	2014, 2017, 2021, 2024 subject to reconstruction	Primary H1-H3 outcome
Gender difference risk	Global Findex	2014, 2017, 2021, 2024	Confirmatory
Bottom-40 versus top-60 income risk difference	Global Findex	2014, 2017, 2021, 2024	Confirmatory
Rural-urban difference risk	Global Findex DEGURBA measure	2021 and 2024 only	Confirmatory module
Account and mobile-money account ownership	Global Findex	Wave dependent	Secondary outcomes

Outcome subgroup or	Primary source	Comparable waves / periods	Status
Wrong-recipient recovery and phone-password protection	Global Findex	2024 only unless a comparable earlier source is frozen	Descriptive / mechanism
Completion, recovery, and redress	Official administrative or provider records	Country-period only where unit and denominator are explicit	Secondary / mechanism
Fraud, complaints, and financial-crime indicators	Official supervisory or administrative records	Only with defined exposure denominators and ascertainment	Safety; otherwise indeterminate

Note. Disability and displacement are confirmatory only if a named comparable source is frozen before outcome inspection.

Disability and displacement are not silently inferred from geography or poverty. They are included as confirmatory dimensions only if a named, comparable individual-level source with adequate sample and time alignment is frozen before outcomes are inspected. Otherwise they remain exploratory, qualitative, or process-tracing dimensions.

7.6 Source provenance and third-party data integrity

Every imported fact or variable has a provenance record containing the exact title and producer, version or effective date, retrieval date, page or table locator, original unit and denominator, geography, observation period, license or access condition, claim supported, conflict or adjudication note, and archived file or cryptographic hash. Quantitative claims retain the source's unit; wallets, accounts, subscriptions, transactions, and people are never treated as interchangeable.

Figures and tables created for this manuscript are labeled "Source: Author's construction." Any later figure using external data will state "Author's calculations from" the named dataset, version, observation period, and transformation. No third-party figure is reproduced in this Stage 1 manuscript. Short factual paraphrases are attributed; longer copyrighted passages are not reproduced.

Table 9. Third-party data and source-control requirements

Required field	Why it is required
Exact title, producer, and source class	Prevents ambiguous institutional citation and matches each source to the claim it can support.
Version, effective date, and retrieval date	Controls revised reports, changing webpages, and historically applicable rules.

Required field	Why it is required
Page, table, paragraph, or API-field locator	Makes each imported claim independently verifiable.
Original unit and denominator	Prevents substitution among people, wallets, subscriptions, accounts, transactions, and complaints.
Geography and observation period	Prevents dated facts from being presented as timeless national conditions.
License or access condition	Demonstrates lawful use and distinguishes public, licensed, and restricted data.
Claim supported and transformation	Prevents a source from being stretched beyond its content and records any author calculation.
Conflict, adjudication, and coding status	Preserves competing official values and makes indeterminate evidence visible.
Archived copy or cryptographic hash	Supports reproducibility when URLs or documents change.

Source: Author's construction.

8. Empirical Strategy and Design Gates

8.1 Primary outcome construction

The primary outcome is the design-weighted country-wave prevalence of adults age 15 and older who made or received a digital payment in the prior year, following the official World Bank definition. The study will reproduce the official aggregate within a preregistered tolerance using the public-use microdata and official construction materials. If a wave-specific reconstruction cannot reproduce the published indicator within 0.5 percentage points after documented review, that wave is excluded from the primary microdata model and retained only through the official aggregate series where appropriate. Gender and bottom-40-percent income gaps are calculated as design-weighted risk differences. Rural gaps are calculated only for 2021 and 2024 using the comparable degree-of-urbanization classification. Survey weights and available design variables are respected. The study never describes repeated cross-sections as within-person change.

8.2 Two-stage country-wave analysis

The primary analysis uses a two-stage design to avoid pseudo-replication from exposures that vary only at the country-wave level.

Stage 1 estimates each country-wave outcome and subgroup contrast from individual microdata using the survey weights and available design information. Each estimate is stored with its standard error, sample size, missingness, fieldwork date, and construction version.

Stage 2 relates those country-wave estimates to time-aligned institutional exposures. The primary model is a weighted country and wave fixed-effects meta-regression or generalized least-squares model, using inverse sampling-variance weights capped at a preregistered percentile to prevent a few very precise estimates from dominating. Equal-country weighting and population weighting are sensitivity analyses, not substitutions. Inference is clustered by country; if the effective cluster count is small, wild cluster bootstrap intervals and randomization-based checks are reported (Cameron et al., 2008).

A secondary individual-level multilevel model may estimate subgroup heterogeneity, but it cannot be used to claim more independent policy exposures than the number of country-waves. Country-wave exposures remain contextual variables, and standard errors are clustered at the exposure-assignment level.

8.3 H1 models

The H1a main-effects model contains implemented payment reach, proportionate entry and assurance, recovery or redress implementation, and the fixed contextual set. The interaction model adds the prespecified pairwise interactions. A three-way interaction is not confirmatory unless the pre-outcome simulation demonstrates adequate power and stable support. H1b adds live consent and data-portability implementation only if at least 25 eligible country-wave observations show nontrivial variation and at least eight economies contribute exposure contrast.

Predictive performance is evaluated by grouped leave-one-country-out cross-validation. All waves from a country are held out together. The primary metric is mean squared prediction error for country-wave prevalence; the Brier or log score is used for any individual-level secondary model. Hyperparameters, if any, are selected inside the training folds. No country-wave can appear in both training and validation data.

8.4 H2 model

The H2 model includes gate severity, ID usability, their interaction, the fixed contextual set, country effects, and wave effects. Marginal effects are reported at prespecified combinations corresponding to the 25th and 75th percentiles of ID usability. The paper does not interpret a negative main effect of ID as evidence for H2. Support requires the conditional pattern.

The primary distributional outcomes are the female-minus-male risk difference and the bottom-40-minus-top-60 income risk difference in digital-payment use. Rural results are a 2021-2024 module. Product-tier and enforcement-date coding is retained in exposure construction, with sensitivity windows of plus or minus six months for ambiguous implementation dates.

8.5 H3 model

The H3 model includes effective cross-sector scope, implementation maturity, market concentration, reciprocity, and the fixed contextual set. The primary exposure is based on live and viable provider participation, not legal eligibility. A bank-only versus cross-sector classification is reported as an interpretable contrast, while the continuous scope measure is primary where construct validity is adequate.

Mobile-money-led markets are identified before outcome inspection using a predeclared criterion based on the share of adults with a mobile-money account relative to financial-institution account ownership. The exact threshold is selected from the 2014 or earliest available pre-exposure Findex data and then fixed. A post-outcome threshold is prohibited.

8.6 Contextual set and causal limits

The fixed contextual set is determined by a directed acyclic graph, published with the preregistration, and includes national income, urbanization, mobile and internet connectivity, financial-sector depth, conflict or fragility, and wave effects (Hernán & Robins, 2020). Variables that are plausible mediators of the institutional exposure are not added merely because they reduce a coefficient. The model table identifies each variable as confounder, moderator, mediator, or outcome-related precision variable.

The primary H1-H3 results are associational. A policy event enters quasi-experimental analysis only if the effective and enforced timing is reconstructable, treatment intensity changes materially, pretreatment outcomes exist, comparators are credible, and no dominant concurrent reform makes attribution untenable. Any staggered-adoption event study uses estimators appropriate to treatment heterogeneity rather than an unexamined two-way fixed-effects coefficient (Callaway & Sant'Anna, 2021; Sun & Abraham, 2021). Pretrends, anticipation, concurrent reforms, and negative controls are reported.

8.7 Design and power gates

Confirmatory modeling proceeds only if the final sample contains at least 25 economies and 60 country-wave observations for the primary outcome, the focal exposure varies within at least eight economies or across at least 20 independent country-wave transitions, and pre-outcome simulation indicates at least 80 percent power to detect the smallest substantively important effect under the planned clustering and missingness. The smallest substantively important effect is 3 percentage points in active digital-payment prevalence for H1 and H3 and a 2-percentage-point conditional contrast for H2. These thresholds are selected *ex ante* as policy-relevance standards rather than estimated from observed outcomes; sensitivity analyses will also display 1-, 2-, and 5-percentage-point contrasts.

If a gate fails, the affected hypothesis is downgraded before outcome modeling to descriptive, exploratory, or process-tracing status. The paper will not compensate for an underpowered contextual design by treating thousands of individual respondents as independent policy treatments.

8.8 Missing data, multiplicity, and robustness

Missing documentary exposure data are never imputed as absence. The primary analysis uses items meeting the evidence threshold. Survey-covariate multiple imputation is permitted when assumptions are plausible and the imputation model respects country and wave structure. Documentary uncertainty is handled through bounded recoding, date windows, and evidence-quality exclusions.

The three primary hypothesis-family tests are controlled using Holm's sequential procedure (Holm, 1979). Secondary outcomes within each family use the Benjamini-Hochberg false-discovery-rate procedure, with unadjusted and adjusted values reported (Benjamini & Hochberg, 1995). Exploratory analyses are labeled and do not inherit confirmatory language.

Robustness is substantive rather than decorative. Prespecified checks include alternative gate-severity definitions, enforcement-date windows, capability and implementation thresholds, country exclusions, evidence-quality cutoffs, concentration measures, weighting choices, and group denominators. A specification curve distinguishes planned from exploratory models. A finding that depends on coding an announcement as implementation or an undocumented absence as zero is not presented as robust.

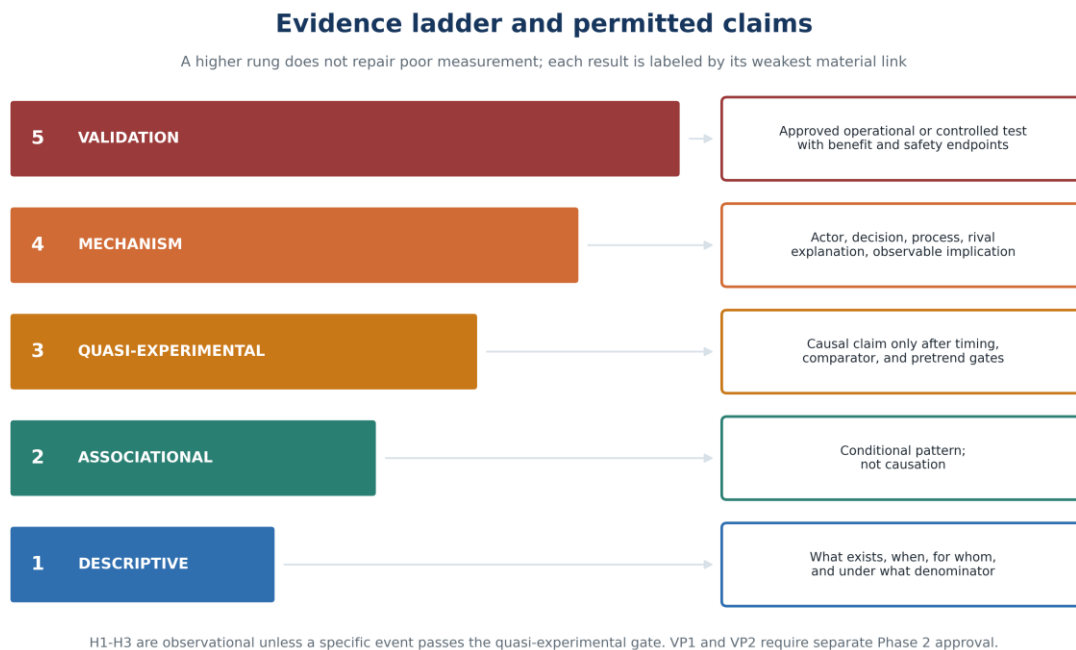


Figure 4. Evidence ladder and permitted claims.

Source: Author's construction.

9. Pre-Results Reporting and Decision Rules

This manuscript is complete in theory and method but intentionally empty of empirical findings. The Stage 2 results will appear in a fixed order: source and sample audit; evidence completeness; capability and implementation profiles; matched-item discordance; H1-H3 primary results; sensitivity analyses; sentinel-case mechanisms; and only in a separate report, any VP1 or VP2 validation. Null, adverse, contradictory, and indeterminate results will appear in the same order as favorable results.

The primary result products are: separate capability and implementation heatmaps with visible not-evidenced cells; matched-item discordance profiles by country-wave and group; a marginal-effects plot for the prespecified models; and a source-coverage panel. No country league table is primary. Small uncertain score differences are not converted into rankings.

Every published chart states its unit, denominator, observation period, source, and missingness; displays uncertainty where appropriate; uses a colorblind-safe palette legible in grayscale; and avoids three-dimensional charts, pie charts, and dual axes. Descriptive figures use no causal verbs. Figures based on third-party data identify the exact dataset version and transformation.

Table 10. Pre-results reporting decisions

Decision point	Rule fixed before outcome analysis
H1	Support requires grouped predictive gain and a substantively coherent marginal contrast; a composite profile is not evidence.
H2	Support requires the prespecified gate-severity by ID-usability conditional pattern, not a negative main effect of national ID.
H3	Support requires live and viable cross-sector scope after maturity and concentration controls; legal eligibility alone is insufficient.
Design gate	A failed sample, variation, or power gate downgrades the affected family before outcome modeling.
Safety	A harm claim without an exposure denominator is indeterminate; Phase 2 requires both benefit and safety endpoints.
Country comparison	Profiles and configurations are primary; causal rankings and spurious league tables are prohibited.

Source: Author's construction.

A result is indeterminate when the source record cannot establish the exposure, when the relevant outcome is unavailable or incomparable, when the design gate fails, or when harm data lack exposure denominators. "No evidence of harm" is not reported as "evidence of safety." A capability that exists in law but is incompletely implemented and disproportionately unrealized is itself an important result even if the average outcome coefficient is null.

10. Expected Contribution and Policy Relevance

If validated, PLI would change how interoperability projects define completion. A switch connection, API standard, or identity-authentication service would be treated as a necessary capability rather than a final inclusion outcome. Program dashboards would add person-level completion, lifecycle continuity, recovery, redress, and distributional measures, aligning institutional accountability with the points at which people lose access.

The national-ID-first hypothesis creates a disciplined alternative to polarized debate. A positive H2 interaction would not imply abandoning national ID. It would imply sequencing strict financial gates with accessible enrollment, correction, authentication, proportionate alternatives, and remediation. A null or opposite interaction would be equally important, showing that strong gates need not suppress participation under the observed usability conditions and challenging the paper's premise.

Effective provider scope has implications for competition and industrial organization. In mobile-money-led markets, limiting open-finance or instant-payment participation to banks can omit the institutions through which many adults transact. Mandatory breadth without viable economics, symmetric obligations, or governance rights can nevertheless produce nominal inclusion and practical dependency.

The measure therefore includes service levels, prefunding, certification, price, reciprocity, and participation rights rather than counting logos.

Provider-neutral addressing may reduce the cost of changing providers and the errors created by institution-specific account details, but only if number lifecycle and privacy are governed. Confirmation of payee can reduce misdirection while enabling name harvesting if queries are unlimited. A persistent alias can support continuity while enabling cross-context graphing if the same identifier is exposed indiscriminately. Purpose limitation, pairwise tokens, throttling, audit, and effective remedy are design conditions, not optional privacy features.

For continental and cross-border initiatives, PLI adds an evaluation layer to existing architectures. The African Union framework does not require one unified continental ID, and member states retain authority over their identity systems (African Union, 2022). Project Aperta and TACH/PIC architecture illustrate how networks and verified attributes can connect without centralizing all identity data (BIS Innovation Hub, 2026; World Bank, 2026). PLI asks whether those architectures remain usable across the final institutional handoffs faced by a person.

The framework may also improve investment discipline. Infrastructure proposals often forecast reach from institutional connectivity. A matched realization baseline makes that forecast conditional on identity usability, provider scope, channel access, recovery, and rights. Donors, regulators, and operators can specify which layer an intervention changes and what evidence would demonstrate conversion, reducing the temptation to label every deployment inclusive before inclusion is measured.

11. Legal, Ethical, Security, and Rights Safeguards

PLI is bounded by law. Jurisdiction-specific mapping distinguishes customer identification, verification, authentication, ongoing due diligence, reliance, outsourcing, agency, consent, legal obligation, and other processing bases. Consent is not presumed to legalize processing that requires another basis, and legal obligation is not relabeled as consent. Cross-border transfer, research use, retention, and onward disclosure are coded separately.

The privacy threat model includes enumeration, linkability, transaction-graph inference, function creep, insider access, biometric compromise, recovery abuse, and secondary use. A stable user-facing payment pointer must not become an unrestricted universal identifier. Minimum disclosure, purpose-specific or pairwise tokens, directory-query controls, rate limits, harvesting detection, access logs, retention limits, revocation, and independent audit are assessed. Biometric templates require particular caution because compromise cannot be repaired like a password.

Security analysis follows the lifecycle. Proofing must resist duplicate or synthetic enrollment. Binding must verify control of the authenticator and financial endpoint. Authentication must be proportionate. Federation must preserve audience and purpose. Recovery must not become the weakest path. Address remapping must be notified and reversible. Provider exit must preserve access to value and evidence. OpenID FAPI 2.0 supplies a relevant high-security API profile, but protocol conformance does not by itself establish accessible consent, correct liability, or effective redress (Fett et al., 2025).

Consumer rights are outcomes and design constraints. Users need intelligible status, receipts, correction, complaint escalation, accessible appeal, due process, and compensation where liability rules provide it. Automated or risk-based restrictions require reason codes and review routes consistent with law and security. The Universal DPI Safeguards Framework's emphasis on safety, inclusion, privacy, and structural vulnerability provides an additional governance reference (United Nations Development Programme, 2024).

Any human-participant validation requires ethics approval or documented exemption, regulator and provider authorization, informed consent appropriate to literacy and language, data minimization, security testing, adverse-event monitoring, and independent stopping authority. No live experiment is authorized by this manuscript. Vulnerable groups will not be recruited merely because their exclusion makes an effect easier to detect.

12. Positionality, Independence, and Institutional Boundaries

The lead author is Founder and Chief Executive Officer of Rego and President of the DRC Fintech Association. These roles create relevant expertise and access, but also a material risk of confirmation bias or perceived commercial benefit. They will be disclosed in protocols, presentations, submissions, funding arrangements, and data-access agreements. Neither role confers authority to determine country coding, safety thresholds, or publication conclusions.

Rego is treated in this research only as a potential technical interoperability and orchestration layer. It is not a bank, e-money issuer, deposit-taker, settlement venue, replacement for a national switch, or civil-identity authority. Regulated institutions retain accounts, customer due diligence, sanctions compliance, transaction monitoring, settlement, customer relationships, and remedy obligations. A Rego ID, if studied in Phase 2, is a persistent nine-digit payment pointer, not civil identity or an unrestricted analytics key. Backend resolution should use purpose-specific or pairwise tokens, minimization, throttling, logging, and oversight.

Independence controls include registration before outcome analysis, independent coding, external methods and ethics review, independent data custody where feasible, blinded outcome analysis for any validation, and publication rights covering null, adverse, contradictory, and indeterminate results. The DRC Fintech Association may facilitate ecosystem access but cannot condition publication. Rego may supply a technical case or controlled implementation but cannot define success unilaterally.

The cross-country H1-H3 exposure coding will not use Rego-generated data. Any Rego operational data are confined to the separately governed Phase 2 protocol, with independent custody, prespecified access roles, and external sign-off on safety conclusions.

13. Limitations

The study faces six principal limitations. First, comparable person-level outcomes are sparse and repeated cross-sections do not follow the same people. Second, legal and implementation histories are unevenly published, and source visibility may correlate with institutional capacity. Third, national measures can conceal provider, product, geographic, and population heterogeneity. Fourth, reforms are bundled, making clean causal events uncommon. Fifth, fraud, privacy, financial-crime, and complaint

data often lack consistent exposure denominators or are selectively disclosed. Sixth, the effective number of independent policy exposures is the number of country-waves, not the number of survey respondents.

The design mitigates but cannot eliminate those constraints. It separates not-evidenced from absent, freezes exposure coding before outcome merge, uses primary sources, restricts causal language, applies design gates, and reports indeterminate safety where necessary. Process tracing can improve explanation but cannot manufacture a counterfactual. A future operational validation can test mechanisms but may have limited external validity.

PLI itself may require revision. The eight-domain structure may fail reliability or invariance tests. Some indicators may be jurisdiction specific. Person-level realization may not aggregate meaningfully across services. Open-finance implementation may have too little country-wave variation for confirmatory H1b analysis. The program therefore treats construct validation and design-gate failure as results. A framework that survives only by deleting contradictory evidence would not be a credible contribution.

14. Conclusion

Sub-Saharan Africa's next financial-infrastructure question is not simply whether payment, identity, and data systems can connect. It is whether people can convert those connections into continuous, safe, and contestable financial capability. Person-level interoperability names that evaluative problem and supplies a method for measuring it without confusing law, implementation, personal realization, and outcomes.

The paper's challenge to the status quo is conditional and falsifiable. National digital identity can be a powerful trust anchor, but requiring it first may suppress participation where the credential is unavailable, difficult to correct, or unusable in the relevant channel. Mobile and financial credentials can preserve regulated access, but must not become substitute civil identities or weakly governed surveillance keys. Progressive assurance and provider-neutral continuity are credible only if participation improves and safety does not deteriorate beyond prespecified margins.

This Stage 1 manuscript fixes the theory, matched-item evidence architecture, hypotheses, outcome definitions, sample strategy, source-control rules, decision thresholds, and independence boundaries before outcome analysis. Its contribution will stand or fall on whether the proposed constructs can be measured, whether the predicted conditional relationships survive credible tests, and whether null and adverse findings are reported. The ultimate question remains deliberately human: when do interoperable institutions produce interoperable lives?

Declarations

Funding. No external research funding is declared for this manuscript. Any subsequent funding, in-kind technical support, or data access will be disclosed by source, amount or nature, and role before submission or registration.

Competing interests. The author is Founder and Chief Executive Officer of Rego and President of the DRC Fintech Association. Rego may have a commercial interest in interoperability infrastructure. The independence controls in Section 12 are conditions of the research program.

Author contributions. Conceptualization, methodology, writing - original draft, writing - review and editing, visualization, and project administration: Yogo Dubois. Coding, statistical analysis, validation, data custody, and independent review roles will be named when appointed and completed.

Data and code availability. No empirical dataset or analysis is reported in this Stage 1 manuscript. The eventual study will publish the source register, nonrestricted coded indicators, data dictionary, versioned analysis code, and reproducible figures. Access to licensed or confidential microdata will follow provider conditions. Synthetic schemas and validation materials will be supplied where lawful.

Ethics. The current manuscript proposes analysis of existing documentary and survey sources. Any interviews, user research, simulation involving participants, or live operational validation will begin only after applicable ethics review or exemption, regulator and provider authorization, security assessment, and independent governance.

Registration. The protocol is prepared for public registration before outcome analysis. The registration record will include the frozen codebook, source-audit plan, statistical analysis plan, and dated amendment policy.

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Appendix A. Minimum Source Register

The following fields are mandatory for each documentary or quantitative source used in exposure coding or factual reporting.

Table 11. Minimum source-register schema

Field	Required contents and decision rule
Source ID	Stable internal identifier linked to the archived file or dataset version.
Claim or indicator	The exact factual claim, construct item, or variable supported.
Producer and exact title	Institution or authors and the complete document, dataset, regulation, or webpage title.
Version and effective date	Edition, revision, legal effect date, supersession date, and historical applicability.
Locator	Page, section, table, paragraph, annex, field name, or API endpoint.
Scope	Jurisdiction, provider types, product tier, geography, and observation period.
Unit and denominator	Original unit, denominator, sample, exclusions, and any weighting.
Rights and access	License, terms of use, access restriction, redistribution rule, and citation requirement.
Evidence class and status	Capability, implementation, realization, or outcome; resolved, not evidenced, not applicable, superseded, challenged, or indeterminate.
Transformation	Any recode, normalization, threshold, aggregation, or author calculation.
Conflict and adjudication	Competing values, reason for preferred source, reviewer, date, and residual uncertainty.
Archive and integrity	Retrieval date, archived path, checksum or hash, and change-log reference.

Source: Author's construction. This register is completed before outcomes are merged.

Appendix B. Companion Instruments and Publication Sequence

This manuscript is accompanied by three separately versioned instruments: (1) a Measurement and Indicator Codebook specifying every capability, implementation, realization, and outcome indicator; (2) a Statistical Analysis and Evidence-Ladder Plan fixing estimands, design gates, identification rules, and falsification triggers; and (3) a DRC Validation Protocol defining governance, phasing, non-inferiority margins, adverse-event monitoring, and stop rules for any future field validation. None authorizes live data collection on its own.

The publication sequence is fixed. The Stage 1 manuscript and codebook are registered first. Documentary coding and the source audit follow. The country-wave sample and exposures are then frozen before outcomes are merged. Stage 2 reports H1-H3 regardless of direction. VP1 and VP2, if approved and implemented, are published separately so operational validation cannot retroactively change the observational claims.

Appendix C. Visual and Reproducibility Standard

Every empirical figure in the Stage 2 manuscript will state the unit, denominator, observation period, source, version, and missingness. Uncertainty intervals will be shown where applicable. Palettes will be colorblind safe and legible in grayscale. Three-dimensional charts, pie charts, and dual axes are prohibited. Descriptive charts will not use causal verbs. Public code will reproduce all nonrestricted transformations, tables, and figures from a clean environment, and restricted data will be represented by synthetic schemas and validation hashes where permitted.