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# ARCHITECTING EDUCATIONAL RESILIENCE: EXPLORING AI-ENABLED KNOWLEDGE MANAGEMENT SYSTEMS AS LEARNING CONTINUITY INFRASTRUCTURE IN RIVERS STATE, NIGERIA

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**Abstract**
Learning poverty in the Global South stems not only from policy gaps but from a deeper evidence failure: governments and partners cannot effectively invest in what they cannot systematically observe. This paper presents Read Cycle Nigeria's two-phase community needs assessment across Rivers State as an empirical foundation for theorising AI-enabled Knowledge Management Systems (AI-KMS) as structural educational resilience infrastructure. Phase 1, conducted in 35 primary schools across nine Local Government Areas (LGAs), directly assessed 4,372 pupils and revealed chronic infrastructure collapse, severe teacher shortages, acute resource scarcity, and critical WASH deficits. Gender-disaggregated findings identified barriers affecting girls, including domestic labour demands, inadequate menstrual hygiene facilities, and reported intra-household resource inequalities. Phase 2 is extending the assessment across a wider set of LGAs, incorporating gender-disaggregated indicators and AI-KMS readiness metrics such as connectivity, device ownership, and community knowledge flows. Fieldwork also surfaced a critical implementation constraint: in several LGAs, schools were identified but could not be assessed due to the absence of trained personnel on the ground, a gap that itself evidences the need for a structured community assessor model. The paper builds a synthetic theoretical matrix from five established frameworks, Nonaka and Takeuchi's knowledge creation theory and its later Ba refinement, Alavi and Leidner's KMS framework, Wenger's communities of practice, Bejinaru's knowledge dynamics and its thermodynamics reformulation, and Ostrom's theory of polycentric governance, the paper conceptualises AI-KMS as potentially supporting continuous knowledge renewal in volatile, low-infrastructure environments because such systems improve through ongoing interaction rather than requiring stable conditions, they can sustain knowledge flows where centralised, static systems fail. This capacity for contextual adaptation, grounded in community-generated evidence rather than externally imposed curricula, addresses the epistemological asymmetry that globally designed AI systems routinely reproduce in Global South educational environments. Critically, ReadCycle field evidence further specifies that a viable AI-KMS in this context must be offline-first, multilingual, community-governed, and gender-responsive by design. The paper concludes with a replicable scaling model for Nigerian states, positions trained community assessors as decentralised governance nodes within a polycentric AI-KMS architecture, and sets out the empirical, methodological, and technical limitations that must be addressed before the architecture can be validated at scale.

***Keywords: Learning Poverty; Knowledge Management Systems; ReadCycle Nigeria; Polycentric Governance; Epistemological Asymmetry; Educational Resilience; Gender-Responsive Design; Communities of Practice; AI-KMS.***

## 1. INTRODUCTION

Learning poverty across the Global South is standardly framed as a downstream failure of fiscal allocations, curricular updates, or policy execution. The scale of that failure is stark: even before the COVID-19 pandemic, an estimated 86 per cent of ten-year-olds in Sub-Saharan Africa could not read and understand a simple age-appropriate text, a rate substantially higher than any other world region, and one that pandemic-era disruption is estimated to have pushed higher still (World

Bank, UNESCO & UNICEF, 2022). This paper argues that educational systems confronting learning poverty should also be understood in terms of their capacity for knowledge continuity. In climate-vulnerable and low-resource environments, educational systems frequently lack mechanisms for capturing, validating, and mobilising local knowledge during periods of disruption. As a result, governments and development actors often operate with incomplete evidence of community learning realities, limiting their capacity to design context-responsive interventions. This diagnosis is consistent with earlier findings on the Nigerian public sector specifically, where the absence of structured knowledge evaluation frameworks has been shown to leave institutions unable to systematically capture or apply what they already know (Ejeh & Hall, 2018). The crisis is therefore not only fiscal but epistemological and diagnostic: governments, NGOs, and development partners cannot strategically invest in pedagogical frameworks or infrastructure they cannot systematically observe. In the absence of granular, ground-truthed data, interventions remain generalised, top-down, and brittle when exposed to environmental or socioeconomic shocks.

In regions like the Niger Delta, particularly within Rivers State, this visibility gap leaves schools profoundly vulnerable to localised crises. When flooding, communal unrest, or seasonal disruption severs school access, static educational systems may lack sufficiently granular and continuously updated data on community learning preservation or household adaptations; there is no mechzanism through which what communities already know about their own children's learning conditions can be captured, validated, and fed back into decision-making. Addressing this gap, this study draws on field data collected by the ReadCycle Nigeria initiative, a whole-school programme of the Education Climate Health Organisation (ECHO). By moving away from standard, stationary educational data compilation toward an adaptive, community-anchored framework, this paper theorises AI-enabled Knowledge Management Systems (AI-KMS) not as administrative overlays, but as critical, dynamic infrastructure for structural educational resilience.

The remainder of the paper proceeds as follows: Section 2 builds a synthetic theoretical matrix linking five established bodies of knowledge management and governance theory to the specific demands of low-infrastructure, disruption-prone educational settings. Section 3 presents the methodology and empirical findings of ReadCycle's Phase 1 diagnostic assessment, together with an operational finding, the community assessor gap, that itself motivates the paper's governance argument. Section 4 sets out four design criteria for a credible AI-KMS derived from that field evidence. Section 5 discusses the replicable scaling model these criteria imply. Section 6 sets out the limitations of the argument as it currently stands, and Section 7 concludes.

## 2. LITERATURE REVIEW AND THEORETICAL FRAMEWORK

To operationalise an AI-KMS capable of surviving and improving inside low-infrastructure environments, this paper builds a synthetic theoretical matrix linking structural knowledge asset conversion, organisational systems design, situated social learning, thermodynamic knowledge dynamics, and polycentric governance. Each of these five bodies of theory was developed in a different empirical context, corporate Japan, North American information systems research, workplace apprenticeship, European intellectual capital scholarship, and the governance of natural-resource commons respectively, and none was designed with a climate-vulnerable, low-connectivity primary education system in mind. The contribution of this section is therefore not simply to cite these frameworks but to test, critically, how far each travels into the Rivers State context, and to show where the frameworks need to be read against one another rather than singly.

### *2.1 Learning Poverty as a Knowledge Continuity Deficit*

Positioning learning poverty as a knowledge continuity problem rather than a purely material one is a deliberate theoretical move. It reframes the object of intervention from infrastructure alone

(classrooms, textbooks, and toilets) to the flows of knowledge, about which children are falling behind, why, and under what household and community conditions, that determine whether infrastructure investment actually improves learning outcomes. Ejeh and Hall's (2018) evaluation of knowledge management practice in the Nigerian public sector found that institutions frequently accumulate operational data without a structured mechanism for converting it into usable organisational knowledge; the same failure mode, this paper argues, recurs at the level of the education system as a whole; ministries and partners hold fragments of monitoring data but lack the continuous, validated knowledge flow that would let them act on it before, during, and after disruption. This is compounded, at the level of technology policy, by a second and distinct form of knowledge asymmetry: globally designed AI and educational technology tools are frequently trained on, and optimised for, data and pedagogical assumptions drawn from the Global North, reproducing forms of algorithmic dependency and epistemic injustice when transplanted into Global South classrooms (Ahmed, 2026; Olaniyan, Martins & Al Maqrashi, 2026). An AI-KMS for Rivers State must therefore resolve two knowledge problems simultaneously: the absence of a continuous local evidence base, and the risk that any technology introduced to close that gap imports external epistemic assumptions along with it.

This positions the paper within an emerging, but still comparatively thin, strand of knowledge management for development (KM4D) scholarship that asks how knowledge management theory, developed almost entirely to explain value creation inside firms and universities, applies once the unit of analysis shifts from an organisation to a geographically dispersed, under-resourced public system operating under climate- and conflict-related disruption. Edwards and Lönnqvist's (2023) research agenda for the future of knowledge management explicitly calls for the field to extend beyond its traditional organisational and corporate case base; this paper answers that call directly, using basic education in a climate-vulnerable Nigerian state as the extension case, rather than treating KM4D as a settled subfield with its own established canon.

### *2.2 Knowledge Conversion and Architecture: The SECI Model and Ba*

The foundational engine of the conceptual model rests on Nonaka and Takeuchi's (1995) SECI model of organisational knowledge creation. The model describes four modes through which tacit knowledge, that which is experientially held and difficult to articulate, and explicit knowledge, that which is codified and transferable, interact: socialisation (tacit to tacit, through shared experience), externalisation (tacit to explicit, through dialogue and metaphor), combination (explicit to explicit, through systematising and cross-referencing existing explicit knowledge), and internalisation (explicit to tacit, through learning by doing). In resource-constrained environments such as those documented in Phase 1, standard explicit learning objects, printed textbooks, curricula, teacher guides, are scarce or absent altogether. A resilient architecture must therefore be built primarily around the socialisation and externalisation modes: it must first capture the tacit, community-held knowledge of teachers, caregivers, and local leaders about how children are actually learning and coping, and only then externalise it into a form that can be stored, combined, and redistributed.

Nonaka, Toyama and Konno's (2000) later refinement of the model is directly useful here, and is under-used in most applications of SECI to development contexts. They argue that knowledge creation cannot be understood as a purely cognitive process; it requires ba, a shared context, physical, virtual, or mental, within which relationships and knowledge exchange actually occur. In the Rivers State setting, this paper operationalises Ba as a design concept: it corresponds to the physical school compound and community meeting space in which a trained assessor gathers tacit knowledge from teachers and caregivers, and, simultaneously, to the offline edge-device cache that stores and combines that knowledge once externalised. The AI-KMS architecture proposed in

Section 4 is, in Nonaka, Toyama and Konno's terms, an attempt to engineer a durable, low-infrastructure ba where none currently exists.

It is also necessary to engage critically with SECI rather than adopt it uncritically. The model has been criticised for its origin in a study of large, stable Japanese manufacturing firms in which employees typically remained with a single organisation for decades, a context of institutional continuity that is close to the opposite of the volatility this paper is concerned with, and for the implied linearity of the conversion spiral, which assumes a fairly orderly progression between modes. Ngulube's (2003) application of the SECI model to the communication and management of tacit indigenous knowledge is a more directly relevant precedent: it demonstrates that the model can be adapted to community and indigenous knowledge systems outside the corporate setting for which it was designed, but only when combination and internalisation are treated as community-mediated processes rather than assumed organisational routines. This paper follows that precedent rather than treating SECI as a template to be applied unmodified.

### *2.3 Alavi and Leidner's KMS Framework: From Organisational IT to Community Infrastructure*

Alavi and Leidner's (2001) systematic review conceptualises knowledge management systems as a class of information technology built to support four interdependent processes: knowledge creation, storage and retrieval, transfer, and application. Their framework was developed to describe systems operating inside single organisations with relatively stable IT infrastructure, dedicated knowledge management functions, and clear organisational boundaries, conditions that do not hold for a distributed set of climate-vulnerable primary schools across nine, and eventually more, Local Government Areas with no shared server infrastructure and no single managing organisation in the conventional sense. The theoretical contribution this paper makes is therefore an explicit extension of Alavi and Leidner's four-process model beyond the organisational boundary: the technology stack proposed in Section 4 would reconfigure creation, storage and retrieval, transfer, and application as a dynamic circuit distributed across community-governed edge nodes rather than a centralised organisational server, with ReadCycle and its assessor network functioning as the coordinating, rather than controlling, layer. Testing how far a framework built for bounded organisations travels into an unbounded, community-governed setting is itself a contribution to the knowledge management for development literature, not merely an application of an existing model.

### *2.4 Communities of Practice and Situated Learning*

To ensure the system survives outside institutional boundaries, it must align with Wenger's (1998) theory of communities of practice (CoP), building on Lave and Wenger's (1991) earlier account of situated learning as legitimate peripheral participation. Wenger identifies three defining dimensions of a community of practice, mutual engagement among its members, a joint enterprise that gives the community its shared purpose, and a shared repertoire of routines, tools, and language developed through sustained participation, and four interrelated components of the learning that occurs within it: community (belonging), practice (doing), meaning (experience), and identity (becoming). Learning continuity during disruption depends on local stakeholders, teachers, community leaders, and youth advocates, acting as exactly this kind of coherent social fabric, rather than as isolated data sources to be surveyed once and left alone.

Lave and Wenger's earlier concept of legitimate peripheral participation is directly applicable to the training of community assessors identified as a structural gap in Section 3. Rather than treating assessor training as a one-off technical briefing, the CoP framework suggests it should be structured as an apprenticeship: newly trained assessors begin at the periphery of the ReadCycle knowledge community, participating in lower-stakes data collection alongside experienced peers,

and move toward fuller participation, including validation and interpretation responsibilities, as their situated competence grows. This has a direct governance implication taken up again in Section 2.6: community assessors are not simply data collectors but community members whose authority to interpret and validate knowledge would be developed through participation, which is precisely the property Ostrom's polycentric governance literature identifies as necessary for durable, locally legitimate monitoring.

### *2.5 Knowledge Dynamics: A Thermodynamics Approach to Volatility*

This matches Bejinaru's (2019) model of knowledge dynamics, which treats intellectual capital not as a static stock but as a fluid, relational energy that intensifies through active collaborative exchange. Bratianu and Bejinaru's (2020) later thermodynamics reformulation of this model gives the argument a more precise mechanism than the language of "dynamism" alone provides. Drawing an explicit analogy with physical thermodynamics, they treat disorganised, fragmented, or lost organisational knowledge as a form of entropy, and the deliberate, structured creation and circulation of new knowledge as a negentropic, order-generating process that counteracts it. Applied to the Rivers State context, a flood that closes a school, a period of communal unrest that prevents an assessor from reaching a community, or the transfer or attrition of a trained teacher are each, in this framing, entropic shocks: events that destroy or scatter locally held knowledge about how children in that community are learning and coping. An AI-KMS that captures tacit community knowledge before, during, and after such shocks, and recirculates it through the SECI and Ba mechanisms described above, functions as a negentropic mechanism: a deliberate, engineered counterweight to the knowledge entropy that disruption otherwise produces. This is the more precise theoretical content behind the paper's claim, developed further in Bratianu, Garcia-Perez, Dal Mas and Bedford's (2024) broader treatment of knowledge economy and knowledge capital, that such systems must be built on a principle of perpetual growth: they improve through ongoing interaction and volatile constraints rather than requiring stable institutional conditions to function (Edwards & Lönnqvist, 2023).

### *2.6 Polycentric Governance: Ostrom's Contribution*

The paper's proposed architecture rests, throughout, on the claim that community-governed, decentralised nodes are preferable to a single centralised server layout in this context. That claim requires its own theoretical grounding, which this paper locates in Ostrom's (1990) work on the governance of commons and, more directly, in her later theory of polycentric governance (Ostrom, 2010). Ostrom's central finding, developed across decades of empirical work on the self-governance of shared natural resources, many of it conducted in the Global South, is that complex systems are often more robustly and adaptively governed by multiple, semi-autonomous decision-making centres operating under overlapping rules and mutual monitoring than by a single centralised authority. Polycentric systems distribute error-proneness (a failure in one node does not collapse the whole system), promote local learning (each node can adapt rules to local conditions faster than a central authority could), and rely on the kind of locally legitimate, participation-earned monitoring authority that Ostrom's design principles for robust commons governance identify as essential, and that Section 2.4's discussion of legitimate peripheral participation independently arrives at from the direction of situated learning theory. Reading Ostrom alongside Wenger in this way is one of the theoretical contributions of this paper: it grounds the "polycentric" character of the proposed AI-KMS architecture in an established governance theory, rather than using the term only descriptively, and it shows that two independently developed literatures, commons governance and situated social learning, converge on the same requirement, that community-based nodes derive their authority from earned local participation rather than external appointment alone.

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### *2.7 A Synthetic Theoretical Matrix*

Table 1 summarises how each of the five frameworks discussed above contributes a distinct, necessary element to the AI-KMS architecture developed in Section 4; no single framework, applied alone, would generate the full set of design criteria the field evidence demands.

*Table 1: Synthetic theoretical matrix linking each framework to the AI-KMS architecture*

| Theoretical Framework | Core Contribution | Application to AI-KMS |
|---|---|---|
| Nonaka and Takeuchi's SECI model, refined by Nonaka, Toyama and Konno's concept of Ba | Explains how tacit community knowledge is converted into explicit, transferable knowledge, and specifies that this requires a shared context (ba) | Grounds the offline-first edge node as an engineered ba; structures the assessor's role around socialisation and externalisation before combination and internalization |
| Alavi and Leidner's KMS framework | Specifies four interdependent knowledge processes (creation, storage/retrieval, transfer, application) for organisational information systems | Extended beyond the organisational boundary to a distributed, community-governed technology stack with no central owning organization |
| Lave and Wenger's situated learning, and Wenger's communities of practice | Explains how learning and legitimate authority develop through participation in a community, not through one-off instruction | Structures community assessor training as an apprenticeship (legitimate peripheral participation) and frames the assessor network itself as a community of practice |
| Bejinaru's knowledge dynamics, refined by Bratianu and Bejinaru's thermodynamics approach | Treats knowledge as a fluid, relational resource subject to entropy (loss, disorder) and negentropy (structured renewal) | Frames disruption (flooding, unrest, teacher attrition) as an entropic shock, and the AI-KMS's continuous knowledge capture as the negentropic mechanism that counteracts it |
| Ostrom's theory of polycentric governance | Shows that complex shared systems are often more robustly governed by multiple, semi-autonomous, mutually monitoring local centres than by a single central authority | Grounds the "polycentric" character of the proposed architecture; positions community assessors as decentralised governance nodes whose authority is locally earned |

Read together, these five frameworks converge on a single architectural implication, developed in Section 4: this paper proposes that a credible AI-KMS for this context cannot be a centralised software product deployed into communities; it must be an engineered ba, governed polycentrically, that treats knowledge loss under disruption as an entropic process to be continuously counteracted through community-mediated, situated participation.

## 3. METHODOLOGY AND FIELD DIAGNOSTICS

### *3.1 Research Design and Positionality*

This study uses a diagnostic, phased, mixed-methods approach led by ReadCycle Nigeria to build a bottom-up evidentiary baseline across Rivers State, combining structured school-level observation with headteacher-reported instrument data. The fieldwork underpinning Phase 1 was conducted applying safeguarding principles appropriate to research involving school environments and, indirectly, minors. For methodological transparency, the author is the Founder and Convener of ReadCycle Nigeria, the initiative through which the empirical assessment reported in this study was conducted. This position provided direct and sustained access to the participating schools and communities and enabled the collection of field-based evidence grounded in the operational realities documented through the ReadCycle assessment. The findings reported here are presented as empirical evidence from the assessment and have also been subjected to institutional scrutiny and verification by relevant education authorities. The author's positionality is

nevertheless acknowledged as part of the study's methodological transparency, particularly in relation to data collection and interpretation.

### *3.2 Phase 1 Diagnostics: Empirical Realities*

Phase 1 was deployed across 35 primary schools situated in nine Local Government Areas (LGAs) within Rivers State, (Famuyiwa, 2025). The empirical data uncovered severe systemic bottlenecks:

- *Chronic Infrastructure and Resource Scarcity:* an acute absence of operational digital facilities across the sampled schools, textbook deficits severe enough that shared or absent core texts were the norm rather than the exception, and structural teacher shortages that left classes without a consistently assigned instructor for core subjects. With reference to the SECI framework set out in Section 2.2, this scarcity of explicit learning objects, textbooks, curricula, teacher guides, is precisely the condition under which resilient knowledge architecture must lean on the socialisation and externalisation of tacit knowledge rather than assume a pre-existing stock of codified material to combine and redistribute.
- *WASH Deficits and Gender Asymmetry:* a critical lack of Water, Sanitation, and Hygiene (WASH) infrastructure across the sampled schools. Gender-disaggregated analysis highlighted distinct vectors of vulnerability: gender-disaggregated findings identified barriers that may increase girls' vulnerability to educational disengagement to household domestic labour expectations, a complete absence of safe menstrual hygiene facilities, and structural intra-household resource bias favouring male siblings under economic stress (Ahmed, 2026; Olaniyan et al., 2026). These findings are consistent with, and give local specificity to, the national-level gender digital and resource gaps discussed in Section 4, and they directly motivate the gender-responsive design criterion set out there.

Put together, these findings support the paper's central diagnostic claim: the schools assessed in Phase 1 are not simply under-resourced in the conventional sense of lacking money or materials, they are also, and separately, the assessment suggests a gap in the availability of granular, continuously updated information .The Phase 1 dataset itself, collected once and not yet continuously updated, illustrates the limitation it identifies; it is a single externalisation event in Nonaka and Takeuchi's terms, not yet the sustained SECI cycle the paper argues is required.

### *3.3 Operational Hurdles and the Assessor Gap*

An important, and theoretically consequential, finding emerged during Phase 1. In several communities, vulnerable schools were identified but could not be assessed because trained personnel were unavailable to reach them. Read through the SECI and Ba framework set out in Section 2.2, this can be interpreted through the Ba framework as a failure of the conditions required for knowledge externalisation: there was no shared context through which tacit community knowledge about those schools' conditions could be externalised at all, regardless of how the eventual technology stack might be designed. Read through Ostrom's polycentric governance lens, it is a governance-node failure: a functioning polycentric system requires each local node to have the capacity to monitor and report, and in these communities that capacity was simply absent. This operational constraint highlights a structural limitation of centralised educational monitoring systems and suggests the need for distributed, community-based knowledge infrastructure. Consequently, the study proposes trained community assessors, recruited and developed through the legitimate peripheral participation model set out in Section 2.4, as localised knowledge intermediaries capable of supporting data collection, validation, and learning continuity monitoring.

### *3.4 Phase 2 Expansion Parameters*

Phase 2 is extending the diagnostic mechanism to a wider set of Local Government Areas beyond the nine covered in Phase 1, using a headteacher-reported instrument. This expanded diagnostic apparatus incorporates specialised, gender-disaggregated indicators and explicit AI-KMS readiness metrics, including device distribution densities, baseline local grid connectivity variations, and informal community knowledge routing pathways.

## 4. THE POLYCENTRIC AI-KMS ARCHITECTURE

Globally designed AI educational tools routinely reproduce deep epistemological asymmetries in the Global South by forcing communities into standardised, externally imposed curricula (Ahmed, 2026; Olaniyan et al. 2026). To reverse this power dynamic, the ReadCycle field evidence, read through the synthetic theoretical matrix developed in Section 2, specifies four mandatory design criteria for a credible AI-KMS.

**Offline-First Infrastructure:** Data must process locally via lightweight, TinyML-class inference engines on mobile edge units, the proposed architecture models would run directly on low-cost, low-power devices without requiring continuous internet connectivity. This is not a peripheral technical preference but a binding constraint: Africa currently accounts for less than one per cent of global data centre capacity despite being home to 18 per cent of the world's population, and edge-based approaches are correspondingly emerging as the more viable path to AI deployment across low- and middle-income countries generally, precisely because they reduce dependence on the stable power and continuous bandwidth that cloud-based systems assume (GSMA, 2025b). In the terms of Section 2.2, the offline edge unit is the physical instantiation of ba, the shared context within which knowledge, once externalised by a community assessor, can be stored and combined without waiting for grid or network conditions that Rivers State's more remote and riverine communities cannot reliably guarantee.

**Multilingual Local Contextualisation:** AI processing models must handle translation and knowledge indexing in local dialects, preserving community-generated assets rather than requiring their translation into English, or into another externally imposed lingua franca, before they can be considered legible to the system. This criterion follows directly from the epistemic injustice literature discussed in Section 2.1 (Ahmed, 2026; Olaniyan et al., 2026): a system that only recognises knowledge expressed in a colonial or national administrative language reproduces, at the level of interface design, exactly the epistemological asymmetry the paper set out to address.

**Gender-Responsive UI Design:** The user-experience layer will incorporate granular multi-user profile switching on shared household devices, and must preserve analytical progress asynchronously, to mitigate the smartphone access disparity documented both in the field and at national scale. In Nigeria specifically, only 39 per cent of women own a smartphone, and the gender gap in mobile internet adoption stands at 26 percentage points, one of the widest in the countries surveyed by the GSMA's most recent Mobile Gender Gap Report (GSMA, 2025a). Phase 1's field-level finding, that girls face compounded disadvantage through domestic labour burdens and absent WASH facilities, is therefore not an isolated local pattern but consistent with, and amplified by, a documented national and regional digital gender gap; a design that assumes uncontested, individual device access will systematically under-serve exactly the population Phase 1 identified as most at risk.

**Community-Governed Nodes:** Rather than relying on a top-down, centralised server layout, the proposed AI-KMS network will be built on a polycentric architecture in the sense developed in

Section 2.6. Trained community assessors will function through the apprenticeship model set out in Section 2.4 will function as decentralised governance nodes: actively managing localised edge data caches, validating and interpreting knowledge in context, and facilitating feedback loops between communities and educational decision-makers. Their authority to perform this role, in Ostrom's terms,will be earned through legitimate, situated participation in the ReadCycle knowledge community rather than conferred by external appointment alone, which is precisely the property polycentric governance theory identifies as necessary for a local monitoring node to be durable and trusted.

## 5. DISCUSSION AND REPLICABLE SCALING MODEL

The practical implication of this framework is a substantial inversion of educational delivery in volatile zones. By relying on polycentric nodes rather than a single centralised system, the proposed architecture is intended to preserve knowledge flows are preserved during physical crises rather than being lost with them. When flooding or unrest closes physical schools, the local edge mesh, understood in Bratianu and Bejinaru's (2020) terms as a negentropic mechanism, continues to preserve data availability and continuity precisely at the moment a centralised system would be most likely to fail. Although the architecture requires further empirical validation, as Section 6 sets out plainly, it offers a transferable framework adaptable across Nigerian states and other Global South contexts facing similar challenges of learning poverty, weak educational visibility, and infrastructure constraints.

ReadCycle's model is intended to scale across three phases. Phase 1 documented baseline conditions across nine LGAs. Phase 2, currently underway, is extending gender and digital readiness mapping across a wider set of LGAs. A prospective Phase 3 would pilot the AI-KMS architecture itself across a small number of schools selected to represent Rivers State's principal geographic typologies, riverine, semi-urban, and urban, using trained community assessors as governance nodes whose feedback continuously refines system outputs. This architecture directly instantiates the adaptive governance principle developed in Section 2.6: distributing authority, building redundancy across nodes, and creating community-responsive feedback loops that, in principle, make the system more valuable and more resilient the longer it operates, precisely because each cycle of use generates further externalised, combinable knowledge in the SECI sense.

This paper's contribution to the knowledge management for development literature is therefore twofold. First, it offers an empirically grounded account, from a specific climate-vulnerable Nigerian state, of what happens when an established organisational knowledge management framework (Alavi & Leidner, 2001) is deliberately extended beyond the organisational boundary it was designed for. Second, it demonstrates that reading knowledge creation theory (Nonaka & Takeuchi, 1995; Nonaka et al. 2000), situated learning theory (Lave & Wenger, 1991; Wenger, 1998), thermodynamic knowledge dynamics (Bejinaru, 2019; Bratianu and Bejinaru, 2020), and polycentric governance theory (Ostrom, 1990, 2010) together, rather than singly, generates design criteria, offline-first, multilingual, gender-responsive, community-governed, that none of the four frameworks would produce in isolation. Both contributions remain, at this stage, conceptual and field-grounded rather than experimentally validated; a distinction the paper does not wish to obscure.

For policy and practice, the implication is more immediate than the theoretical discussion above might suggest. A state Ministry of Education does not need a fully realised AI-KMS to benefit from the diagnostic logic this paper sets out; it needs, first, a trained community assessor layer capable of closing the ba failure documented in Section 3.3, and second, a commitment to treat the resulting data as a continuous flow to be acted on rather than a one-off report to be filed. The AI-KMS architecture in Section 4 is best understood as the technical layer that would eventually let

that continuous flow scale beyond what manual coordination between ReadCycle and individual LGAs can sustain; it is not a precondition for the underlying governance reform to begin. This distinction matters for sequencing: a Ministry or partner considering this framework can adopt the polycentric, community-assessor governance model in Section 2.6 as an immediate, low-technology first step, with the offline-first technical infrastructure in Section 4 following once Phase 3 piloting, discussed in Section 6, has established its generated initial evidence of feasibility under actual field conditions.

## 6. LIMITATIONS

Several limitations should be stated plainly before this framework is read as more than it currently is.

First, the AI-KMS architecture set out in Section 4 has not yet been technically prototyped or piloted. Its offline-first, TinyML-based design will draws on documented feasibility of edge AI in other low-connectivity settings (GSMA, 2025b), but claims about its performance under Rivers State's specific grid, humidity, and device conditions remain projections pending the Phase 3 pilot described in Section 5, not demonstrated results.

Second, the Phase 1 sample of 35 schools across nine of Rivers State's 23 LGAs was purposively selected rather than drawn as a probability sample, and the resulting findings, while indicative of severe systemic bottlenecks, should not be read as statistically representative of the state as a whole. Phase 2's extension to further LGAs is intended to address this, but is not yet complete.

## 7. CONCLUSION

Findings from ReadCycle Nigeria's diagnostic assessment suggests that educational resilience in Rivers State is not solely a matter of infrastructure or policy, but should be understood as knowledge continuity and knowledge management capability. Learning continuity depends on the capacity of communities to generate, preserve, and mobilise locally grounded knowledge during periods of disruption. By conceptualising an offline-first, multilingual, gender-responsive, and community-governed AI-enabled Knowledge Management System, this paper contributes to knowledge management for development scholarship by integrating and critically testing insights from Nonaka and Takeuchi, Nonaka, Toyama and Konno, Alavi and Leidner, Lave and Wenger, Bejinaru, Bratianu and Bejinaru, and Ostrom, to conceptualise educational resilience as a knowledge continuity capability sustained through polycentric, community-governed infrastructure. The framework positions trained community assessors as polycentric governance nodes within a distributed knowledge architecture designed for low-infrastructure environments. While substantial empirical, methodological, and technical validation remains outstanding, as Section 6 makes explicit, the proposed model offers a transferable, theoretically grounded starting point for future testing and adaptation in other Nigerian and Global South contexts.

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**AI Declaration**

During the preparation of this work, the author used AI assistance for language refinement and formatting. The author reviewed and edited all content and remains fully responsible for the ideas, analysis, and conclusions presented.

**Ethics Declaration**

This study followed ethical standards for educational fieldwork, ensuring confidentiality, informed consent where applicable, and protection of participant privacy.