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Operationalizing Mobile Cloud Learning in Conflict Affected Universities: An Evidence Based Adoption Model from Sudan

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ABSTRACT

Mobile cloud learning has emerged as a promising approach to supporting educational continuity in conflict-affected and resource-constrained higher education environments. However, existing research has primarily focused on readiness assessment and adoption intention while providing limited guidance on how assessment outcomes can be translated into practical implementation strategies. This study addresses this gap by proposing an evidence-based operational adoption model that synthesizes previously validated readiness assessment outcomes and critical success factors into a structured implementation framework. Using a conceptual model development approach, the study translates existing evidence into actionable guidance for institutional decision-making. The main results include the development of a readiness-based classification framework that categorizes institutions into low, medium, and high readiness adoption paths, an operational decision logic linking readiness conditions to appropriate implementation strategies, and a four-phase implementation roadmap consisting of preparation, deployment, evaluation, and continuous improvement. The proposed model emphasizes proportional adoption, low-cost feasibility, and alignment between institutional capacity and implementation scope, making it particularly relevant for fragile and resource-constrained higher education settings. By repositioning readiness assessment as a foundation for operational decision-making rather than a diagnostic endpoint, the study contributes an implementation-oriented perspective to mobile cloud learning adoption research. As a conceptual study, the proposed framework is intended to guide institutional leaders, policymakers, and crisis education planners, while future research should empirically evaluate its effectiveness in real world educational contexts.

1. Introduction

1.1 Context and Motivation

The growing reliance on digital learning environments has heightened the importance of technologies that support education beyond traditional campus boundaries. Mobile cloud learning combines mobile accessibility with cloud-based service delivery, enabling students and institutions to access learning resources regardless of location or local infrastructure limitations. This capability is particularly valuable in conflict-affected environments where educational continuity is frequently disrupted by instability, infrastructure damage, and restricted access to physical learning spaces.

In conflict affected contexts where traditional learning infrastructures are frequently disrupted, under resourced, or inaccessible mobile cloud learning can reduce dependency on local infrastructure while leveraging widespread mobile penetration. Such solutions support learning continuity, flexibility, and inclusivity even under volatile conditions.

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Sudanese higher education institutions exemplify these challenges. Persistent instability, infrastructural limitations, and financial constraints have hindered the adoption and sustainability of traditional e-learning systems. Mobile cloud learning, by contrast, offers a feasible pathway to maintain pedagogical interactions and access to academic content with minimal local infrastructure investment.

Since the outbreak of the armed conflict in Sudan in 2023, higher education institutions have faced unprecedented disruptions, including campus closures, population displacement, damage to educational infrastructure, interruptions in electricity supply, and unstable Internet connectivity. Many universities have been forced to suspend or partially relocate academic activities, creating significant challenges for educational continuity. Under these circumstances, mobile cloud learning represents a potentially viable alternative because it reduces dependence on physical infrastructure while enabling remote access to learning resources through widely available mobile devices.

1.2 Research Gap

In previous research on mobile and cloud learning adoption in higher education, readiness assessment, user acceptance, and critical success factors such as perceived usefulness, service quality, and facilitating conditions have been emphasized. (Al Fraihat et al., 2020; Oliveira et al., 2021). While these studies provide important diagnostic insights, they predominantly treat readiness as an analytical endpoint rather than as an input for implementation oriented decision making. Thus, existing models are limited in their ability to guide institutions in developing feasible and proportionate deployment strategies, especially against a backdrop of instability and scarce resources (Bond et al., 2021; Dwivedi et al., 2022). This limitation is especially evident in Sudanese higher education, where prolonged conflict, fragile infrastructure, and financial constraints necessitate operational frameworks that move beyond assessment toward actionable execution.

1.3 Research Question and Objectives

The purpose of this study is not to empirically validate a new adoption model but to develop a conceptual operational framework that addresses a recognized gap in the mobile cloud learning adoption literature. While previous studies have generated valuable insights regarding institutional readiness, user readiness, and critical success factors, limited attention has been given to translating these findings into practical implementation guidance, particularly in conflict affected higher education environments. Accordingly, this study synthesizes established evidence from readiness assessment and adoption research to develop an implementation oriented framework that supports institutional decision making.

Accordingly, the central research question is formulated as follows:

How can readiness assessment outcomes and critical success factors inform the development of a practical adoption framework for mobile cloud learning in conflict affected higher education institutions?

Aligned with this question, the objectives of this study are to:

1. Propose an evidence based operational adoption model that translates readiness assessment findings into practical implementation pathways for mobile cloud learning in conflict affected higher education institutions.
2. Support institutional decision makers and educational planners by providing structured, readiness driven guidance for planning and deploying mobile cloud learning solutions.
3. Demonstrate how analytical outcomes derived from readiness and Critical Success

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Factor (CSF) assessments can be transformed from diagnostic analysis into executable implementation strategies.

1.4 Contribution of the Paper

The proposed contributions are motivated by a persistent limitation in the mobile cloud learning adoption literature. Although prior studies have provided extensive evidence regarding readiness assessment dimensions and critical success factors, most have treated these outcomes as diagnostic instruments rather than implementation enablers. Consequently, institutional decision makers often receive assessment results without corresponding guidance on how such findings should inform adoption planning and execution. This gap is particularly evident in conflict affected higher education environments, where resource constraints and operational uncertainties require structured and context sensitive implementation strategies. The contributions of this study therefore focus on bridging the gap between analytical assessment and practical adoption by transforming readiness related evidence into operational decision support mechanisms.

- It develops a readiness driven operational adoption model that systematically translates readiness assessment outcomes and critical success factors into implementation decisions aligned with institutional capacities and contextual constraints.
- It presents a multi path implementation roadmap that accommodates varying levels of institutional readiness, enabling proportional and context sensitive adoption rather than uniform deployment approaches.It delivers a context sensitive framework designed specifically for higher education institutions in unstable and resource constrained environments, offering practical relevance beyond traditional theoretical models.

By shifting emphasis from readiness assessment to adoption execution, this study enriches the academic discourse and provides actionable insights for decision making and practice in mobile cloud learning adoption.

2. Background and Related Work

2.1 Institutional Readiness for Mobile Cloud Computing

Successful adoption of technology in higher education is widely recognized as being heavily influenced by institutional readiness. In the context of mobile cloud computing, readiness encompasses a combination of technical capacity, organizational support, and human factors that collectively influence an institution's ability to adopt and sustain cloud based learning services.

Several studies have demonstrated the importance of structured readiness assessment frameworks for identifying strengths, gaps, and potential risks before adoption. However, such assessments are often treated as standalone evaluations rather than as inputs to operational decision making processes.

2.2 User Centric Adoption Challenges

Usability factors, accessibility factors, trust issues, and alignment with learning requirements play an important role in mobile cloud learning adoption. Previous studies indicate that perceived usefulness, ease of use, and trust are among the strongest predictors of users' intention to adopt mobile and cloud based learning technologies (Davis, 1989; Al Emran, Mezhuyev, &Kamaludin, 2018; Abdallah, Abdallah, &Kielani, 2024).

Moreover, learners' engagement with mobile cloud learning systems is negatively affected by limitations of internet connectivity, device limitations, and varying levels of digital literacy in resource constrained environments (Naveed et al., 2023; Traxler, 2017).

The literature underscores the importance of considering both technical and non technical constraints when planning mobile cloud learning initiatives, including infrastructure

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readiness, user skills, and organizational support (Al Sharafi et al., 2021). However, despite identifying a wide range of adoption challenges, many existing studies primarily focus on descriptive analyses and fail to propose practical mechanisms or implementation frameworks to address these challenges in real educational settings (Mizher, 2021; Naveed et al., 2023). This section has outlined the conceptual foundations related to institutional readiness and user centric adoption challenges.

While existing studies provide valuable insights into adoption determinants, they reveal a persistent gap in translating such insights into actionable implementation strategies. The following sections build upon this foundation by presenting a methodological approach and an operational model designed to bridge this gap.

To provide a clearer comparison of existing studies and identify the research gap addressed by the present study, Table 1 summarizes the key characteristics, contributions, and limitations of representative studies related to mobile cloud learning adoption.

Table 1. Summary of Related Studies and Identified Research Gap

Study	Focus	Contribution	Limitation
Traxler (2017)	Mobile Learning	Learning potential	No implementation guidance
Al Sharafi et al. (2021)	Adoption	Adoption factors	Intention focused
Muniandy & Kamsin, 2024	Readiness	Readiness assessment	No operationalization
Naveed et al. (2023)	Crisis Learning	Digital resilience	No adoption pathways
Wang et al., (2024	Technology Adoption	Deployment insights	No phased implementation
Present Study	Operational Adoption	Adoption model and roadmap	Future validation needed

As shown in Table 1, previous studies have largely concentrated on readiness assessment, adoption factors, and digital learning challenges. However, limited attention has been given to translating readiness assessment outcomes and critical success factors into operational implementation strategies. The present study addresses this gap by proposing a readiness driven operational adoption model and a multi path implementation roadmap tailored to conflict affected higher education institutions.

3. Methodological Foundation

This section presents the methodological foundation of the study, clarifying how the proposed operational adoption model was developed. The paper does not introduce new empirical investigations; rather, it systematically builds upon validated findings from prior research to support decision oriented and implementation focused outcomes.

3.1 Research Basis

This study adopts a conceptual model development approach based on the secondary synthesis of validated research findings. Rather than collecting new empirical data, the study systematically integrates readiness assessment results and critical success factors identified through the author's doctoral research conducted within Sudanese higher education institutions. The objective is to transform analytical findings into an implementation oriented framework capable of supporting institutional decision making.

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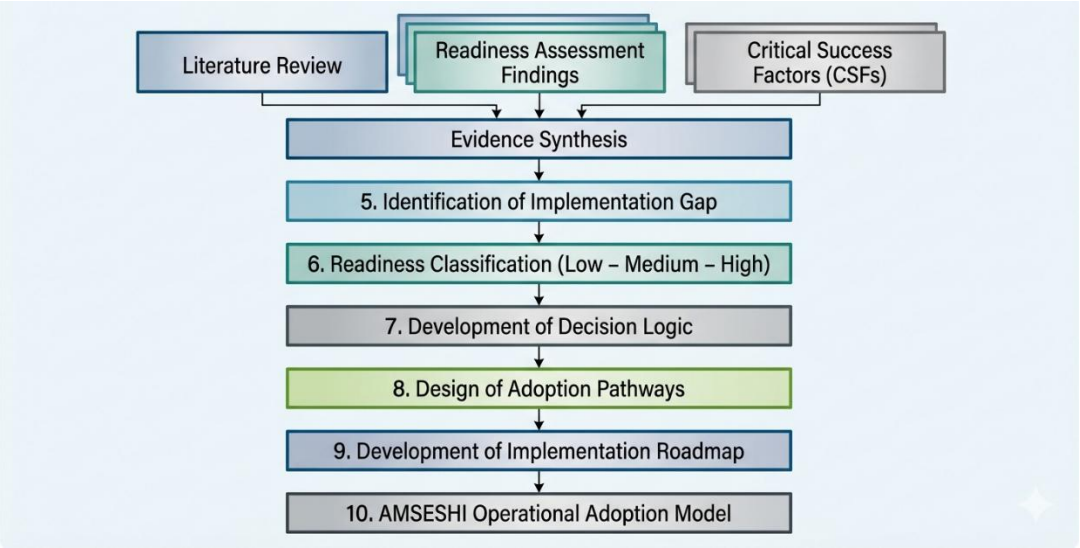

Figure 1. Methodological Process for Developing the Operational Adoption Model

Figure 1 illustrates the methodological process used to develop the proposed operational adoption model. The model was not derived from a single analytical procedure; rather, it emerged through the systematic synthesis of readiness assessment outcomes and critical success factors, followed by readiness classification, decision logic formulation, adoption pathway design, and implementation roadmap development. This process ensured that the resulting framework remained aligned with both institutional readiness conditions and practical implementation requirements.

The original doctoral study employed a mixed method approach involving readiness assessment, critical success factor identification, and analytical prioritization techniques. The findings used in the present paper were selected because they demonstrated consistent relevance to institutional adoption decisions and implementation feasibility. No additional participant recruitment, data collection, or intervention was undertaken for this study; therefore, no new ethical approval was required. The study exclusively reuses previously generated findings for conceptual and theoretical development purposes.

This approach is methodologically and ethically sound, as it avoids redundant data collection while adhering to principles of research integrity. Importantly, the reuse of validated findings serves a distinct analytical purpose: shifting the focus from assessment and diagnosis toward operationalization and implementation.

Accordingly, the objective of this study is not to generate new empirical evidence, but to translate existing, validated evidence into actionable implementation guidance tailored to higher education institutions operating in constrained and unstable environments.

3.2 Analytical Foundation

From an analytical perspective, the proposed operational adoption model is informed by two core inputs:

- Readiness assessment outcomes, reflecting levels of institutional and user preparedness for mobile cloud learning adoption.
- Critical Success Factors (CSFs), encompassing both technical and non technical dimensions that influence adoption effectiveness and long term sustainability.

These inputs are employed as decision support elements rather than as subjects of further quantitative or mathematical analysis. The study deliberately avoids algorithmic

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modeling, mathematical formulations, or detailed technical exposition of analytical methods such as the Analytical Hierarchy Process (AHP). Instead, readiness outcomes and CSFs are interpreted at a conceptual and strategic level to inform adoption pathways and implementation planning.

This analytical orientation ensures that the proposed model remains accessible, adaptable, and applicable across diverse institutional contexts particularly those in which technical complexity or analytical opacity may hinder practical adoption. By prioritizing decision relevance and operational clarity over analytical depth, the methodology directly supports the study's implementation focused objectives. While empirical validation is beyond the scope of this study, the proposed model is grounded in validated findings and is intended to serve as a decision oriented framework suitable for future empirical evaluation.

3.3 Research Provenance Statement (Methodological Protection)

This paper is derived from the author's doctoral research, which is currently under examination and has not yet been published. The study does not replicate prior analyses but recontextualizes validated findings into an implementation oriented operational adoption model.

4. Proposed Operational Adoption Model

4.1 Conceptual Overview

Despite extensive research on mobile cloud learning and institutional readiness, higher education institutions especially in conflict affected and resource limited environments continue to struggle with translating readiness assessments into actionable implementation strategies (Naveed et al., 2023). Mobile cloud learning integrates mobile learning (m learning) and cloud computing to deliver educational services that are flexible, scalable, and location agnostic, which is particularly crucial where traditional infrastructure is weak or unstable (Ugwu, 2025; Hameed & Sumari, 2024).

However, readiness assessments, while diagnostic, often remain abstract unless embedded within frameworks that connect evaluation results with context aware decision pathways and phased implementation strategies (Al Adwan et al., 2018). This operational adoption model responds to that need by transforming validated readiness and critical success factor (CSF) findings into a structured, centralized framework that supports phased, feasible, and low cost adoption tailored to institutional capabilities and contextual constraints.

Globally, adoption studies highlight differences between developed and developing contexts. Developed countries demonstrate higher capacity for large scale integration due to stronger infrastructure and policy support, while developing and conflict affected contexts such as Sudan require models that accommodate incremental deployment, adaptive use of mobile/cloud resources, and minimal capital expenditures (Wang et al., 2024; Al Ammary & Saleh, 2021).

The proposed model synthesizes empirical evidence and international trends into a decision oriented structure designed to support higher education institutions in progressing from readiness assessment toward practical implementation.

4.2 AMSESHI as a Conceptual Operational Framework

In this study, AMSESHI is defined as a conceptual operational framework not a fully developed software structured to assist decision makers in organizing assessment outcomes, interpreting critical success factors, and selecting implementation options aligned with institutional context. The framework integrates three core components:

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1. Readiness Assessment Inputs: Incorporates documented readiness indicators (technical infrastructure, human capacity, policy alignment, and user acceptance) derived from validated assessment findings. These inputs reflect the multidimensional nature of readiness necessary before operational execution (Muniandy & Kamsin, 2024).
2. Critical Success Factors (CSFs): These include both technical (e.g., cloud integration, connectivity) and non technical factors (e.g., leadership support, digital literacy, pedagogical alignment) that influence the successful adoption of mobile cloud learning (Ahmad, 2020). CSFs act as enablers or constraints within the adoption process.
3. Operational Decision Logic: A structured mechanism that aligns readiness levels and CSFs with appropriate implementation strategies, enabling institutions to prioritize actions that match their context, such as capacity building or technology acquisition. Such logic reflects best practices documented in cloud computing
4. adoption research and extends them into the mobile learning domain (Alqatan et al., 2025).

To operationalize the readiness assessment component of the AMSESHI framework, the study identifies a set of key readiness dimensions and representative indicators derived from the literature and readiness assessment research. These dimensions provide the basis for evaluating institutional preparedness and determining the scope and intensity of implementation activities. As shown in Table 2, each readiness dimension influences specific aspects of the adoption process and contributes to implementation planning and decision making.

Table 2. Readiness Indicators

Readiness Dimension	Example Indicators	Implementation Influence
Technical Readiness	Internet connectivity, cloud access, device availability	Determines deployment scope
Organizational Readiness	Leadership support, policies, governance	Determines institutional commitment
Human Readiness	Digital literacy, staff competencies	Determines training requirements
User Readiness	Acceptance, perceived usefulness, trust	Determines adoption speed
Financial Readiness	Budget availability, sustainability plans	Determines implementation scale

Note: The indicators were synthesized and adapted from the author's previously validated readiness assessment framework.

The readiness indicators presented in Table 2 serve as the primary inputs for the proposed framework. Rather than functioning solely as assessment criteria, these indicators inform subsequent implementation decisions by identifying institutional strengths, constraints, and priority areas requiring intervention before adoption can proceed effectively. By integrating these components, AMSESHI moves institutions beyond *abstract readiness classification* toward strategic operational decisions. The framework's emphasis on alignment between institutional capacity and adoption ambition mitigates the risk of premature or unsustainable deployments, particularly in conflict affected regions where strategic alignment is crucial for success.

4.3 Readiness Based Adoption Paths

A central element of the proposed operational adoption model is the classification of institutions into three readiness based adoption paths. These paths function as strategic decision categories that support institutional leaders in determining the appropriate scope and ambition of mobile cloud learning adoption based on demonstrated preparedness.

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Rather than prescribing implementation timelines or procedural steps, the adoption paths define levels of engagement with mobile cloud learning in relation to institutional capacity. Institutions may be positioned along low, medium, or high readiness paths, each reflecting a distinct combination of technological infrastructure, organizational support, and user preparedness.

This classification provides a conceptual decision lens that enables institutions to assess which form of adoption is feasible, proportionate, and sustainable, without assuming uniform readiness or linear progression across higher education systems.

Building upon the readiness assessment outcomes, the AMSESHI framework incorporates a decision logic mechanism that translates readiness conditions into implementation strategies. This approach enables institutions to align adoption decisions with their actual capacities and contextual realities. Table 3 summarizes the relationship between readiness levels, institutional characteristics, and the corresponding adoption strategies recommended by the framework.

Table 3. Engagement with Roadmap Phases Across Readiness Levels

Readiness Level	Typical Characteristics	Recommended Adoption Strategy
Low	Weak infrastructure, limited skills, low support	Pilot projects and capacity building
Medium	Partial infrastructure and moderate support	Controlled departmental deployment
High	Strong infrastructure and institutional support	Full scale implementation and optimization

Note: The indicators were synthesized and adapted from the author's previously validated readiness assessment framework.

As illustrated in Table 3, the framework promotes a proportional adoption approach in which implementation intensity is matched to institutional readiness. This decision logic reduces the risks associated with premature large scale deployment and supports a more sustainable progression from readiness assessment to operational implementation.

4.3.1 Low Readiness Path

Institutions classified under the low readiness path are characterized by limited institutional capacity, including infrastructural constraints, restricted digital skills, and weak organizational support for digital learning. At this level, engagement with mobile cloud learning is conceptually limited to exploratory and preparatory adoption, emphasizing institutional learning and risk containment rather than scale or integration. Examples include low bandwidth learning materials, asynchronous content delivery, mobile friendly resources, offline access mechanisms, emergency communication channels, and foundational digital literacy training.

4.3.2 Medium Readiness Path

Institutions positioned at the medium readiness level demonstrate partial preparedness, including emerging infrastructure and growing institutional commitment. Conceptually, this path corresponds to selective and controlled engagement with mobile cloud learning, allowing institutions to extend adoption beyond experimentation while retaining flexibility and adaptability. Typical implementation activities may include departmental pilot projects, limited course deployment, targeted faculty development programs, and predefined success indicators before institutional expansion.

4.3.3 High Readiness Path

High readiness institutions exhibit robust infrastructure, organizational alignment, and user acceptance. At this level, the adoption path

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supports comprehensive and sustained engagement with mobile cloud learning, where integration, scalability, and long term optimization become feasible objectives. While less common in conflict affected contexts, this path accommodates institutions capable of advanced adoption without overstretching capacity. Sustainability mechanisms should include cloud service continuity planning, periodic infrastructure audits, disaster recovery procedures, staff succession planning, and diversified funding strategies to maintain resilience during periods of instability.

4.4 Model Characteristics and Design Principles

The proposed operational adoption model is guided by a set of design principles grounded in international research on educational technology implementation:

- Contextual Adaptability: Acknowledges institutional diversity and avoids one size fits all assumptions, particularly across stable and conflict affected environments (Wang et al., 2024).
- Incremental Orientation: Frames adoption as a progressive capability building process rather than a one time transition.
- Low Cost Feasibility: Prioritizes cloud based solutions that minimize reliance on local infrastructure and capital expenditure.
- Decision Transparency: Explicitly links readiness levels and critical success factors to adoption scope, supporting accountable and evidence based decision making.

This section introduced a conceptual operational adoption model that classifies institutions into readiness based adoption paths and articulates the design principles underpinning proportionate adoption decisions. The model establishes the strategic logic that connects assessment outcomes to adoption scope, forming the basis for the implementation roadmap presented in the following section. Figure 2 illustrates how institutional readiness paths are systematically linked to the phased implementation roadmap, providing a clear transition from strategic decision making to operational execution.

5. Results

The application of the proposed AMSESHI framework produced three interrelated outcomes that collectively transform readiness assessment findings into actionable implementation guidance for mobile cloud learning adoption. As illustrated in Figure 1, the framework was developed through the synthesis of readiness assessment findings, critical success factors, and relevant literature, resulting in a structured operational adoption model.

The first outcome is the establishment of a readiness classification mechanism based on multiple readiness dimensions, including technical, organizational, human, user, and financial readiness. The readiness indicators presented in Table 1 provide a structured basis for evaluating institutional preparedness and identifying factors that may influence implementation decisions. This classification enables institutions to align adoption efforts with their existing capacities and contextual conditions.

The second outcome is the development of an operational decision logic that links readiness levels to appropriate implementation strategies. As shown in Table 2, institutions characterized by low, medium, or high readiness are guided toward different adoption approaches ranging from pilot initiatives and capacity building activities to controlled deployment and full scale implementation. This decision oriented mechanism supports evidence based planning and reduces the risks associated with uniform adoption strategies.

The third outcome is the formulation of readiness based adoption pathways integrated within the AMSESHI framework (Figure 2). These pathways provide a structured progression from assessment to

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implementation by connecting readiness conditions, decision logic, and adoption strategies. Together, these outcomes establish the foundation for the phased implementation roadmap presented in the following section, which translates strategic guidance into practical implementation activities across preparation, deployment, evaluation, and continuous improvement phases.

6. Implementation Roadmap

Following the readiness based adoption paths defined in Section 4, this section operationalizes the execution of the selected adoption scope through a structured implementation roadmap. The roadmap does not prescribe a uniform adoption trajectory; rather, it provides a common execution logic that institutions engage with at varying depths and speeds depending on their readiness classification

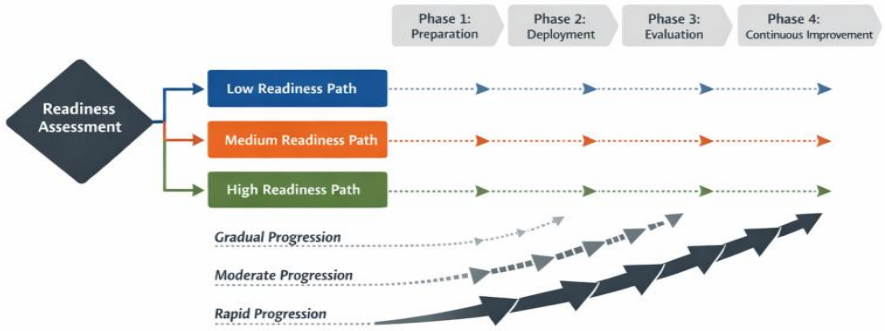

Figure 2. Readiness Based Operational Adoption Model

The roadmap is organized into four sequential phases preparation, deployment, evaluation, and continuous improvement which collectively translate strategic adoption decisions into sustained operational practice.

To support the operationalization of the proposed framework, a phased implementation roadmap is developed to guide institutions through the adoption process. The roadmap translates readiness informed decisions into a structured sequence of implementation activities, ensuring that adoption progresses in a systematic and sustainable manner. As shown in Table 4, each phase is associated with specific activities and expected outputs that collectively support the successful deployment of mobile cloud learning initiatives.

Table 4. Readiness Aligned Implementation Roadmap

Phase	Key Activities	Expected Outputs
Preparation	Review readiness outcomes, identify priorities, establish governance structure, define objectives	Institutional adoption plan
Deployment	Select cloud platform, launch pilot implementation, provide user training and technical support	Initial operational deployment
Evaluation	Monitor system performance, assess user engagement and satisfaction, review CSFs alignment	Evaluation and improvement report
Continuous Improvement	Expand services, enhance features, conduct periodic readiness reviews, provide ongoing training	Sustainable and scalable adoption

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The implementation roadmap provides a practical mechanism for moving from readiness assessment and adoption planning to operational execution. By organizing implementation into sequential phases, the roadmap helps institutions manage resources effectively, monitor progress, and continuously improve adoption outcomes. Furthermore, the phased structure accommodates varying readiness conditions and supports proportional implementation strategies aligned with institutional capacities.

6.1 Phase 1: Preparation

The preparation phase operationalizes the strategic positioning established by the selected readiness path. At this stage, institutions focus on translating conceptual adoption scope into realistic organizational commitments, ensuring alignment between ambition, capacity, and contextual constraints.

Key activities in this phase include:

- Reviewing readiness assessment outcomes to validate the selected adoption path and identify priority intervention areas.
- Building institutional awareness and consensus among leadership, academic staff, and support units regarding the scope and intent of adoption.
- Mapping existing technical infrastructure, human expertise, and organizational responsibilities required to support the chosen adoption level.
- Defining readiness aligned operational objectives, explicitly avoiding commitments that exceed demonstrated institutional capacity.

By grounding execution in evidence based preparation, this phase reduces the likelihood of misaligned investments and establishes institutional ownership, which is critical for sustainable adoption in unstable environments.

6.2 Phase 2: Deployment

The deployment phase represents the controlled execution of the selected readiness path. Rather than assuming full scale implementation, deployment scope and complexity are calibrated to match institutional readiness, ensuring proportionality and feasibility.

Deployment activities may include:

- Selecting cloud based learning platforms consistent with the institution's readiness level, financial capacity, and user needs.
- Enabling mobile access to learning resources with minimal dependence on local infrastructure.
- Initiating deployment through targeted pilots or limited rollouts aligned with the defined adoption scope.
- Providing foundational training and technical support appropriate to the scale of deployment.

This readiness aligned deployment approach allows institutions to operationalize adoption while minimizing disruption, supporting experiential learning before any expansion

6.3 Phase 3: Evaluation

The evaluation phase functions as the decision feedback mechanism within the roadmap. Its purpose is not retrospective assessment but evidence informed adjustment of execution in relation to the selected readiness path.

Evaluation activities include:

- Monitoring system reliability, accessibility, and usability from the user perspective.
- Assessing user engagement, satisfaction, and perceived pedagogical value relative to the intended adoption scope.
- Reviewing alignment between implementation outcomes and the critical success factors identified during readiness assessment.
- Identifying technical, pedagogical, or organizational constraints requiring recalibration.

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The insights generated during this phase inform decisions regarding refinement, stabilization, or cautious progression, preventing escalation beyond institutional capacity.

6.4 Phase 4: Continuous Improvement

Continuous improvement represents the long term operationalization of the adoption path. Rather than signaling completion, this phase supports sustained alignment between evolving institutional readiness and mobile cloud learning practices.

Activities in this phase include:

- Incremental enhancement of system features and learning content informed by evaluation findings.
- Gradual expansion of services only when readiness indicators demonstrate improved capacity.
- Ongoing professional development to strengthen institutional and user capability.
- Periodic reassessment of readiness to guide future strategic decisions.

This phase is particularly critical in conflict affected contexts, where institutional conditions may fluctuate, requiring adoption strategies to remain adaptive rather than static.

6.5 Alignment of the Implementation Roadmap with Readiness Levels

The implementation roadmap is operationally aligned with the readiness based adoption paths introduced in Section 4. Institutions positioned at different readiness levels engage with the roadmap at varying depths and speeds, ensuring proportional and context sensitive execution.

Institutions with lower readiness typically emphasize extended preparation and limited deployment, while institutions with higher readiness can progress more rapidly across deployment and evaluation phases. This alignment allows the roadmap to function as a flexible execution mechanism, accommodating institutional diversity without enforcing uniform implementation trajectories.

By separating conceptual readiness classification from procedural execution, the model ensures that adoption decisions remain evidence based while implementation remains adaptive to contextual realities.

7. Practical Implications

The proposed operational adoption model offers significant practical implications for key stakeholders involved in planning, implementing, and governing mobile cloud learning in conflict affected and resource constrained higher education contexts. By translating readiness assessment outcomes into structured and proportional implementation pathways, the model directly addresses a well documented gap between analytical evaluation and actionable decision making in digital and cloud based education initiatives. Prior studies on cloud and mobile learning adoption emphasize that the absence of implementation oriented guidance often limits the practical value of readiness and adoption assessments (Al Sharafi et al., 2021; Mizher, 2021).

Unlike technology driven adoption approaches that frequently neglect contextual, organizational, and capacity related constraints, the proposed model supports risk aware and evidence based adoption. This orientation is particularly critical in fragile higher education environments, where empirical studies have shown that premature or resource intensive technology deployments can exacerbate institutional vulnerabilities and lead to sustainability failures (Traxler, 2017; Naveed et al., 2023).

7.1 Implications for Higher Education Institutions

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For higher education institutions, the proposed model provides a decision oriented and readiness aligned framework that reduces uncertainty associated with adopting mobile cloud learning under constrained conditions. Prior studies indicate that institutions in developing and conflict affected contexts frequently experience adoption failure due to misalignment between technological ambition and institutional capacity (Muniandy & Kamsin, 2024; Naveed et al., 2023).

By grounding adoption decisions in validated readiness and critical success factors, the model may assist institutions in:

- Prioritize digital investments based on institutional readiness and contextual feasibility, rather than external pressure or technological trends.
- Reduce implementation risks through phased and proportionate deployment strategies, consistent with best practices in educational technology implementation.
- Support incremental capacity building across technical, organizational, and pedagogical domains, which has been shown to enhance long term sustainability.
- Enhance institutional resilience by enabling flexible and mobile enabled learning delivery during periods of disruption, a critical requirement in the Sudanese higher education context.

Through clearly defined adoption paths, the model assists institutions in avoiding premature or unsustainable initiatives that have characterized many failed e learning projects in resource constrained settings (Wang et al., 2024)

7.2 Implications for Policymakers and Educational Authorities

For policymakers and educational authorities, the proposed model functions as a strategic planning and governance tool for guiding digital education initiatives at both institutional and national levels. Evidence from developing regions suggests that policy level digital transformation efforts often fail due to the absence of readiness based planning frameworks (Traxler, 2017; Al Sharafi et al., 2021).

The model is intended to support evidence based policy formulation by linking readiness assessment results to actionable implementation strategies, thereby enabling policymakers to:

- Inform funding allocation decisions by distinguishing between institutions requiring preparatory support and those ready for large scale deployment.
- Support the design of phased national or regional mobile learning initiatives, rather than uniform mandates.
- Establish structured criteria for assessing institutional eligibility for cloud based education programs.
- Enhance coordination and interoperability across institutions through standardized yet adaptable adoption frameworks.

In conflict affected contexts such as Sudan, where educational resources are severely constrained, such structured and proportional planning mechanisms are essential for maximizing impact and ensuring accountability (Mizher, 2021; Naveed et al., 2023).

7.3 Implications for Crisis Education Planners and Development Partners

Crisis education planners and international development partners can leverage the proposed model as a context sensitive operational framework for designing and supporting mobile learning interventions in fragile and emergency settings. Humanitarian education literature increasingly emphasizes the importance of scalable, low cost, and adaptable digital solutions in crisis response (INEE, 2021; Mizher, 2021; Naveed et al., 2023).

The model's emphasis on readiness aligned adoption enables planners and partners to:

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- Design mobile learning interventions that are adaptive to instability and infrastructure volatility.
- Support rapid yet controlled deployment of learning services during emergencies without compromising quality.
- Enable monitoring and evaluation using predefined readiness indicators and success criteria.
- Promote sustainability by embedding capacity development and continuous improvement mechanisms beyond short term emergency responses.

By emphasizing operational feasibility over technological sophistication, the model contributes to bridging the persistent gap between emergency education response and long term system strengthening, which remains a critical challenge in crisis affected regions.

Overall, the practical implications of the proposed operational adoption model extend across institutional, policy, and crisis planning levels. By providing a structured, evidence based approach to mobile cloud learning adoption, the model is intended to support more resilient, efficient, and context aware educational practices. While grounded in the Sudanese higher education context, its principles and implementation logic offer transferable insights applicable to other conflict affected and resource constrained higher education systems worldwide.

8. Discussion

This study set out to address a critical gap in the literature on mobile cloud learning adoption in conflict affected higher education contexts: the absence of operational guidance that translates readiness assessment outcomes into actionable implementation strategies. Most extant research has emphasized readiness evaluation or adoption intention modeling without providing concrete mechanisms for operationalization (Naveed et al., 2023; Al Sharafi et al., 2024). This study's proposed operational adoption model directly responds to this gap by repositioning readiness as a decision enabling construct rather than a static classification, thereby facilitating informed decision making and execution.

8.1 From Assessment to Execution

A key contribution of this study lies in its explicit linkage between readiness assessment outcomes and implementation decisions. Traditional readiness studies often result in descriptive outputs (e.g., readiness scores or factor weights) that do not, on their own, inform concrete action (Fadelelmoula, 2025). Although such analyses are valuable for understanding institutional conditions, they seldom guide how to act on these insights.

By embedding readiness results within a structured operational framework that incorporates critical success factors and adoption pathways, the proposed model may assist institutions to move beyond descriptive analysis toward context specific action. This shift aligns with calls in the technology adoption literature for frameworks that bridge diagnostic assessment and practical execution, particularly in volatile environments where misaligned adoption can exacerbate resource scarcity (Muniandy & Kamsin, 2024; Alanazi et al., 2024).

In conflict affected contexts like Sudan, where institutional capacity may fluctuate with external instability, this linkage is especially valuable. Operationalizing readiness data helps avoid misdirected investments, implementation delays, and strategic misalignment issues widely documented in technology projects in fragile environments (Mizher, 2021; Naveed et al., 2023)

8.2 Suitability for Conflict Affected Contexts

The proposed model's utility in conflict affected higher education stems from its emphasis on flexibility, incremental implementation, and low cost deployment, characteristics that align with the resource

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realities of such environments. Conventional adoption models often assume stable infrastructure and continuous administrative capacity, conditions that rarely exist in conflict zones (Mizher, 2021; Naveed et al., 2023).

The readiness based adoption paths enable institutions to engage with mobile cloud learning at levels proportionate to their readiness, reducing the risk of systemic failure. This stratified approach is consistent with adaptive change theories, which argue that interventions in unstable environments must be scalable, iterative, and resilient to external shocks (Bryson, J. M., & George, B. (2024); Hameed & Sumari, 2024).

Furthermore, the phased implementation roadmap supports gradual learning and adaptation an approach shown to improve technology uptake and sustainability when organizational absorptive capacity is limited (Wang et al., 2024). In contexts marked by frequent disruptions, such as Sudan and similar settings in sub Saharan Africa and the Middle East, this adaptive posture allows institutions to learn while implementing, rather than implement before learning.

8.3 Comparison with Existing Adoption Models

Traditionally, technology adoption models in education such as the Technology Acceptance Model, the Unified Theory of Acceptance and Use of Technology, and related frameworks place a high value on psychological and behavioral constructs like perceived utility, ease of use, and behavioral intention (Venkatesh et al., 2016; Jiang et al., 2025). While these models offer valuable insights into factors influencing individual or institutional acceptance, they are less effective in guiding practical implementation, especially where structural constraints dominate decision outcomes.

In contrast, the proposed operational model emphasizes operational feasibility and contextual alignment. Rather than predicting adoption likelihood, it focuses on enabling adoption through structured decision making and practical execution strategies, making it more suited for environments where readiness and resource constraints govern adoption success. In this sense, the model complements classical theoretical frameworks by filling a practical implementation gap rather than replacing foundational theoretical insights.

8.4 Decision Support Without Over Engineering

A significant strength of the proposed approach is its avoidance of over engineered solutions. By positioning AMSESHI as a conceptual operational framework rather than a fully developed software system, the study maintains methodological rigor while avoiding unrealistic implementation claims. Over engineering can hinder adoption in practice, particularly where technical expertise and infrastructure are limited (Singh et al., 2020).

The emphasis on conceptual decision support highlights the value of structured planning based on evidence rather than reliance on high complexity technical systems that may not be sustainable in resource limited or unstable contexts. Conceptual frameworks like AMSESHI function as cognitive tools that help decision makers anticipate challenges, allocate resources proportionately, and sequence actions logically a necessity in environments where trial and error can be costly (Abdallah et al., 2024).

8.5 Limitations and Future Directions

While the proposed model offers practical and context sensitive guidance, it has limitations. First, the framework derives from validated findings within specific national and contextual settings, which may affect its generalizability across diverse global contexts. As with any model adapted from localized empirical inputs, contextual nuances—such as policy environments, cultural factors, and

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funding structures—may require adaptation for different regions.

Second, this study does not include empirical evaluation of the complete implementation roadmap. Although conceptual grounding and readiness alignment provide theoretical justification, pilot implementations and longitudinal studies are necessary to validate the model's effectiveness in practice. Future research should focus on:

- Pilot testing the proposed model across varied institutional settings to assess contextual adaptability.
- Developing lightweight decision support tools that operationalize the conceptual framework into user friendly interfaces.
- Examining long term educational and organizational outcomes associated with mobile cloud learning adoption, especially in volatile and resource challenged contexts.

In summary, this discussion articulates how the proposed operational adoption model advances the literature by bridging the gap between readiness assessment and practical implementation—a gap frequently noted but seldom addressed directly. By prioritizing feasibility, proportionality, and contextual sensitivity, the model offers a viable and evidence based pathway for higher education institutions seeking to adopt mobile cloud learning under challenging conditions such as conflict, instability, and resource scarcity. Its contribution lies not merely in theory development but in offering a structured, operationally meaningful approach capable of informing real policy and practice decisions.

The study contributes to the mobile cloud learning literature by repositioning readiness assessment as a decision enabling mechanism and by introducing an implementation oriented framework that translates readiness outcomes into operational adoption strategies.

9. Limitations

This study has several limitations. First, the proposed operational adoption model is conceptual and has not yet been empirically implemented or validated in real institutional settings. Second, the framework is grounded in findings derived from Sudanese higher education institutions, which may limit direct generalization to other contexts. Finally, the model emphasizes implementation guidance rather than quantitative prediction. Future studies should empirically evaluate the framework and examine its applicability across different higher education environments**.**

Future studies should empirically validate the proposed framework across different institutional contexts and evaluate its effectiveness through pilot implementations and longitudinal investigations.

10.Conclusion

This study proposed an operational adoption model for mobile cloud learning tailored to higher education institutions operating in conflict affected and resource constrained environments. By addressing the gap between readiness assessment and implementation, the proposed AMSESHI framework transforms readiness indicators and critical success factors into structured decision making guidance, readiness based adoption pathways, and a phased implementation roadmap. Unlike approaches that focus primarily on adoption intention or readiness measurement, the model emphasizes operational feasibility, institutional capacity, and context sensitive implementation. The framework provides educational leaders and policymakers with a practical mechanism for planning mobile cloud learning initiatives in fragile settings while supporting sustainable and scalable adoption. As a conceptual contribution derived from previously validated readiness assessment findings, the model should be viewed as an implementation oriented decision support framework whose empirical validation remains an important direction for future research.

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