

Digital Health Services in Sub-Saharan Africa: A Narrative Review of Benefits, Adoption Factors, and Implementation Challenges

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ABSTRACT

Digital health is often presented as a way for African health systems to overcome shortages of facilities, specialists, and dependable supply chains, yet the supporting evidence is scattered across separate literatures. This article reviews published work on digital health services in sub-Saharan Africa, with particular attention to telemedicine and mobile health (mHealth). The review uses a narrative design with a documented search specification covering material published between 2012 and 2026. Thirty sources were retained and coded using a hybrid framework, in which three themes were set deductively from the review questions while subthemes were developed inductively from the reading. The methodological character of each source was recorded rather than scored, since the corpus mixes trials, qualitative studies, and reviews. Three findings emerge. First, the evidence for benefit is strongest at the level of reach and utilisation, as in South Africa's MomConnect, and considerably thinner at the level of clinical outcomes, so the two should not be conflated. Second, adoption studies in Nigeria and Ethiopia converge in showing that performance expectancy, effort expectancy, and facilitating conditions predict intention while social influence does not, which suggests that provider incentives and institutional readiness matter more than peer persuasion. Third, barriers separate into foundational constraints, namely infrastructure and financing, and context-specific ones that vary by country. The review contributes an integrative framework linking enabling conditions, adoption, and outcomes, and sets out priority questions for further research.

1. Introduction

1.1. Background

Few regions illustrate both the promise and the difficulty of digital health as vividly as sub-Saharan Africa. Across much of the region, health systems have long contended with a familiar set of constraints: too few doctors and specialists, facilities concentrated in cities while most patients live far from them, fragile supply chains, and financing that rarely stretches to meet demand [1]. These constraints are not abstract. Survey evidence drawn from across the region shows that distance and cost, together with the sheer difficulty of reaching a facility, remain decisive in whether a mother seeks care for a sick child at all [2]. Such problems are

not new, and they will not be dissolved by technology alone.

What has changed is the communications substrate on which health services can now be built. Mobile telephony spread far faster than fixed infrastructure ever did, giving health workers and patients a channel that did not previously exist [3]. Digital health has consequently attracted growing policy attention. The World Health Organization has encouraged member states to treat digital tools not as ends in themselves but as instruments for strengthening health systems, setting out a shared vision in its global strategy for 2020 to 2025 [4], and an earlier guideline stressed that a digital intervention is worth adopting only insofar as it

addresses a genuine health-system need [5]. At national level, the picture is uneven rather than uniform. South Africa has operated a digital maternal messaging service at national scale for several years [6], Rwanda has integrated drone-based delivery into its national blood supply chain [7], and Ethiopia has identified provider-to-provider telemedicine as a priority intervention in its national digital health blueprint [8]. It is therefore accurate to say that digital health has become a significant element of health-system policy in a number of countries in the region, though not that it has become central everywhere.

1.2. Geographical Scope of the Review

Because conditions vary so widely, the geographical boundary of this review requires an explicit statement. The review is confined to sub-Saharan Africa. This decision reflects the evidence base rather than a judgement about the rest of the continent: the empirical literature on digital health service delivery is concentrated in this sub-region, and the North African countries operate within different health-financing arrangements, different regulatory traditions, and a largely Arabic and French language literature that the present search could not cover. The term sub-Saharan Africa is used throughout, and country names are used wherever a claim rests on evidence from a specific setting. Where a cited source itself refers to Africa as a whole, that wording is preserved in describing the source but is not carried into the conclusions of this review. The residual imbalance within sub-Saharan Africa, discussed in Section 3.1, remains a genuine limitation.

1.3. Previous Reviews and the Remaining Gap

Several reviews already address parts of this field, and it is worth stating what each contributes. Aranda-Jan and colleagues catalogued mHealth implementation across Africa and identified what worked and what did not [3]. Bloomfield and colleagues examined mHealth for non-communicable diseases [9], while Bervell and Al-Samarraie compared mHealth and eHealth utilisation across the sub-region [10]. On telemedicine, Dadoo and colleagues traced programme development and its challenges [11] and, in a companion study, catalogued barriers during the COVID-19 period [12]. Agbeyangi and Lukose compared telemedicine adoption in South Africa, Kenya, and Nigeria [13], and Kruse and colleagues ranked mHealth barriers across developing countries generally [14].

Taken together these reviews cover their chosen boundaries thoroughly, and this article does not claim the field is unexamined. The gap is narrower. Existing reviews are organised either by technology or by outcome domain, and each therefore treats benefits, adoption, and barriers as separate objects of study. What is missing is a synthesis that holds the three together and asks how they condition one another. That question

matters because the same factor recurs on both sides of the ledger: facilitating conditions appear as a predictor of adoption in one literature and as an infrastructure barrier in another, and financing appears as an enabler in one and as a sustainability failure in the other. Reading these as separate findings obscures the fact that they describe a single underlying variable.

1.4. Review Questions and Integrative Perspective

This article therefore pursues three connected questions. First, what benefits do digital health services deliver in sub-Saharan African settings, and at what level of evidence? Second, what factors shape whether those services are taken up and sustained? Third, what challenges impede their implementation at scale?

The three questions are integrated through a socio-technical perspective on health-system strengthening. That perspective is established rather than novel, and this review does not claim to originate it. Implementation science has produced several frameworks that treat a technology, the people expected to use it, and the organisation hosting it as interacting rather than separable domains. The closest to the present concern is NASSS, developed to explain why health technologies go unadopted, are abandoned, or fail to scale, and which places the explanation across seven interacting domains rather than in any one of them [15]. Work on scale-up in low- and middle-income countries points the same way. A systematic review of that literature found that scaling requires simultaneous change in how services are organised, how they are practised, and how they are understood, with the availability of financial, human, and material resources the most prominent structural factor [16]. Two positions inside the reviewed literature carry the same logic: the WHO holds that a digital intervention derives its value from the health-system need it addresses rather than from its technical properties [4], [5] and Leon and colleagues locate the determinants of scale in governance, financing, and workforce rather than in software [17]. Together these yield the working proposition tested in Section 3, that enabling conditions, adoption behaviour, and barriers are three vantage points on one set of system properties.

The intended contribution is accordingly threefold, and the first needs stating precisely. NASSS was built from case studies in a high-income system, where the binding constraints are typically clinical complexity and organisational capacity. Whether its logic holds where electricity, connectivity, and recurrent financing are the binding constraints is an open question, and testing it against regional evidence is what this review offers rather than a new perspective. The product of that test is the framework presented in Figure 2 and derived component by component in Table 10, which links enabling conditions to adoption and to service delivery outcomes with barriers acting across the pathway. It

identifies cross-country patterns in adoption by comparing acceptance studies conducted in different national settings. And it distinguishes levels of evidence for claimed benefits, separating demonstrated reach and utilisation from demonstrated health outcomes, a distinction that the existing literature frequently leaves implicit.

2. Research Method

2.1. Review Design

This study is a narrative literature review supported by a structured and documented search. A narrative design was chosen because the subject spans several distinct technologies, countries at very different stages of development, and study designs ranging from randomised trials to qualitative implementation research. A protocol-driven synthesis would have required a narrower question than the integrative one posed here.

One consequence of that choice governs how the method is reported below. The review does not follow the procedures of the PRISMA 2020 statement [18]: it was not registered, screening was not duplicated by a second reviewer, no meta-analysis was attempted, and

intermediate screening counts were not tracked as a protocol-driven search would require. We therefore do not present a PRISMA-style flow diagram, since stage-by-stage counts would imply a procedural control this review did not exercise and such diagrams are easily mistaken for evidence of systematic conduct. We report instead the search specification in Table 1 and the full composition of the corpus in Section 2.4 and Figure 1, so that a reader can see exactly what the synthesis rests on. Readers seeking protocol-driven coverage should consult the systematic reviews cited in Section 1.3 [11], [13], [14]. Conduct was guided by SANRA, an instrument developed for narrative reviews [19].

2.2. Search Strategy and Data Sources

Literature was sought in PubMed, Scopus, and Google Scholar, supplemented by hand-searching the reference lists of the reviews discussed in Section 1.3 and by direct retrieval from institutional repositories. The corpus was finalised in August 2026 and restricted to material published from 2012 onwards. Table 1 gives the complete specification: the string for each source, the fields searched, the filters applied, and the handling rule where a source returns an unstable result set. It is stated in full so the search can be repeated and its yield compared against the corpus in Section 2.4.

Table 1. Search Specification by Source

Source	Search string, fields, and handling rule
PubMed	((("digital health"[Title/Abstract] OR "telemedicine"[Title/Abstract] OR "telehealth"[Title/Abstract] OR "mHealth"[Title/Abstract] OR "mobile health"[Title/Abstract] OR "eHealth"[Title/Abstract]) AND ("Africa"[Title/Abstract] OR "sub-Saharan Africa"[Title/Abstract] OR "African"[Title/Abstract])) with filters: publication date from 2012/01/01; language English.
Scopus	TITLE-ABS-KEY(("digital health" OR telemedicine OR telehealth OR mhealth OR "mobile health" OR ehealth) AND (africa OR "sub-saharan africa" OR african)) AND PUBYEAR > 2011 AND LIMIT-TO(LANGUAGE, "English"). Screening applied to titles of the first 200 hits ordered by relevance.
Google Scholar	("digital health" OR telemedicine OR mHealth) AND ("sub-Saharan Africa" OR Nigeria OR Kenya OR "South Africa" OR Ghana OR Rwanda OR Ethiopia), custom range from 2012, citations and patents excluded. Because the engine returns a large and unstable result set, screening was capped in advance at the first ten pages of relevance-ranked results and records were assessed by title and abstract only. Material beyond that cap was not examined; this is reported as a limitation in Section 2.7.
Reference lists	Backward citation searching of the reviews discussed in Section 1.3.
Institutional repositories	WHO and African Union repositories browsed directly for digital health strategy, guideline, and legal instruments.

The country names in the Google Scholar string require justification, since naming individual countries can bias retrieval. Three points apply. The broad terms Africa, African, and sub-Saharan Africa were used alone in the PubMed and Scopus strings, so no country was privileged in the indexed databases. Country names were added only in Google Scholar, whose relevance ranking otherwise returns many results from outside the region, and they were chosen because prior reviews identify them as the settings with the largest published literature [10], [11], [13]. Ethiopia was added during screening when acceptance studies from that country surfaced through reference-list searching. The consequence is nonetheless a corpus weighted towards

anglophone settings with established research output, and Section 3.1 treats that imbalance as a finding rather than a footnote.

2.3. Inclusion and Exclusion Criteria

Sources were assessed against the criteria in Table 2. A small number of works from outside the region were retained where they supplied the theoretical apparatus used in the analysis, most notably the technology acceptance literature [20] and the methodological instruments [18], [19], [21]. Two further sources from outside sub-Saharan Africa were retained as explicit comparators rather than as evidence about the region: a systematic review of digital health for diabetes in the

Eastern Mediterranean Region [22] and a World Health Organization global survey of digital and artificial intelligence readiness among infection prevention professionals [23]. These six works are treated throughout as supporting apparatus and are excluded from the corpus counts reported in Section 3.1.

Table 2. Inclusion and Exclusion Criteria Applied in the Review

Aspect	Included	Excluded
Topic	Digital health, telemedicine, telehealth, mHealth, eHealth services, and digitally coordinated health logistics	Health technology with no service-delivery or service-coordination dimension
Setting	One or more sub-Saharan African countries; theoretical and methodological sources where analytically necessary	Studies conducted wholly outside the region with no transferable framework
Source type	Peer-reviewed articles, systematic and narrative reviews, authoritative institutional reports	Editorials, opinion pieces, and promotional material without evidence
Period	Published from 2012 onwards	Published before 2012
Language	English	Languages other than English

The lower bound of 2012 was not set by a single publication. Three considerations support it. Two foundational analyses of the health-system barriers to scaling digital health appeared in 2012 and 2013 and still frame current debate [17], [24]. Ghana enacted the region's earliest comprehensive data protection statute in 2012, marking the start of the regulatory environment in which today's services operate [25]. Most importantly, the mobile-broadband expansion underpinning current service models postdates 2012 in most of the region, so earlier studies describe a materially different technological setting rather than an earlier stage of the same one.

2.4. Composition of the Corpus

Thirty sources met the criteria in Table 2 and were carried into the synthesis. Because intermediate screening counts were not tracked, this section reports what the corpus contains rather than how many records were discarded. That is the more useful disclosure in any case, since a reader can check every claim below against the reference list, which is not true of a screening tally.

The provenance of the corpus can be stated exactly. Three are institutional instruments retrieved from the WHO and African Union repositories [4], [5], [26]. The other twenty-seven are peer-reviewed articles found through the searches in Table 1 and through backward citation searching of the reviews in Section 1.3. Reference-list searching brought the Ethiopian acceptance literature into the corpus [8], [27], [28], since those studies did not surface in the initial database screening. That is also why Ethiopia appears in the Google Scholar string but not in the indexed-database strings, a sequence recorded here rather than tidied away. The supporting works named in Section 2.3 were located outside the health databases.

Figure 1 characterises the thirty sources by year of publication and by setting studied. Both panels derive from the reference list, so the figure can be verified independently of any claim we make about searching. Twenty of the thirty sources appeared in 2018 or later, and the distribution across settings is markedly uneven, a pattern taken up in Section 3.1.

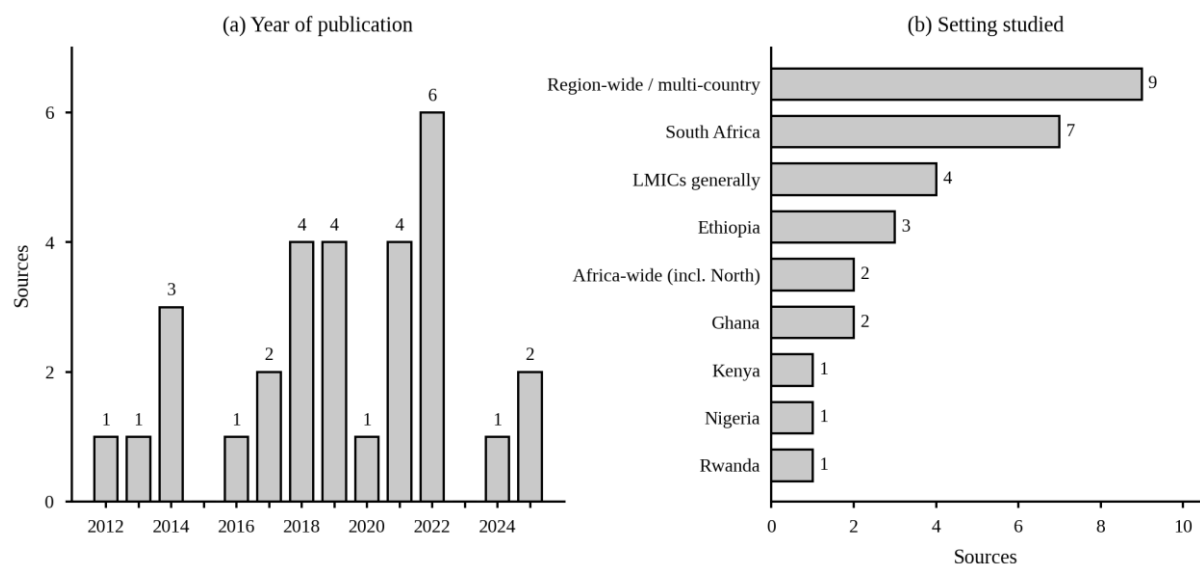


Figure 1. Composition of the thirty included sources by (a) year of publication and (b) setting studied. Both panels are derived from the reference list and can be verified independently. Region-wide denotes multi-country sub-Saharan African studies; LMICs generally denotes low- and middle-income country evidence retained for transferable findings

2.5. Handling of Evidence Types and Methodological Appraisal

The corpus mixes randomised trials, observational analyses, qualitative implementation studies, prior reviews, and institutional strategy documents. Treating these as equivalent would be indefensible. No formal risk-of-bias score was assigned, since scoring is designed for pooling effect estimates and this review pools no estimates. Instead the methodological character of each source was recorded using the design categories

of the Mixed Methods Appraisal Tool [21], and that character governs the weight each source carries in the argument. This approach has precedent in regional digital health reviews: a systematic review of digital health interventions for diabetes in the Eastern Mediterranean Region applied a single instrument across all designs for the same reason, namely that no design-specific tool could appraise a corpus combining randomised, non-randomised, and observational studies consistently [22]. Table 3 reports the resulting profile.

Table 3. Methodological Profile of the 30 Included Sources and Their Evidential Role

Design category	n	Role in the synthesis
Randomised controlled trial	2	Strongest basis for causal claims about intervention effects [29], [30].
Observational and time-series analysis	3	Supports claims about operational performance, reach, and population patterns where randomisation is impractical [2], [7], [31],
Cross-sectional survey with structural modelling	3	Supports claims about predictors of adoption intention, not about actual use [8], [27], [32]
Qualitative implementation study	3	Supports explanatory claims about why interventions succeed or fail in practice [33], [34], [35]
Pilot feasibility study	1	Establishes technical feasibility and acceptability only; no effectiveness claim drawn [36]
Systematic or narrative review	10	Used for cross-study patterns; not treated as primary evidence for individual effects [3], [9], [10], [11], [12], [13], [14], [24], [28], [37]
Programme description	2	Descriptive context on programme design and scale; not used to support effect claims [6], [38]
Health-system framework analysis	2	Frames the structural constraints within which digital services operate [1], [17]
Document and legal analysis	2	Evidence on the regulatory and data-protection environment [25], [26]
Institutional strategy	2	Normative and policy context only [4], [5]
Total	30	

Two rules follow from this profile and are applied throughout Section 3. Claims about effects are supported only by trials or observational analyses reporting measured outcomes. Claims drawn from prior reviews are attributed to those reviews explicitly rather than presented as independent findings, so that the reader can see where a statement rests on one synthesis rather than on several primary studies. The six supporting works identified in Section 2.3, comprising the acceptance framework [20], the three methodological instruments [18], [19], [21], and the two external comparators [22], [23], are excluded from this table and from the counts that follow.

2.6. Thematic Synthesis

The coding was hybrid rather than purely inductive, and the earlier description of it as inductive was imprecise. Three organising themes, namely benefits and value, factors shaping adoption, and implementation challenges, were set deductively because they correspond directly to the three review questions stated in Section 1.4. Within each theme, subthemes were developed inductively from close reading: the distinction between reach and outcomes in Section 3.3, and the separation of foundational from context-specific barriers in Section 3.6, were not anticipated but emerged from comparing studies. Coding proceeded in two passes: the first assigned each source a primary theme, the second added secondary themes where a source spoke to more than one question. Where evidence

conflicted, the disagreement is reported rather than reconciled.

2.7. Methodological Limitations

Four limitations should temper how the findings are read. First, the review was not registered, screening was not duplicated by a second reviewer, intermediate screening counts were not tracked, and no risk-of-bias instrument was applied. Selection therefore remains interpretive despite the documented specification, and the coverage of the corpus cannot be expressed as a proportion of what a protocol-driven search would have retrieved. Second, the Google Scholar component was capped at ten pages of relevance-ranked results, so material beyond that cap will have been missed. Third, the restriction to English under-represents work in French and Portuguese, reinforcing the anglophone weighting discussed in Section 3.1. Compounding this, the search used only internationally indexed databases and omitted regional platforms such as African Journals Online, which hosts several hundred peer-reviewed journals published on the continent. Work appearing only in African-published journals outside the international indexes is therefore likely absent here, and searching such platforms is a concrete improvement available to future reviews. Fourth, as Aranda-Jan and colleagues caution, the published record on African digital health tends to over-report positive results, partly because donor-funded projects face pressure to demonstrate success [3]. Scepticism is warranted wherever the evidence appears uniformly favourable.

3. Result and Discussion

3.1. Profile of the Reviewed Literature

Table 4 reports how the 30 sources distribute across themes under the two-pass coding described in Section 2.6. Because most sources speak to more than one question, both primary and secondary assignments are shown, and the second column sums to more than 30.

The earlier claim that the field is more energetic in demonstrating what digital health can do than in explaining why it fails to endure cannot be sustained on these figures and is withdrawn. Under primary coding, benefits do predominate; under secondary coding, implementation challenges appear in more sources than any other theme. The correct and more modest statement is that benefits more often supply the organising purpose of a study, while challenges are more often reported as incidental findings within studies designed for another

purpose. Whether that reflects the priorities of the field or the sampling of this review cannot be determined from 30 sources, and no inference about publication practice is drawn from Table 4.

Table 4. Thematic Distribution of the 30 Included Sources Under Two-Pass Coding

Theme	Primary	Any theme	Primary share
Benefits and value	10	18	33%
Implementation challenges	8	21	27%
Factors shaping adoption	5	14	17%
Policy, guidance, and regulation	4	7	13%
Health-system context	2	5	7%
Concept and scope	1	9	3%
Total	30	n/a	100%

The geographical and design profile in Table 5 is more consequential, because it constrains what the review can legitimately conclude.

Table 5. Geographical Distribution of the Country-Specific Evidence

Setting	Sources	Predominant evidence type
Region-wide or multi-country (sub-Saharan Africa)	9	Systematic and narrative reviews; regional survey analysis
South Africa	7	Trials, programme evaluation, qualitative studies
Ethiopia	3	Cross-sectional acceptance surveys, review
Ghana	2	Qualitative implementation studies
Kenya	1	Randomised controlled trial
Nigeria	1	Cross-sectional acceptance survey
Rwanda	1	Observational time-series analysis
Africa-wide, including North Africa	2	Document and legal analysis
Low- and middle-income countries generally	4	Global guidance and cross-country reviews
Total	30	

Fifteen of the 30 sources report on a specific country, and seven of those concern South Africa; Kenya, Nigeria, and Rwanda contribute one apiece. The country-level evidence therefore rests substantially on one national context, and that context is atypical: South Africa has the region's strongest research infrastructure, comparatively developed connectivity, and an established professional guidance framework. Sub-regions including the Sahel, Central Africa, and the lusophone countries are absent altogether.

This concentration is not peculiar to sub-Saharan Africa, and recognising that changes how it should be read. A systematic review of digital health interventions for diabetes across the Eastern Mediterranean Region reported that 47 per cent of its included studies came from Iran and 24 per cent from Saudi Arabia, leaving 29 per cent for the remaining countries of that region, and its authors noted that the two dominant settings have more developed digital infrastructure and health systems than the low-resource and conflict-affected states alongside them [22]. The imbalance documented here is therefore better understood as a structural feature of regional digital health literature than as an artefact of this search strategy. Research output accumulates where research infrastructure and funding are already in place, and where connectivity is reliable. Those are precisely the conditions under which digital health is least

constrained. The resulting bias is systematic rather than random: regional evidence bases over-represent the settings in which digital health is easiest to implement, and under-represent those where the need is greatest.

Three consequences follow, and they qualify everything in the remainder of Section 3. Findings reported here describe the settings studied and should not be read as characterising sub-Saharan Africa uniformly. Where a claim rests on a single country, that country is named rather than generalised. And the apparent consistency of some findings, particularly on barriers, may partly reflect the narrowness of the evidence base rather than genuine convergence across the region, since several of the region-wide reviews draw on overlapping primary studies.

3.2. The Concept and Scope of Digital Health

eHealth is the broadest term, covering any use of information and communication technology for health, including electronic records and routine health information systems. mHealth is a subset centred on mobile devices and the services running on them, while telemedicine and telehealth describe the remote delivery of clinical care. The categories overlap, and the WHO framing treats them as one family of tools serving health-system strengthening [4], [5].

The inclusion of Rwanda's drone delivery programme requires explicit justification, since an autonomous aircraft is not obviously a digital health service. Three grounds support its inclusion. The WHO classification of digital health interventions treats the digital management of health commodities and supply chains as a category of digital health intervention in its own right, alongside client-to-provider telemedicine, rather than as a peripheral application [5]. The intervention evaluated in Rwanda is not the aircraft in isolation but an electronic ordering and fulfilment system of which flight is the delivery mechanism, and the reported gains depend on that information system [7]. And within the framework used here, the programme occupies the same analytical position as a teleconsultation service: both substitute an information and logistics channel for physical travel in order to overcome distance. On that reading the case belongs to the review, and it is treated throughout as evidence about service delivery and supply-chain performance rather than about clinical care.

The substrate on which these services run gives them their particular character. Bervell and Al-Samarraie describe a mobile-centred pattern in which mobile channels carry a disproportionate share of digital health activity relative to conventional eHealth systems [10]. Many programmes were consequently designed for the mobile phone from the outset, relying on SMS, unstructured supplementary service data (USSD), and voice calls that work on basic handsets and under patchy connectivity [13].

3.3. Benefits and Value

Claims of benefit in this literature operate at three distinct levels, and conflating them is the most common weakness in the field. Reach describes how many people a service enrolled. Utilisation describes whether they engaged with it. Outcomes describe whether their health changed. Table 6 classifies the benefit evidence accordingly, and the pattern it reveals is the central finding of this section: the evidence is strong at the level of reach, mixed at utilisation, and thin at outcomes.

Table 6. Level of Evidence for Claimed Benefits Across the Reviewed Programmes

Programme	Country	Level demonstrated	What the evidence does and does not show
MomConnect [6], [38][33]–[31]	South Africa	Reach and utilisation	Demonstrates national-scale enrolment and, in [33], user comprehension and value; [31] shows registration and message exposure diverge. No clinical outcome data reported.
Drone blood delivery [7]	Rwanda	Operational outcome	Demonstrates measured reductions in delivery time and product wastage. Does not report patient survival or morbidity.
USSD adolescent SRH app [29]	Kenya	Outcome (trial)	Randomised design supports causal inference about the information outcome studied; single setting, limited duration.
SMS adherence support [30]	South Africa	Outcome (trial)	Randomised design; effect on adherence-related outcome measured directly.
iThemba Life viral-load app [36]	South Africa	Feasibility	Pilot demonstrating technical feasibility and acceptability only. No effectiveness claim is supported.
CHW support tools [24]	Multi-country	Mixed	Review reporting performance and retention effects that vary with how the tool is embedded in routines.

3.3.1. Reach and Utilisation: The MomConnect Evidence

MomConnect is the clearest case of demonstrated reach in the corpus. It sends pregnant and postpartum women stage-appropriate information by text message and runs a two-way helpdesk. Within three years it had reached more than 1.5 million women, covered some 95 per cent of public health facilities, and enrolled roughly 63 per cent of women attending a first antenatal visit [6]. Reaching that scale required deliberate work on the underlying health information system architecture [38].

These are enrolment figures and should not be read as evidence of health benefit. Two companion studies make the point directly. Qualitative work with pregnant women and new mothers across five provinces found the service was valued and broadly well understood [33]. A parallel performance analysis, however, separated registering women from actually exposing them to messages and showed that the two diverge [31]. Neither

study reports maternal or neonatal clinical outcomes, and no source in this corpus does so for MomConnect. The defensible conclusion is that a text-messaging service can be operated at national scale and is acceptable to its users, which is a substantial achievement in itself, but that its effect on maternal and neonatal health remains unestablished in the literature reviewed here.

3.3.2. Operational Outcomes: Logistics and Efficiency

The Rwandan drone programme provides the corpus's strongest operational evidence. A study in *The Lancet Global Health* examining deliveries to twenty district and provincial hospitals found that median delivery time fell from roughly 139 minutes by road to about 41 minutes by drone, and that blood-product wastage at participating hospitals fell by approximately 67 per cent over twelve months [7]. These are measured operational outcomes rather than proxies, which places this evidence a level above the reach data discussed above.

Two qualifications apply. The design is retrospective and observational, so concurrent changes in the blood supply system cannot be excluded, and the reported outcomes are logistical rather than clinical. Faster delivery and less wastage are plausible precursors of clinical benefit, not demonstrations of it. What the case does establish is that digitising the coordination layer produced measurable system gains where the binding constraint was distance.

3.3.3. Clinical and Behavioural Outcomes: Where the Evidence Is Strongest and Scarcest

Only two studies in the corpus use randomised designs in the region. A single-blind trial in South Africa tested whether SMS messages could support treatment adherence among adults with high blood pressure [30], and a randomised trial in Kibra, Kenya, tested a USSD-based application providing adolescents with on-demand sexual and reproductive health information [29]. Both address the problem of sustaining engagement between visits, and both were built for basic handsets. That is itself a finding: where stigma and distance operate together, a low-technology channel can be more inclusive than a sophisticated one.

Against these sit studies that establish less. The Johannesburg viral-load application demonstrated technical feasibility and acceptability in a pilot and makes no effectiveness claim [36]. The multi-country review of community health worker tools reports improvements in performance, supervision, and retention, but stresses that effects depend on how the intervention is embedded in existing routines [24].

The thinness of outcome evidence is a feature of this literature rather than of the interventions themselves, and a comparison outside the region makes that clear. A systematic review of digital health for diabetes in the Eastern Mediterranean Region assembled 46 studies reporting measured clinical endpoints and found

statistically significant improvements in glycated haemoglobin in 25 of them, drawing on a comparable mix of designs and much the same set of technologies, principally phone calls, text messaging, and mobile applications [22]. The contrast is instructive. What separates the two evidence bases is not the sophistication of the tools. It is how much outcome evaluation has been commissioned and funded, and how much of it has reached publication. The absence of clinical outcome data for sub-Saharan African programmes should therefore be read as a gap in evaluation, not as evidence that the programmes do not work.

Comparing across these cases yields a pattern that no single study shows. The interventions with demonstrated outcomes are those with a narrow, well-defined behavioural target and a short causal chain between the message and the measured result, namely adherence and information-seeking. The interventions with demonstrated reach but unproven outcomes are those attempting broader health promotion across a longer causal chain. This is not a criticism of the latter, since population-scale services are harder to evaluate than trials, but it does explain the shape of the evidence base and indicates where evaluation effort would be most valuable.

3.4. Factors Shaping Adoption

If benefits are real at least at the level of reach, why is uptake so uneven? The Unified Theory of Acceptance and Use of Technology and its extension hold that intention to use a technology is driven by performance expectancy, effort expectancy, social influence, and facilitating conditions [20]. The claim in the earlier version of this article that these constructs travel to African digital health reasonably well was asserted rather than demonstrated, and it is replaced here by a comparison of the three acceptance studies in the corpus, summarised in Table 7.

Table 7. Comparison of Technology Acceptance Findings Across Three Studies in Two Countries

Study and setting	Sample	Significant predictors	Non-significant or added constructs
Adenuga et al. [32], Nigeria, clinicians	Clinicians, cross-sectional	Performance expectancy; effort expectancy; facilitating conditions	Social influence not significant. Reinforcement (incentives) added by the authors and significant.
Hailu et al. [8], Ethiopia, public hospitals	601 professionals, SEM, $R^2 = 0.71$	Performance expectancy ($\beta = 0.184$); effort expectancy ($\beta = 0.183$); facilitating conditions ($\beta = 0.249$); digital literacy ($\beta = 0.403$)	Social influence not significant ($\beta = -0.028$, $p = 0.644$). Digital literacy added and the strongest predictor.
Shiferaw et al. [27], Ethiopia, COVID-19 period	Providers, extended UTAUT	Effort expectancy significant	Performance expectancy, social influence, and facilitating conditions not significant in this online survey.

Three observations follow from this comparison, of which the third is the most useful. First, the core constructs perform reasonably but not uniformly: performance expectancy and effort expectancy predict intention in the Nigerian and Ethiopian hospital studies, but performance expectancy and facilitating conditions were not significant in the Ethiopian study conducted

online during the pandemic [27], whose authors attribute the divergence partly to the survey mode. The framework therefore travels with qualifications, and the appropriate claim is that it accounts for a substantial share of variance where it has been tested rather than that it holds across the region.

Second, and more strikingly, social influence failed to reach significance in all three studies [8], [27], [32]. A pattern that recurs across two countries, two study designs, and both pre-pandemic and pandemic periods is more informative than any single result. The practical implication is that strategies relying on peer champions and professional norms to drive telemedicine uptake have little empirical support in these settings, and that resources may be better directed elsewhere.

Third, both studies that extended the model found the added construct to be substantial. Adenuga and colleagues added reinforcement, meaning rewards and incentives, and found it significant; Nigerian clinicians tended to regard telemedicine as a shared responsibility that would be shouldered only if supported and encouraged [32]. Hailu and colleagues added digital literacy and found it the single strongest predictor, exceeding all four original constructs [8]. Read together these suggest that the standard model is under-specified for this context in a specific way: it assumes a workforce that is already digitally capable and already motivated, and where neither assumption holds, the omitted variables dominate. This is a cross-study inference rather than a finding of either paper, and it should be tested directly rather than accepted on the strength of two studies.

A global survey coordinated by the World Health Organization gives this pattern a quantitative shape from a different angle. Among 441 valid respondents drawn from all six WHO regions, roughly three-quarters reported at least some familiarity with digital and artificial intelligence tools, yet only 24.5 per cent were currently using them in practice and just 6.8 per cent had received formal training [23]. Familiarity, in short, has outrun capability. That survey is global rather than African and its respondents were self-selected, so it is

cited here as context rather than as regional evidence. It nonetheless converges with the Ethiopian finding from the opposite direction: where digital literacy is the single strongest predictor of acceptance in one setting [8] and formal training is almost absent in another [23], the binding constraint on adoption is the capability of the workforce rather than its willingness.

These individual-level findings must be read alongside institutional and system conditions, which no acceptance survey captures. Mobile penetration supplies reach, and donor funding with public and private partnership has repeatedly provided early momentum, yet neither guarantees durable uptake [13]. Mbunge and colleagues argue the field is still struggling to move from pilot to genuine integration [37], and a systematic review of Ethiopian telemedicine reaches the same conclusion from a single-country vantage point, identifying policy, infrastructure, and organisational readiness rather than user attitudes as the binding constraints

[28]. The recurring pattern of successful demonstration followed by quiet discontinuation is better explained organisationally than psychologically.

3.5. Comparative Insights across Three Countries

Table 8 summarises how adoption differs across the three countries with the largest published literature. Its provenance must be stated plainly: the comparison derives substantially from the systematic review by Agbeyangi and Lukose [13], supplemented where indicated by other sources in this corpus. It is a summary of that review's conclusions rather than an independent synthesis of primary evidence, and readers should weigh it accordingly.

Table 8. Comparative profile of telemedicine adoption in three countries, after [13]

Country	Adoption profile and principal constraints	Supporting sources
South Africa	Highest reported adoption of the three, supported by comparatively strong infrastructure and existing professional guidance; deployment spans specialist teleconsultation, chronic disease management, and mental health. Constrained by a persistent urban and rural divide and by affordability.	[13]; programme evidence [6], [30], [36]
Kenya	Strong mHealth integration on a mobile-first ecosystem, with activity in maternal health, HIV care, and sexual and reproductive health. Constrained by the absence of a formal national framework and by device and data costs.	[13]; trial evidence [29]
Nigeria	Advancing innovation in remote diagnosis and teleconsultation on a base of very high mobile penetration. Constrained by infrastructural and regulatory gaps and by uneven digital literacy, particularly in rural areas.	[13]; acceptance evidence [32]

The earlier version of this article observed that the country with the most developed professional guidance also shows the highest uptake and inferred that regulation functions as a precondition for adoption. That inference is not supportable and is withdrawn. Three countries cannot establish a relationship, the comparison rests largely on one review, and the direction of any association is indeterminate: guidance may enable adoption, adoption may generate the demand that

produces guidance, or both may follow from the same underlying investment in health-system capacity. South Africa also differs from the other two in research output and health financing, as well as in connectivity, and any of these could account for the difference. The defensible statement is narrower. Among these three countries, higher reported adoption coincides with more developed professional guidance, and this association is consistent with the proposition that regulatory clarity supports

uptake but does not establish it. Testing that proposition would require longitudinal data tracking adoption before and after specific regulatory changes, which Section 3.8 identifies as a research priority.

A second observation is better supported. The constraints recur across all three countries even though the enablers differ, and they recur in the single-country Ethiopian literature as well [28]. Convergence of constraints across settings with different enabling

conditions is what makes it meaningful to speak of shared barriers, and Section 3.6 takes up that question.

3.6. Implementation Challenges and Their Relative Weight

Table 9 sets out the recurring barriers. It adds a column absent from the earlier version, indicating how consistently each barrier is reported, because listing barriers without weighting them offers little guidance to anyone deciding where to act first.

Table 9. Implementation Barriers, Ordered by Consistency of Reporting Across Sources

Barrier	Typical manifestation	Sources	Consistency
Infrastructure	Unreliable electricity, patchy network coverage, insufficient devices	[11], [12], [14], [28]	Foundational: reported in every review examined
Financing and sustainability	Donor-dependent pilots without recurrent funding after grant end	[3], [11], [17], [23], [37]	Foundational: reported across the full period 2012 to 2025
Digital literacy	Limited confidence among patients and providers; exclusion of low-literacy users	[8], [13], [14], [23]	Provisional: strongest predictor in [8] and top-ranked globally in [23], but variable across African studies
Regulation and licensing	Unresolved licensing, reimbursement, liability, cross-border practice	[11], [13], [28]	Context-specific: varies markedly by country
Data protection	Uneven statutory coverage and enforcement for electronic health records	[13], [25], [26]	Context-specific: see qualification below
Workflow fit	Tools that do not match how frontline staff actually work	[34]	Context-specific: single strong case study
Socio-cultural acceptance	Scepticism toward remote care; gendered norms; reliance on trusted local figures	[13], [35]	Context-specific: demand-side evidence limited

The distinction in the final column carries the argument. Infrastructure and financing are treated here as foundational because they appear in every review examined, across the fulltime span, and in every country represented, and because they condition the others: digital literacy training cannot compensate for absent electricity, and a supportive regulatory framework cannot sustain a service whose funding has ended. Kruse and colleagues found that the most frequently cited obstacles in developing countries cluster around infrastructure, equipment, and the technology gap [14], and the region-specific reviews concur [11], [12], [28]. The remaining barriers are real but conditional. They vary from one country to another, and with both the technology deployed and the group expected to use it, becoming the binding constraint only once the foundational two are addressed. Evidence from the wider implementation literature points the same way. A systematic review of scale-up in low- and middle-income countries found that, among the structural changes scaling demands, the availability of financial, human, and material resources was the factor reported most often [16]. That this holds for public health interventions generally, and not only digital ones, strengthens the case for treating resourcing as foundational rather than as one barrier among several. For programme designers the practical implication is sequencing rather than triage: the context-specific barriers deserve attention, but not before the foundational ones have an answer.

Evidence from outside the region allows this ranking to be tested rather than asserted. In the WHO global survey, the two most frequently reported barriers were lack of training and skills, cited by 74.4 percent of respondents, and limited funding, cited by 71.4 percent, followed at some distance by integration difficulties with existing systems at 43.3 per cent and data privacy concerns at 37.4 per cent [23]. Two implications follow. The first requires qualifying the classification proposed above. Workforce capability ranks at the very top of that list, above funding, which suggests that digital literacy may belong closer to the foundational category than the sub-Saharan African literature alone indicated. It is placed among the context-specific barriers in Table 9 because its reported salience varies markedly between African studies, and that placement should be treated as provisional rather than settled. The second implication is more reassuring for the classification: the same two constraints, capability and money, dominate in a global sample spanning every WHO region, which strengthens the case that they are structural features of digital health implementation rather than peculiarities of the African setting.

The same survey is informative about what helps. Respondents identified staff training (84.1 per cent), leadership support (69.8 per cent), and integration with existing systems (64.9 per cent) as the leading facilitators [23]. These map onto the enabling conditions in Figure 2, a correspondence worth noting because the two sets were derived independently.

Two barriers require more careful statement than the earlier version gave them. On financing, the pattern of pilots that cannot secure recurrent funding was already identified in 2012 in the South African health-system analysis of Leon and colleagues [17] and remains visible in the most recent literature [37]. Persistence of a barrier across thirteen years is itself evidence that it is structural rather than transitional.

On data protection, the earlier assertion that many countries still lack comprehensive and well-enforced law was too broad and is corrected here. Munung and colleagues analysed 37 data protection instruments across the continent and found that more than half of African countries now have data protection legislation in force, that data subject rights including access, rectification, erasure, and portability are widely recognised, and that consent and adequacy assessments are the most common legal grounds for cross-border transfer [25]. Coverage in the countries central to this review is in fact established: Ghana legislated in 2012, Kenya in 2019, South Africa's framework took effect in 2020, and Nigeria enacted a statute in 2023. At continental level the Malabo Convention entered into force in June 2023 after Mauritania became the fifteenth state to ratify, although a majority of member states have still not ratified it [26].

The accurate problem is therefore not absence of law but unevenness and fragmentation. Munung and colleagues report considerable variation between countries in the legal requirements governing cross-border data transfer, which creates practical obstacles for services operating

across national boundaries [25], and ratification of the continental instrument remains partial [26]. Enforcement capacity, as distinct from statutory coverage, was not assessed by any source in this corpus, so no claim about enforcement is made here. This is a narrower and better-supported statement than the one it replaces, and it points to a different remedy: harmonisation rather than enactment.

Finally, the organisational and cultural dimension can quietly decide an intervention's fate. An mHealth tool built to support maternal and neonatal decision-making in Ghana was used far less than its designers expected, not because the technology failed but because it sat awkwardly with frontline workflow and working conditions [34]. On the demand side, qualitative work in rural Ghana shows that social and cultural expectations shape health-seeking in ways additional bandwidth will not alter [35]. This evidence rests on two qualitative studies from one country and is reported as suggestive rather than established.

3.7. Synthesis: Deriving the Framework

The working proposition set out in Section 1.4 was that enabling conditions, adoption, and barriers are three vantage points on the same system properties rather than three separate topics. The evidence assembled above supports it, and Figure 2 represents the resulting framework. Because a framework that cannot be traced back to the evidence is merely a diagram, Table 10 states which findings generated each component.

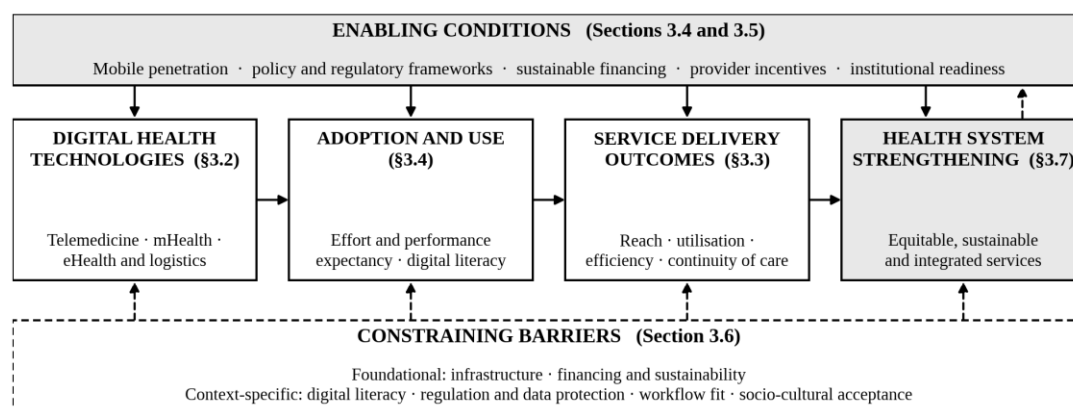


Figure 2. Integrative framework linking enabling conditions, adoption, service delivery outcomes, and constraining barriers. Solid arrows denote the pathway from technology to health-system strengthening; dashed arrows rising from the lower band denote barriers acting at every stage, and the dashed arrow on the right denotes feedback through evaluation and reinvestment.

Table 10. Derivation of Each Framework Component from the Review Findings

Component	Derived from	Evidential basis
Enabling conditions	Institutional and system-level factors that recur as preconditions in Sections 3.4 and 3.5	Mobile penetration and partnership funding as momentum [13]; policy and guidance covarying with adoption [13]; organisational readiness as binding constraint [28], [37]
Adoption and use	Predictors of intention compared across three acceptance studies in Section 3.4, cross-checked against a global practitioner survey	Performance and effort expectancy and facilitating conditions significant [8], [32]; social influence non-significant in all three [8], [27], [32]; digital literacy strongest single predictor [8]; familiarity exceeding capability globally [23]

Component	Derived from	Evidential basis
Service delivery outcomes	The three-level classification of benefit evidence established in Section 3.3	Reach and utilisation [6], [31], [33]; operational outcomes [7]; behavioural outcomes from trials [29], [30].
Health system strengthening	The WHO position that digital tools derive value from system needs, tested against the corpus	[4], [5]; consistent with the health-system framing of scale-up constraints [17]
Constraining barriers acting across all stages	The consistency analysis in Section 3.6, which found the same barriers reported at every stage rather than at one	Infrastructure and financing recurring in every review [3], [11], [12], [14], [17], [28]; training and funding top-ranked in a global survey [23]; workflow fit defeating a technically sound tool [34]
Feedback loop	The observed pattern of pilots that demonstrate and then discontinue, indicating evaluation and reinvestment as a distinct system function	[3], [17], [37]

The framework's central claim is that barriers act across the whole pathway rather than at one point. This is an inference from the pattern in Section 3.6 rather than a finding reported by any single source, and it rests on the observation that the same two barriers, infrastructure and financing, surface in studies of adoption, of service delivery, and of discontinuation alike. Figure 2 is not offered as a rival to established implementation frameworks. Its domains overlap substantially with those of NASSS [15], and that overlap is deliberate, since a regional framework contradicting the general literature would itself require explanation. What Figure 2 adds is a ranking. Because the evidence reviewed here identifies infrastructure and financing as conditioning the remaining barriers, the framework separates foundational from context-specific constraints instead of weighting all domains equally, and that ranking is what applying the perspective to this region produces. The framework remains an organising device consistent with the reviewed evidence rather than a validated model, and testing it would require the longitudinal designs discussed below.

3.8. Implications for Practice

Four implications follow, and each is tied here to the specific findings that support it rather than offered as general advice.

Plan financing and integration before piloting. This follows from the persistence of the financing barrier across thirteen years of literature, from Leon and colleagues in 2012 to Mbunge and colleagues in 2022 [17], [37], and from the pattern of demonstration followed by discontinuation identified in Section 3.4. The corollary is concrete: a pilot without an answer to who funds year five is a pilot designed to end. The WHO global survey frames the same failure in organisational terms, observing that pilots frequently do not transition into routine workflows because implementation planning stops at technical feasibility instead of extending to organisational embedding, procurement, and the accountability that scale-up requires [23].

Invest in digital literacy as an adoption intervention, not only as an equity measure. This follows from Hailu and colleagues, where it was the strongest single predictor of acceptance among 601 health professionals,

exceeding all four original UTAUT constructs [8], and from the exclusion of low-literacy users reported in the barrier literature [13], [14]. The finding concerns providers as much as patients, which is not how digital literacy is usually framed.

Do not rely on peer influence to drive provider uptake. This follows directly from the non-significance of social influence in all three acceptance studies [8], [27], [32], and from the significance of reinforcement in the Nigerian study [32]. Where uptake adds to an already stretched workload, incentives and facilitating conditions have empirical support in these settings and professional persuasion does not.

Design for the lowest available technology and for hybrid delivery. This follows from the deliberate use of SMS and USSD channels in the two trials with demonstrated outcomes [29], [30] and from the reach achieved by a text-based service at national scale [6]. Sophistication did not produce results in this corpus; fit to the available handset and network did. Equity measures such as subsidised access follow from the same evidence, since higher-specification channels systematically favour the connected [13], [14].

3.9. Priority Questions for Further Research

Stating that more longitudinal and cost-effectiveness research is needed is too general to guide anyone. The gaps identified in this review support five specific questions, ordered by how directly the present evidence base motivates them.

First, does a national messaging programme with demonstrated reach change clinical outcomes? Section 3.3.1 established that MomConnect has documented enrolment and user acceptability but no reported maternal or neonatal outcome data across four studies [6], [38] to [31]. A cohort or stepped-wedge design linking enrolment records to routine antenatal and delivery outcomes would resolve the field's most consequential open question, since population-scale messaging is the model most widely emulated in the region. That such evidence is attainable is shown by the Eastern Mediterranean literature, where 46 studies reporting measured clinical endpoints have been assembled for a single condition [22].

Second, does the drone logistics model transfer, and does faster delivery change patient outcomes? The Rwandan evidence is a single-country retrospective analysis reporting logistics rather than clinical endpoints [7]. Prospective evaluation in a second country, with morbidity or mortality among transfusion recipients as the endpoint, would test both transferability and the assumed causal chain.

Third, is digital literacy the dominant adoption predictor beyond Ethiopia? The finding that it exceeded all original UTAUT constructs rests on one study in one country [8]. Replication in Nigeria, Kenya, and South Africa using a common instrument would establish whether the standard model is under-specified for the region generally, as Section 3.4 tentatively infers, or whether the result is local.

Fourth, does regulatory change precede or follow adoption? Section 3.5 withdrew a causal claim precisely because cross-sectional comparison cannot settle the direction. An interrupted time-series design around a datable regulatory event, such as Nigeria's 2023 data protection statute or a national telemedicine guideline, would supply the missing evidence.

Fifth, what is the comparative cost-effectiveness of these delivery models? No source in this corpus reports cost per outcome, so it is impossible to say whether SMS messaging, teleconsultation, or digitally coordinated logistics offers better value for a given budget. This is the gap most directly relevant to ministries allocating scarce resources.

Two priorities cut across all five. Each should be pursued in settings under-represented here, particularly the Sahel, Central Africa, and the lusophone and francophone countries. Each would also benefit from reporting that separates reach, utilisation, and outcomes explicitly, following Table 6.

4. Conclusion

This review asked what digital health delivers in sub-Saharan Africa, what governs its uptake, and what obstructs it at scale. Reading those questions together rather than separately is what produced the findings below.

On benefits, the evidence divides sharply by level. Reach and operational performance are well documented. A text-messaging service has run at national scale and was found acceptable by the women using it [6], [33]. A digitally coordinated logistics system has cut delivery times and product wastage by measurable margins [7]. Clinical outcomes are another matter. Two randomised trials report behavioural effects for narrowly targeted interventions [29], [30], yet no source in this corpus shows that a population-scale digital programme alters clinical outcomes. The first claim is often overstated into the second, and the two need to be kept apart.

A related caution applies to scale itself. The programmes described here succeeded in particular places under particular conditions: a maternal messaging service in the country with the region's strongest health information infrastructure, drone logistics in a small state whose government committed to the model early. Success in a few favourable settings is not evidence that these models transfer. Whether they transfer is an empirical question the reviewed literature does not answer, and Section 3.9 sets out the study designs that would.

On adoption, comparing acceptance studies across Nigeria and Ethiopia yielded more than any of them separately. Performance expectancy, effort expectancy, and facilitating conditions predicted intention with reasonable consistency. Social influence did not, in any of the three [8], [27], [32]. Where authors extended the model, what they added proved substantial: incentives in one study, digital literacy in the other, the latter outweighing every construct in the original framework. Uptake in these settings looks like a problem of workforce capability and institutional backing rather than of professional persuasion.

On barriers, infrastructure and financing behave unlike the rest. Both appear in every review examined and across the whole period studied, and both condition the others. Literacy training cannot substitute for absent electricity, and a supportive regulatory framework cannot fund a service whose grant has ended. Listing all barriers together hides that relation, which is why Table 9 separates the foundational from the context-specific.

These conclusions describe the settings the literature has actually examined. Seven of the fifteen country-specific sources concern South Africa, while the Sahel, Central Africa, and the lusophone states are absent altogether. Nothing here should be read as characterising sub-Saharan Africa uniformly, and the regional label used throughout this article denotes the scope of the question rather than the reach of the answer. That the same concentration appears in an adjacent region [22] suggests the remedy lies in where research is commissioned, not in how this review was assembled.

What the review adds is not a further inventory of what digital health can do. It is an argument about how three bodies of work fit together. Treating enabling conditions, adoption behaviour, and implementation barriers as facets of one socio-organisational problem explains something none of them explains alone: why facilitating conditions surface as a predictor of uptake in the acceptance literature and as an infrastructure barrier in the implementation literature, when both describe the same underlying property of a health system. That socio-organisational reading is itself established in implementation science [15], [16]. What belongs to this review is the ranking it yields: applied to sub-Saharan African evidence, the perspective does not leave all

domains equally weighted but places infrastructure and financing beneath the rest. Figure 2 states that relation, Table 10 traces each component back to the findings that generated it, and Table 6 supplies the distinction between demonstrated reach and demonstrated outcome that the field has tended to leave implicit. Digital health in this region is neither a remedy nor a fashion. It is a set of tools whose value depends on conditions that must be built deliberately, and those conditions are better understood as one connected system than as a checklist of separate requirements.

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