

Accessible Mobile Applications for Inclusive Digital Transformation in Saudi Arabia: A Vision 2030 Framework for People with Disabilities and Diverse User Groups

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Abstract: Inclusive digital transformation depends on whether mobile services remain usable for people whose abilities, devices, languages, literacy, and connectivity differ from the assumptions embedded in mainstream interfaces. This review develops a Saudi Vision 2030 framework for accessible mobile applications by synthesizing research published from 2020 to 2025 on disability, mobile accessibility, assistive technologies, usability, digital inclusion, and public-service adoption. A structured integrative review was used because the evidence spans human-computer interaction, digital health, software quality, and Saudi e-government research rather than a single experimental tradition. Findings show that accessibility is strongest when semantic structure, Arabic and right-to-left behavior, multimodal interaction, responsive performance, and recovery from errors are treated as one service-quality system. Evidence concerning people with visual, hearing, motor, cognitive, and age-related needs further indicates that compliance checks alone cannot establish inclusion; task-based testing with representative users and assistive technologies remains necessary [1-8]. The review proposes a closed-loop architecture in which user evidence, technical telemetry, reusable components, and governance continuously refine service standards. It also presents a staged implementation roadmap linking inclusive design to equitable access, trusted service completion, digital participation, and institutional learning. The central implication is that accessible mobile delivery should be governed as shared digital infrastructure rather than as a late-stage interface correction.

Keywords: Accessible mobile applications; digital inclusion; people with disabilities; assistive technology; usability; Saudi Arabia; Vision 2030; digital government; diverse user groups.

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1. INTRODUCTION

Mobile applications increasingly mediate essential relationships between citizens and institutions. Government transactions, health services, education, employment, finance, transport, and social support can now be initiated through a small-screen interface, which makes the quality of

that interface consequential for participation. Saudi Arabia's digital transformation has accelerated this shift. Yet a service is not genuinely digital merely because it can be opened on a phone. It must be perceivable, understandable, operable, resilient, and recoverable for users who differ in vision, hearing,

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mobility, cognition, age, language, digital confidence, device capability, and network access.

The disability literature demonstrates why this distinction matters. Research on the disability digital divide shows uneven access to devices, internet services, and digital skills even in highly connected societies [13]. Studies of mobile and digital health similarly report that inaccessible navigation, limited compatibility with assistive technologies, inadequate personalization, weak support, and connectivity constraints can convert a nominally available service into a practical barrier [1,11,12,14-19]. Saudi evidence is especially relevant. Alanazi and colleagues found that people with disabilities encountered interface, language, infrastructure, maintenance, and digital-literacy barriers when using AI-enabled health technologies [1]. Al-Sakran and Alsudairi identified accessibility and usability shortcomings in Saudi mobile government services [2], while Almulhem's study of older adults showed that familiarity, perceived ease of use, family support, confidence, and fear of making errors influence mobile-health acceptance [15].

These problems are often addressed separately. Accessibility teams may focus on standards; designers on usability; engineers on performance; and service owners on adoption. Such separation is risky because the user experiences these properties together. A screen-reader user may technically reach a control but abandon the task if focus order is unstable. An older user may understand the content but fail when a time-limited authentication step expires. A low-vision user may enlarge text only to find that critical buttons disappear. A rural user may depend on accessible voice interaction, yet weak connectivity may make feedback unpredictable. Inclusive mobile design therefore requires integration across interface semantics, interaction patterns, performance, content, assistive technologies, and organizational governance.

This review addresses that integration. Its contribution is not another isolated accessibility checklist. Instead, it organizes recent evidence into a framework for Saudi digital services in which diverse user needs shape requirements, requirements are encoded into reusable components and performance rules, services are tested with representative users and assistive technologies, and real-world outcomes feed back into governance. The approach aligns with Vision 2030 by treating digital inclusion as a capability that supports equal access, trusted transactions, service efficiency, and broader participation rather than as a narrow compliance exercise.

2. Aim, Objectives and Review Questions

The aim of this study is to develop an evidence-based framework for designing, governing, and improving accessible mobile applications that support inclusive digital transformation in Saudi Arabia. The review focuses on people with disabilities while deliberately extending the analysis to older adults, users with low digital literacy, multilingual users, and people operating under constrained device or network conditions.

Four objectives guide the analysis. First, the review identifies recurring barriers that prevent diverse users from completing mobile-service journeys. Second, it examines design and engineering practices that translate accessibility requirements into dependable interaction. Third, it evaluates how usability research, assistive-technology testing, performance evidence, and service analytics can be combined without reducing accessibility to a single score. Fourth, it proposes a governance and maturity model through which Saudi institutions can reuse validated patterns across multiple applications.

The review addresses three questions: which accessibility barriers most strongly affect mobile participation; which design, technical, and evaluation practices reduce those barriers; and how can Saudi institutions institutionalize accessible mobile delivery as a scalable Vision 2030 capability?

3. REVIEW METHODOLOGY

A structured integrative review was selected because the research question cuts across several evidence traditions. Mobile accessibility studies use inspections, automated tools, laboratory tasks, field studies, and user interviews; digital-inclusion research examines structural and social barriers; software-quality work addresses non-functional behavior; and Saudi adoption studies analyze institutional and cultural conditions. Pooling these heterogeneous outcomes statistically would obscure rather than clarify their meaning. The methodological objective was therefore transparent selection, critical comparison, thematic synthesis, and framework development.

The evidence window was restricted to 2020-2025. Searches were organized around four concept clusters: mobile applications and digital services; disability, accessibility, assistive technology, or inclusive design; usability, interaction quality, or responsive behavior; and Saudi Arabia, digital government, digital health, or Vision 2030. Sources were eligible when they reported empirical findings, validated evaluation methods, systematic or scoping evidence, or implementation frameworks that could inform mobile-service design. Studies centered on desktop-only interfaces or purely clinical outcomes

without a digital-interaction component were excluded. Saudi studies were prioritized for contextual claims, whereas international evidence was retained when the mechanism was directly transferable to mobile accessibility.

The final synthesis uses thirty references with publication dates between 2020 and 2025 and resolvable DOI records. Each source was coded against six domains: user group, barrier, interaction mechanism, evaluation method, implementation context, and governance implication. A second coding pass identified cross-cutting patterns such as semantic labeling, focus behavior, multimodal communication, text scaling, cognitive load, connectivity, user training, family support, component reuse, and institutional ownership. Evidence was not treated as equivalent merely because it used the word accessibility. Studies involving people with disabilities or representative user testing were weighted more heavily for lived-experience claims than automated inspections alone [4-8,11-19].

The synthesis process produced two analytical artifacts. Table 1 maps user groups and recurring barriers to design responses, validation methods, and Saudi implementation considerations. Table 2 translates the evidence into a maturity roadmap with measurable gates. Figure 1 presents a closed-loop architecture connecting user diversity, inclusive requirements, accessible engineering, validation, service delivery, and observed outcomes. Figure 2 presents the staged institutional pathway. This review does not claim a formal pooled effect size and does not invent primary data. Its framework is a conceptual integration of published evidence intended for subsequent empirical validation in Saudi mobile-service portfolios.

Quality appraisal was deliberately pragmatic. Studies were not ranked by journal label alone; the review considered whether authors described participants or artifacts clearly, whether the evaluation method could support the reported claim, whether limitations were acknowledged, and whether the interaction mechanism was relevant to mobile use. Evidence from inspection studies was used to identify recurring technical defects, whereas evidence from interviews and task studies was used to interpret burden, confidence, autonomy, and support needs. Conflicting findings were retained when they exposed contextual variation. This approach reduces the risk of turning heterogeneous accessibility research into a false hierarchy and makes the reasoning behind the framework traceable.

4. Accessibility and Inclusive Digital Transformation in Saudi Arabia

Digital inclusion is broader than connectivity. People may own smartphones and still face exclusion when interfaces assume precise vision, rapid motor responses, fluent reading, high confidence, or stable broadband. Johansson and colleagues describe a persistent disability digital divide involving device access, internet use, and digital skills [13]. Kaihlanen *et al.*, similarly show that vulnerable users encounter intertwined barriers related to skills, trust, support, service design, and the organization of digital care [17]. Choukou *et al.*, demonstrate that digital-health literacy becomes especially fragile when users must interpret large volumes of information under stressful conditions [19]. These findings suggest that inclusive transformation requires both accessible interfaces and enabling support environments.

Saudi evidence adds cultural, linguistic, and geographic detail. The attached 2025 study reports accessibility and usability barriers among people with disabilities, including incompatible interfaces, weak Arabic-language adaptation, connectivity limitations, and uneven technical support [1]. Al-Sakran and Alsudairi's assessment of Saudi mobile government services documents persistent accessibility and usability concerns [2]. Alayed's work on Saudi banking applications shows that accessibility for blind and partially sighted users cannot be assumed even in mature digital sectors [7]. Almulhem's research with older adults further indicates that anxiety, low familiarity, health limitations, and fear of error shape mobile adoption [15].

These findings make accessibility a service-delivery issue rather than a specialist feature. Under Vision 2030, a high-volume application may serve millions of users. A recurrent defect in authentication, date entry, payment confirmation, or document upload can therefore produce exclusion at scale. Conversely, a validated accessible component can create benefits across agencies if it is reused. The strategic question is not simply whether individual applications pass an audit, but whether institutions possess a repeatable capability for converting diverse user needs into requirements, tested components, measurable journeys, and corrective action.

Inclusion also has an administrative dimension. Users who cannot complete a mobile journey independently may be forced to travel, telephone a service center, disclose personal information to another person, or abandon an entitlement altogether. The burden is therefore transferred from the interface into time, transport, privacy, and family support. For people with

disabilities, such substitution can reinforce dependency even when the digital service was intended to increase autonomy. A Vision 2030 accessibility framework should consequently measure channel substitution, assistance required, and unsuccessful completion alongside technical defect counts. These indicators reveal whether digitalization is actually reducing friction for diverse users or merely moving it elsewhere.

5. Diverse User Groups and Barrier Patterns

People with disabilities are not a homogeneous population, and inclusive design becomes weaker when categories are treated as interchangeable. Visual impairment may require screen-reader compatibility, meaningful labels, predictable focus, nonvisual status feedback, scalable text, and sufficient contrast. Research on visually impaired mobile users identifies persistent difficulties with unlabeled controls, navigation, small targets, hidden state changes, and interaction patterns that depend on visual interpretation [4]. Work on accessible gesture typing also demonstrates that interaction techniques can be redesigned around low-vision behavior instead of forcing users to adapt to a standard keyboard model [6].

Hearing and speech differences create another set of requirements. Audio-only instructions, voice authentication without alternatives, and media without synchronized text can exclude users. The attached Saudi study reports voice-recognition difficulties and emphasizes multimodal communication and cultural-linguistic adaptation [1]. Inclusive applications should therefore provide equivalent information through text, visuals, haptics, and audio where appropriate, without making one mode a prerequisite for task completion. Speech interfaces require particular caution in Arabic because dialect, speech impairment, background noise, and code-switching can reduce recognition accuracy.

Motor impairments affect targeting, gesture complexity, timing, and device handling. Small touch targets, closely spaced controls, drag-only interactions, rapid timeouts, and precision gestures can convert a simple task into a physical challenge. Accessible flows should allow generous target sizes,

alternative activation methods, sufficient time, clear focus states, and recovery from accidental input. Compatibility with switch controls, voice control, and external assistive technologies should be verified on real devices, not inferred from static screens.

Cognitive, learning, and neurodivergent users may experience barriers from dense content, inconsistent navigation, unexplained abbreviations, multi-step memory demands, ambiguous errors, and sudden context changes. The inclusive eHealth review by van Calis *et al.*, argues for involving people with intellectual disabilities in design and implementation rather than treating them only as recipients [16]. This supports plain language, progressive disclosure, visible progress, consistent terminology, confirmation before high-consequence actions, and alternatives to complex verification steps where risk permits. Error prevention matters as much as error messaging because repeated failure can damage confidence and discourage future use.

Older adults often experience combinations of these constraints. Almulhem found that Saudi older users' acceptance of mobile health was shaped by usefulness, ease, familiarity, trust, family support, and digital literacy, with concerns about mistakes and technology replacing human care [15]. This implies that accessibility should not be separated from assisted use. Applications may need secure delegation, explainable status, printable or shareable confirmations, and help pathways that allow family or support personnel to assist without taking over a user's identity.

Diverse user groups also include people who are temporarily impaired, operating in bright sunlight, using one hand, coping with fatigue, or relying on older devices and unstable networks. Accessibility measures often improve these contexts as well. Clear hierarchy, large targets, concise content, persistent state, and multimodal feedback are not niche accommodations; they reduce interaction risk generally. The most defensible design strategy is therefore capability-based. Teams should ask what users need to perceive, understand, operate, and recover from, then validate those capabilities with representative users rather than designing solely around diagnostic labels.

Table 1: User groups, barriers, design responses, and validation requirements for accessible mobile services

User group / context	Recurring barrier	Design / engineering response	Validation evidence	Saudi implementation relevance
Blind or low-vision users	Unlabeled controls, unstable focus, visual-only status, poor text scaling	Semantic names and roles; predictable focus; scalable text; nonvisual state feedback	Screen-reader task testing; enlarged-text testing; critical-journey completion	Arabic/RTL semantics and bilingual reading order must be tested on real devices

User group / context	Recurring barrier	Design / engineering response	Validation evidence	Saudi implementation relevance
Hearing or speech differences	Audio-only instructions; voice-only interaction; weak recognition of atypical speech	Equivalent text/visual/haptic cues; alternative input; captioning; multimodal communication	Task completion without audio; speech-error analysis; alternative-mode success	Arabic dialects, speech variation and code-switching require localized validation
Motor impairments	Small targets, precision gestures, short timeouts, drag-only actions	Larger targets; simple gestures; sufficient time; switch/voice alternatives; recoverable input	Switch/voice access testing; target accuracy; timeout and recovery tests	High-consequence government journeys should not depend on precise motor control
Cognitive / learning needs	Dense language, hidden prerequisites, memory load, ambiguous errors	Plain language; progressive disclosure; visible progress; consistent terms; error prevention	Observed tasks; comprehension checks; assistance required; error recovery	Public-service terminology and Arabic content need readability governance
Older / low-literacy users	Low familiarity, fear of mistakes, weak confidence, complex authentication	Guided flows; explicit status; secure assistance; simple navigation; durable confirmations	Segmented usability results; confidence; help requests; assisted vs independent completion	Family support can enable use, but systems should avoid creating unnecessary dependency
Constrained devices / networks	Slow response, refresh, interrupted uploads, layout breakage	Performance budgets; persistent state; resumable actions; responsive layouts; offline-safe feedback	Network simulation; lower-end devices; crash/latency telemetry; layout-regression tests	Regional connectivity differences make resilience part of digital inclusion

6. Accessible Mobile Interaction and Technical Architecture

Accessible interaction begins with semantic structure. Controls need programmatic names, roles, states, and relationships that assistive technologies can interpret. Reading order and focus order should follow the task, not the visual placement of elements. Dynamic content must announce meaningful changes without overwhelming the user. Form fields should expose labels, required status, input purpose, and errors in a way that remains understandable through screen readers. These principles are reflected in mobile accessibility evaluation frameworks and user-centered studies [3-5].

Arabic and right-to-left behavior require architectural treatment rather than cosmetic translation. Layout mirroring, reading sequence, mixed Arabic-English strings, dates, numbers, icons, and bidirectional text should be defined in reusable patterns. A component that works in English but becomes ambiguous when direction changes is not a completed component. Saudi applications should test both language modes with assistive technologies, large text, and common device configurations. Localization also includes culturally meaningful wording and help content, not merely translated labels.

Assistive-technology compatibility should be designed into the component layer. Screen readers, switch control, voice access, magnification, dynamic text, and alternative input methods interact with native mobile semantics differently. Pereira *et al.*, note that accessibility evaluation approaches frequently underuse direct user testing [5]. Al-Razgan *et al.*, likewise show that usability problems experienced by visually impaired users cannot be captured fully by generic interface assumptions [4]. The component definition should therefore include semantic behavior, focus behavior, text-scaling rules, supported interaction modes, and known failure conditions.

Technical resilience also shapes accessibility. Non-functional testing research shows that device fragmentation, resource constraints, compatibility, and performance need systematic validation [22]. Layout-regression research demonstrates that responsive interfaces can fail at particular viewport states even when they appear correct elsewhere [23]. For accessibility, these defects are especially consequential: enlarged text can hide controls, slow loading can break focus, repeated refreshes can disorient screen-reader users, and network uncertainty can prompt duplicate submissions. Performance budgets for critical journeys should

therefore be tested alongside accessibility rather than managed by a separate team.

The architecture proposed in Figure 1 places these mechanisms inside a closed loop. User diversity and service context generate inclusive requirements. Requirements are implemented through accessible components, bilingual content patterns, resilient interaction states, and assistive-technology

compatibility. Validation combines automated inspection, expert review, representative-user tasks, device and network testing, and production telemetry. Service outcomes then update the shared component library and governance rules. This prevents a defect found in one high-volume application from being rediscovered independently in several others.

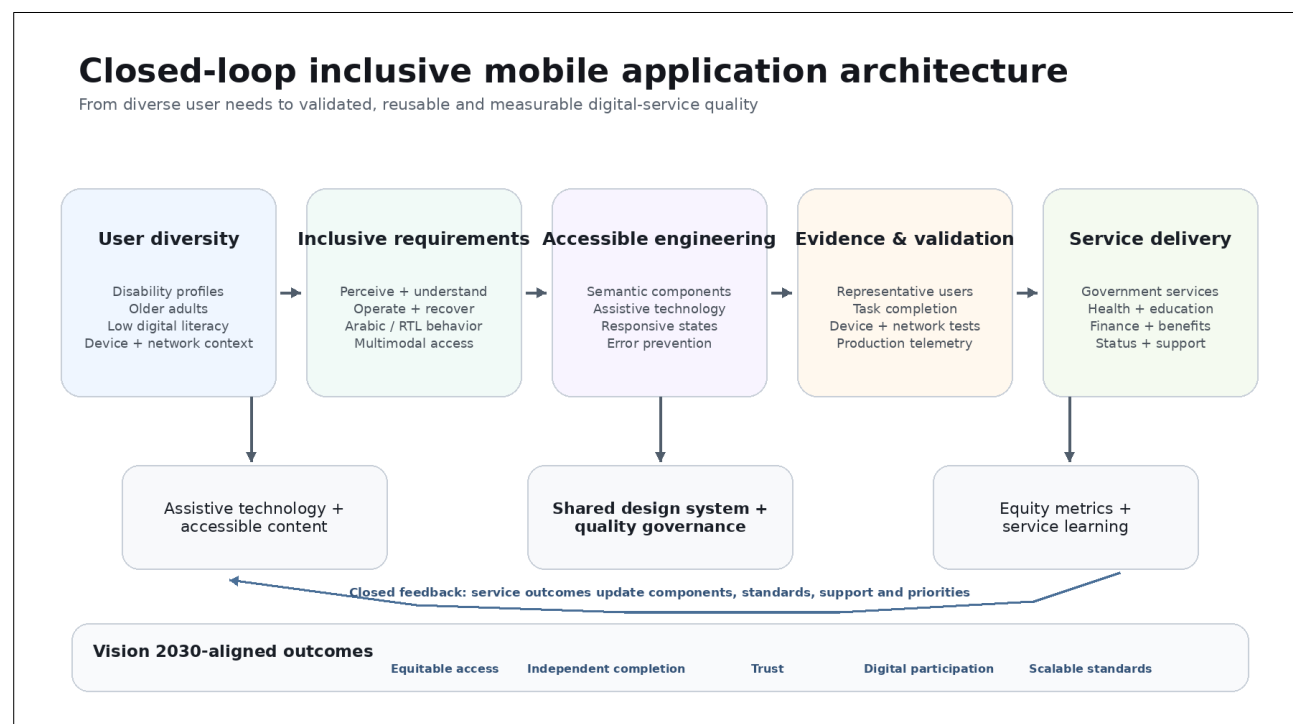


Figure 1: Closed-loop inclusive mobile application architecture for Saudi digital services

7. Evaluation: From Compliance to Evidence of Successful Use

A technically compliant interface can still fail its users. Accessibility evaluation therefore needs layered evidence. Automated checks are efficient for missing labels, contrast errors, and some semantic defects, but they cannot determine whether a person understands a journey, whether focus movement is logical, or whether an error can be recovered from. Paiva *et al.*, support combining usability and accessibility criteria [3], while Pereira *et al.*, emphasize the limitations of evaluation practices that exclude people with disabilities [5].

Task-based evaluation should define success before testing begins. For a benefits application, success may mean finding eligibility information, authenticating, completing a form, uploading evidence, and understanding the final status. For a banking service, it may involve locating an account function, entering an amount, confirming payee information, and recognizing completion. Measurements should include completion, critical errors, retries, assistance required, time,

abandonment, and perceived confidence. Representative users should include the assistive technologies and interaction methods they normally use.

Usability instruments can complement these measures but should not replace them. Research on mobile usability shows that effectiveness, efficiency, satisfaction, learnability, errors, and context contribute to the overall experience [9,10]. Short instruments such as UMUX-LITE and established usability scales can support trend comparisons when administered consistently [24-26]. However, subgroup results matter. A favorable average may conceal severe difficulty among screen-reader users, older adults, or users on lower-specification devices.

Production evidence closes the loop. Analytics should measure accessible journey completion, error recurrence, help requests, latency, crashes, interrupted sessions, and repeated attempts. Support logs and app-store reviews can help identify recurring issues, but they require interpretation rather than simple sentiment counting. The purpose

is to connect observed behavior to root causes and then update components, content rules, or service processes. Evaluation becomes most useful when it changes the system rather than merely producing a report.

Acceptance criteria should be attached to journeys and components before development is complete. For example, an authentication component may require logical focus order, readable error announcements, sufficient time, successful text enlargement, alternative input support, and a defined response under network delay. A document uploader may require clear file constraints, progress feedback, recoverable interruption, and equivalent status information for screen-reader users. Such criteria make accessibility testable within normal release engineering. They also improve accountability because a failed requirement has an owner and a remediation path. Repeated manual discovery becomes less necessary when important checks are automated and the remaining human evaluation is focused on interaction quality that automation cannot judge.

8. Governance, Reusable Patterns and Institutional Scale

Accessibility at national scale depends on governance because isolated project teams cannot repeatedly solve the same problems efficiently. Design-system research shows that reusable components require ownership, documentation, contribution rules, and coordination across teams [21]. A design system for public mobile services should therefore be treated as a quality-control mechanism, not only as a visual library.

Core components should carry explicit accessibility contracts. Buttons, fields, navigation structures, dialogs, alerts, date pickers, document uploaders, identity steps, and status messages should specify semantics, target size, focus behavior, text scaling, right-to-left behavior, loading states, error states, and supported assistive technologies. Components should not enter the shared library merely because they look consistent. They should pass accessibility, usability, localization, and performance gates.

A federated governance model is preferable to either total centralization or uncontrolled local variation. A central team can own foundational tokens, accessibility policy, core components, testing utilities, and documentation. Product teams can contribute domain-specific patterns when they provide evidence from real services. High-severity defects found in one application should trigger review of the corresponding shared component or rule. Versioning and deprecation are equally

important because old inaccessible components can remain embedded long after a correction exists.

Saudi adoption research suggests that institutional factors influence whether digital services succeed. Hasan *et al.*, highlight barriers and drivers affecting e-government adoption [27]; Nusir examines acceptance mechanisms in mobile government [28]; Alshahrani identifies leadership, readiness, skills, interoperability, and strategic alignment as relevant to emerging technologies in government [29]; and Al-Rahmi *et al.*, connect information-system quality with e-government success [30]. These studies support a governance model in which accessibility is linked to service ownership, procurement, training, analytics, and leadership reporting rather than delegated to a final quality-assurance checkpoint.

Useful portfolio metrics include the proportion of critical journeys tested with people with disabilities, severe accessibility defects per release, recurring component defects, accessible completion rate, unresolved assistive-technology incompatibilities, shared-component adoption, performance-budget compliance, and time to remediate high-severity barriers. Metrics should be interpreted as signals for improvement, not as targets that encourage superficial passing behavior.

Procurement and workforce capability are part of this governance. Contracts for mobile development should specify accessibility evidence, supported assistive technologies, language behavior, test-device coverage, performance budgets, defect-severity rules, and responsibility for remediation after release. Internal staff need enough accessibility literacy to evaluate supplier claims and recognize when an apparently minor interface change creates exclusion. Training should therefore include designers, developers, testers, content specialists, product owners, procurement teams, and service managers. A shared vocabulary across these roles reduces the common situation in which accessibility is treated as somebody else's task and discovered only when a specialist performs a late audit.

9. Integrated Vision 2030 Framework and Implementation Roadmap

The proposed framework has five connected stages. Stage one establishes evidence: institutions map high-volume journeys, diverse user groups, current barriers, assistive-technology dependencies, and technical constraints. Stage two creates accessible foundations through semantic components, Arabic and right-to-left rules, text scaling, multimodal feedback, error recovery, and documented performance expectations. Stage three integrates representative-user validation, device and

network testing, usability measures, and production telemetry. Stage four scales validated patterns through a governed design system and procurement requirements. Stage five uses service outcomes to revise standards and prioritize investment.

Table 2 converts these stages into a maturity model. The transition between stages should be evidence-based rather than calendar-based. An institution should not declare maturity because it published an accessibility policy; it should demonstrate that critical journeys work for representative users and that defects are corrected at reusable levels. Similarly, a shared component library does not constitute a design system if product teams can bypass it without review or if accessibility behavior is undocumented.

The Vision 2030 value of this model lies in participation and operational quality. Accessible mobile services can reduce the need for in-person assistance, expand reach for people with disabilities and older users, improve completion, lower support demand, and strengthen trust. They also create reusable national knowledge. When an Arabic date picker, identity flow, consent pattern, or payment confirmation is validated thoroughly, that evidence can benefit many services rather than one project. Figure 2 therefore frames maturity as a progression from fragmented remediation to adaptive inclusion, where service data and user research continuously shape shared digital infrastructure.

Implementation should begin with a limited portfolio of high-consequence journeys rather than attempting simultaneous transformation of every

application. Identity, appointments, benefits, payments, document submission, and status tracking are useful candidates because failures create significant user burden. Early pilots should include people with different disabilities, older adults, users with lower digital confidence, and participants using varied devices and networks. Lessons should be incorporated into common patterns before broader rollout. This sequence makes accessibility visible as an operational improvement program, not a symbolic compliance initiative.

A balanced measurement set is essential during rollout. Outcome indicators should include completion by assistive-technology users, abandonment, error recovery, support contacts, user confidence, and successful task completion on constrained devices. Process indicators should include coverage of accessibility tests, age of unresolved severe defects, percentage of shared components with documented semantics, and the proportion of releases reviewed with representative users. Equity indicators should compare outcomes across relevant user groups while respecting privacy. No single metric should determine success. A high conformance score with poor completion is a warning, just as high adoption with heavy dependence on family assistance may indicate hidden exclusion. Mature governance interprets these signals together.

These measures make accessibility visible to executives, helping investment decisions reflect user outcomes rather than release volume or feature counts.

Table 2: Maturity roadmap for accessible mobile delivery under Vision 2030

Maturity stage	Priority actions	Evidence gate	Core indicators	Vision 2030 contribution
1. Baseline evidence	Map journeys, user groups, barriers, components and current service outcomes	Critical journeys and exclusion risks documented	Completion, severe defects, support demand, channel substitution	Creates a measurable inclusion baseline
2. Accessible foundation	Build semantic components, Arabic/RTL rules, text scaling, multimodal feedback and recovery	Core components pass assistive-technology and localization checks	AT pass rate, text-scaling pass rate, severe defect age	Improves equitable access and independent use
3. Integrated validation	Add representative-user tasks, device/network testing, usability measures and performance budgets	Critical journeys succeed under defined access and technical conditions	Task success, critical errors, tail latency, assistance required	Raises reliability and citizen confidence
4. Scaled governance	Deploy shared design system, procurement gates, contribution rules and portfolio reporting	New services use approved patterns or justify evidence-based exceptions	Component adoption, recurrence, remediation time, test coverage	Scales quality across institutions and suppliers

Maturity stage	Priority actions	Evidence gate	Core indicators	Vision 2030 contribution
5. Adaptive inclusion	Use telemetry, user research and equity comparisons to refine standards continuously	Service outcomes demonstrably feed back into shared rules and investment	Equity gaps, trust, support demand, recurring barriers, completion trends	Supports durable digital participation and institutional learning

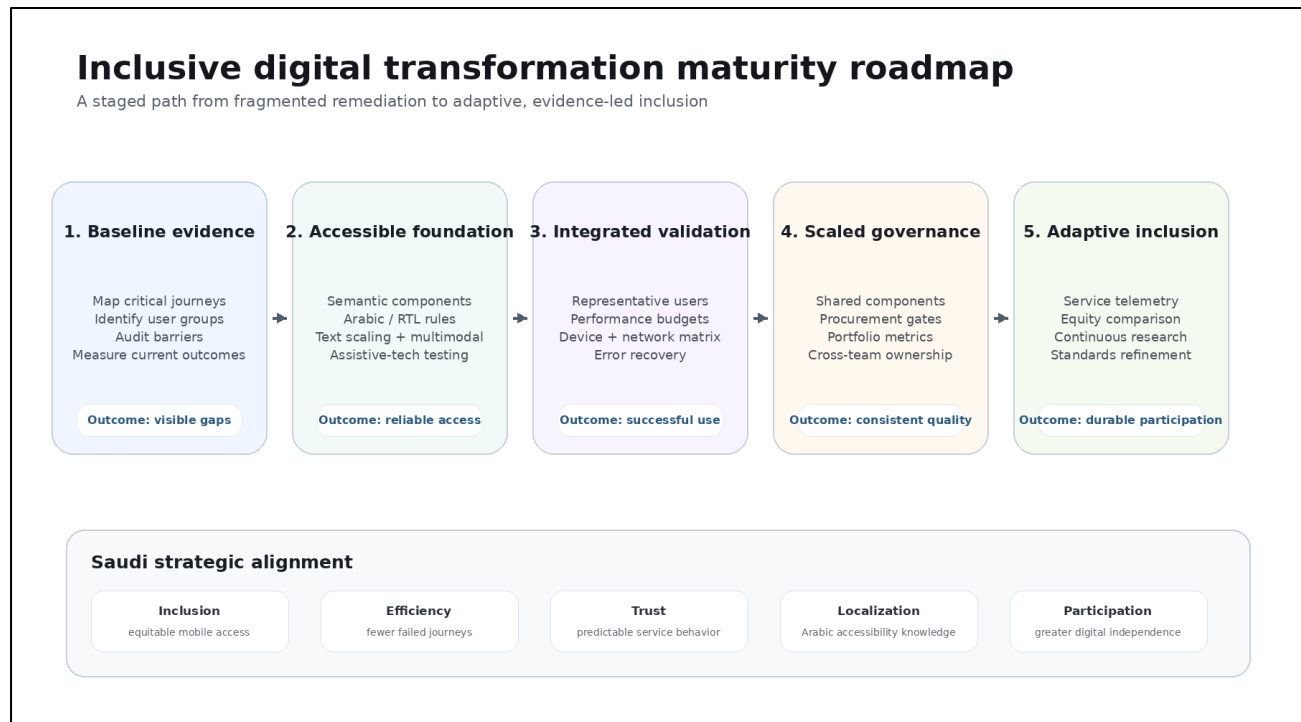


Figure 2: Inclusive digital transformation maturity roadmap for Saudi mobile-service portfolios

10. DISCUSSION AND RESEARCH GAPS

The reviewed evidence supports a shift from accessibility as interface inspection to accessibility as service engineering. Three gaps remain important. First, Saudi research contains valuable studies of disability, mobile government, banking, health applications, and adoption, but few longitudinal studies connect interface changes to completion, trust, support demand, and equity outcomes across multiple agencies [1,2,7,15,20,27-30]. Second, direct participation by people with cognitive, speech, and multiple disabilities remains less common than broad usability surveys. Third, the relationship between accessibility and performance under lower-end devices or unstable networks is insufficiently measured.

Future research should therefore compare service outcomes before and after adoption of shared accessible components; test Arabic and right-to-left behavior with assistive technologies; examine secure delegation and assisted use; and evaluate whether centralized accessibility governance reduces recurrent defects. Studies should report subgroup outcomes rather than relying on aggregate satisfaction. Economic analysis is also needed to compare the cost of early accessible design with

repeated remediation, contact-center demand, failed transactions, and exclusion from digital channels.

A further research priority concerns the boundaries between personalization and consistency. Diverse users benefit from adjustable text, contrast, input, notification, and assistance preferences, yet excessive customization can increase complexity and make support harder. Saudi services need evidence on which preferences should be global across government applications and which should remain service-specific. Secure persistence of accessibility preferences could reduce repeated configuration, but it raises questions about privacy, consent, identity, and interoperability. Research is also needed on multilingual conversational interfaces, voice recognition for atypical speech, haptic feedback, and accessible biometric authentication. These technologies may remove barriers for some users while creating new dependencies for others, making comparative evaluation essential.

11. LIMITATIONS

This review synthesizes heterogeneous evidence and does not estimate pooled effects. International studies may not transfer completely to

Saudi administrative, linguistic, and cultural settings, and the 2020-2025 window excludes older foundational work. DOI-resolvable literature also underrepresents some practitioner guidance and lived-experience sources. The framework should therefore be treated as a testable synthesis rather than a validated national standard. Its value depends on future evaluation across real Saudi applications, user groups, devices, and service domains.

12. CONCLUSION

Accessible mobile applications are a prerequisite for inclusive digital transformation because service availability has little value when users cannot perceive, understand, operate, or recover from the interaction. Evidence from 2020-2025 shows that disability, age, digital literacy, language, device constraints, and connectivity interact rather than occur as isolated variables. Saudi studies add a clear requirement for Arabic and cultural adaptation, assistive-technology compatibility, user support, and attention to regional infrastructure differences.

The proposed Vision 2030 framework connects diverse user evidence to accessible requirements, reusable components, responsive behavior, representative-user testing, production analytics, and cross-service governance. Its central principle is continuous institutional learning: barriers found in one journey should improve the shared system that shapes many journeys. By moving accessibility upstream into architecture and downstream into service measurement, Saudi institutions can reduce repeated defects, improve trusted completion, and extend digital participation to people who are most easily excluded by standardized assumptions. Inclusive mobile quality should therefore be managed as durable digital infrastructure and as a measurable public-service outcome.

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