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UNIVERSITA' DEGLI STUDI DI PADOVA

Designing an accessibility learning toolkit - Bridging the gap between guidelines and implementation

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DIPARTIMENTO MATEMATICA

First and not least: Mobile accessibility

Definition: Ability for users to fully perceive, understand, navigate, and interact with digital content regardless of capabilities

The mobile reality:

- 1.3 billion people worldwide live with disabilities (WHO, 2023)
- **Mobile-first** era: 6.8 billion smartphone users globally
- Mobile interfaces create new **accessibility barriers** for assistive technology users

First and not least: Mobile challenges

Touch interaction barriers:
- **Target size** not standardized and difficult to use
- **Complex gestures** might exclude different categories of users
- **One-handed operation** limitations

Mobile context issues:
- **Small screens** affect content hierarchy
- **Orientation changes** disrupt navigation
- **Performance impact** on battery and processing

Accessibility guidelines gap

Current standards:

- **WCAG 2.2 (2023):** 4 principles, 3 levels of conformance - **web-focused**
- **MCAG (2015):** Mobile adaptation - **based on WCAG 2.0**
- **WCAG2Mobile (2025):** Recent mobile guidance - **interpretations only**

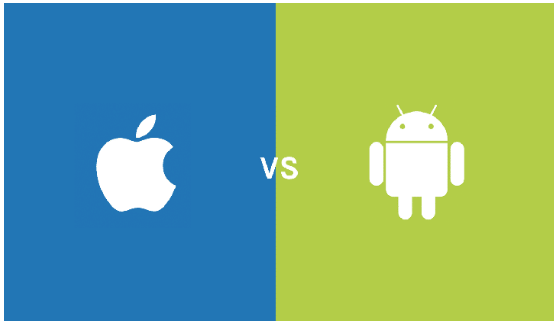
The problem:

- **Outdated foundation:** MCAG missing WCAG 2.1/2.2 mobile criteria
- **Implementation void:** No practical framework for mobile developers
- **Knowledge fragmentation:** Scattered resources, unclear costs

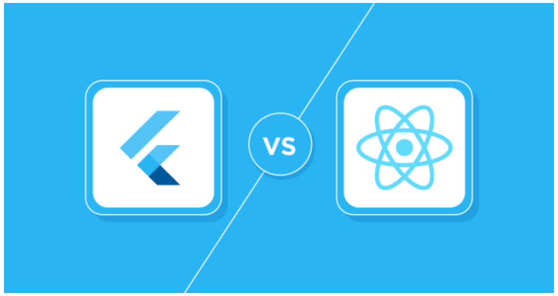
Result: Mobile developers lack comprehensive accessibility implementation guidance

Platform implementation gap

Platform differences:
- **iOS:** VoiceOver, Voice Control, Switch Control
- **Android:** TalkBack, Switch Access



Framework responses:
- **Flutter:** Single accessibility tree, platform adaptation layer
- **React Native:** Platform-specific accessibility props, native bridge



The developer challenge:
- **Budai (2024):** Tested component accessibility → fragmented knowledge
- **Gap identified:** No comprehensive learning resource bridging platforms

AccessibleHub – Bridging the gap

Research Questions as standard approach:

- **RQ1:** Are React Native components accessible by default?
- **RQ2:** Can non-accessible components be made accessible?
- **RQ3:** What's the implementation cost (code overhead)?

AccessibleHub: React Native application **tested on both Android and iOS** serving as **interactive accessibility manual** for mobile developers

- **Every screen analyzed** for accessibility patterns and costs
- **Educational platform** bridging theory to practice

A comprehensive toolkit for implementing accessibility in React Native

React Native v0.73 | WCAG 2.2 | Expo SDK

AccessibleHub – Overview

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Core sections:

🔧 **Accessible Components**: UI implementations with copyable code
📚 **Best Practices**: Educational content on accessibility challenges
🛠️ **Tools - Settings**: Resource catalog for testing and common settings
📊 **Framework Comparison**: Evidence-based evaluation methodology
👥 **Instruction & Community**: Social learning & collaborative resources

Research innovation: Every screen analyzed as case study
- **Dual methodology**: Both research vehicle & educational tool
- **20+ components tested** with TalkBack and VoiceOver
- **Cross-platform validation** ensuring patterns work universally

Systematic analysis approach

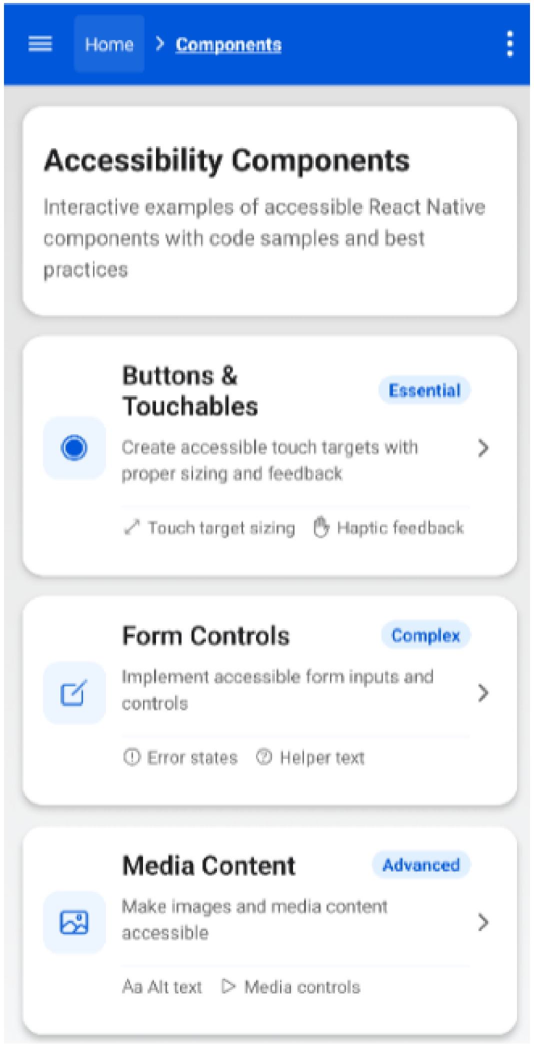
The transformation challenge: WCAG guidelines are abstract and difficult to implement directly in mobile code

Layer	Input	Output	Example
Theoretical Foundation	WCAG abstract principles	Success criteria	"Content must be perceivable"
Implementation Patterns	Success criteria	React Native code	`accessibilityLabel="Save document"`
Screen-Based Analysis	Code patterns	Quantified metrics	13.3% overhead for buttons

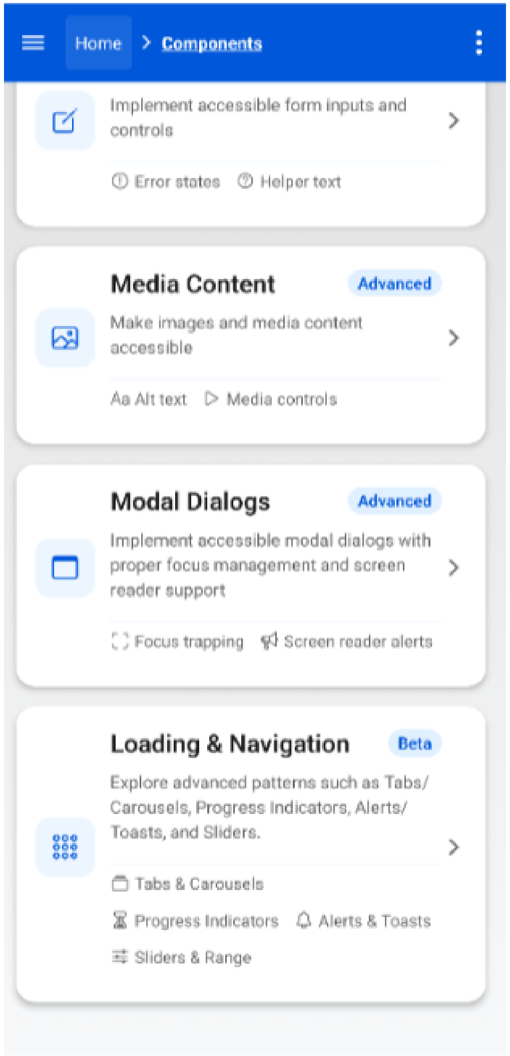
Basic workflow - Enabling data-driven accessibility decisions

Abstract WCAG → Implementation Patterns → Quantified Metrics → Educational Platform

Systematic analysis – Example (1)



(a) Components screen - Top section



(b) Components screen - Bottom section

Systematic analysis – Example (2)

Table 3.5: Components screen component-criteria mapping with WCAG2Mobile considerations

Component	Semantic Role	WCAG 2.2 Criteria	WCAG2Mobile Considerations	Implementation Properties
ScrollView Container (main screen container)	scrollview	2.1.1 Keyboard (A) 2.4.3 Focus Order (A)	Screen-based navigation patterns; Touch-based scrolling alternatives	`accessibilityRole="scrollview"`, `accessibilityLabel="Accessibility Components Screen"`

Table 3.6: Components screen screen reader testing with WCAG2Mobile focus

Test Case	VoiceOver (iOS)	TalkBack (Android)	WCAG2Mobile Considerations
Screen Title	✓ Announces "Accessibility Components, heading"	✓ Announces "Accessibility Components, heading"	SC 1.3.1 and 2.4.6 interpreted for screens instead of web pages

Table 3.7: Components screen accessibility implementation overhead

Accessibility Feature	Lines of Code	Percentage of Total Code	Complexity Impact
Semantic Roles	15 LOC	2.6%	Low
Descriptive Labels	28 LOC	4.9%	Medium

Accessibility implementation costs

Key finding: Accessibility implementation requires 12-23% additional code across component types

Component Type	Complexity Level	Code Overhead	Primary Contributors
Media	Low	12.7%	Alt text, captions
Buttons	Low	13.3%	Semantic roles, labels
Dialogs	Medium	16.2%	Focus management
Forms	Medium	21.5%	State management, error handling
Advanced	High	22.7%	Custom controls, gestures

Critical insights:

- **Even complex components stay under 25%**
- **Correlation** between interaction complexity and implementation cost
- **Manageable overhead** for significant usability improvements
- **First quantitative framework** for mobile accessibility cost assessment

Formal evaluation metrics

Innovation: Evidence-based methodology for quantifying mobile accessibility implementation across frameworks

Implementation Overhead (IMO)
Direct code cost measurement for equivalent functionality

Screen Reader Support Score (SRSS):
Likert scale based on VoiceOver/TalkBack functionality

WCAG Compliance Ratio (WCR):
Standards adherence tracking (A/AA/AAA levels)

Complexity Impact Factor (CIF):
Development difficulty classification (Low/Medium/High)

Development Time Estimate (DTE):
Resource planning with complexity adjustments

Framework comparison

Architecture differences:

- **React Native:** Property-based model (`accessibilityLabel`, `accessibilityRole`)
- **Flutter:** Widget-based approach (explicit `Semantics` wrappers)

Metric	React Native	Flutter	Decision Factor
Implementation Overhead	45% less code	Baseline	Development speed
Screen Reader Support	4.2/5.0	3.8/5.0	User experience
Default Accessibility	38%	32%	Both require intervention
Architecture	Property-based	Widget-based	Code complexity
Learning Curve	Moderate	Steep	Team onboarding

REACT NATIVE vs FLUTTER

Framework comparison results (1)

Component	React Native	Flutter	Code Overhead	Screen Reader Support
Text Language	✓ Default	✗ Manual	Flutter +200%	RN: 4.2, FL: 3.7
Headings	✗ Manual	✗ Manual	Flutter +57%	RN: 4.3, FL: 4.0
Form Fields	✗ Manual	✗ Manual	Flutter +53%	RN: 4.0, FL: 3.8
Custom Gestures	✗ Manual	✗ Manual	Flutter +27%	RN: 3.8, FL: 3.2
OVERALL	38% Default	32% Default	Flutter +119%	RN: 4.2, FL: 3.8

Key Patterns Identified:

- **Text language declaration**: Largest overhead difference (Flutter +200%)
- **Custom gestures**: Smallest gap (Flutter +27%) - both frameworks struggle
- **Default accessibility**: React Native provides more out-of-box features (38% vs 32%)
- **Screen reader consistency**: React Native scores higher across all component types

Framework comparison results (2)

Metric	React Native	Flutter	Key Finding
Default Accessibility	38%	32%	RN +6% advantage
Implementation Overhead	Baseline	+119% more code	RN significantly more efficient
Screen Reader Support	4.2/5	3.8/5	RN better cross-platform consistency
WCAG Compliance (AA)	92%	85%	RN +8.2% higher compliance

Critical insights:

- Choose **React Native** when: Rapid development, web accessibility experience, tight deadlines
- Choose **Flutter** when: Complex custom components, long-term maintenance teams, granular control

Research impact and conclusions

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Key contributions:

- Extended research framework from Flutter-only to comparative analysis
- First quantitative framework for mobile accessibility cost assessment
  - 45% implementation overhead reduction with React Native
- Systematic methodology bridging WCAG theory to mobile practice

Research answers:

- **RQ1**: No framework accessible by default (38% vs 32%)
- **RQ2**: Both achieve 100% WCAG compliance with proper implementation
- **RQ3**: React Native requires 45% less code for equivalent accessibility